Final Highway Traffic Noise Report
I-496 Design-Build
Lansing Road to Grand River

Prepared for

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

March 30, 2022

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

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

Table of Contents

Figures

Tables

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
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
LT	Long-Term
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 and potential noise abatement associated with an I-496 Lansing Road to Grand River Design-Build improvement project in Lansing, MI. I-496 in this area experiences a high volume of traffic daily. This project is intended to ease congestion, increase safety by adding new east bound and west bound auxiliary lanes between Lansing Road and the Martin Luther King Jr. Blvd ramps, and realigning through traffic lanes closer to the center of the roadway between Lansing Road and Grand Avenue and Walnut St. ramps.

FHWA defines Type I projects as Federal highway projects in a new location, a physical alteration of an existing highway that significantly changes either horizontal or vertical alignment or increases the number of through lanes. The I-496 Lansing Road to Grand River MDOT project includes the addition of an auxiliary lane totaling approximately 2800 ft. and ramp realignment; thus meeting the Type 1 project criteria under Title 23: Highways - Part 772.5. FHWA requires a noise study for all Type I projects to assess potential noise impacts and mitigation options.

This noise study included on site noise measurements in the project vicinity, conducted in October of 2020. Two long-term measurements were conducted, one along each side of the highway, along with ten short-term measurements dispersed across the project area.

A 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. These predicted levels were checked against FHWA and MDOT noise abatement criteria standards to determine impacts in the area. Noise Abatement for these impacts were analyzed according to MDOT feasibility and reasonableness standards.

The project included ten Common Noise Environments (CNEs), with impacts identified in nine of the ten. Abatement was considered in several locations but only recommended in one. A summary of these findings is presented in Table ES-0-1 and discussed in more detail in the body of the report.

Table ES-0-1 Summary of Project Impacts and Proposed Noise Abatement

CNE	Description/Location	2020 Impact	2040 Impacts	Recommended Noise Abatement
CNE-1	Single family homes, North of I-496, West of Grand Ave.	12	12	677-foot noise barrier
CNE-2	Multi-family residential, South of I-496, West of Grand Ave.	2	2	Not Recommended
CNE-3	Mixed use, commercial residential North of I-496 Between Grand and Walnut	0	0	No Impacts
CNE-4	Michigan Women’s Historical Center and Gardens, South of I-496, between Grand and Townsend	2	2	Not Recommended
CNE-5	Mixed use, commercial and residential North of I-496, Between Walnut and Pine	5	5	Not Recommended
CNE-6	Mixed use, commercial and residential North of I-496, Between Pine and MLK Jr. Blvd	29	29	Not Recommended
CNE-7	Single family homes, North of I-496, Between MLK Jr. Blvd and Everett	35	35	Not Recommended
CNE-8	Single family homes, school South of I-496, Between MLK Jr. Blvd and Everett	16	16	Not Recommended
CNE-9	Single family homes, School North of I-496, Between Everett and Claire	9	9	Not Recommended
CNE-10	Single family homes, school South of I-496, Between Everett and Clare	10	10	Not Recommended

1. Introduction and Project Description

1.1 Project Description

This project includes improvements to I-496 between Lansing Road and the Grand River in Lansing Michigan. The improvements include the addition of new east bound and west bound auxiliary lanes between Lansing Road and the Martin Luther King Jr. Blvd ramps, realignment of through traffic lanes closer to the center of the roadway between Lansing Road and Grand Avenue, and realignment of Walnut St. ramps. The project would also include pavement upgrades and some structural upgrades and repairs, as required. Some pavement upgrades may also be extended to service roads, St Joseph St to the north of the highway and Malcolm X street to the south.

The general project location, project limits and areas of project improvements are shown in Figure 1-1.

