Draft Traffic Noise Technical Report, US-12/M-51 Interchange Improvements

Prepared for

Michigan Department of Transportation
425 W. Ottawa Street, 3rd Floor
P.O. Box 30050
Lansing, MI 48909
(517) 241-2445

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Prepared for:

Michigan Department of Transportation
425 W. Ottawa Street, 3rd Floor
P.O. Box 30050
Lansing, MI 48909

Prepared by:

Paul Burge, INCE Board. Cert.
Principal Acoustics and Noise Control Engineer
T: 619-610-7873
E: paul.burge@aecom.com

George Hitterman
Noise Control Specialist
T: 708-228-4441
E: george.hitterman@aecom.com

AECOM
401 West A Street
Suite 1200
San Diego, CA 92101
aecom.com

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List of Acronyms and Abbreviations

ANSI	American National Standards Institute
CNE	common noise environment
CPBU	cost per benefited receptor unit
dB	decibel (measure of sound pressure level on a logarithmic scale)
dBA	A-weighted decibel (sound pressure level)
DU	dwelling unit
DUE	dwelling unit equivalent
FHWA	Federal Highway Administration
HMA	Hot Mix Asphalt
Leq	equivalent sound level (energy averaged sound level)
Leq(1h)	A-weighted, energy average sound level during a 1-hour period
LOS	level of service
MDOT	Michigan Department of Transportation
mph	miles per hour
NAC	noise abatement criteria
NR	noise reduction
ROW	right of way
ST	short-term
TNM	Traffic Noise Model

Executive Summary

This noise analysis was conducted to assess the noise impacts associated with the US-12/M-51 intersection improvement project in Niles, MI. The purpose of the proposed project improvements is to improve safety, maintain required capacity, provide operational consistency within the regional US-12 corridor, and adhere to current MDOT design and environmental standards. The project includes improvements to both US-12 and M-51. In addition to the interchange modifications, the project includes intersection and signal improvements, Hot Mix Asphalt (HMA) mill & overlay, pavement repairs, and sidewalk work.

FHWA defines Type I projects as Federal highway projects that result in a highway in a new location, a physical alteration of an existing highway that significantly changes either horizontal or vertical alignment, or an increase to the number of through lanes. This noise study is required for this project because the interchange/intersection improvement would require a significant change in the elevation of the US-12 travel lanes approaching the new US-12/M-51 intersection, satisfying the definition of a Type I project. Thus, the entire project area needs to be studied as a Type I project and assessed for potential noise impacts and mitigation options.

This noise study included on-site noise measurements in the project vicinity. Measurements were conducted in September 2021 to validate noise models. A total of twelve short-term (ST) noise measurements were conducted at representative locations across the project area.

A predictive noise model was developed in the FHWA Traffic Noise Model (TNM) version 2.5 and validated against these field measurements. Noise-sensitive receptors were then identified and classified with existing and future levels calculated in TNM 2.5. Predicted noise levels were then checked against FHWA and MDOT standards to determine traffic noise impacts in the study area. Noise abatement for these impacts was analyzed using TNM and assessed per MDOT feasibility and reasonableness criteria.

The analysis identified a total of twelve defined Common Noise Environments (CNEs). Of these twelve established CNEs, seven were identified to contain impacted receptors. Abatement in the form of noise walls were considered in each impacted CNE but none were determined to be reasonable and feasible in accordance with MDOT policy. A summary of these findings is presented in Table ES-1 and discussed in more detail in the body of the report.

Table ES-1 Summary of Project Impacts and Proposed Noise Abatement

CNE	Description/Location	Existing Impacts	Future Impacts	Noise Abatement Recommendation
CNE-1	Single-Family Homes North of US-12, East of M-51	2	9	Not Recommended
CNE-2	Commercial, Single-Family Homes North of Brandywine St., East of M-51	0	0	No Impacts
CNE-3	Cemetery, Baseball Park North of Silverbrook St., East of M-51	8	8	Not Recommended
CNE-4	Single-Family Homes, Commercial North of Cherry St., East of M-51	6	6	Not Recommended
CNE-5	Single-Family Homes North of Main	4	4	Not Recommended
CNE-6	Commercial, Single-Family Homes North of Silverbrook St., West of M-51	0	0	No Impacts
CNE-7	Commercial North of Fort St., West of M-51	0	0	No Impacts
CNE-8	Commercial, Single-Family Homes, Public Park North of US-12, West of M-51	1	1	Not Recommended
CNE-9	Single-Family Homes South of US-12, West of 3rd St.	3	3	Not Recommended
CNE-10	Commercial South of Bell St., West of M-51	0	0	No Impacts
CNE-11	Commercial, Single-Family Homes South of Bell St., East of M-51	0	0	No Impacts
CNE-12	Single-Family Homes South of US-12, East of M-51	6	6	Not Recommended

1. Introduction and Project Description

1.1 Project Description

The project is located on M-51 from south of Chestnut Lane northerly to M-60BR and on US-12 from west of 3rd Street easterly to east of M-51, including the associated ramps at US-12 and M-51 in Niles Charter Township and the city of Niles in Berrien County. The project area and ramps are shown in Figure 1-1. The primary objective of the project is to remove the grade-separated US-12/M-51 interchange and replace it with a signalized intersection as shown in Figure 1-2. Additional work associated with the larger project area includes intersection and signal improvements, HMA mill & overlay, pavement repairs, and sidewalk work. The proposed US-12/M-51 interchange modifications qualify the project as Type I and thus require a full noise analysis. Although these qualifying improvements are localized to the interchange area, FHWA and MDOT policy requires the noise analysis to assess the entire project area for noise impacts and potential noise abatement. All noise-sensitive properties with a defined outdoor use area within approximately 500 feet of the project roadways were evaluated for noise impacts and potential noise abatement in accordance with MDOT policy.

The areas along US-12 west of the interchange include several residential properties, a church, and a nature park on 3rd St. East of the interchange north and south of US-12, there are residential properties on Oakdale Ave. and Greendale Ave. respectively. The area along M-51 between the interchange and Chestnut Lane to the south is primarily developed as commercial properties with some residential and undeveloped areas. The area along M-51 between the interchange and M-60BR (Oak Street) to the north includes several areas with residential land uses (South St., Ferndale Blvd., Brandywine St., Lambert St., Cherry St. Maple St., and Hickory St.), hotels, a ballpark, a cemetery, a few fast-food restaurants with outdoor seating areas, and vacant land.

In addition to the above-described areas within the project area are construction zones beyond the main project area where temporary cross-over lanes will be constructed at the beginning of the project that will be removed at project completion. These areas will be evaluated for possible construction noise impacts only. These construction areas are also shown in Figure 1-1.

1.2 Description of Alternatives

This project includes one future build alternative to be evaluated:

- Future build (includes all proposed improvements and projected traffic volumes for Year 2043)

Figure 1-1 Project Overview

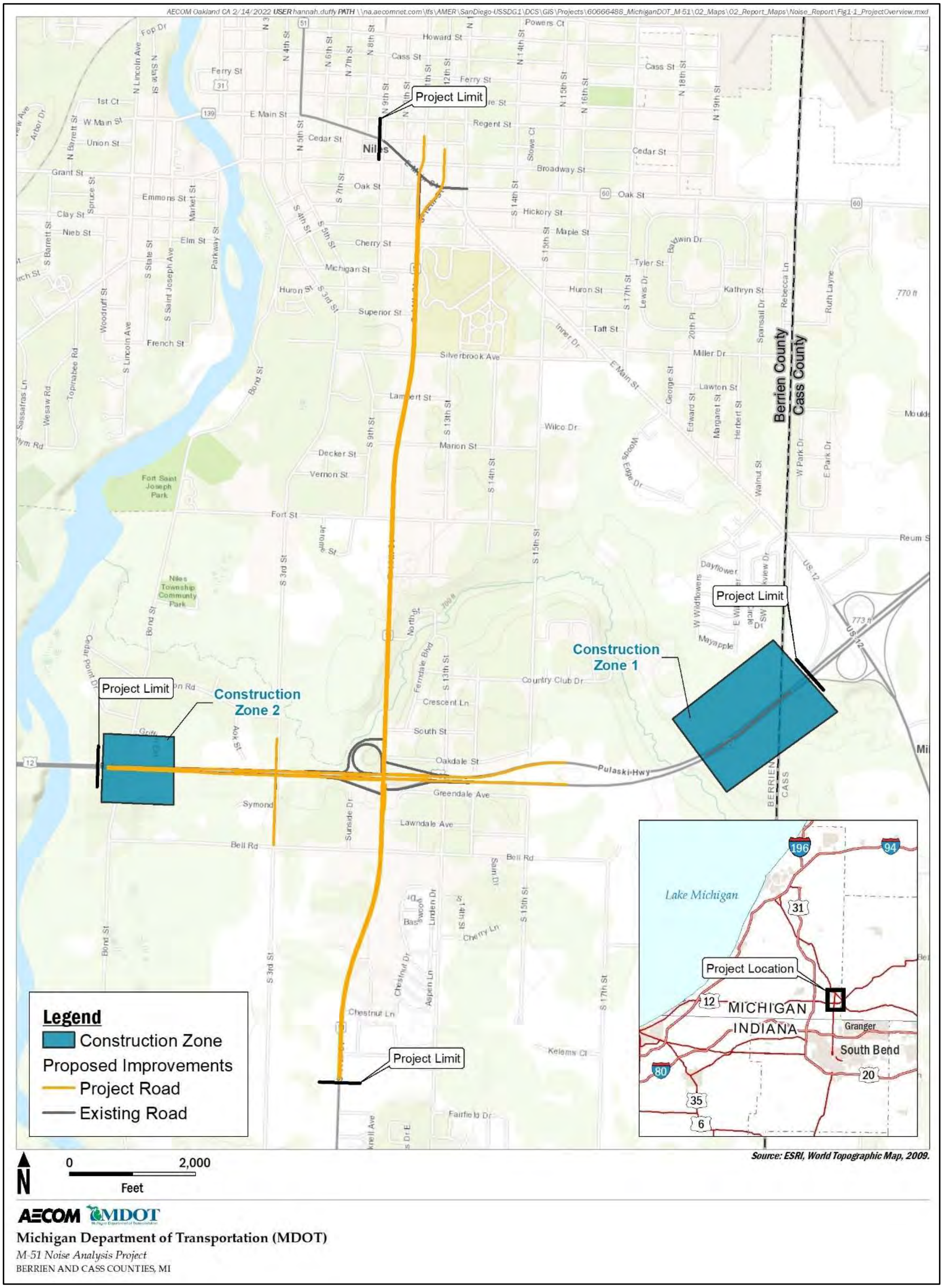
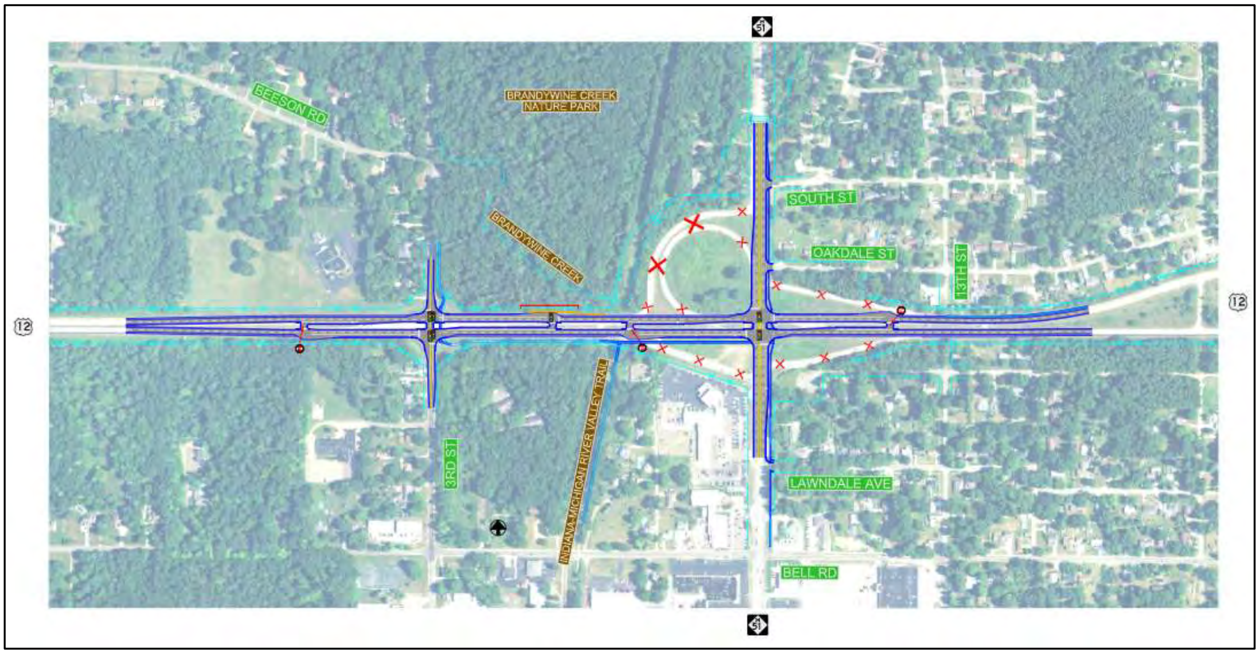


Figure 1-2 Proposed US-12/M-51 Intersection Improvements



2. Traffic Noise Concepts

The following glossary of acoustical terms is intended to help frame the discussion of project-generated noises and their potential effects on neighboring communities in the project area.

2.1 Glossary of Acoustical Terms

Noise: Whether something is perceived as a noise event is influenced by the type of sound, the perceived importance of the sound, and its appropriateness in the setting, the time of day, and the type of activity during which the noise occurs, and the sensitivity of the listener. Local jurisdictions may have legal definitions of what constitutes "noise" and such environmental parameters to consider.

Sound: For this analysis, sound is a physical phenomenon generated by vibrations that result in waves that travel through a medium, such as air, and result in auditory perception by the human brain.

Frequency: Sound frequency or "pitch" is measured in hertz (Hz), which is a measure of how many times each second the crest of a sound pressure wave passes a fixed point. For example, when a drummer beats a drum, the skin of the drum vibrates a number of times per second. When the drum skin vibrates 100 times per second, it generates a sound pressure wave that is oscillating at 100 Hz, and this pressure oscillation is perceived by the brain as a tonal pitch of 100 Hz. Sound frequencies between 20 and 20,000 Hz are within the range of sensitivity of the best human ear.

Amplitude or Level: Sound levels are measured in decibels (dB) using a logarithmic scale. A sound level of zero dB is approximately the threshold of human hearing and is barely audible under extremely quiet listening conditions. Normal speech has a sound level of approximately 60 dB. Sound levels above approximately 110 dB begin to be felt inside the human ear as discomfort and eventually as pain at 120 dB and higher levels. The minimum change in the sound level of individual events that the average human ear can detect is about 1 to 2 dB. A 3 to 5 dB change is readily perceived. A change in sound level of about 10 dB usually is perceived by the average person as a doubling (or if decreasing by 10 dB, halving) of the sound's loudness. Table 2-1 shows typical indoor and outdoor sounds and their corresponding dB levels, arranged on what often is referenced as an "acoustic thermometer" to show relative loudness.

Sound pressure: Sound level usually is expressed by reference to a known standard. This report refers to sound pressure level, which is expressed on a logarithmic scale with respect to a reference value of 20 micropascals. Sound pressure level depends not only on the power of the source, but also on the distance from the source and the acoustical characteristics of the space surrounding the source.

A-weighting: Sound from a tuning fork contains a single frequency (a pure tone), but most sounds heard in the environment do not consist of a single frequency; instead, they are composed of a broad band of frequencies, differing in sound levels. The method commonly used to quantify environmental sounds consists of evaluating all frequencies of a sound according to a weighting system that reflects the typical frequency-dependent sensitivity of average healthy human hearing. This is called “A-weighting,” and the measured decibel level is referred to as A-weighted decibels (dBA).

Equivalent sound level: Environmental noise levels vary continuously and include a mixture of noise from near and distant sources. A single descriptor, energy-average sound level during a measured time interval (L_{eq}), may be used to describe such sound that is changing in level from one moment to another. L_{eq} is the energy-average sound level during a measured time interval. This is the “equivalent” constant sound level that would have to be produced by a single, steady source to equal the acoustic energy contained in the fluctuating sound level measured.

Insertion loss (IL): The IL is the reduction in noise level at a location from noise abatement means, placed in the sound path between that location and a sound source.

2.2 Fundamentals of Traffic Noise Assessment and Control

Sound Propagation

Atmospheric conditions (e.g., wind, temperature gradients, humidity) can change how sound propagates over distance and can affect the level of sound received at a given location. The degree to which the ground surface absorbs acoustical energy also affects sound propagation. Sound traveling over an acoustically absorptive surface (e.g., grass) attenuates at a greater rate than sound traveling over a hard surface (e.g., pavement, expanses of open water). When located near either the sound source or the listener position, physical barriers (e.g., naturally occurring ridgelines or buildings, and other topography that block the line-of-sight between a source and receiver) also increase the attenuation of sound over distance.

Multiple Sound Sources

Because sound pressure levels in decibels are based on a logarithmic scale, they cannot be added or subtracted in an arithmetic fashion. Therefore, sound pressure level dB are logarithmically added on an energy summation basis. In other words, adding a new noise source to an existing noise source, both producing noise at the same level, does not double the noise level. Instead, if the difference between two noise sources is 10 dBA or more, the louder noise source dominates, and the resultant noise level is equal to the noise level of the louder source. In general, if the difference between two noise sources is 0 to 1 dBA, the resultant noise level is 3 dBA higher than the louder noise source, or both sources if they are equal. If the difference between two noise sources is 2 to 3 dBA, the resultant noise level is 2 dBA above the louder noise source. If the difference between two noise sources is 4 to 10 dBA, the resultant noise level is 1 dBA higher than the louder noise source.

How Noise is Measured

Sound can vary over an extremely large range of amplitudes. The decibel (dB) is a logarithmic unit that is the accepted standard unit for measuring the amplitude of sound because it accounts for these large variations in amplitude and reflects the way people perceive changes in sound amplitude. Different sounds may have different frequency content. Frequency content of a sound refers to its tonal quality or pitch. When describing sound and its effect on a human population, A-weighted (dBA) sound levels are typically used to account for the response of the human ear. The term "A-weighted" refers to a filtering of the noise signal to emphasize frequencies in the middle of the audible spectrum and to de-emphasize low and high frequencies in a manner corresponding to the way the human ear perceives sound. This filtering network has been established by the American National Standards Institute (ANSI). The A-weighted noise level has been found to correlate well with peoples' judgments of the noisiness of different sounds and has been used for many years as a measure of community noise. Table 2-1 illustrates sound pressure levels in dBA of various sound sources between 0 dBA (threshold of hearing) and 120 dBA (threshold of pain). An increase of 3 dBA in noise level can barely be perceived, while an increase of 5 dBA is readily noticeable and considered a significant noise increase. A 10 dBA increase corresponds to a subjective doubling of loudness. A relationship between changes in noise level and loudness is indicated in Table 2-2. Since noise fluctuates from moment to moment, it is common practice to condense the noise level over a specified period of time into a single number called the Equivalent Noise Level (Leq). Many surveys have shown that the Leq properly predicts annoyance, and thus this metric is commonly used for noise measurements, prediction, and impact assessment.

Table 2-1 Common Indoor and Outdoor Noise Levels

Common Outdoor Noise Levels Noise Level	Noise Level (A-weighted decibels)	Common Indoor Noise Levels
	110	Rock Band
Jet Flyover at 1000 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
Gas Lawn Mower at 100 feet	70	Vacuum Cleaner at 10 feet
Commercial Area		Normal Speech at 3 feet
	60	
		Large Business Office
Quiet Urban Daytime	50	Dishwasher Next Room
Quiet Urban Nighttime	40	Small Theater
Quiet Suburban Nighttime		Library
	30	
Quiet Rural Nighttime		Bedroom at Night
	20	
		Broadcast & Recording Studio
	10	
	0	Threshold of Hearing

Source: Adapted from Guide on Evaluation and Attenuation of Traffic Noise, AASHTO-1974

Table 2-2 Relationship between Changes in Noise Level and Perceived Loudness

Increase (or Decrease) in Noise Level	Loudness Multiplied (or Divided) by
3 decibels	1.2
6 decibels	1.5
10 decibels	2
20 decibels	4

How Highway Noise is Generated

Highway noise is generated from three primary sources: tire/pavement noise, engine noise, and exhaust noise. Tire/pavement noise is the noise generated by the rubber tires rolling over the pavement surface and may vary in intensity and character depending on the type and condition of both the tires and the pavement. For automobiles and light trucks traveling at typical highway speeds (over about 50 miles per hour [mph]), tire/pavement noise is generally the dominant noise source. For medium and heavy trucks (like large commercial delivery vehicles and long-haul tractor-trailers) engine and exhaust noise also contribute to the noise that they produce. At typical highway speeds, one large truck can produce as much noise energy as ten automobiles. How highway noise is experienced at nearby homes is controlled by a number of factors, including: the total number of vehicles on the highway, the percentage of large trucks, the average speed of the vehicles, the distance to the highway, obstructions blocking the view of the highway, and meteorological conditions. Generally speaking, the more vehicles, the higher percentage of large trucks or the closer one is to the highway, the greater the noise will be. Intervening obstructions, either manmade (buildings, walls, berms) or natural (such as intervening terrain) will reduce noise levels. Foliage and vegetation can reduce noise levels, but it must be dense (completely obscuring the view of the highway) and thick (on the order of 50 to 100 feet) to make a noticeable difference.