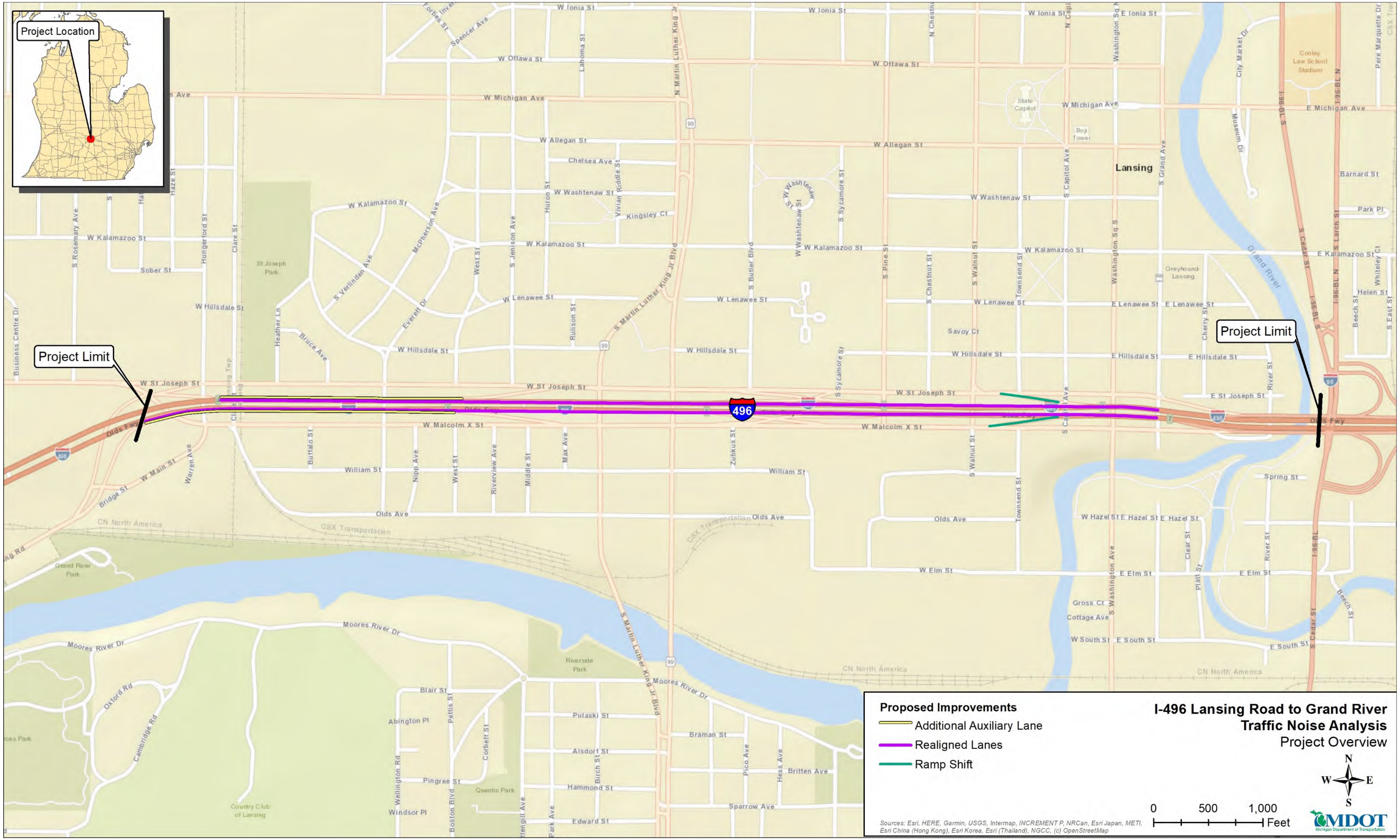
FHWA and MDOT define a Type I project as a Federal highway project being constructed in a new location, a significant change in horizontal or vertical alignment of an existing roadway, or an increase in the number of through-traffic lanes. As this project includes addition of new mainline lanes and existing lane realignment on mainline I-496, and some ramp realignments, the entire project as defined in the environmental document meets the Type 1 project criteria and requires a noise analysis.

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 2045)

Figure 1-1 Project Overview



2. Traffic Noise Concepts

This section identifies and reviews the methodology and policy for the technical tasks and analyses used in this report. The actual results of these tasks and analyses are presented in subsequent sections of this report.