How Highway Noise Can Be Reduced

Highway noise can be reduced in several ways. Here are some of the most recognized:

Traffic Controls
The faster vehicles travel, and the higher percentage of large trucks, the louder the noise. Reduced speed limits, or more rigorously enforced existing speed limits, and heavy truck restrictions will reduce noise levels. However, the implementation of such measures is often politically difficult for the sake of lower noise levels alone.

Land Use Controls:
Perhaps the most common sense and fiscally responsible solution to highway noise, and one favored by most highway agencies is to restrict the development of lands near highways. Restricting development of land near new highway corridors to non-noise sensitive land uses, such as commercial or industrial activities can eliminate most noise problems. However, this approach is not suitable for circumstances when land near existing or future highways has already been developed for residential land use.

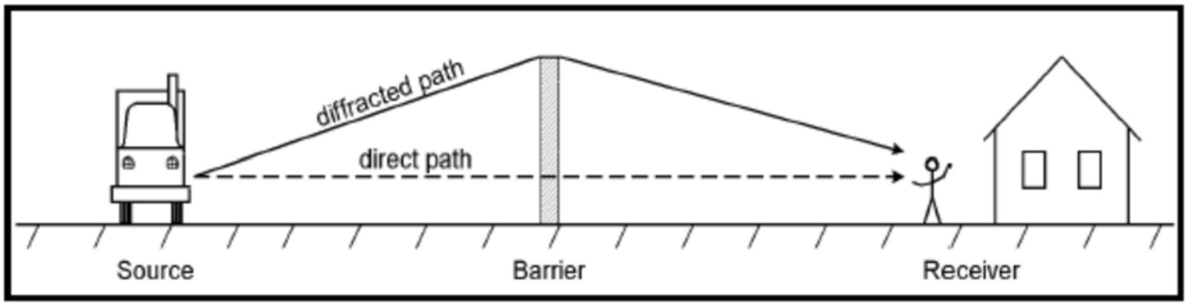
Quieter Vehicle Noise Sources
Quieter vehicles mean less highway noise. For automobiles, this means quieter tires (since tire/pavement noise is the dominant noise source). For large trucks, the EPA has established standards for maximum noise levels for new and in-use trucks. The maximum noise levels for new trucks are lower than those for some older trucks, so as old trucks are phased out and replaced with newer ones the noise produced by the average truck may go down.

Noise Barrier Walls and Berms
Noise barriers, both structural walls and earthen berms, are often constructed specifically for the purpose of reducing highway noise levels. Noise barriers can be very effective for reducing noise levels at nearby homes, often reducing noise levels by as much as 10 decibels at the closest homes (a perceived halving of loudness). Noise barriers can be expensive to build, on the order of $2 million per mile. Because of their cost, the construction of noise barriers is often restricted to large highway improvement or construction projects. Some jurisdictions; however, are quite active in constructing “retrofit” noise barriers on existing highways.

Quieter Pavements
It has long been recognized that some pavement types tend to be quieter than others. White concrete pavement, for example, is typically louder than asphalt blacktop. White concrete with tining (grooves cut into the pavement surface) is louder still. However, white concrete pavement (also known as Portland Concrete Cement, or PCC) is thought to be more durable, and perhaps safer than blacktop pavements (due to better skid resistance and drainage). There is also considerable concern that the low noise advantages of some blacktop pavements may diminish over time. As the tiny “nooks and crannies” in the blacktop pavement that give it acoustical absorption may fill up with silt and sand or become compressed over time, the acoustical benefits are reduced. The quest for quiet, safe, and durable highway pavements is currently the focus of a considerable amount of research.

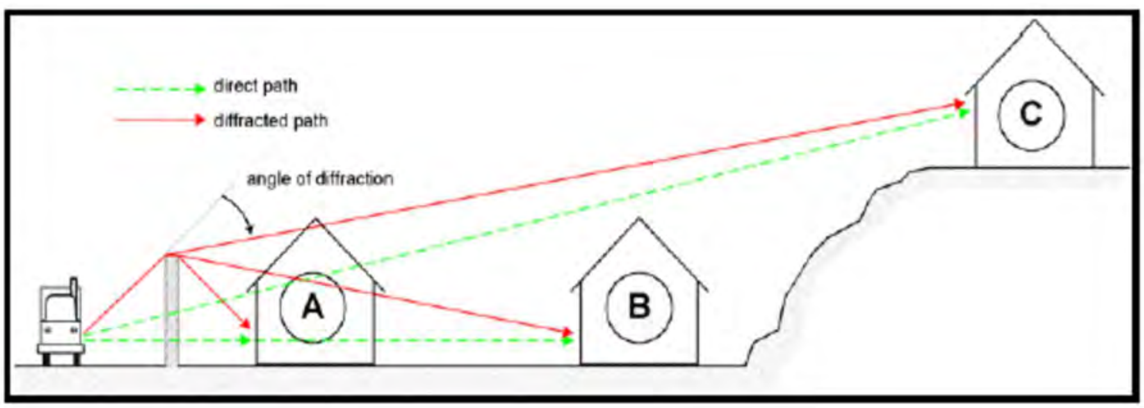
How Noise Barriers Work
Noise barriers reduce noise levels by interrupting or lengthening the path that the noise takes between the source and the receiver. To be effective at reducing noise, noise barriers must be able to block the “line of sight” between the object producing the noise (like vehicles on the highway) and the person subjected to the noise (like residents living near the highway). The amount that the noise will be reduced is related to the path length difference between the “direct path” that the uninterrupted sound would take between the source and receiver (with no barrier) and the “diffracted path” that the sound must take going over or around the barrier, as illustrated in Figure 2-1

Figure 2-1 Simple Noise Barrier Geometry



Noise barriers may work better for some homes than for others. In Figure 2-2, below, home "A" is relatively close to the highway where the noise barrier can provide a large path length difference between the direct and diffracted paths, resulting in a substantial noise reduction (perhaps as much as 10 to 15 decibels). Home "B" is further from the barrier and the path length difference is not as great, resulting in less noise reduction (perhaps 7 to 10 decibels). Home "C" is even further from the highway and also elevated above the highway grade, providing an even smaller path length difference (resulting in a noise reduction of perhaps 3 to 5 decibels). In general, for a given barrier height and location, the further the receiver is from the barrier or the higher the receiver is elevated, the smaller the path length difference (or angle of diffraction) and the smaller the resulting noise reduction.

Figure 2-2 Path Length Difference for Varying Receiver Geometry



2.3 Regulatory Overview

2.3.1 Federal Regulations

The FHWA noise policy is contained within The Code of Federal Regulations, Title 23, Part 772 (23 CFR 772) which provides procedures for preparing operational and construction noise studies and evaluating noise abatement considered for federal and federal-aid highway projects. The code was recently updated in July of 2010. Under the current version of 23 CFR 772.5, projects are categorized as Type I, Type II, or Type III projects. The FHWA defines a Type I project as a proposed federal or federal-aid highway project for the construction of a highway on a new location, the physical alteration of an existing highway which significantly changes either the horizontal or vertical alignment, or increases the number of through-traffic lanes. The proposed project is a Type I project as defined by the FHWA.

Type I projects include those that create a completely new noise source, as well as those that increase the volume or speed of traffic or move the traffic closer to a receptor. Type I projects include the addition of an interchange, ramp, auxiliary lane, or truck-climbing lane to an existing highway, or the widening of an existing ramp by a full lane width for its entire length. Projects unrelated to increased noise levels, such as lighting, signing, and landscaping, are not normally considered Type I projects.

Under 23 CFR 772.13, noise abatement must be considered for Type I projects if the project is predicted to result in a traffic noise impact. In such cases, 23 CFR 772 requires that the project sponsor “consider” noise abatement before adoption of the final NEPA document. This process involves identification of noise abatement measures that are reasonable, feasible, and likely to be incorporated into the project, and of noise impacts for which no apparent solution is available.

Traffic noise impacts, as defined in 23 CFR 772.5, occur when the design year condition noise levels approach or exceed the noise abatement criteria (NAC) specified in 23 CFR 772, or design year condition noise levels create a substantial noise increase over existing noise levels. 23 CFR 772 does not specifically define the terms “substantial increase” or “approach”; these criteria are defined in the MDOT Noise Analysis and Abatement Handbook (July 13, 2011), as described in the following section.

Table 2-3 summarizes the FHWA NAC corresponding to various defined land use activity categories. Activity categories and related traffic noise impacts are determined based on the actual land use in each area.

In identifying noise impacts, primary consideration is given to exterior areas of frequent human use. Interior noise impacts will only be addressed for land uses listed with Activity Category D.

Table 2-3 FHWA Noise Abatement Criteria

Activity Category	Activity Criteria		Evaluation Location	Activity description
	Leq(h)	L10(h)		
A	57	60	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67	70	Exterior	Residential
C	67	70	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	55	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio stations recording studios, schools, and television studios.
E	72	75	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F.
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.

1 Either Leq(h) or L10(h) (but not both) may be used on a project.

2 The Leq(h) and L10(h) Activity Criteria values are for impact determination only, and are not design standards for noise

3 Includes undeveloped lands permitted for this activity

2.3.2 State Regulations and Policies

MDOT has published the noise policy which provides guidelines in the analysis of highway traffic noise and the evaluation of noise abatement measures. Effective July 13, 2011, the MDOT *Highway Noise Analysis and Abatement Handbook* (hereafter referred to as “the MDOT handbook”) also includes current policies, procedures, and practices to be used by agencies that sponsor new construction or reconstruction of federal or federal-aid highway projects. The MDOT noise handbook defines that a noise impact occurs when the sound level approaches or exceeds the assigned NAC level for a specific category, which is defined as an Leq(h) sound level 1 dBA less than the NAC identified in 23 CFR 772. This means that for an Activity Category B land use (residential), a peak hour noise level of 66 dBA is considered to approach the NAC of 67 dBA and is identified as an impact. The MDOT noise handbook defines a noise increase as substantial when the predicted traffic noise levels with project implementation exceed existing noise levels by 10 dBA. The MDOT noise handbook provides detailed technical guidance for the evaluation of highway traffic noise. This includes field measurement methods, noise modeling methods, and report preparation guidelines. In addition to the NAC criteria above, the MDOT noise handbook also specifies the following definitions and policies:

Benefited Receptor is the recipient of an abatement measure that receives a noise reduction at or above the minimum threshold of 5 dBA.

Feasible Noise Abatement Measure is an abatement measure that is acoustically feasible and meets engineering requirements for constructability. A noise abatement measure is considered feasible when it can provide at least a 5 dBA reduction to at least 75% of impacted noise receptors and meets constructability, safety, access, utility, and drainage requirements.

Reasonable Noise Abatement Measure is an abatement measure that has been determined to be cost-effective if it costs at or below the allowable cost per benefited receptor unit (CPBU) of $49,301.00 and is considered acceptable to the majority of residents and property owners who benefit from the noise abatement. The MDOT design year attenuation requirement requires that a minimum of one benefited receptor achieve at least a 10 dBA noise reduction and that at least 50% of benefited receptors achieve a 7 dBA reduction.

3. Methods of Noise Analysis

3.1 Defining Area or Potential Impact

The extent of the noise study analysis area should include all receptors potentially impacted by the project. The FHWA does not establish a fixed distance to define the noise impact analysis area. Historically, absolute noise impacts (those areas with noise levels approaching or exceeding the NAC – 66 dBA for residential land uses) rarely exist beyond about 500 feet from the roadway. The MDOT noise handbook defines the study zone to be a minimum of 500 feet, including all noise-sensitive receptors on all sides of the highway. If an impact is identified at 500 feet, the next closest receptor would need to be analyzed until a distance where impacts are no longer identified is reached. If no receptors are located within the 500-foot zone, then the closest receptor(s) should be analyzed.

3.2 Field Measurement Procedures

Several field noise measurements were conducted for this project. In general, the noise measurement procedures in the field follow recommended standard procedures, including those outlined in the FHWA's Measurement of Highway Related Noise, May 1996, and the MDOT noise handbook. Specifically, the following practices and procedures were used.

The short-term noise measurements (typically 15-25 minutes) were conducted at actual or representative receptor locations and were used primarily to validate the noise prediction model (at locations where traffic noise was dominant). Short-term noise measurements were generally conducted at exterior areas of frequent human use and were only conducted during periods of free-flowing traffic, dry roadways, and low to moderate wind speeds (less than 12 mph to avoid extraneous wind noise).

No long-term noise measurements were conducted for this study due to inclement weather.

Only ANSI (American National Standards Institute) Class I sound level meters were used for short-term measurements. The meters were subjected to a field calibration check before and after each measurement period. Calibration certificates for each meter used in the Project can be found in Appendix A.

Concurrent traffic counts (classified in auto, medium and heavy trucks, buses, and motorcycles) for the acoustically dominant road were conducted for each short-term measurement. Traffic was videotaped during the measurements to be subsequently counted. The traffic counts can be found in Table 3-3.

All field data were recorded on field data sheets, which included the time, name and location of the measurement, instrument information, observed meteorological data, field calibration results, a measurement site diagram, GPS coordinates, and notes regarding the dominant noise sources and any other observed acoustically relevant events (such as aircraft over-flights, emergency vehicle pass-bys, etc.). Field sheets and photographs of measurement sites can be found in Appendix A.

3.3 Analysis Objectives

The purpose of this noise analysis report is to identify, and document potential noise impacts associated with the proposed future Project and to identify feasible and reasonable abatement. The general analysis procedure for the Project noise study includes the following steps:

1. **Review Project Description:** Review the project description and project data to be analyzed and collect additional required data (including roadway design files, existing and future traffic data, land use data, etc.). Consider all alternatives, design options, and construction phasing scenarios. This information is presented in Section 1 of this report.

2. **Identify Regulatory Framework:** Investigate and establish the regulatory framework to be followed for the noise analysis, including federal, state, and local regulations and ordinances applicable to the Project. This information is presented in Section 2 of this report.

3. **Noise Analysis Methodology and Establish Existing Land Use and Noise Environment:** Investigate and document the existing noise environment for the Project area, including existing noise-sensitive land uses and existing noise levels in the Project area. These were accomplished with a careful review of local zoning information, review of aerial photography, and a site visit to the Project area. This information is presented in Section 3 of this report.

4. **Predict Future Noise Levels and Assess Noise Impacts:** Future noise levels at noise-sensitive land uses for the future build alternative are predicted using the FHWA TNM Version 2.5. For each alternative, future noise levels (as well as increases in future noise levels over existing noise levels) are assessed for compliance with the identified noise impact criteria and quantify resulting noise impacts. This information is presented in Section 4 of this report.

5. **Evaluate Noise Abatement:** Where noise impacts are identified, evaluate potential noise abatement measures. Abatement measures are evaluated for feasibility and reasonableness according to FHWA and MDOT standards. This information is presented in Section 5 of this report.

6. **Construction Noise Considerations:** Analyze potential construction noise impacts and discuss available abatement options. This information is presented in Section 6 of this report.

7. **Information for Public Officials:** Provide or identify appropriate information for local public officials to help avoid future noise impacts. This information is presented in Section 7 of this report.

A more detailed accounting of the specific procedures involved in each of the above analysis steps is provided in the indicated report section.

3.4 Selection of Noise-Sensitive Receptors

In general, modeled noise-sensitive receptors are identified to represent potentially impacted land uses within the Project area. A common noise environment, or CNE, is generally defined as a group of receptors within the same Activity Category in Table 2-3 that are exposed to similar noise sources and levels; traffic volumes, traffic mix, and speed; and topographic features. Generally, common noise environments occur between two secondary noise sources, such as interchanges, intersections, and/or cross-roads. The delineated CNEs for this Project are described in Section 3.9.2 of this report. Within each CNE, representative noise measurements and noise prediction locations are identified. Typically, each CNE would have one short-term measurement location and multiple noise prediction locations. The number and locations of the receptors (measurement and modeling locations) within each CNE are selected to adequately represent all of the noise-sensitive property units (dwellings) within that CNE, and these properties may include Activity Categories A through E and G in Table 2-3 (including residential, noise-sensitive commercial, parks, schools, hotels, and undeveloped lands.). Activity Category F (agriculture, retail, industrial, transportation, and utilities), may still be located within a CNE, but would be considered a noise-compatible land use and would not require noise analysis. For residential properties, more-isolated residences would generally be modeled as individual receptors, while residences in multi-family buildings and dense neighborhoods may be modeled with one modeled receptor location representing multiple dwelling units or homes (receptors).

All noise prediction locations are placed to represent an exterior area of frequent human use of the receptor. For residential properties, this would normally be an exterior activity area between the structure and the proposed project roadway, such as a pool, patio, or play area.

3.5 Loudest Hour Noise Conditions

When determining noise impacts, traffic noise predictions must be made for the loudest noise hour (generally during level of service [LOS] C or D with high heavy truck volumes and speeds close to the posted speed limit or design speed). The loudest hour noise is typically either the peak vehicular truck hour or the peak vehicular volume hour (with LOS A through D conditions).

3.6 Noise Abatement Requirements

According to FHWA policy and the MDOT noise handbook, once a noise impact has been identified, feasible and reasonable noise abatement measures must be considered. For noise abatement, primary consideration is given to the exterior areas of frequent human use.

When traffic noise impacts are identified, noise barrier walls, at a minimum, are required to be considered. In addition to noise walls, other abatement elements may also be considered, if appropriate and applicable, including the following:

- Traffic management measures.
- Alteration of horizontal and vertical alignments.
- Acquisition of property to serve as a buffer to preempt development that would be adversely impacted by traffic noise; and
- Noise insulation (NAC D Only).

When noise barriers are considered, a noise barrier design analysis must show that the barrier is feasible. This typically requires that the barrier provides a minimum required level of noise reduction. According to the MDOT noise handbook, feasible noise barriers must provide at least 5 dBA of noise reduction to at least 75% of impacted receptors. In addition to meeting minimum noise reduction requirements, noise barriers must also meet engineering and constructability feasibility requirements in terms of safety, property and emergency access, drainage control, overhead and underground utility clearance, and other issues.

Noise barrier reasonableness is generally related to cost-effectiveness and benefited receptors. The MDOT noise handbook expresses barrier cost-effectiveness by a quotient formula called the Cost Per Benefited Receptor Unit (CPBU), which divides the total square-foot-cost of the barrier (at a rate of $45.00/ft^2) by the number of benefitted dwelling units. To maintain reasonableness, the total CPBU cannot exceed $49,301.00, (the total allowable cost established by MDOT for FY 2021). Barriers must also achieve the MDOT noise reduction design goal of 10 dBA reduction for at least one benefited receptor, and 7dBA reduction for at least 50% of benefitted receptors.

If noise barriers are determined to be reasonable and feasible as defined above, then the viewpoints of property owners and residences should be taken into consideration. Approval by a simple majority (greater than 50%) of all responding benefited owners and residences is needed to implement noise abatement. Public votes should occur during final design and could happen during the Context Sensitive Design aesthetic public input phase.

3.7 Noise Modeling Methodology

Future build noise levels, along with existing noise levels, were predicted using FHWA TNM Version 2.5, the most recent version available at the time of the analysis. All conventional modeling techniques and recommendations for TNM by both FHWA and MDOT were implemented. These included the following modeling procedures and conventions:

- TNM roadways were generally modeled as bundled roadways with no more than three lanes represented by a single modeled roadway.
- All roadway pavement types were modeled as “Average”.

- Traffic speeds and volumes for peak traffic hour as provided in the traffic data were modeled to predict worst-case noise levels. Traffic speeds and volumes used in this analysis were based on the predicted traffic data included in Table 3-1.
- Existing terrain lines (topography) and buildings were modeled where appropriate.
- All TNM inputs and models runs were reviewed for accuracy by an independent noise analyst.
- Sample TNM input/output files for this project provided in Appendix B
- All TNM model runs are available upon request

3.8 Project Traffic Data

Predicted traffic data for the existing and Future Build were provided by MDOT. Existing traffic data from 2018, the most recent available, and Future Build data for year 2043 were used in the study. AM and PM peak values were evaluated; however, it was determined that combined AM peak values were greater and therefore were used in the loudest hour noise analysis. A summary of the traffic data used for this analysis can be found in Table 3-1.

Table 3-1 Existing and Future Peak Hour Traffic Volumes

	Existing Traffic (AM Peak)							
	M-51				US-12			
	M-51 North of US-12		M-51 South of US-12		US-12 East of M-51		US-12 West of M-51	
	NB	SB	NB	SB	EB	WB	EB	WB
Speed (mph)[1]	50	50	50	50	55	55	55	55
Total	965	782	1266	894	753	335	585	550
Auto and Light Trucks	927	768	1216	877	632	277	492	483
Medium Duty Trucks	38	6	50	7	38	17	29	23
Heavy Duty Tucks	0	8	0	10	83	41	64	44
	Future Traffic (AM Peak)							
	M-51				US-12			
	M-51 North of US-12		M-51 South of US-12		US-12 East of M-51		US-12 West of M-51	
	NB	SB	NB	SB	EB	WB	EB	WB
Speed (mph)[1]	50	50	50	50	55	55	55	55
Total	1093	949	1434	1013	853	598	950	856
Auto and Light Trucks	1050	870	1377	994	716	495	798	708
Medium Duty Trucks	43	70	57	8	43	31	48	45
Heavy Duty Tucks	0	9	0	11	94	72	104	103

Notes
1. posted speeds or for Autos/Medium Trucks/ Heavy Trucks
Source: MDOT PEL Study

3.9 Existing Condition and Common Noise Environments

3.9.1 Existing Land Use and Zoning

Land uses within the Project study area are a mix of residential (single- and multi-family), commercial, industrial, and undeveloped land. Undeveloped areas are assumed to be available for future residential or commercial development.

3.9.2 Common Noise Environments

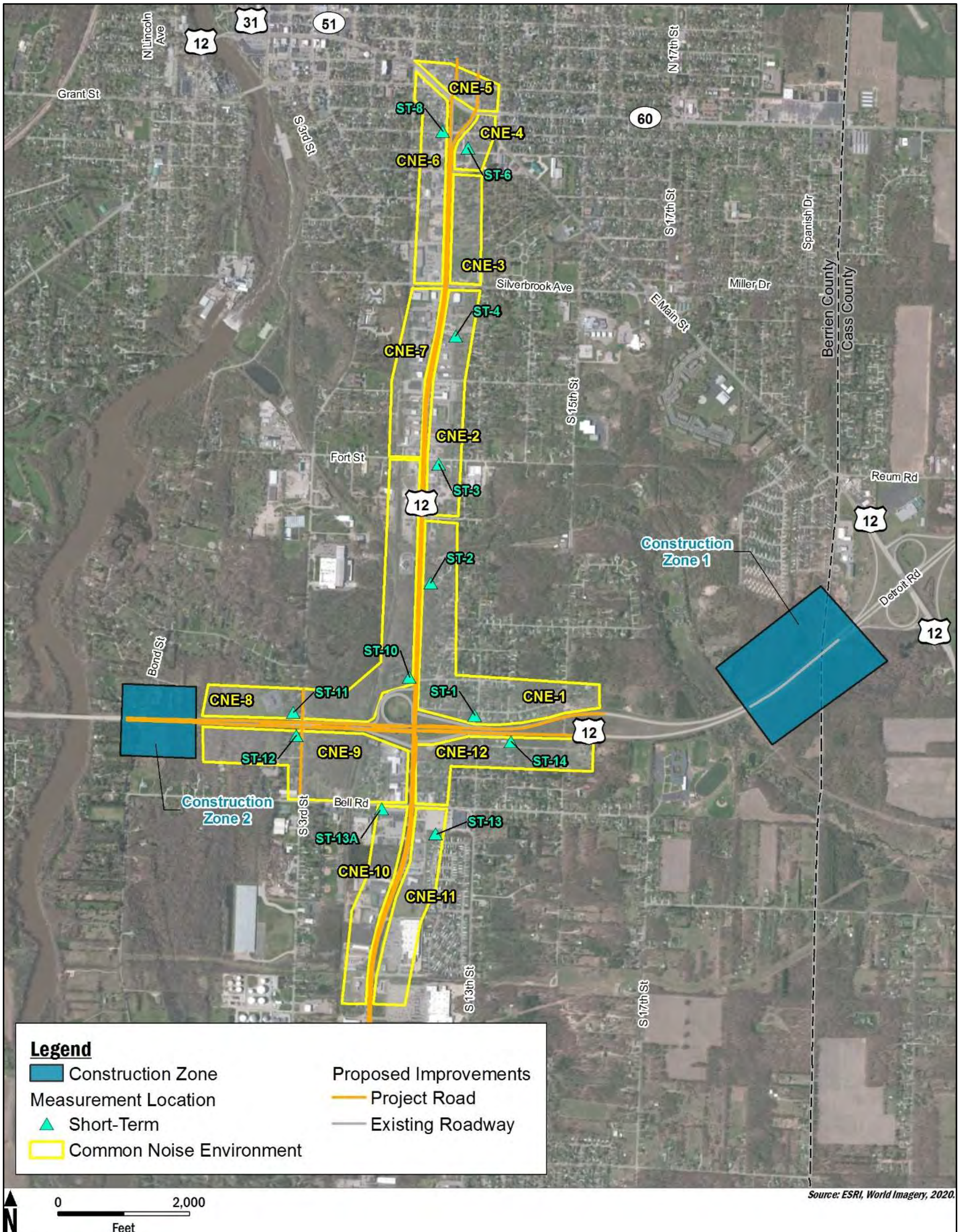
To better categorize the potential noise impacts and evaluate noise abatement for the various project alternatives, all of the potentially impacted noise-sensitive receptors have been organized into Common Noise Environments (CNEs). A CNE is defined as an area containing land uses that share a common highway traffic noise influence. Descriptions of delineated CNEs, including location, primary land use, and type of noise-sensitive receptors are listed in Table 3-2. Figure 3-2 shows an overview of the Project area illustrating the defined CNEs.

Table 3-2 Common Noise Environments

CNE	Location	Land Use	Measurement ID
CNE-1	North of US-12, East of M-51	Single Family Homes	ST-1, ST-2, ST-3
CNE-2	North of Brandywine St., East of M-51	Commercial, Single Family Homes	ST-4
CNE-3	North of Silverbrook St., East of M-51	Cemetery, Baseball Park	None*
CNE-4	North of Cherry St., East of M-51	Single Family Homes, Commercial	ST-6
CNE-5	North of Main	Single Family Homes	None*
CNE-6	North of Silverbrook St., West of M-51	Commercial, Single Family Homes	ST-8
CNE-7	North of Fort St., West of M-51	Commercial	None*
CNE-8	North of US-12, West of M-51	Commercial, Hotel Single Family Homes, Public Park	ST-10, ST-11
CNE-9	South of US-12, West of 3rd St.	Single Family Homes	ST-12
CNE-10	South of Bell St., West of M-51	Commercial, Hotel	ST-13A
CNE-11	South of Bell St., East of M-51	Commercial, Single Family Homes	ST-13
CNE-12	South of US-12, East of M-51	Single Family Homes	ST-14

*Note: Noise measurements were unable to be performed at CNE-3, CNE-5, and CNE-7 due to inclement weather

Figure 3-1. Common Noise Environments and Noise Measurement Sites



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3.9.3 Existing Noise Environment

3.9.3.1 Field Noise Measurements

Noise measurements were conducted for this project between September 20 and September 24, 2021. Noise measurements were conducted to provide information for noise model validation (short-term measurements with accompanying classified traffic counts) and to establish the loudest traffic noise hour. Noise measurements were conducted as described in Section 3.2. Appendix A includes measurement-related materials.

A total of twelve ST noise measurements were conducted as summarized in Table 3-3. Figure 3-2 contains an aerial figure of the Project area showing each measurement location.

3.9.3.2 Noise Model Validation and Results

The FHWA TNM Version 2.5 was used to predict noise levels for both the existing condition and future build alternative at receptor locations where noise levels are dominated by traffic noise on project roadways. To demonstrate that the noise model is predicting traffic noise levels within a reasonable margin of error, the noise model runs were validated by comparing predicted noise levels to measured noise levels for similar traffic conditions. However, since the TNM only predicts noise levels associated with traffic noise, the model runs can only be validated at measurement locations where noise levels were dominated by project roadways. For this project, noise model validation was possible for all twelve ST noise measurement locations. Noise models are considered to be validated if the difference between measured and modeled noise levels for comparable conditions is 3 dBA or less. The successful results of the noise validation effort are presented in Table 3-3.

Table 3-3 TNM Validation Summary

Measurement ID and Location	Observed Traffic Count			Measured Leq, dBA	Modeled Leq, dBA	Difference
ST-1	**Type**	**US-12 EB**	**US-12 WB**	58.7	57.8	-0.9
	Autos	438	426			
	Medium Trucks	10	16			
	Heavy Trucks	46	62			
	Busses	0	0			
	Motorcycles	2	0			
ST-2	**Type**	**M-51 NB**	**M-51 SB**	63.5	62.8	-0.7
	Autos	651	730			
	Medium Trucks	27	6			
	Heavy Trucks	0	8			
	Busses	3	4			
	Motorcycles	0	0			
ST-3	**Type**	**M-51 NB**	**M-51 SB**	61.6	62.6	1.0
	Autos	945	702			
	Medium Trucks	21	6			
	Heavy Trucks	3	9			
	Busses	3	0			
	Motorcycles	0	3			
ST-4	**Type**	**M-51 NB**	**M-51 SB**	57.9	57.8	-0.1
	Autos	945	702			
	Medium Trucks	21	6			
	Heavy Trucks	3	9			
	Busses	3	0			
	Motorcycles	0	3			
ST-6	**Type**	**M-51 NB**	**M-51 SB**	59.6	61.8	2.2
	Autos	495	380			
	Medium Trucks	3	6			
	Heavy Trucks	12	0			
	Busses	6	0			
	Motorcycles	0	0			
ST-8	**Type**	**M-51 NB**	**M-51 SB**	62.7	63.4	0.7
	Autos	495	380			
	Medium Trucks	3	6			
	Heavy Trucks	12	0			
	Busses	6	0			
	Motorcycles	0	0			
ST-10	**Type**	**M-51 NB**	**M-51 SB**	67.6	69.0	1.4
	Autos	651	730			
	Medium Trucks	27	6			
	Heavy Trucks	0	8			
	Busses	3	4			

Measurement ID and Location	Observed Traffic Count			Measured Leq, dBA	Modeled Leq, dBA	Difference
	Motorcycles	0	0			
ST-11	**Type**	**US-12 EB**	**US-12 WB**	68.6	70.2	1.6
	Autos	279	306			
	Medium Trucks	33	30			
	Heavy Trucks	48	45			
	Busses	0	0			
	Motorcycles	0	0			
ST-12	**Type**	**US-12 EB**	**US-12 WB**	68.9	68.9	0.0
	Autos	279	306			
	Medium Trucks	33	30			
	Heavy Trucks	48	45			
	Busses	0	0			
	Motorcycles	0	0			
ST-13	**Type**	**M-51 NB**	**M-51 SB**	52.9	54.2	1.3
	Autos	543	756			
	Medium Trucks	21	36			
	Heavy Trucks	3	12			
	Busses	3	0			
	Motorcycles	0	0			
ST-13A	**Type**	**M-51 NB**	**M-51 SB**	60.2	60.1	-0.1
	Autos	543	756			
	Medium Trucks	21	36			
	Heavy Trucks	3	12			
	Busses	3	0			
	Motorcycles	0	0			
ST-14	**Type**	**US-12 EB**	**US-12 WB**	69.7	67.6	-2.1
	Autos	438	426			
	Medium Trucks	10	16			
	Heavy Trucks	46	62			
	Busses	0	0			
	Motorcycles	2	0			

As shown in Table 3-3, all calculated differences between modeled and measured noise levels are less than 3.0 dBA, therefore, the noise model predictions are considered to be valid.

TNM validation runs developed for this Project are digitally archived and will be made available upon request.

4. Noise Impact Analysis

4.1 Future Noise Levels and Impacts

This section presents predicted noise levels and noise impacts (or noise impact distances for identified CNE areas and general undeveloped areas).

4.1.1 Predicted Noise Levels and Noise Impacts

Traffic noise impacts, as defined in 23 CFR 772.5, occur when the design year condition noise levels approach or exceed the noise abatement criteria (NAC) specified in 23 CFR 772, or design year condition noise levels create a substantial noise increase over existing noise levels. 23 CFR 772 does not specifically define the terms "substantial increase" or "approach"; these criteria are defined in the MDOT Noise Analysis and Abatement Guidelines (July 13, 2011), as described in the following section. Table 2-3 summarizes the FHWA NAC corresponding to various defined land use activity categories.

MDOT noise handbook defines that a noise impact occurs when the sound level approaches or exceeds the NAC level, which is defined as an Leq(h) sound level 1 dBA less than the NAC identified in 23 CFR 772. This means that a loudest-hour noise level of 66 dBA is considered to approach the NAC for Category B of 67 dBA and is identified as an impact. The MDOT noise handbook defines a noise increase as substantial when the predicted traffic noise levels with project implementation exceed existing noise levels by 10 dBA. All conventional modeling techniques and recommendations for TNM by both FHWA and MDOT were implemented, as described in Section 3.7.

Table 4-1 below contains a summary of the predicted noise levels and noise impacts at all modeled CNE locations in the Project. Figures 5-1 (CNE-1), 5-2 (CNE-2 and CNE-7), 5-3 (CNE-3, CNE-4, CNE-5, and CNE-6), 5-4 (CNE-8), 5-5 (CNE-9), 5-6 (CNE-10 and CNE-11), and 5-7 (CNE-12) contain detailed aerial imagery of the Project area showing all modeled receptor locations and predicted future build impacts. Due to the large number of modeled receptors and CNEs within the Project area, prediction information for individual receptors is presented in detail in Appendix C.

Table 4-1 Summary of Predicted Noise Levels by CNE

CNE	No. of Modeled Receptors	Total Dwelling Units	Predicted Noise Level (Range), Leq (1h)		Total Number of Noise Impacted Units		
			Existing	Future Build	Approach or Exceed NAC	Significant Increase	Total Impacted DU
CNE-1	56	56	52.8 - 65.7	53.5 - 68.8	9	0	9
CNE-2	12	16	51.8 - 67.4	52.4 – 68.0	0	0	0
CNE-3	10	8	56.8 - 61.4	57.4 - 61.9	8	0	8
CNE-4	19	20	55.5 - 71.5	55.9 - 71.8	6	0	7
CNE-5	26	26	46.0 – 70.0	46.2 - 70.1	4	0	4
CNE-6	52	52	49.9 - 64.5	50.4 - 64.9	0	0	0
CNE-7	1	0	66.0	68.7	0	0	0
CNE-8	7	4	57.7 - 65.8	59.2 - 66.5	1	0	1
CNE-9	14	14	55.6 - 67.5	56.1 - 68.5	3	0	3
CNE-10	0	0	NA	NA	0	0	0
CNE-11	12	12	52.6 - 56.6	53.2 - 57.2	0	0	0
CNE-12	32	32	53.7 - 68.9	53.9 - 71.2	6	0	6

Figures showing all receiver locations along with evaluated noise abatement elements are included in Section 5.

5. Noise Abatement Evaluation

5.1 Noise Abatement Measures

According to FHWA and MDOT policies, when noise impacts are identified, noise barriers (at a minimum) must be considered as noise abatement. Other potential noise abatement measures might include heavy truck or speed restrictions, alignment changes, and depressed roadways. Of these alternatives, the Project alignment was evaluated and compared for noise impacts (as presented in Section 4), but truck restrictions and speed restrictions below proposed speed limits would significantly reduce the value of the roadway. Noise barriers were evaluated for each CNE with noise impacts for feasibility and reasonableness. The following section describes the results of the barrier assessments for each evaluated CNE.

5.2 Feasible and Reasonable Criteria and Requirements

For abatement to be recommended, the barrier must meet certain feasibility and reasonableness requirements established by MDOT in the Noise Analysis and Abatement Guidelines.

When noise barriers are considered, a preliminary noise barrier design analysis must show that the barrier is feasible. According to the MDOT noise handbook, feasible noise barriers must provide at least 5 dBA of noise reduction to 75% of the impacted receptors. In addition to meeting minimum noise reduction requirements, noise barriers must also meet engineering and constructability feasibility requirements in terms of safety, property and emergency access, drainage control, overhead and underground utility clearance, and other issues.

Noise barrier reasonableness is generally related to cost-effectiveness and benefited receptors, where a benefited receptor receives at least 5 dBA of noise reduction (NR), and cost-effectiveness is driven by a Cost per Benefited Receptor Unit (CPBU) value. The handbook identifies a CPBU of $49,301, which is a final quotient resulting from dividing the total cost of abatement (at a rate of $45.00 ft^2) by the total number of benefited receptors. Additionally, The MDOT design year attenuation requirement requires that a minimum of one benefited receptor achieve at least a 10 dBA noise reduction and that at least 50% of benefited receptors achieve a 7dBA reduction for noise abatement to be reasonable.

To summarize, for a barrier to be considered feasible and reasonable, it must have:

- A noise reduction of at least 5 dBA must be achieved at 75% of impacted receptors
- A noise reduction of 10 dBA must be achieved for at least one receptor
- A noise reduction of 7 dBA must be achieved at 50% of benefitted receptors

For a noise barrier to be considered reasonable in addition to the requirements listed above, the viewpoints of benefited property owners and residents must be taken into consideration. Greater than 50% in favor of all responding benefited owners and residents is needed to construct noise abatement. Public viewpoints and votes of benefited receptors are not part of this noise analysis but are collected during the Preliminary Engineering Phase and are recorded in the environmental documentation.

5.3 Findings and Recommendations for Noise Abatement

Noise abatement was considered for each CNE with identified noise impacts. Initially, noise abatement was checked for feasibility (5 dBA reduction for at least 75% of impacted receptors and access restrictions). If abatement was determined to be feasible, the abatement was analyzed for cost-effectiveness and other reasonableness factors. For all impacted receptors meeting feasibility requirements, preliminary barrier designs were evaluated using TNM. If the abatement was found to be both reasonable and feasible, it would be recommended for inclusion in the project pending a polling of viewpoints from benefited receptors. A summary of the barrier locations and resulting sound levels are provided in Table 5-1. The details of the barrier analysis including determinations of feasibility and reasonableness are included in Table 5-2. The narrative results of abatement evaluations for each impacted CNE are summarized in subsequent sub-sections.

Table D-1 in Appendix D lists the predicted existing, future build, and future build with barrier noise levels per modeled receptor location. The table also includes the information regarding benefited receptors and barrier design goal achievement.

Table 5-1 Evaluated Barrier Descriptions

Barrier ID	Location	Existing Leq (dBA)	Future Leq Range (dBA)		Barrier Noise Reduction (dBA)	Barrier Geometries (feet)	
			No Barrier	With Barrier		Length	Avg. Height
Wall 1A	CNE 1, along US12 ROW, east of M51 intersection	61-66	63-69	57-62	1-10	1400	11.5
Wall 1B	CNE 1, along M51 ROW, north of Oakdale, along proposed sidewalk	56-66	56-66	54-62	1-7	400	15.75
Wall 3	Along M51, Following fence line of existing cemetery	68-69	69-70	60-64	5-10	1100	6.36
Wall 4	CNE 4, along M51, south of Main St, between existing sidewalk and ROW line	60-70	60-71	58-61	3-12	250	9.2
Wall 5	Along M51, South of Main St, between existing sidewalk and ROW line	60-71	66-69	59-62	5-10	200	9.5
Wall 12	CNE 12, along US12 ROW, east of M51 intersection	54-68	55-71	53-66	0-10	600	9.5

Table 5-2 Barrier Analysis Results

Barrier ID	Number of Attenuated Locations[1]					Cost[2]	Cost Per Benefitted Unit	Feasible?	Reasonable?	Recommended?
	≥ 10 dBA	≥ 7 dBA		≥ 5 dBA (Benefitted Receptors)						
		#	% of Benefit	#	% of Impacts					
Wall 1A	3	6	67%	9	100%	$724,500	$80,500	Yes	No	No
Wall 1B	0	1	100%	1	100%	$283,500	$283,500	Yes	No	No
Wall 3	1	6	75%	8	100%	$314,820	$39,353	No	Yes	No
Wall 4	2	3	75%	5	100%	$103,500	$20,700	No	Yes	No
Wall 5	1	1	50%	2	100%	$85,500	$42,750	No	Yes	No
Wall 12	1	1	50%	2	67%	$256,500	$128,250	No	No	No

Note:
1) MDOT policy requires that reasonable and feasible noise walls must be constructable, provide at least 10 dBA noise reduction at one impacted receptor, at least 7 dBA noise reduction for at-least 50% of benefited receptors, at least 5 dBA noise reduction for at least 75% of impacted receptors, and be constructed at an estimated cost of no more than $49,301 per benefited receptor.
2) Wall costs reported here are based on wall area in square feet as calculated by TNM times MDOT unit cost of $45.00/square foot.

5.3.1 CNE-1 Noise Abatement Analysis

CNE-1, north of US-12 and east of M-51, contains 56 modeled receiver locations representing a total of 56 individual single-family homes with each home representing one dwelling unit. Nine receptors were determined to be impacted under the future build condition. Two noise walls were analyzed, Wall 1A on the north side of US-12, and Wall 1B on the east side of M-51. Neither wall was found to meet MDOT reasonableness standards. Wall 1A would cost at least $80,500 per benefitted receptor, exceeding the allowable CPBU. Wall 1B also exceeded the CPBU and did not achieve a 10 dB reduction at an impacted receptor. Thus, abatement is not recommended for this CNE. These walls are shown in Figure 5-1.

5.3.2 CNE-2 Noise Abatement Analysis

CNE-2 contains 12 modeled receiver locations representing a total of 16 individual dwelling units, none of which were impacted. As there were no impacts, no abatement was analyzed. CNE-2 is shown in Figure 5-2.

5.3.3 CNE-3 Noise Abatement Analysis

CNE-3 contains two separate land uses, a cemetery, and a public baseball field, both of which would be considered an Activity Category C land use with an exterior impact threshold of 66 dBA, Leq. The baseball field, Thomas Memorial Stadium, was determined not to be impacted due to a 40-foot set back from M-51 and noise reduction provided by an existing solid 8-foot-high wall surrounding the playing field and seating area. However, the cemetery, city owned Silverbrook Cemetery, has no such acoustical protection. Guidance in Appendix D of the MDOT Highway Noise Analysis and Abatement Handbook was used to determine Dwelling Unit Equivalents (DUEs) for the cemetery. The cemetery contains about 77,000 square feet of land within the 66 dBA noise impact distance from M-51, extending about 70 feet in from the cemetery fence line. When compared to a typical lot size of a nearby home (821 S. 15th St. – 9,652 square feet) this equates to 8 impacted DUEs. A noise wall 1100 feet long and with an average height of 6.4 feet at this location would have met MDOT requirements for acoustical performance and cost. However, there are several considerations that would create feasibility issues for a wall at this location. First, the cemetery has been identified as an historic property so the existing iron fence would probably need to remain, and a noise wall located further to the west, which may also require relocating the sidewalk at substantial additional cost. Second, the only available wall alignment coincides with overhead power lines and an underground gas line that would impact constructability. Finally, it was judged that this historic part of the cemetery is very lightly used, with new burials occurring in this section only once or twice a year and very few visitors according to cemetery staff, so the benefit of a noise wall at this location would be very limited. Therefore, a noise wall is not recommended for this location. CNE-3 is shown in Figure 5-3.

5.3.4 CNE-4 Noise Abatement Analysis

CNE-4 is east of the northernmost stretch of M-51 within the project area and contains 19 modeled receptor locations representing 20 individual dwelling units, primarily single-family homes and one multi-family residence. Seven dwelling units were determined to be impacted under the future build condition. Wall 4 was analyzed along M-51, extending 250 feet from north of Hickory Street to Oak Street/M-60BR between the existing sidewalk and ROW line. The noise wall at this location was ultimately determined to be not feasible in accordance with MDOT noise policy for several reasons. These included significant constructability issues associated with interference with existing drainage features, utility conflicts (overhead electric, underground gas, watermain, fiber optic and telephone), conflicts with adjacent existing sidewalk as well as sidewalk connectivity to E. Main Street. In addition, a clear safe zone in this area would require a noise wall to be located 16 to 18 feet from the near travel lane which would be in very close proximity to existing residential structures. For these reasons, a noise wall is not recommended for this area. CNE-4 is shown in Figure 5-3.

5.3.5 CNE-5 Noise Abatement Analysis

CNE-5 contains 26 modeled receptors representing a total of 26 dwelling units, all single-family homes. Four receptors were determined to be impacted under future build conditions. Two impacted receptors are located on Oak Street at the southern end of the CNE. Abatement for these receptors would block street access, therefore, no abatement was analyzed. The other two impacted receptors, 05-06 and 05-07 are located alongside Main Street at the northwestern corner of the CNE north of E. Main Street between Cedar Street and N. 10th Street. A 200-foot-long, 10-foot-high wall along Main Street could provide the required noise reduction for the two impacted receptors. However, a noise wall constructed at a sufficient setback distance to provide a safe clear zone from traffic on Main Street (approximately 18 feet) would be located just a few feet from the corner of the house represented at 05-07 (914 Cedar Street), creating safety and constructability issues. It is also noted that the proximity of the wall to the south-west corner of the house at this location would restrict or eliminate access to the back yard area from the house and may also create potential damage issues to the foundation of the structure. Therefore, noise abatement at this location is considered to be not feasible and is not recommended. CNE-5 is shown in Figure 5-3.

5.3.6 CNE-6 Noise Abatement Analysis

CNE-6 contains 52 modeled receptor locations representing 52 dwelling units, none of which were impacted. As there were no impacts, no abatement was analyzed. CNE-6 is shown in Figure 5-3.

5.3.7 CNE-7 Noise Abatement Analysis

CNE-7 contains one modeled receptor location, a single restaurant with an outdoor eating area. This receptor was determined not to be impacted by future build conditions; therefore, no abatement was analyzed. CNE-7 is shown in Figure 5-2.

5.3.8 CNE-8 Noise Abatement Analysis

CNE-8 contains seven modeled receptor locations representing a total of four individual dwelling units, one of which was impacted. Following a basic assumption that a barrier would need to extend at least 3 times the distance from the barrier to the receiver in each direction and be tall enough to block the line of sight to the highway vehicles, a barrier of at least 800 feet in length and at least 12 feet in height would be needed to provide a minimum of 5 dBA reduction at the receptor. At $45/square foot, this barrier would cost at least $432,000 per benefitted receptor, far exceeding the CPBU. Thus, no abatement was modeled for this location. CNE-8 is shown in Figure 5-4.

5.3.9 CNE-9 Noise Abatement Analysis

CNE-9 contains 14 modeled receptor locations representing a total of 14 individual dwelling units, of which three were impacted. Impacted receptors included two single-family homes located along 3rd Street, represented by receptors 09-07 and 09-09, and another single-family home southwest of the intersection, represented by receptor 09-01. Noise impacts at the receptors along 3rd Street (09-07 and 09-09) were determined to be in part due to traffic on 3rd Street, which cannot be mitigated for without cutting off street access to these homes, therefore any abatement for noise from US12 would not adequately reduce noise levels at the impacted receptors. Therefore, no abatement was analyzed for this location. CNE-9 is shown in Figure 5-5.

5.3.10 CNE-10 Noise Abatement Analysis

CNE-10 contains no noise-sensitive land uses; thus no abatement was analyzed. CNE-10 is shown in Figure 5-6.

5.3.11 CNE-11 Noise Abatement Analysis

CNE-11 contains 12 modeled receptor locations representing 12 dwelling units, all single-family homes, none of which were impacted. As there were no impacts, no abatement was analyzed for this area. CNE-11 is shown in Figure 5-6.

5.3.12 CNE-12 Noise Abatement Analysis

CNE-12, located south of US-12 and east of M-51, contains 32 modeled receptor locations representing 32 dwelling units, of which six were impacted. The receptors in this area consist solely of single-family homes. Three of the impacted receptors are located along M-51, with direct driveway access onto and intersecting with roads precluding abatement in this area, thus no abatement was considered for these receptor locations. The remaining three receptors are located along US-12; two are within 200 feet of each other (12-05 and 12-06) and the third is approximately 1,100 feet further to the east (12-21). Following the same assumptions used for CNE-8, it was determined that a barrier at least 320 feet in length and 8 feet in height would be required to provide 5 dBA of noise reduction for the individual receptor location (12-21), costing $115,200 and exceeding the maximum allowable CPBU value. Therefore, no noise abatement was considered for this receptors location. For the other two locations (12-05 and 12-06), a wall 600 feet in length with an average height of 9.5 feet could provide benefit to both impacted receptors, including a 10 dBA reduction at a single impacted receptor, but was otherwise unable to meet MDOT reasonableness requirements due to a CPBU of at least $128,250. Thus, this barrier is not recommended. CNE-12 is shown in Figure 5-7.

Figure 5-1 Acoustical Analysis for CNE-1

Figure 5-2 Acoustical Analysis for CNE-2 and CNE-7

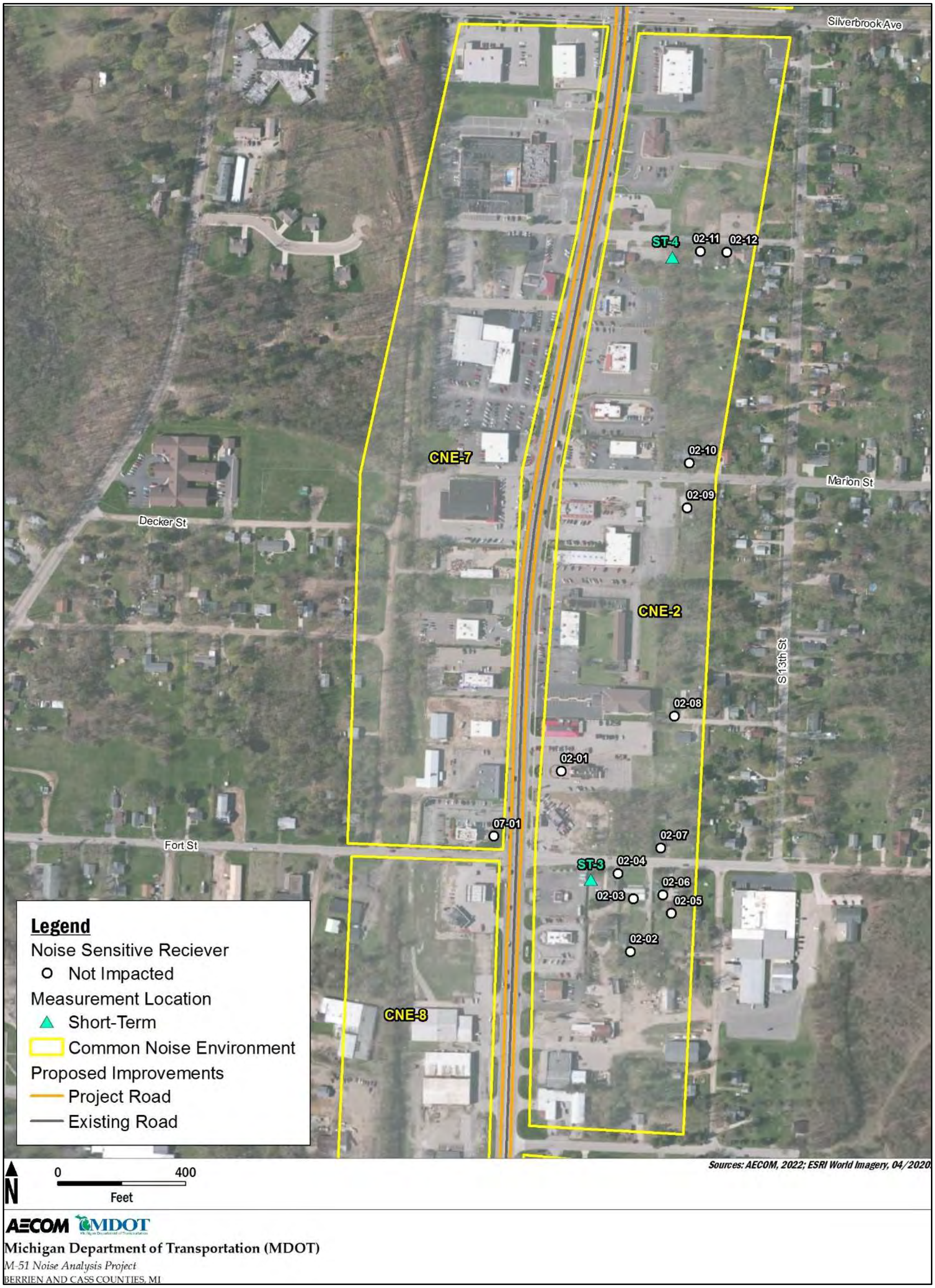


Figure 5-3 Acoustical Analysis for CNE-3, CNE-4, CNE-5, & CNE-6

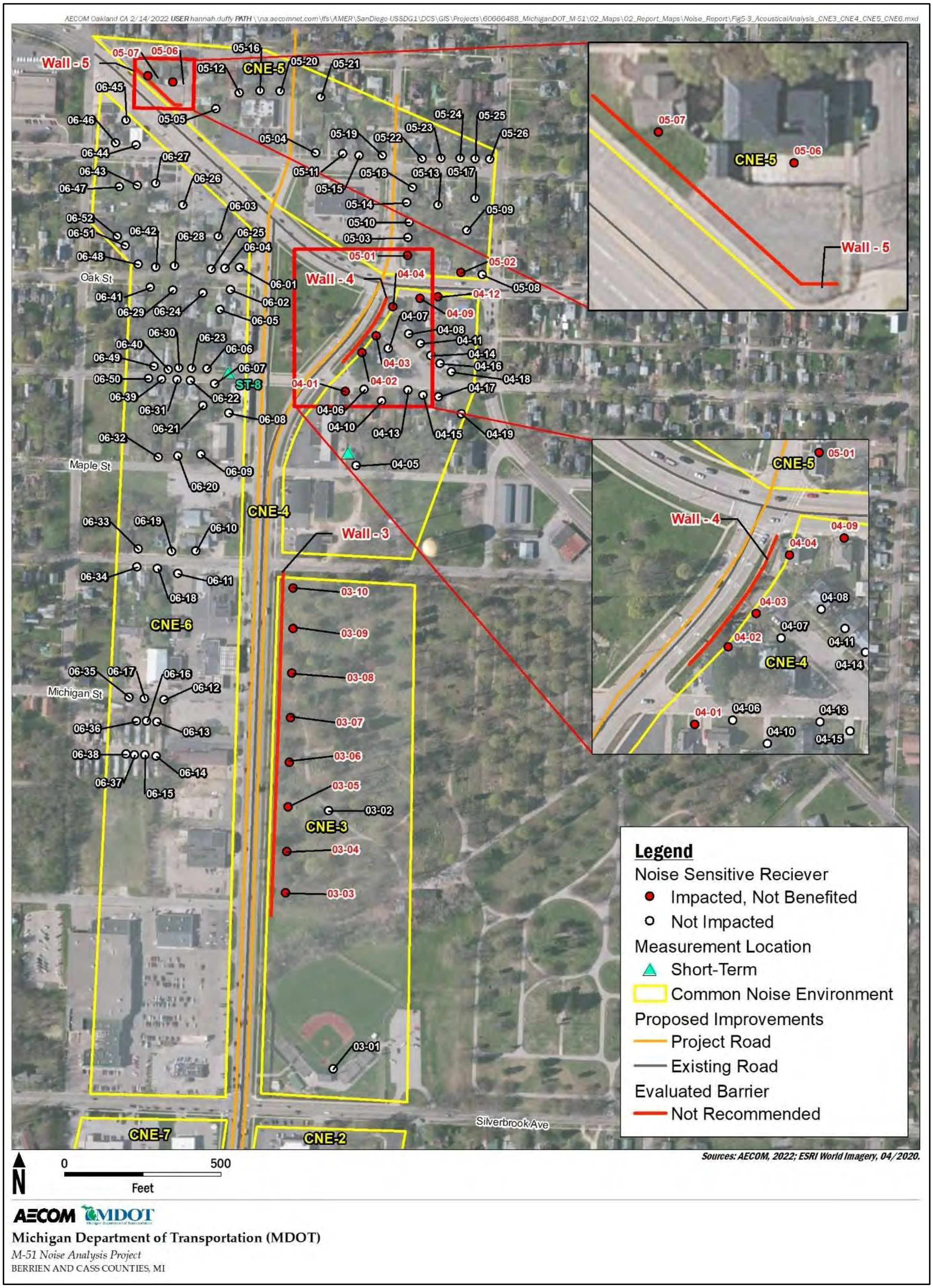


Figure 5-4 Acoustical Analysis for CNE-8

Figure 5-5 Acoustical Analysis for CNE-9

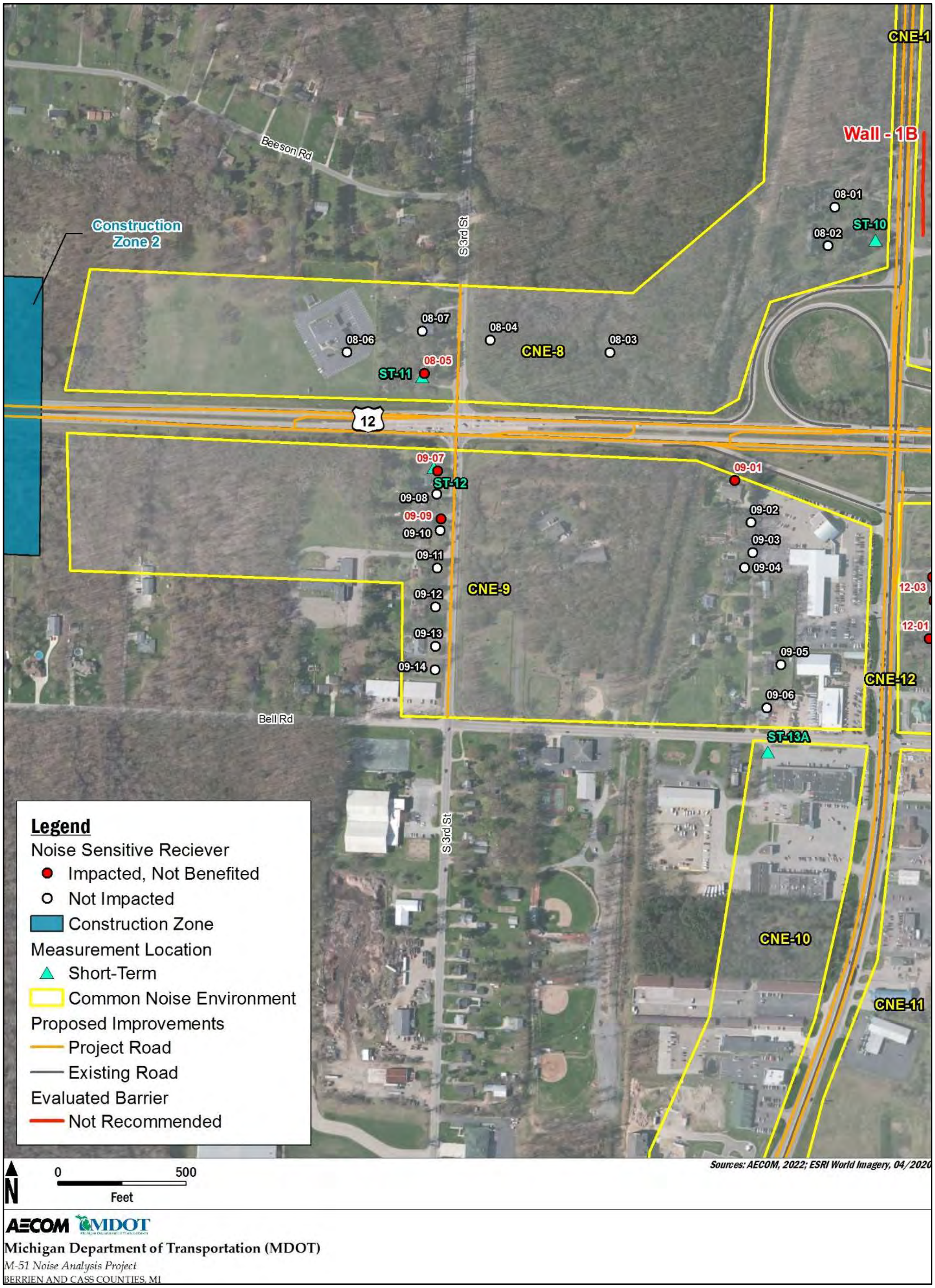
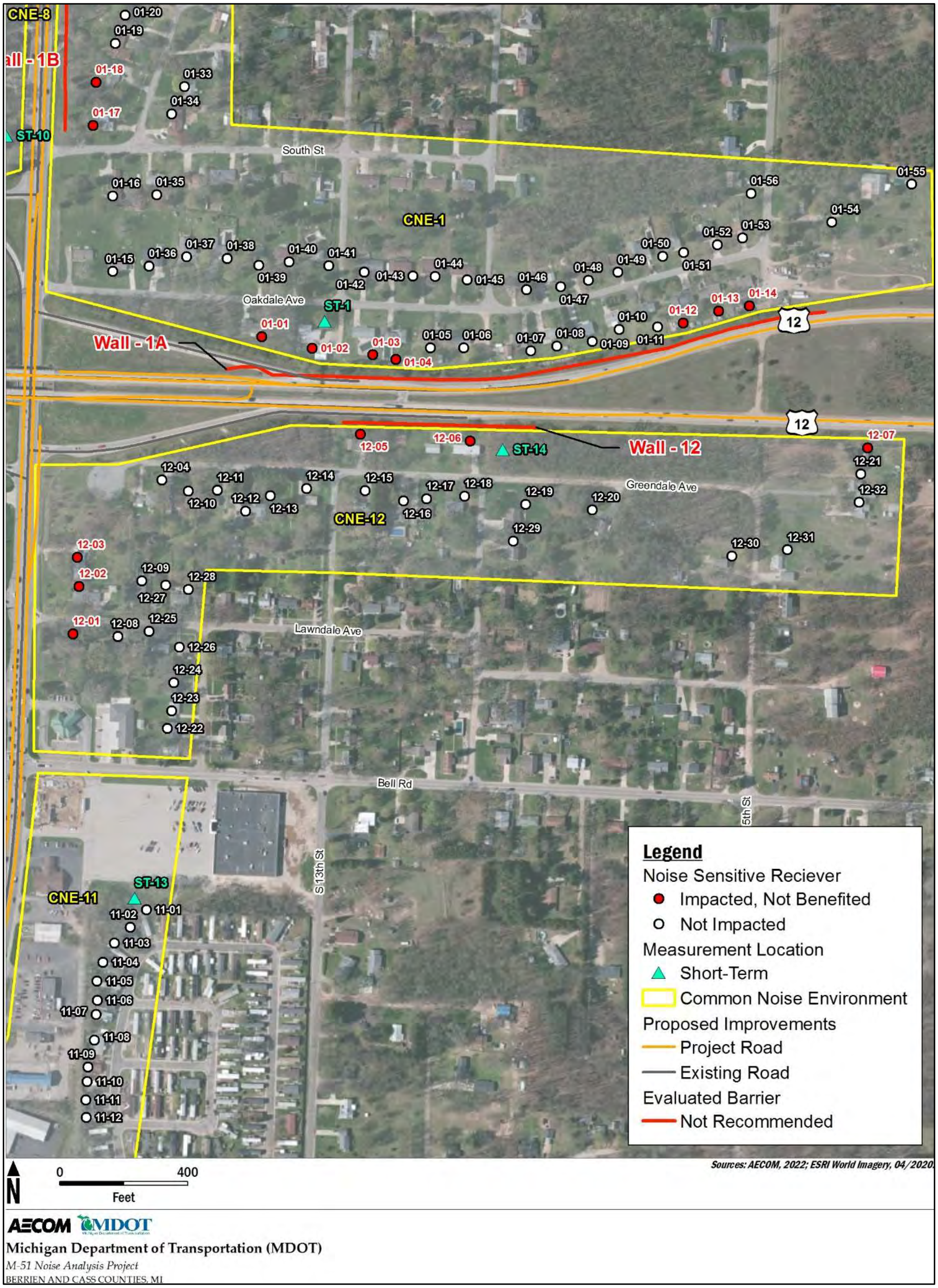


Figure 5-6 Acoustical Analysis for CNE-10 & CNE-11

Figure 5-7 Acoustical Analysis for CNE-12



6. Construction Noise Analysis

FHWA policy requires that construction noise be considered in a Type 1 highway noise analysis. This analysis would generally include the following:

1. Identification of land uses that may be affected by construction noise,
2. Determination of the measures needed in the plans and specifications to minimize or eliminate construction noise impacts; and,
3. Incorporate needed abatement into the plans and specifications.

Neither FHWA nor MDOT identify specific construction noise impact criteria. In addition, the detailed information necessary to predict actual construction noise levels (construction schedules, phasing, equipment lists, laydown areas, etc.) has not yet been determined. However, for this project, it is anticipated that pile driving and some nighttime construction work will be required.

It is recognized that areas adjacent to the highway right of way and other construction areas (such as staging areas and laydown sites) can temporarily be exposed to high levels of noise during peak construction periods. It is reasonable to assume that the same CNEs identified for potential traffic noise impacts could also be exposed to construction noise. The effect of the noise on the local area can be reduced if the hours and days of construction activity are limited to less sensitive time periods. The project construction standard noise specifications help minimize the effects of construction noise.

The following special provisions may be incorporated into the construction contract:

- Inform the local public in advance of construction activities that may generate particularly high noise levels (such as pile drivers) or periods of nighttime construction activity.
- Noise barriers approved for incorporation into the project should be constructed as close to the beginning of the project's construction timeline as practical.
- Noise created by truck movement shall not exceed 88 dBA at a distance of 50 feet.
- When working between 7:00 P.M. and 10:00 P.M., use “smart alarms” instead of standard reverse signal alarms or use spotters. When working between 10:00 P.M. and 7:00 A.M. use spotters instead of auditory alarms.
- Have portable noise meters on the job at all times for noise level spot checks on specific operations. Employ an individual trained in the use of noise meters, with working knowledge of sound measurements and their meaning and use as applied to these abatement/abatement measures.

6.1 Typical Construction Noise Levels

Table 6-1 contains a list of commonly used construction equipment and noise levels associated with using that equipment.

Table 6-1 Typical Construction Equipment Noise Levels

Equivalent Type	Lmax Ref dBA (50 feet)	AUF %
Auger Drill	84	20
Backhoe	78	40
Boring Jack Power Unit	83	50
Chain Saw	84	20
Compactor (ground)	83	20
Compressor (air)	78	40
Concrete Mixer Truck	79	40
Concrete Pump Truck	81	20
Concrete Saw	90	20
Crane	81	16
Dozer	82	40
Drill Rig Truck	79	20
Drum Mixer	80	50
Dump Truck	76	40
Excavator	81	40
Flat Bed Truck	74	40
Front End Loader	79	40
Generator (>25KVA)	81	50
Generator (<25KVA)	73	50
Gradall	83	40
Grader	85	40
Horizontal Boring Jack	82	25
Hoe Ram	90	20
Jackhammer	89	20
Man Lift	75	20
Pavement Scarafier	90	20
Paver	77	50
Pickup Truck	75	40
Pneumatic Tools	85	50
Pumps	81	50
Roller	80	20
Scraper	84	40
Shears (on backhoe)	96	40
Tractor	84	40
Vacuum Excavator	85	40
Vacuum Street Sweeper	82	10
Ventilating Fan	79	100
Vibrating Hopper	87	50
Vibratory Concrete Mixer	80	20
Warning Horn	83	5
Welder/Torch	74	40

Source: RCNM User Guide, Table 1 (actual measured Lmax)

6.2 Construction Noise Abatement Measures

Although MDOT does not identify any specific abatement measures related to construction noise, the following list could be considered best practices for the avoidance of any potential problems related to construction noise impacts:

- No construction shall be performed within 1,000 feet of an occupied dwelling unit on Sundays, legal holidays, or between the hours of 10 p.m. and 6 a.m. on other days without the approval of the MDOT construction project manager.
- All equipment used shall have sound-control devices no less effective than those provided on the original equipment. No equipment shall have unmuffled exhaust.
- All equipment shall comply with pertinent equipment noise standards of the U.S. Environmental Protection Agency.

- No pile driving or blasting operations shall be performed within 3,000 feet of an occupied dwelling unit on Sundays, legal holidays, or between the hours of 8 p.m. and 8 a.m. on other days without the approval of the MDOT construction project manager.
- The noise from rock crushing or screening operations performed within 3,000 feet of any occupied dwelling shall be mitigated by strategic placement of material stockpiles between the operation and the affected dwelling or by other means approved by the MDOT construction project manager.

If a specific noise impact complaint is received during construction of the project, the contractor may be required to implement one or more of the following noise abatement measures at the contractor's expense, as directed by the construction project manager:

- Locate stationary construction equipment as far from nearby noise-sensitive properties as feasible.
- Shut off idling equipment.
- Reschedule construction operations to avoid periods of noise annoyance identified in the complaint.
- Notify nearby residents whenever extremely noisy work will be occurring.
- Install temporary or portable acoustic barriers around stationary construction noise sources.
- Operate electrically powered equipment using line voltage power or solar power.

Special Construction Zones

In addition to construction noise associated with the proposed improvements within the defined project area, there are two defined "Construction Zones" on either end of the project area along US-12 (as shown in Figure 1-1). The purpose of these construction zones is to stage and construct a set of temporary cross-over ramps on either side of the project to redirect traffic on US-12 during the intersection reconstruction. Construction Zone 1, east of the project area, would be situated within approximately 300 feet of the Silverbrook mobile home community northwest of the US-12/E Main Street interchange. Construction Zone 2, west of the project, would be immediately adjacent to the Griffin Estates apartment complex northeast of the US-12/Bond Street intersection. Both Construction Zones would be close enough to temporarily create elevated noise levels at the nearby residential communities (depending on the type of equipment being used). It is therefore recommended to follow the same abatement measures listed above for construction activity within the vicinity of residential areas within the project.

7. Information for Local Government Officials

FHWA and MDOT policy specify that local officials should be provided appropriate information to assist with future compatible land use planning, especially regarding the planning and development of undeveloped lands near the proposed project right-of-way.

Table 7-1 shows noise impact distance for the 66 dBA and 71 dBA levels (NAC categories B/C and E, respectively) from both highways in the project area. Future developments should not place applicable noise-sensitive land uses within the distances listed from edge of pavement.

Table 7-1 Noise Impact Distances for Undeveloped Lands

	Distance From the Edge of Pavement (Feet)	
Project Roadway	**71 dBA**	**66 dBA**
M-51	29	108
US-12	54	136

8. Conclusions and Recommendations

The noise analysis for the proposed project included a total of twelve measurement locations and 233 predicted representative noise levels for 232 dwelling units in the project area. The project was split into twelve separate CNEs for noise impact analysis within the study area.

Seven of the twelve CNEs contained receptors with predicted future noise levels approaching or exceeding the NAC. Noise abatement was evaluated in five locations. But none were found to be feasible and reasonable as defined by MDOT policy. Therefore, no noise abatement is recommended for this project.

9. Statement of Likelihood

Based on the studies thus far accomplished, MDOT does not intend to install highway traffic noise abatement for this project. The preliminary noise abatement measures were based on preliminary roadway design, and design and costs for noise abatement as presented in Table 5-2 in this document. If roadway designs have substantially changed during the final design process, noise abatement measures may be re-evaluated.

10. References

Federal Highway Administration, 23 CFR 772, Procedures for Abatement of Highway Traffic Noise and Construction Noise, July 2010. https://www.fhwa.dot.gov/legsregs/directives/fapg/cfr0772.htm

Federal Highway Administration (FHWA). 2011. Highway Traffic Noise: Analysis and Abatement Guidance. U.S. Department of Transportation, Federal Highway Administration, Washington, DC. . https://www.fhwa.dot.gov/environment/noise/regulations_and_guidance/analysis_and_abatement_guidance/revguidance.pdf

Michigan Department of Transportation, Highway Noise Analysis and Abatement Handbook. July 13, 2011. https://www.michigan.gov/documents/mdot/MDOT_HighwayNoiseAnalysis_and_AbatementHandbook_358156_7.pdf

Appendix A Noise Measurement Data and Documentation

Appendix A contains the following noise measurement data and documentation:

- Short-term Noise Measurement Summary Table
- Noise Measurement Photo Log
- Noise Measurement Field Data Sheets
- Noise Measurement Equipment Calibration Certificates

Short Term Measurement Summary

ID	*Location*	*Average Leq (dBA)*	*Leq Range (dBA)*	*Start (hh:mm)*	*Stop (hh:mm)*	*Duration (hh:mm)*
ST-1	1228 Oakdale Ave	58.7	54-62.1	11:24	11:39	0:16
ST-2	1103 North St	63.5	61.8-66	11:08	11:40	0:33
ST-3	1401 S 11th St	61.6	56.2-65.6	14:22	14:51	0:30
ST-4	1001 S 11th St	57.9	54.8-63.3	14:22	14:53	0:32
ST-6	1119 Maple St	59.6	54.1-66.9	13:17	13:50	0:33
ST-8	939 Hickory St	62.7	59.2-66.7	13:20	13:48	0:27
ST-10	1556 S 11th St	67.6	65-70.4	11:10	11:39	0:30
ST-11	1730 S 3rd St	68.6	64.1-72.3	9:30	9:50	0:21
ST-12	1814 S 3rd St	68.9	64.7-71.1	11:16	11:38	0:23
ST-13	1908 S 11th St	52.9	50-56.2	12:03	12:26	0:24
ST-13A	1016 Bell Rd	60.2	55.5-68.8	12:05	12:28	0:24
ST-14	1325 Greendale Ave	69.7	64-74.2	9:28	9:51	0:23

Noise Measurement Photo Log

ST-01 1228 Oakdale Ave.

ST-01 Facing North

ST-01 Facing Southwest

ST-02 North Street

ST-02 Facing East

ST-02 Facing South

ST-03 1124 Fort Street

	
ST-03 Facing Southeast	ST-03 Facing West

ST-04 1122 Lambert Street

	
ST-04 Facing North	ST-04 Facing South

ST-06 1119 Maple Street

	
ST-06 Facing North	ST-06 Facing South

ST-08 939 Hickory Street

	
ST-08 Facing West	ST-08 Facing East

ST-10 1556S. 11th Street /M-51

	
ST-10 Facing Southwest	ST-10 Facing South

ST-11 1776 S. 3rd Street

	
ST-11 Facing North	ST-11 Facing South

ST-12 1814 S. 3rd Street

	
ST-12 Facing East	ST-12 Facing South

ST-13 Big Lots Parking Lot

	
ST-13 Facing Northwest	ST-13 Facing South

ST-13A 1016 Bell Road

	
ST-13A Facing West	ST-13A Facing East

ST-14 Greendale Ave.

	
ST-14 Facing North	ST-14 Facing West

Field Data Sheets

AECOM Acoustics and Noise Control Practice

FIELD NOISE MEASUREMENT DATA FORM

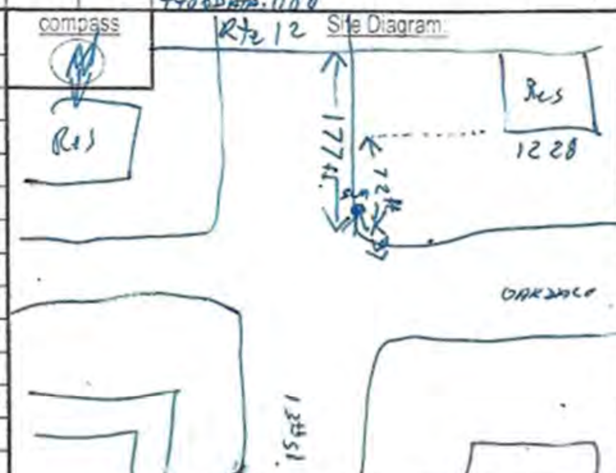
Project Name: MDOT US-12/M-51 Project # 60666488 Date: 9-22-2021 Page 1 of 1

Measurement Location: NSA-N1 ST-1 Analyst: B Varghese

Sound Level Meter	Field Calibration	Meteorological Data
Model # LD LXT	Model # LD CAL 200	Model # Kestrel 3500 Time Obs/Meas
Serial # 4486	Serial # 5789	Serial #
Weighting A / C / Flat	Calibration Level (dB) 94 / 114	Precipitation Yes (explain) / No
Response Slow / Fast / Impl	Pre-Test 114 dBA	Wind Steady / Gusty / Calm
Windscreen Yes / No (explain)	Post-Test dBA	Avg Wind Speed Direction N-9
Topo: Flat / Hilly	GPS Coordinates (at SLM location)	Temp (F) 54% RH % 81%
Terrain: Hard Soft Mixed Agg Snow	N 41° 48' 7" W 86° 14' 41"	Bar Pr (in g) Cloud Cover (%) 100%

Loc ID	Start Time (hh:mm)	Stop Time (hh:mm)	Metrics L_{eq}	L_{max}	L	Statistics L	L	L	Notes/Events
ST-1	11:18	11:40	55.1						roadway semi dry
			57.4						
			61.9						car passing) 11:19 + 11:20 + 11:25 x2
			56.9						on OAKDALE 11:32 x2
			55.7						
			54.0						
			56.5						
			57.5						
			56.6						
			60.9						
			59.2						
			59.8						
			62.1						video traffic
			58.4						
			57.8						4486Dmm.008

Roadway Name/Dir	OAKDALE	
Speed (post/obs*)		
Number of Lanes	1	
Width (pave/row)		
1- or 2-way		
Grade		
Bus Stops		
Stoplights		
Motorcycles		
Automobiles	see	
Medium Trucks	video	
Heavy Trucks		
Buses		
Count duration		



- Note coordinate system if other than NAD84 * - Speed estimated by Radar Driving Observation

Photos Taken? Yes / No

Additional Notes/Comments:

Noise Sources (circle all that apply): distant aircraft roadway traffic rail ops landscaping rustling leaves children playing dogs barking birds vocalizing insects mechanical

Additional Notes and Sketches on Reverse or Indicated Separate Sheet(s)

AECOM ANCP, Field Noise Measurement Form, Vers 1.3 rev081816

AECOM Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: MDOT US-12/M-51 Project #: 60666488 Date: 9/2/21 Page 1 of 1
Measurement Location: ST-2 Analyst: GH

Sound Level Meter
Model #: LD LxT
Serial #: 4926
Weighting: (A) / C / Flat
Response: (Slow) / Fast / Impl
Windscreen (Yes) / No (explain)

Field Calibration
Model #: CAC 200
Serial #: 4637
Calibration Level (dB): 94 / (114)
Pre-Test +0.12 dBA
Post-Test −0.03 dBA

Meteorological Data
Model #: Kestrel 3500 Time Obs/Meas: 11:04
Serial #: 2058305
Precipitation: Yes (explain) / (No)
Wind: Steady / Gusty / (Calm)
Avg Wind Speed/Direction: — m/s / MPH
Temp (°F): 75.3 RH (%): 72.5
Bar Psr (Hg): 29.29 Cloud Cover (%): 100%

Topo: Flat / (Hilly)
Terrain: Hard / Soft / (Mixed) / Agg / Snow

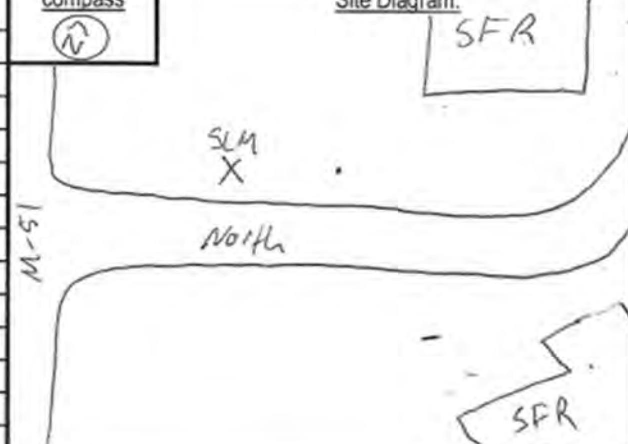
GPS Coordinates (at SLM location)#: 41.8072216, -86.24177084

Loc. ID	Start Time (hh:mm)	Stop Time (hh:mm)	L_{eq}	L_{min}	L_{max}	L_{10}	L_{50}	L_{90}	Notes/Events
	11:07	11:41							
	11:35								Resident stopped to
									ask about work
	11:10		62.5						
	11:15		63.6						
	11:20		62.0						
	11:25		64.2						
	11:30		63.4						
	11:35		64.3						
	11:40		62.8						

Roadway Name/Dir.	M-51	
Speed (post/obs*)	50	
Number of Lanes	4	
Width (pave/row)		
1- or 2- way	2	
Grade		
Bus Stops	NB	
Stoplights		
Motorcycles		
Automobiles	217	
Medium Trucks	9	
Heavy Trucks		
Buses	1	
Count duration	20 min	

compass

Site Diagram:



- note coordinate system if other than NAD84 * - Speed estimated by Radar / Driving / Observation

Photos Taken? (Yes) / No

Additional Notes/Comments:

Noise Sources (circle all that apply): distant aircraft/(roadway traffic)/rail ops/landscaping/rustling leaves/children playing/dogs barking/(birds vocalizing)/(insects)/mechanical
Additional Notes and Sketches on Reverse or Indicated Separate Sheet(s)

AECOM ANCP, Field Noise Measurement Form, Vers. 1.3 rev081816 File: LxT_Data.008

AECOM Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: MDOT US-12/M-51 Project #: 60666488 Date: 9.20.2021 Page 1 of 1
Measurement Location: NSA-N3 ST-3 Analyst: B. Vasquez

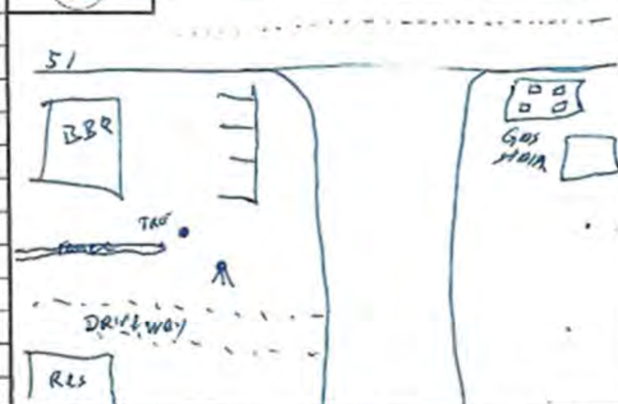
Sound Level Meter	Field Calibration	Meteorological Data
Model #: LD LXT	Model #: LD CAL 200	Model #: Kestrel 3500 Time Obs/Meas
Serial #: 4486	Serial #: 5789	Serial #:
Weighting: A/C/Flat	Calibration Level (dB): 94 / 114	Precipitation: Yes (explain) / No
Response: Slow / Fast / Impl	Pre-Test: dBA	Wind: Steady / Gusty / Calm
Windscreen: Yes / No (explain)	Post-Test: dBA	Avg Wind Speed/Direction: S 13
Topo: Flat / Hilly	GPS Coordinates (at SLM location)*: N: 41° 48' 44 W: 86° 14' 50	Temp (°F): 75° RH (%): 81%
Terrain: Hard / Soft / Mixed / Agg / Snow		Bar Press (Hg): Cloud Cover (%): 90%

Loc ID	Start Time (hh:mm)	Stop Time (hh:mm)	Metrics L_{eq}	L_{max}	L_{min}	Statistics L	L	L	Notes/Events
ST-3	14:25	14:55	64.8						motor home idling across from street
			59.4						
			60.4						
			60.1						screeching brakes from bike
			56.2						
			61.4						
			61.1						
			65.1						
			60.4						
			60.7						
			59.2						
			61.6						
			65.6						
			60.0						
			59.4						

Roadway Name/Dir	61.4		
Speed (post/obs*)			
Number of Lanes			
Width (pave/row)			
1- or 2-way			
Grade			
Bus Stops			
Stoplights			
Motorcycles			
Automobiles			
Medium Trucks			
Heavy Trucks			
Buses			
Count duration			

compass: N →

Site Diagram:



* - note coordinate system if other than NAD84 * - Speed estimated by Radar, Driving, Observation

Photos Taken? Yes / No

Additional Notes/Comments:

Noise Sources (circle all that apply): distant aircraft/roadway traffic/rail ops/landscaping/rustling leaves/children playing/dogs barking/birds vocalizing/insects/mechanical
Additional Notes and Sketches on Reverse or Indicated Separate Sheet(s)

AECOM ANCP Field Noise Measurement Form Vers 1.3 rev081816

AECOM Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: MDOT US-12/M-51 Project #: 60666488 Date: 9/20/21 Page 1 of 1

Measurement Location: ST-4 Analyst: 64

Sound Level Meter

Model #: LDLxT
Serial #: 4926
Weighting: (A) / C / Flat
Response: (Slow) / Fast / Impl
Windscreen: (Yes) / No (explain)

Field Calibration

Model #: ______
Serial #: ______
Calibration Level (dB): 94 / 114
Pre-Test ______ dBA
Post-Test ______ dBA

Meteorological Data

Model #: Kestrel 3500
Serial #: 2058303
Time Obs/Meas: 14:22
Precipitation: Yes (explain) / (No)
Wind: Steady / Gusty / (Calm)
Avg Wind Speed/Direction: 1-2 N. m/s / (MPH)

Topo: (Flat) / Hilly
Terrain: Hard / Soft / (Mixed) / Agg / Snow

GPS Coordinates (at SLM location)#: 41.8176923, -86.2464379

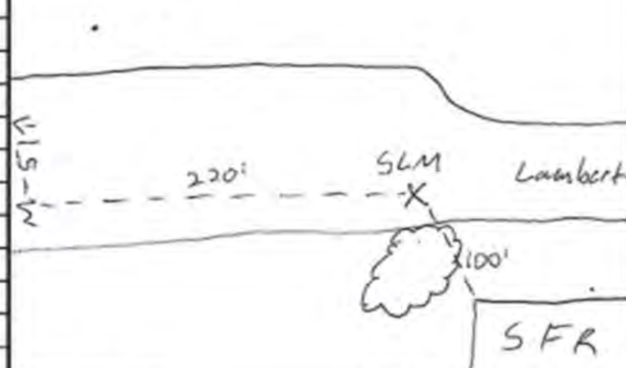
Temp (°F): 81.1 RH (%): 68.4
Bar Psr (Hg): 29.22 Cloud Cover (%): 60%

Loc. ID	Start Time (hh:mm)	Stop Time (hh:mm)	L_{eq}	L_{min}	L_{max}	L_{10}	L_{50}	L_{90}	Notes/Events
	14:24	14:58							- Runtime, Meter time off
									by ~3 min.
	14:25		55.4						
	14:30		56.8						
	14:35		55.6						
	14:40		56.6						
	14:45		56.3						
	14:50		58.6						
	14:55		58.8						

Roadway Name/Dir.	M-51	
Speed (post/obs*)	50 mph	
Number of Lanes	4	
Width (pave/row)		
1- or 2- way	2	
Grade		
Bus Stops		
Stoplights		
Motorcycles		
Automobiles	549	
Medium Trucks	9	
Heavy Trucks	4	
Buses	1	
Count duration	20 min.	

compass

Site Diagram:



- note coordinate system if other than NAD84 * - Speed estimated by Radar / (Driving) / Observation

Photos Taken? (Yes) / No

Additional Notes/Comments: - Distant Landscaping Audible

Noise Sources (circle all that apply): distant aircraft / (roadway traffic) / rail ops / landscaping / (rustling leaves) / children playing / dogs barking / birds vocalizing / (insects) / mechanical

Additional Notes and Sketches on Reverse or Indicated Separate Sheet(s)

AECOM ANCP, Field Noise Measurement Form, Vers. 1.3 rev081816 File.007

AECOM Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: MDOT US-12/M-51 Project #: 60666498 Date: 9/22/21 Page 1 of 1
Measurement Location: ST-6 Analyst: GH

Sound Level Meter	Field Calibration	Meteorological Data
Model #: LD LxT	Model #: CAL 200	Model #: Kestrel 3500 Time Obs/Meas: 13:18
Serial #: 4926	Serial #: 4637	Serial #: 2058303
Weighting: (A) / C / Flat	Calibration Level (dB): 94 / (114)	Precipitation: Yes (explain) / (No)
Response: (Slow) / Fast / Impl	Pre-Test −0.03 dBA	Wind: Steady / (Gusty) / Calm
Windscreen: (Yes) / No (explain)	Post-Test +0.03 dBA	Avg Wind Speed/Direction: 1.5 E m/s / (MPH)
Topo: (Flat) / Hilly	GPS Coordinates (at SLM location)[#]	Temp (°F): 60.4 RH (%): 82.4
Terrain: Hard / Soft / (Mixed) / Agg / Snow	41.8252602, -86.2461030	Bar Psr (Hg): 29.23 Cloud Cover (%): 100

Loc. ID	Start Time (hh:mm)	Stop Time (hh:mm)	L_{eq}	L_{min}	L_{max}	L_{10}	L_{50}	L_{90}	Notes/Events
	13:16	13:51							Runtime
	13:41								Small Child on bike + Parent passed by SLM, approx 3ft
	13:48								Child + Parent returned, dog inside residence 3 houses down audible barking
	13:20		58.4						
	13:25		54.8						
	13:30		63.3						
	13:35		58.7						
	13:40		56.3						
	13:45		58.3						
	13:50		59.0						

Roadway Name/Dir.	M-51	
Speed (post/obs*)	50	
Number of Lanes	4	
Width (pave/row)		
1- or 2- way	2	
Grade		
~~Bus Stops~~	NB	
Stoplights		
Motorcycles		
Automobiles	165	
Medium Trucks	1	
Heavy Trucks	4	
Buses	2	
Count duration	20 min.	

compass (N)

Site Diagram:

- note coordinate system if other than NAD84 * - Speed estimated by Radar / (Driving) / Observation

Photos Taken? (Yes) / No

Additional Notes/Comments:

Noise Sources (circle all that apply): distant aircraft / (roadway traffic) / rail ops / landscaping / (rustling leaves) / children playing / dogs barking / birds vocalizing / (insects) / mechanical

~~Additional Notes~~ and Sketches on Reverse or Indicated Separate Sheet(s)

AECOM ANCP, Field Noise Measurement Form, Vers. 1.3 rev081816

AECOM Acoustics and Noise Control Practice

FIELD NOISE MEASUREMENT DATA FORM

Project Name: MDOT US-12/M-51 Project # 60664488 Date: 9.22.2021 Page 1 of 1

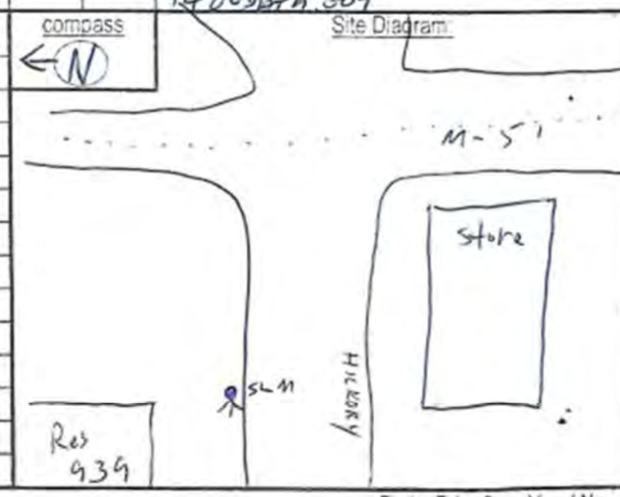
Measurement Location: NSA-N8 ST-8 Analyst: B Vasquez

Sound Level Meter	Field Calibration	Meteorological Data
Model #: LD LXT	Model #: LD CAL 200	Model #: Kestrel 3500 Time Obs Meas
Serial #: 4486	Serial #: 5789	Serial #:
Weighting: A / C / Flat	Calibration Level (dB): 94 / 0	Precipitation: Yes (explain) / No
Response: Slow / Fast / Impl	Pre-Test: 114 dBA	Wind: Steady / Gusty / Calm
Windscreen: Yes / No (explain)	Post-Test: dBA	Avg Wind Speed Direction: 10 N m/s
Topo: Flat / Hilly	GPS Coordinates (at SLM location): N 41° 49' 34" W 86° 14' 50"	Temp (°F): 55° RH (%): 76%
Terrain: Hard / Soft / Mixed / Agg / Snow		Bar Pr (Hg): Cloud Cover (%): 100%

Loc ID	Start Time (hh:mm)	Stop Time (hh:mm)	L_{eq}	L_{max}	L_{min}	L	L	L	Notes Events
ST-8	13:20	13:50	60.9						
			59.2						13:31 siren NB M51
			62.8						13:36 garbage truck on Hickory
			63.6						+ squealing brakes
			63.9						13:40 train horn
			63.2						
			63.2						
			61.5						
			60.5						
			60.3						
			63.7						
			69.7						
			66.7						
			61.1						
			60.6						4486Data.009

Roadway Name/Dir	M 51	
Speed (post/obs*)		
Number of Lanes	2	
Width (pave/row)		
1- or 2-way	circle	
Grade		
Bus Stops	–	
Stoplights	–	
Motorcycles		
Automobiles	190	
Medium Trucks	3	
Heavy Trucks		
Buses		
Count duration	30 min	

Site Diagram:



- note coordinate system if other than NAD84 * - Speed estimated by Radar / Driving / Observation

Additional Notes/Comments: EMT siren

Photos Taken? Yes / No

Noise Sources (circle all that apply): distant aircraft / roadway traffic / rail ops / landscaping / rustling leaves / children playing / dogs barking / birds vocalizing / insects / mechanical

Additional Notes and Sketches on Reverse or Indicated Separate Sheet(s)

AECOM ANCP, Field Noise Measurement Form, Vers 1.3 rev081816

AECOM Acoustics and Noise Control Practice

FIELD NOISE MEASUREMENT DATA FORM

Project Name: MDOT US-12/M-51 Project #: 60666488 Date: 9.21.2021 Page 1 of 1

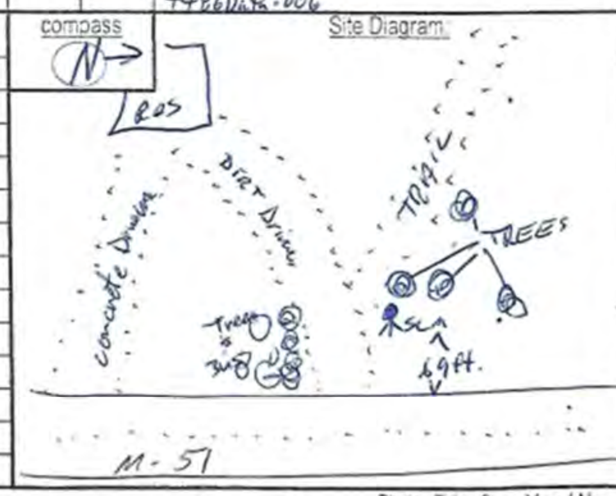
Measurement Location: NSA-N10 ST-10 Analyst: B. Vasquez

Sound Level Meter	Field Calibration	Meteorological Data
Model #: LD LXT	Model #: LD CAL 200	Model #: Kestrel 3500
Serial #: 4486	Serial #: 5789	Serial #:
Weighting: A / C / Flat	Calibration Level (dB): 94 / 114	Precipitation: Yes (explain) / No
Response: Slow / Fast / Impl	Pre-Test: 114 dBA	Wind: Steady / Gusty / Calm
Windscreen: Yes / No (explain)	Post-Test: dBA	Avg Wind Speed Direction: m/s / MPH
Topo: Flat / Hilly	GPS Coordinates (at SLM location)*:	Temp (F): 67° RH (%): 83%
Terrain: Hard Soft Mixed Agg Snow	N: 41° 48' 15 W: 86° 14' 55"	Bar Pst (Hg): Cloud Cover (%): 98%

Loc ID	Start Time (hh:mm)	Stop Time (hh:mm)	L_{eq}						Notes Events
ST-10	11:10	11:40	65.3						traffic main noise source
			67.1						dog barkin across M-51
			66.1						rustling leaves, crickets insects
			68.4						
			67.2						
			67.9						
			66.7						
			66.3						
			68.2						
			67.0						
			66.6						
			67.7						
			67.8						
			65.0						
			68.8						4486Data.006

Roadway Name/Dir	M-51	
Speed (post obs*)		
Number of Lanes		
Width (pave/row)		
1- or 2-way		
Grade		
Bus Stops		
Stoplights		
Motorcycles		
Automobiles	365	
Medium Trucks	3	
Heavy Trucks	4	
Buses	2	
Count duration	30 min	

Site Diagram:



* Note coordinate system if other than NAD84 * ; Speed estimated by Radar, Driving, Observation

Photos Taken? Yes / No

Additional Notes/Comments:

Noise Sources (circle all that apply): distant aircraft roadway traffic rail ops landscaping rustling leaves children playing dogs barking birds vocalizing insects mechanicals

Additional Notes and Sketches on Reverse or Indicated Separate Sheet(s)

AECOM ANCP, Field Noise Measurement Form Vers 1.3 rev081616

AECOM Acoustics and Noise Control Practice

FIELD NOISE MEASUREMENT DATA FORM

Project Name: MDOT US-12/M-51 Project #: 60666488 Date: 9.24.2021 Page 1 of 1

Measurement Location: NSA N11 ST-11 Analyst: B. Vasquez

Sound Level Meter	Field Calibration	Meteorological Data
Model = LD LXT	Model = LD CAL 200	Model = Kestrel 3500 Time Obs/Meas
Serial = 4486.	Serial = 5789	Serial =
Weighting A / C / Flat	Calibration Level (dB) 94 / 114	Precipitation: Yes (explain) / No
Response: Slow / Fast / Imp	Pre-Test 114 dBA	Wind: Steady / Gusty 0-
Windscreen: Yes / No (explain)	Post-Test dBA	Avg Wind Speed Direction mph/MPH
Topo: Flat / Hilly Terrain: Hard / Soft / Mixed / Agg / Snow	GPS Coordinates (at SLM location)* N: 41° 48' 6" W: 86° 15' 17"	Temp (F): 55° RH (%): 76% Bar Press (in Hg): Cloud Cover (%): 0

Loc ID	Start Time (hh:mm)	Stop Time (hh:mm)	Metrics			Statistics			Notes Events
ST-11	09:30	09:50							intersection of RTE 12 & 13th St.
									4486 Data [illegible]

Roadway Name/Dir	RTE 12	13th St.
Speed (post obs*)	55	
Number of Lanes	4 E/W	
Width (pave/row)		
1- or 2-way		
Grade		
Bus Stops		
Stoplights	Yes.	
Motorcycles		
Automobiles		
Medium Trucks		
Heavy Trucks		
Buses		
Count duration		

* note coordinate system if other than NAD84 *: Speed estimated by Radar / Driving / Observation

Photos Taken? Yes / No

Additional Notes/Comments:

Noise Sources (circle all that apply): distant aircraft / roadway traffic / rail ops / landscaping / rustling leaves / children playing / dogs barking / birds / cool sitting insects / mechanical

Additional Notes and Sketches on Reverse or Indicated Separate Sheet(s)

AECOM ANCP. Field Noise Measurement Form. Vers. 1.3 rev081816

AECOM Acoustics and Noise Control Practice

FIELD NOISE MEASUREMENT DATA FORM

Project Name: MDOT US-12/M-51 Project #: 60666488 Date: 9/29/21 Page 1 of 1

Measurement Location: ST-12 Analyst: G H

Sound Level Meter	Field Calibration	Meteorological Data
Model #: LD LxT	Model #: CAL 200	Model #: Kestrel 3500 Time Obs/Meas: 9:32
Serial #: 4926	Serial #: 4637	Serial #: 2058303
Weighting: (A) / C / Flat	Calibration Level (dB): 94 / (114)	Precipitation: Yes (explain) / (No)
Response: (Slow) / Fast / Impl	Pre-Test -0.05 dBA	Wind: Steady / Gusty / (Calm)
Windscreen: (Yes) / No (explain)	Post-Test -0.00 dBA	Avg Wind Speed/Direction: — m/s / MPH
Topo: Flat / (Hilly)	GPS Coordinates (at SLM location)#: 41.8009730, -86.2548939	Temp (°F): 67.7 RH (%): 68.4
Terrain: Hard / Soft / (Mixed) / Agg / Snow		Bar Psr (Hg): 29.22 Cloud Cover (%): 10%

Loc. ID	Start Time (hh:mm)	Stop Time (hh:mm)	L_{eq}	L_{min}	L_{max}	L_{10}	L_{50}	L_{90}	Notes/Events
	9:27	9:52							Runtime
	9:30		71.0						
	9:35		65.9						
	9:40		64.7						
	9:45		69.5						
	9:50		72.5						

Roadway Name/Dir.	US-12	
Speed (post/obs*)	45	
Number of Lanes	4	
Width (pave/row)		
1- or 2- way	2	
Grade		
~~Bus Stops~~	E.B.	W.B.
Stoplights		
Motorcycles		
Automobiles		
Medium Trucks	11	10
Heavy Trucks	16	15
Buses	93	102
Count duration	20 min	20 min

compass

Site Diagram:

- note coordinate system if other than NAD84 * - Speed estimated by Radar / (Driving) / Observation

Photos Taken? (Yes) / No

Additional Notes/Comments: Audible Beeping from Crossing Signal

Noise Sources (circle all that apply): distant aircraft / (roadway traffic) / rail ops/landscaping / (rustling leaves) / children playing/dogs barking / (birds vocalizing) / (insects) / mechanical

Additional Notes and Sketches on Reverse or Indicated Separate Sheet(s)

AECOM ANCP, Field Noise Measurement Form, Vers. 1.3 rev081816 File .012

AECOM Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

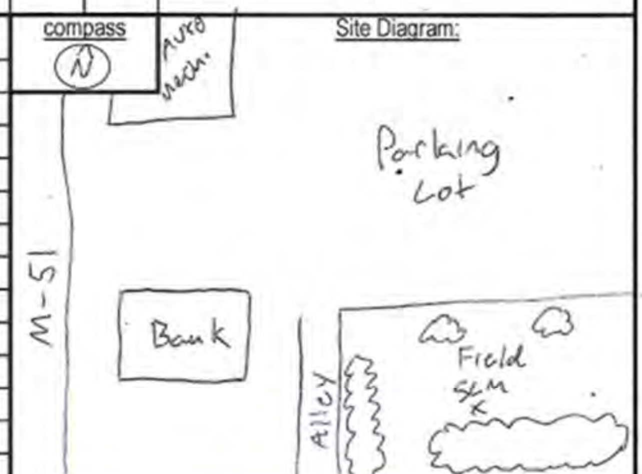
Project Name: MDOT US-12/M-51 Project #: 60666418 Date: 9/21/21 Page 1 of 1
Measurement Location: ST-13 Analyst: GH

Sound Level Meter	Field Calibration	Meteorological Data
Model #: LD LxT	Model #: CAL 200	Model #: Kestrel 3500; Time Obs/Meas: 12:05
Serial #: 4026	Serial #: 4657	Serial #: 2058303
Weighting: (A) / C / Flat	Calibration Level (dB): 94 / (114)	Precipitation: Yes (explain) / (No)
Response: (Slow) / Fast / Impl	Pre-Test +0.12 dBA	Wind: Steady / Gusty / (Calm)
Windscreen: (Yes) / No (explain)	Post-Test −0.03 dBA	Avg Wind Speed/Direction: — m/s / MPH
Topo: (Flat) / Hilly	GPS Coordinates (at SLM location)[#]	Temp (°F): 74.6 RH (%): 73.2
Terrain: Hard / (Soft) / Mixed / Agg / Snow	41.796405, -86.24067	Bar Psr (Hg): 29.21 Cloud Cover (%): 100

Loc. ID	Start Time (hh:mm)	Stop Time (hh:mm)	L_{eq}	L_{min}	L_{max}	L_{10}	L_{50}	L_{90}	Notes/Events
	12:02	12:27							Runtime
	12:05		51.7						
	12:10		61.8						
	12:15		52.0						
	12:20		55.3						
	12:25		53.3						

Roadway Name/Dir.	M-51	
Speed (post/obs*)	50	
Number of Lanes	4	
Width (pave/row)		
1- or 2- way	2	
Grade		
~~Bus Stops~~	NB	
Stoplights		
Motorcycles		
Automobiles	181	
Medium Trucks	7	
Heavy Trucks	1	
Buses	1	
Count duration	~~25~~ 17m	

Site Diagram:



- note coordinate system if other than NAD84. * - Speed estimated by Radar / Driving / Observation

Photos Taken? (Yes) / No

Additional Notes/Comments: - Sporadic Noise from Auto. Mech.
- Sporadic vehicle traffic in parking lot

Noise Sources (circle all that apply): distant aircraft / (roadway traffic) / rail ops / landscaping / (rustling leaves) / children playing / dogs barking / (birds vocalizing) / (insects) / mechanical
Additional Notes and Sketches on Reverse or Indicated Separate Sheet(s)

AECOM ANCP, Field Noise Measurement Form, Vers. 1.3 rev081816 LxT_Data.009

AECOM Acoustics and Noise Control Practice

FIELD NOISE MEASUREMENT DATA FORM

Project Name: MDOT US-12/M-51 Project #: 60666488 Date: 9.21.2021 Page 1 of 1

Measurement Location: NSA-S3 13A 1016 Bell Rd Analyst: B. Vasquez

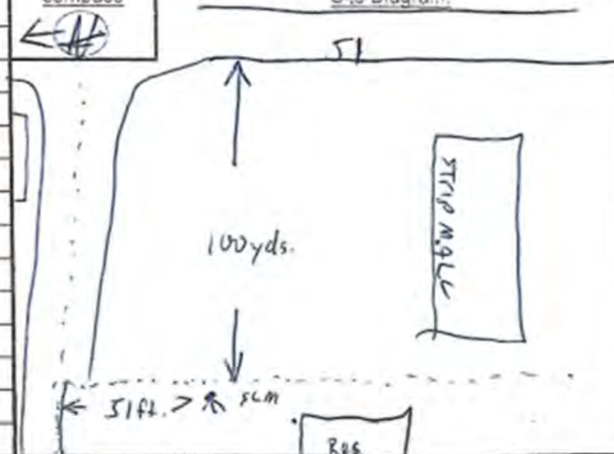
Sound Level Meter	Field Calibration	Meteorological Data
Model #: LD LXT	Model #: LD CAL 200	Model #: Kestrel 3500
Serial #: 4491	Serial #: 5789	Serial #:
Weighting: A / C / Flat	Calibrator Level (dB): 94 / 114	Precipitation: Yes (explain) / No
Response: Slow / Fast / Impl	Pre-Test: 114 dBA	Wind: Steady / Gusty / Calm
Windscreen: Yes / No (explain)	Post-Test: dBA	Avg Wind Speed Direction: m/s / MPH
Topo: Flat / Hilly	GPS Coordinates (at SLM location):	Temp (°F): 68° RH (%): 85%
Terrain: Hard / Soft / Mixed / Agg / Snow	N: 41°47'52 W: 86°15'0"	Bar Pr (Hg): Cloud Cover (%):

Loc ID	Start Time (hh:mm)	Stop Time (hh:mm)	Metrics L_{eq}	L	L	Statistics L	L	L	Notes Events
ST-13A	12:05	12:30	57.5						
			56.8						spike at 12:08 big truck passing
			56.9						" " 12:4 big truck "
			68.8						" " 12:25 UPS passing
			62.1						
			56.9						
			61.1						
			59.6						
			59.6						
			58.8						
			57.0						
			58.0						
			59.6						
			55.5						
			59.0						4486Data.007

Roadway Name Dir	M-51 S	
Speed (post/obs*)		
Number of Lanes	2	
Width (pave/row)		
1- or 2-way		
Grade	–	
Bus Stops		
Stoplights	yes	
Motorcycles	1	
Automobiles	234	
Medium Trucks	2	
Heavy Trucks	3	
Buses		
Count duration		

compass

Site Diagram:



- note coordinate system if other than NAD84 * - Speed estimated by Radar / Driving / Observation

Photos Taken? Yes / No

Additional Notes/Comments:

Noise Sources (circle all that apply): distant aircraft/roadway traffic/rail ops/landscaping/rustling leaves/children playing/dogs barking/birds vocalizing/insects/mechanical

Additional Notes and Sketches on Reverse or Indicated Separate Sheet(s)

AECOM ANCP. Field Noise Measurement Form. Vers 1.3 rev081816

AECOM Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: MDOT US-12/M-51 Project #: 60666488 Date: 9/22/21 Page 1 of 1

Measurement Location: ST-14 Analyst: CH

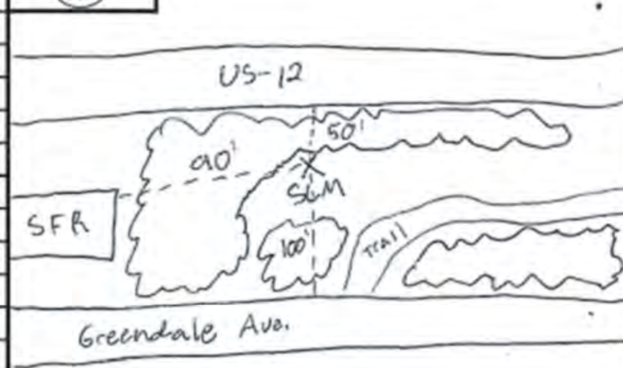
Sound Level Meter	Field Calibration	Meteorological Data
Model #: LD LXT	Model #: CAL 200	Model #: Kestrel 3500 Time Obs/Meas: 11:20
Serial #:	Serial #: 4637	Serial #: 2058303
Weighting: (A) / C / Flat	Calibration Level (dB): 94 / (114)	Precipitation: Yes (explain) / (No)
Response: (Slow) / Fast / Impl	Pre-Test -0.03 dBA	Wind: (Steady) / Gusty / Calm
Windscreen: (Yes) / No (explain)	Post-Test +0.03 dBA	Avg Wind Speed/Direction: 2 N m/s / (MPH)
Topo: Flat / (Hilly)	GPS Coordinates (at SLM location)#: 41.80071173, -86.24128676	Temp (°F): 57.3 RH (%): 79.5
Terrain: Hard / (Soft) / Mixed / Agg / Snow		Bar Psr (Hg): 29.27 Cloud Cover (%): 100

Loc. ID	Start Time (hh:mm)	Stop Time (hh:mm)	L_{eq}	L_{min}	L_{max}	L_{10}	L_{50}	L_{90}	Notes/Events
	11:15	11:40							
	11:20		67.8						
	11:25		70.3						
	11:30		68.3						
	11:35		69.9						

Roadway Name/Dir.	US-12	
Speed (post/obs*)	50	
Number of Lanes	4	
Width (pave/row)		
1- or 2- way	2	
Grade		
Bus Stops		
Stoplights		
Motorcycles		
Automobiles		
Medium Trucks		
Heavy Trucks		
Buses		
Count duration		

compass: (N)

Site Diagram:



- note coordinate system if other than NAD84 * - Speed estimated by Radar / (Driving) Observation

Photos Taken? (Yes) / No

Additional Notes/Comments: Distant landscaping work audible 11:15-11:27
-Vehicle Counts from Camera on US-12

Noise Sources (circle all that apply): distant aircraft / (roadway traffic) / rail ops / landscaping / (rustling leaves) / children playing / dogs barking / (birds vocalizing) / (insects) / mechanical

Additional Notes and Sketches on Reverse or Indicated Separate Sheet(s)

AECOM ANCP, Field Noise Measurement Form, Vers. 1.3 rev081816 File. 010

Equipment Calibration Certificates

CERTIFICATE OF CALIBRATION
26401-1
FOR LARSON DAVIS PRECISION INTEGRATING SOUND LEVEL METER

Model **LxT1** Serial No. **0004926**
ID No. **4926**
With Microphone **377C20** Serial No. **151721**
With Preamplifier **PRMLxT1L** Serial No. **042680**

Customer: **AECOM**
San Diego, CA 92101 P.O. No. **Credit Card**

was tested and met Larson Davis specifications at the points tested and as outlined in ANSI S1.4-1983 Type 1; IEC 61672-2002 Class1; 60651-2001 Type 1

on **07 JUN 2021** BY **HAROLD LYNCH**
Service Manager

As received and as left condition: Within Specification.
Re-calibration due on: **07 JUN 2022**

Certified References*

Mfg.	Type	Serial No.	Cal Date	Due Date
B&K	1051	1777523	28 SEP 2020	28 SEP 2021
B&K	2636	1423390	04 JAN 2021	04 JAN 2022
B&K	4226	3274134	30 NOV 2020	30 NOV 2021
B&K	4231	1770857	10 SEP 2020	10 SEP 2021
HP	34401A	MY45023668	28 JAN 2021	28 JAN 2022
HP	3458A	2823A07179	21 JUL 2020	21 JUL 2021

Performed in Compliance with ANSI, NCSL Z-540-1, 1994
and ISO 17025, ISO 9001:2015 Certification NQA No. 11252
*References are traceable to NIST (National Institute of Standards and Technology).

Note: For calibration data see enclosed pages.
The data represent both "as found" and "as left" conditions.

Reference Test Procedure: **ACCT Procedure LxT-831 Version 0.5.1.**

Temperature	Relative Humidity	Barometric Pressure
23°C	41 %	986.52 hPa

Note: This calibration report shall not be reproduced, except in full, without written consent by Odin Metrology, Inc.

Signed: [signature]

ODIN METROLOGY, INC.
CALIBRATION OF SOUND & VIBRATION INSTRUMENTATION
3533 OLD CONEJO ROAD, SUITE 125 THOUSAND OAKS CA 91320
PHONE: (805) 375-0830 FAX: (805) 375-0405

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Odin Metrology, Inc.
Calibration of Sound & Vibration Instruments

Certificate Number: **26401-6**

Certificate of Calibration for Larson Davis Calibrator

This calibration is performed by comparison with measurement reference standard microphone:

Type No.	4134
Serial No.	1315901
Calibrated by	HL
Cal Date	24 MAR 2021
Due Date	24 MAR 2022

a) Estimated uncertainty of comparison: ± 0.05 dB
b) Estimated uncertainty of calibration service for standard pistonphone: ± 0.06 dB
c) Total uncertainty: $\sqrt{a^2+b^2}$ = ± 0.08 dB
d) Expanded uncertainty (coverage factor k = 2 for 95% confidence level): = ± 0.16 dB

This acoustic calibrator has been calibrated using standards with values traceable to the National Institute of Standards and Technology. This calibration is traceable to NIST Test Number **683/289533-17.**

Condition of Test		
Ambient Pressure	**989.33**	hPa
Temperature	**23**	°C
Relative Humidity	**41**	%
Date of Calibration	**08 JUN 2021**	
Re-calibration due on	**08 JUN 2022**	

The calibration of this acoustic calibrator was performed using a test system conforming to the requirements of ANSI/NCSLZ540-1, 1994, ISO 17025, and ISO 9001:2015, Certification NQA No. 11252.

Calibration procedure: **OM-P-1001-Acoustic_Calibrator, Rev. 1.0 20130522.**

Calibration performed by [signature]

Harold Lynch, Service Manager

Calibrator type	**CAL200**
Serial no.	**4637**
Submitted by	**AECOM** **San Diego, CA 92101**
Purchase order no.	**Credit Card**
Asset no.	**N/A**

This calibrator has been found to perform **within** the specifications listed below at the normalized conditions stated.

SPL produced in coupler terminated by a loading volume of a ½" microphone	94.0 ± 0.2 dB 114 ± 0.2 dB
Frequency	1,000 Hz ± 1%
Distortion	< 2%
At 1,013 hPa, 23°C, and 65% relative humidity	

Performance as Received		
Frequency	**1000.1**	Hz
SPL (94 dB)	**93.97**	dB
SPL (114 dB)	**113.97**	dB
Distortion (at 94 dB)	**0.3**	%
Battery Voltage	**9.4**	V

Was adjustment performed? **No**
Were batteries replaced? **No**

Final Performance		
Frequency	**1000.1**	Hz
SPL (94 dB)	**93.97**	dB
SPL (114 dB)	**113.97**	dB
Distortion (at 94 dB)	**0.3**	%

Note: This calibrator was **within** manufacturer's specifications as received.

Odin Metrology, Inc.
3533 Old Conejo Road, Suite 125
Thousand Oaks, CA 91320
Phone: (805) 375-0830; Fax: (805) 375-0405

Note: This calibration report shall not be reproduced, except in full, without written consent of Odin Metrology, Inc.

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Doc. Rev. 18 Jun 2020

CERTIFICATE OF CALIBRATION
26354-7
FOR LARSON DAVIS PRECISION INTEGRATING SOUND LEVEL METER

Model **LxT1** | Serial No. **0004486**
ID No. **N/A**

With Microphone **377B20** | Serial No. **149336**
With Preamplifier **PRMLxT1L** | Serial No. **029355**

Customer: **AECOM**
San Diego, CA 92101 | P.O. No. **Credit Card**

was tested and met Larson Davis specifications at the points tested and as outlined in ANSI S1.4-1983 Type 1; IEC 61672-2002 Class1; 60651-2001 Type 1

on **06 MAY 2021** BY **HAROLD LYNCH**
Service Manager

As received and as left condition: Within Specification.
Re-calibration due on: **06 MAY 2022**

Certified References*

Mfg.	Type	Serial No.	Cal Date	Due Date
B&K	1051	1777523	28 SEP 2020	28 SEP 2021
B&K	2636	1423390	04 JAN 2021	04 JAN 2022
B&K	4226	3274134	30 NOV 2020	30 NOV 2021
B&K	4231	1770857	10 SEP 2020	10 SEP 2021
HP	34401A	MY45023668	28 JAN 2021	28 JAN 2022
HP	3458A	2823A07179	21 JUL 2020	21 JUL 2021

Performed in Compliance with ANSI, NCSL Z-540-1, 1994
and ISO 17025, ISO 9001:2015 Certification NQA No. 11252
*References are traceable to NIST (National Institute of Standards and Technology).

Note: For calibration data see enclosed pages.
The data represent both "as found" and "as left" conditions.

Reference Test Procedure: **ACCT Procedure LxT-831 Version 0.5.1.**

Temperature	Relative Humidity	Barometric Pressure
23°C	**37** %	**990.38** hPa

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CALIBRATION OF SOUND & VIBRATION INSTRUMENTATION
3533 OLD CONEJO ROAD, SUITE 125 THOUSAND OAKS CA 91320
PHONE: (805) 375-0830 FAX: (805) 375-0405

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Appendix B Sample TNM Input/Output Files

Sample TNM output tables are provided for CNE 4 Abatement analysis. Additional input and output files are available upon request.

CNE 4 TNM Sound Level Prediction Output Table

Sound Levels : Barrier_4_2-4

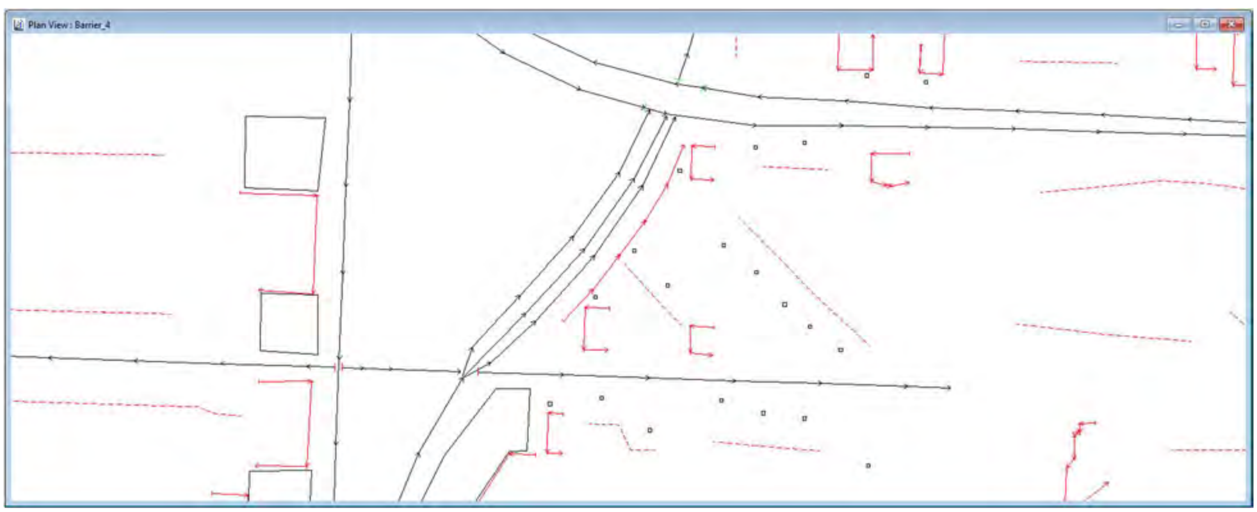
AECOM | 15 December 2021
GH | TNM 2.5
| Calculated with TNM 2.5

RESULTS: SOUND LEVELS
PROJECT/CONTRACT: MDOT US12/M51
RUN: Barrier 4 Analysis
BARRIER DESIGN: Uniform 10'
ATMOSPHERICS: 68 deg F, 50% RH

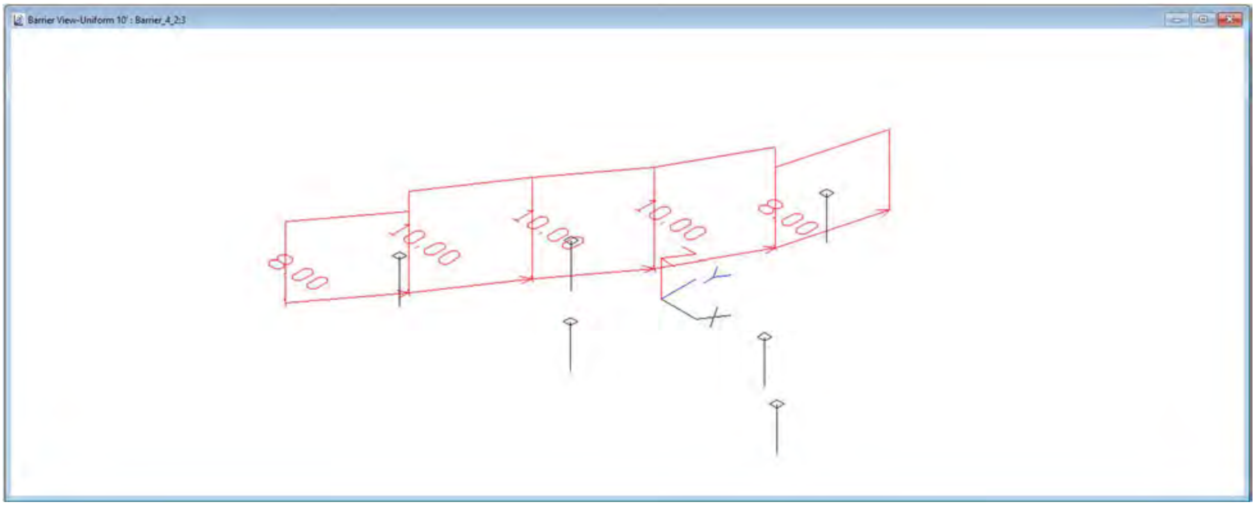
Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

Receiver Name	No.	#DUs	Existing LAeq1h	No Barrier LAeq1h Calculated	No Barrier LAeq1h Crit'n	Increase over existing Calculated	Increase over existing Crit'n Sub'l Inc	Type Impact	With Barrier Calculated LAeq1h	Noise Reduction Calculated	Noise Reduction Goal	Calculated minus Goal
			dBA	dBA	dBA	dB	dB		dBA	dB	dB	dB
04-11	81	1	0.0	60.4	66	60.4	10	—	57.7	2.7	8	-5.3
04-08	78	1	0.0	62.8	66	62.8	10	—	58.6	4.2	8	-3.8
04-07	77	1	0.0	63.1	66	63.1	10	—	58.0	5.1	8	-2.9
04-04	74	1	0.0	70.6	66	70.6	10	Snd Lvl	61.2	9.4	8	1.4
04-03	73	2	0.0	69.5	66	69.5	10	Snd Lvl	58.0	11.5	8	3.5
04-02	72	1	0.0	69.6	66	69.6	10	Snd Lvl	58.6	11.0	8	3.0

Plan View



Barrier Analysis Screenshot



Barrier Description Table

Barrier Descriptions Table : Barrier_4_2.5

AECOM — 15 December 2021
GH — TNM 2.5

RESULTS: BARRIER DESCRIPTIONS
PROJECT/CONTRACT: MDOT US12/M51
RUN: Barrier 4 Analysis
BARRIER DESIGN: Uniform 10'

Barriers

Name	Type	Heights along Barrier			Length	If Wall	If Berm			Cost
		Min	Avg	Max		Area	Volume	Top Width	Run:Rise	
		ft	ft	ft	ft	sq ft	cu yd	ft	ft:ft	$
Proposed Barrier 4	W	8.00	9.20	10.00	250	2302				103605
									Total Cost:	103605

Appendix C Predicted Noise Levels and Impacts

Table C-1 Loudest Hour Noise Levels, Leq(1h), dBA

Receptor Number	Land Use	Activity Category	Units	FHWA/MDOT NAC	Existing	Build	Change
			CNE 1				
01-01	Residential	B	1	66	61	**66**	5
01-02	Residential	B	1	66	64	**69**	4
01-03	Residential	B	1	66	63	**68**	6
01-04	Residential	B	1	66	63	**69**	5
01-05	Residential	B	1	66	61	64	3
01-06	Residential	B	1	66	61	64	3
01-07	Residential	B	1	66	62	64	2
01-08	Residential	B	1	66	62	64	2
01-09	Residential	B	1	66	62	64	2
01-10	Residential	B	1	66	61	63	2
01-11	Residential	B	1	66	62	64	2
01-12	Residential	B	1	66	63	**66**	2
01-13	Residential	B	1	66	65	**68**	2
01-14	Residential	B	1	66	**66**	**68**	2
01-15	Residential	B	1	66	61	62	1
01-16	Residential	B	1	66	61	61	0
01-17	Residential	B	1	66	65	**66**	1
01-18	Residential	B	1	66	**66**	**66**	1
01-19	Residential	B	1	66	63	63	1
01-20	Residential	B	1	66	62	63	1
01-21	Residential	B	1	66	62	62	1
01-22	Residential	B	1	66	61	61	1
01-23	Residential	B	1	66	56	57	1
01-24	Residential	B	1	66	55	55	1
01-25	Residential	B	1	66	56	56	1
01-26	Residential	B	1	66	58	59	1
01-27	Residential	B	1	66	58	59	1
01-28	Residential	B	1	66	58	59	1
01-29	Residential	B	1	66	61	62	1
01-30	Residential	B	1	66	61	61	1
01-31	Residential	B	1	66	55	56	1
01-32	Residential	B	1	66	53	54	1
01-33	Residential	B	1	66	56	56	0
01-34	Residential	B	1	66	56	57	0
01-35	Residential	B	1	66	58	58	0
01-36	Residential	B	1	66	59	61	2
01-37	Residential	B	1	66	60	61	2
01-38	Residential	B	1	66	60	62	1
01-39	Residential	B	1	66	60	61	1
01-40	Residential	B	1	66	58	59	1
01-41	Residential	B	1	66	57	58	1
01-42	Residential	B	1	66	57	58	1
01-43	Residential	B	1	66	56	58	1
01-44	Residential	B	1	66	57	58	2
01-45	Residential	B	1	66	57	58	2
01-46	Residential	B	1	66	57	60	2
01-47	Residential	B	1	66	58	60	2
01-48	Residential	B	1	66	58	60	2
01-49	Residential	B	1	66	58	60	2
01-50	Residential	B	1	66	57	59	2
01-51	Residential	B	1	66	58	60	2
01-52	Residential	B	1	66	58	60	2
01-53	Residential	B	1	66	57	60	2

Receptor Number	Land Use	Activity Category	Units	FHWA/MDOT NAC	Existing	Build	Change
01-54	Residential	B	1	66	56	58	2
01-55	Residential	B	1	66	53	55	2
01-56	Residential	B	1	66	54	56	2
				CNE 2			
02-01	Commercial (Restaurant)	E	0	71	67	68	1
02-02	Residential	B	1	66	54	55	1
02-03	Residential	B	6	66	57	57	1
02-04	Residential	B	1	66	60	61	1
02-05	Residential	B	1	66	53	54	1
02-06	Residential	B	1	66	54	55	1
02-07	Residential	B	1	66	57	58	1
02-08	Residential	B	1	66	53	53	1
02-09	Residential	B	1	66	53	53	1
02-10	Residential	B	1	66	52	53	1
02-11	Residential	B	1	66	54	55	1
02-12	Residential	B	1	66	52	52	1
				CNE 3			
03-01	Active Sport Area	C	0	66	57	57	1
03-02	Cemetery	C	0	66	61	62	1
03-03	Cemetery	C	1	66	**68**	**69**	1
03-04	Cemetery	C	1	66	**68**	**69**	1
03-05	Cemetery	C	1	66	**68**	**69**	1
03-06	Cemetery	C	1	66	**68**	**69**	1
03-07	Cemetery	C	1	66	**68**	**69**	1
03-08	Cemetery	C	1	66	**69**	**69**	1
03-09	Cemetery	C	1	66	**69**	**69**	1
03-10	Cemetery	C	1	66	**69**	**70**	1
				CNE 4			
04-01	Residential	B	1	66	**66**	**67**	1
04-02	Residential	B	1	66	**69**	**70**	1
04-03	Residential	B	2	66	**69**	**70**	1
04-04	Residential	B	1	66	**70**	**71**	1
04-05	Residential	B	1	66	60	60	0
04-06	Residential	B	1	66	64	64	0
04-07	Residential	B	1	66	63	63	1
04-08	Residential	B	1	66	62	63	1
04-09	Residential	B	1	66	**71**	**71**	0
04-10	Residential	B	1	66	59	59	0
04-11	Residential	B	1	66	60	60	0
04-12	Residential	B	1	66	**72**	**72**	0
04-13	Residential	B	1	66	60	60	0
04-14	Residential	B	1	66	59	59	0
04-15	Residential	B	1	66	58	58	0
04-16	Residential	B	1	66	58	59	0
04-17	Residential	B	1	66	58	58	0
04-18	Residential	B	1	66	58	58	0
04-19	Residential	B	1	66	56	56	0
				CNE 5			
05-01	Residential	B	1	66	**68**	**68**	0
05-02	Residential	B	1	66	**70**	**70**	0
05-03	Residential	B	1	66	64	65	0
05-04	Residential	B	1	66	61	62	0
05-05	Residential	B	1	66	65	65	0
05-06	Residential	B	1	66	**66**	**66**	0
05-07	Residential	B	1	66	**69**	**69**	0
05-08	Residential	B	1	66	65	65	0
05-09	Residential	B	1	66	56	56	0
05-10	Residential	B	1	66	58	58	0

Receptor Number	Land Use	Activity Category	Units	FHWA/MDOT NAC	Existing	Build	Change
05-11	Residential	B	1	66	53	53	0
05-12	Residential	B	1	66	57	57	0
05-13	Residential	B	1	66	51	52	0
05-14	Residential	B	1	66	50	51	0
05-15	Residential	B	1	66	46	46	0
05-16	Residential	B	1	66	51	51	0
05-17	Residential	B	1	66	56	56	0
05-18	Residential	B	1	66	60	60	0
05-19	Residential	B	1	66	59	60	0
05-20	Residential	B	1	66	55	55	0
05-21	Residential	B	1	66	55	55	0
05-22	Residential	B	1	66	59	59	0
05-23	Residential	B	1	66	53	53	0
05-24	Residential	B	1	66	50	51	0
05-25	Residential	B	1	66	49	49	0
05-26	Residential	B	1	66	47	48	0
CNE 6							
06-01	Residential	B	1	66	64	64	0
06-02	Residential	B	1	66	61	62	1
06-03	Residential	B	1	66	60	60	1
06-04	Residential	B	1	66	61	61	0
06-05	Residential	B	1	66	59	59	1
06-06	Residential	B	1	66	62	62	0
06-07	Residential	B	1	66	62	63	0
06-08	Residential	B	1	66	61	62	1
06-09	Residential	B	1	66	60	60	1
06-10	Residential	B	1	66	61	61	1
06-11	Residential	B	1	66	59	59	1
06-12	Residential	B	1	66	52	53	1
06-13	Residential	B	1	66	52	53	1
06-14	Residential	B	1	66	52	53	1
06-15	Residential	B	1	66	52	52	1
06-16	Residential	B	1	66	51	52	1
06-17	Residential	B	1	66	51	51	1
06-18	Residential	B	1	66	58	59	1
06-19	Residential	B	1	66	58	59	1
06-20	Residential	B	1	66	58	59	0
06-21	Residential	B	1	66	56	56	0
06-22	Residential	B	1	66	61	62	0
06-23	Residential	B	1	66	60	61	0
06-24	Residential	B	1	66	57	57	0
06-25	Residential	B	1	66	59	59	0
06-26	Residential	B	1	66	60	60	0
06-27	Residential	B	1	66	60	60	0
06-28	Residential	B	1	66	56	56	0
06-29	Residential	B	1	66	55	55	0
06-30	Residential	B	1	66	59	59	0
06-31	Residential	B	1	66	60	61	0
06-32	Residential	B	1	66	57	58	0
06-33	Residential	B	1	66	56	57	1
06-34	Residential	B	1	66	57	58	1
06-35	Residential	B	1	66	50	50	1
06-36	Residential	B	1	66	50	51	1
06-37	Residential	B	1	66	51	51	1
06-38	Residential	B	1	66	50	51	1
06-39	Residential	B	1	66	59	59	0
06-40	Residential	B	1	66	59	60	0
06-41	Residential	B	1	66	54	54	0
06-42	Residential	B	1	66	55	55	0
06-43	Residential	B	1	66	59	59	0

Receptor Number	Land Use	Activity Category	Units	FHWA/MDOT NAC	Existing	Build	Change
06-44	Residential	B	1	66	63	63	0
06-45	Residential	B	1	66	65	65	0
06-46	Residential	B	1	66	61	61	0
06-47	Residential	B	1	66	57	58	0
06-48	Residential	B	1	66	54	54	0
06-49	Residential	B	1	66	57	57	0
06-50	Residential	B	1	66	58	59	0
06-51	Residential	B	1	66	54	55	0
06-52	Residential	B	1	66	54	55	0
CNE 7							
07-01	Commercial (Restaurant)	E	0	71	69	69	1
CNE 8							
08-01	Residential	B	1	66	60	60	1
08-02	Residential	B	1	66	58	59	2
08-03	Trail	C	0	66	58	60	2
08-04	Trail	C	0	66	64	64	0
08-05	Residential	B	1	66	**66**	**67**	1
08-06	Church	C	0	66	63	63	0
08-07	Residential	B	1	66	60	59	-1
CNE 9							
09-01	Residential	B	1	66	**66**	**67**	1
09-02	Residential	B	1	66	61	61	1
09-03	Residential	B	1	66	57	58	1
09-04	Residential	B	1	66	56	56	1
09-05	Residential	B	1	66	56	56	1
09-06	Residential	B	1	66	56	57	0
09-07	Residential	B	1	66	**68**	**69**	1
09-08	Residential	B	1	66	65	65	0
09-09	Residential	B	1	66	**66**	**66**	0
09-10	Residential	B	1	66	65	65	0
09-11	Residential	B	1	66	64	64	0
09-12	Residential	B	1	66	63	64	0
09-13	Residential	B	1	66	63	64	1
09-14	Residential	B	1	66	64	64	1
CNE 10 (No Receivers)							
CNE 11							
11-01	Residential	B	1	66	54	55	1
11-02	Residential	B	1	66	55	56	1
11-03	Residential	B	1	66	56	56	1
11-04	Residential	B	1	66	56	57	1
11-05	Residential	B	1	66	56	57	1
11-06	Residential	B	1	66	55	55	1
11-07	Residential	B	1	66	55	56	1
11-08	Residential	B	1	66	57	57	1
11-09	Residential	B	1	66	56	57	1
11-10	Residential	B	1	66	54	55	1
11-11	Residential	B	1	66	53	54	1
11-12	Residential	B	1	66	53	53	1
CNE 12							
12-01	Residential	B	1	66	**66**	**66**	0
12-02	Residential	B	1	66	**66**	**66**	0
12-03	Residential	B	1	66	**66**	**67**	0
12-04	Residential	B	1	66	61	63	3
12-05	Residential	B	1	66	**68**	**71**	3
12-06	Residential	B	1	66	**68**	**70**	3
12-07	Residential	B	1	66	**69**	**70**	1
12-08	Residential	B	1	66	57	58	0
12-09	Residential	B	1	66	58	59	0
12-10	Residential	B	1	66	60	62	2

Receptor Number	Land Use	Activity Category	Units	FHWA/MDOT NAC	Existing	Build	Change
12-11	Residential	B	1	66	60	62	2
12-12	Residential	B	1	66	60	60	1
12-13	Residential	B	1	66	61	61	1
12-14	Residential	B	1	66	61	62	1
12-15	Residential	B	1	66	60	61	1
12-16	Residential	B	1	66	59	60	1
12-17	Residential	B	1	66	59	59	1
12-18	Residential	B	1	66	59	60	1
12-19	Residential	B	1	66	59	61	2
12-20	Residential	B	1	66	59	61	2
12-21	Residential	B	1	66	63	64	1
12-22	Residential	B	1	66	54	55	0
12-23	Residential	B	1	66	54	54	0
12-24	Residential	B	1	66	54	54	0
12-25	Residential	B	1	66	56	56	0
12-26	Residential	B	1	66	55	55	0
12-27	Residential	B	1	66	57	58	0
12-28	Residential	B	1	66	57	57	1
12-29	Residential	B	1	66	54	55	1
12-30	Residential	B	1	66	55	57	1
12-31	Residential	B	1	66	55	57	2
12-32	Residential	B	1	66	58	60	1

Note: Bolded values represent noise impacts.

Appendix D Noise Barrier Analysis Detail

Table D-1 Noise Barrier Analysis, Receiver Level Detail

Receptor Number	Land Use	Category	Units	FHWA/MDOT NAC	Build	Noise Level w/Barr	Noise Reduction	Benefit?
Wall 1A								
01-01	Residential	B	1	66	**66**	61	5	Y
01-02	Residential	B	1	66	**69**	61	8	Y
01-03	Residential	B	1	66	**68**	59	10	Y
01-04	Residential	B	1	66	**69**	59	10	Y
01-05	Residential	B	1	66	64	57	7	Y
01-06	Residential	B	1	66	64	57	6	Y
01-07	Residential	B	1	66	64	61	3	
01-08	Residential	B	1	66	64	62	2	
01-09	Residential	B	1	66	64	62	2	
01-10	Residential	B	1	66	63	62	1	
01-11	Residential	B	1	66	64	62	3	
01-12	Residential	B	1	66	**66**	59	6	Y
01-13	Residential	B	1	66	**68**	58	9	Y
01-14	Residential	B	1	66	**68**	58	10	Y
Wall 1B								
01-16	Residential	B	1	66	61	60	1	
01-17	Residential	B	1	66	**66**	62	4	
01-18	Residential	B	1	66	**66**	59	7	Y
01-19	Residential	B	1	66	63	59	4	
01-20	Residential	B	1	66	63	60	3	
01-21	Residential	B	1	66	62	61	1	
01-22	Residential	B	1	66	61	61	1	
01-33	Residential	B	1	66	56	54	2	
01-34	Residential	B	1	66	57	55	2	
01-35	Residential	B	1	66	58	57	1	
Wall 3								
03-03	Cemetery	C	1	66	**69**	64	5	Y
03-04	Cemetery	C	1	66	**69**	62	7	Y
03-05	Cemetery	C	1	66	**69**	62	8	Y
03-06	Cemetery	C	1	66	**69**	61	8	Y
03-07	Cemetery	C	1	66	**69**	60	10	Y
03-08	Cemetery	C	1	66	**69**	61	8	Y
03-09	Cemetery	C	1	66	**69**	63	7	Y
03-10	Cemetery	C	1	66	**70**	64	5	Y
Wall 4								
04-02	Residential	B	1	66	**70**	59	11	Y
04-03	Residential	B	2	66	**70**	58	12	Y
04-04	Residential	B	1	66	**71**	61	9	Y
04-07	Residential	B	1	66	63	58	5	Y
04-08	Residential	B	1	66	63	59	4	
04-11	Residential	B	1	66	60	58	3	
Wall 5								
05-06	Residential	B	1	66	**66**	62	5	Y
05-07	Residential	B	1	66	**69**	59	10	Y
Wall 12								

Receptor Number	Land Use	Category	Units	FHWA/MDOT NAC	Build	Noise Level w/Barr	Noise Reduction	Benefit?
12-02	Residential	B	1	66	**66**	65	0	
12-03	Residential	B	1	66	**67**	**66**	0	
12-04	Residential	B	1	66	63	62	1	
12-05	Residential	B	1	66	**71**	65	6	Y
12-06	Residential	B	1	66	**70**	60	10	Y
12-09	Residential	B	1	66	59	58	0	
12-10	Residential	B	1	66	62	60	2	
12-11	Residential	B	1	66	62	60	2	
12-12	Residential	B	1	66	60	59	1	
12-13	Residential	B	1	66	61	60	2	
12-14	Residential	B	1	66	62	60	2	
12-15	Residential	B	1	66	61	59	2	
12-16	Residential	B	1	66	60	58	2	
12-17	Residential	B	1	66	59	58	2	
12-18	Residential	B	1	66	60	58	2	
12-19	Residential	B	1	66	61	60	1	
12-20	Residential	B	1	66	61	61	0	
12-27	Residential	B	1	66	58	57	0	
12-28	Residential	B	1	66	57	57	1	
12-29	Residential	B	1	66	55	53	1	