2.1 Glossary of Acoustical Terms

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

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.

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.

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.

Day-night level (L_{dn}): The L_{dn} is the energy average of the A-weighted sound levels occurring during a 24-hour period, with 10 dB added to A-weighted sound levels occurring between 10 p.m. and 7 a.m. (nighttime).

Sound transmission loss (TL): The TL is a value representing 10 times the base-10 logarithm of the ratio of sound power incident on one side of a partition to the sound power transmitted through and subsequently emitting from the other side of the partition into an adjoining space (separated from the sound in the “source” space by the partition).

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 mile/hour), 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) in order 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 existing trucks, so as old trucks are phased out and replaced with newer ones the noise produced by the average truck may go down.

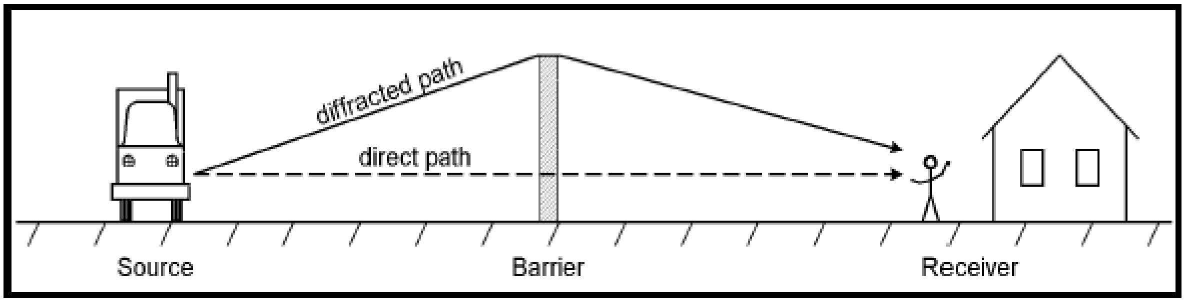
Noise Barrier Walls and Berms
Noise barriers, both structural walls and earthen berms, are often constructed specifically for the purpose of reducing highway noise levels. Noise barriers can be very effective for reducing noise levels at nearby homes, often reducing noise levels by as much as 10 decibels 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 barrier 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

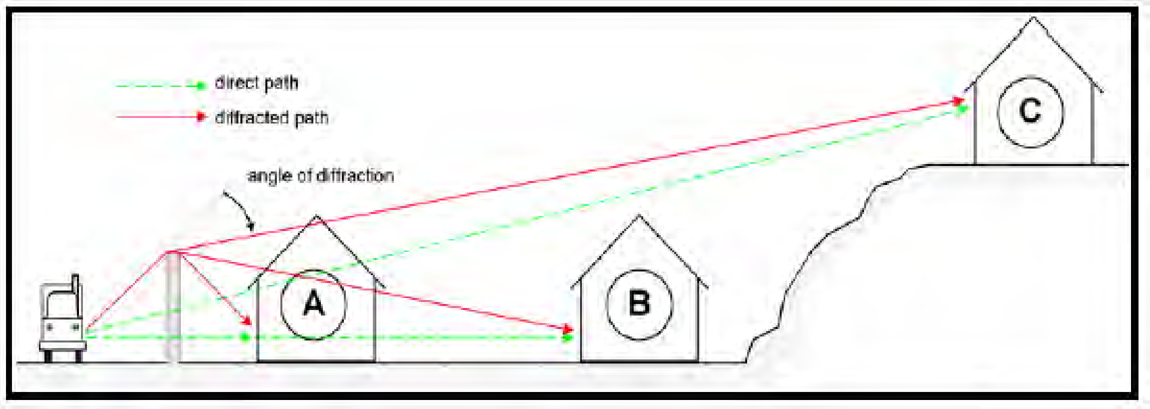
Noise barriers reduce noise levels by interrupting or lengthening the path that the noise takes between the source and the receiver. In order to be effective at reducing noise, noise barriers must be able to block the “line of sight” between the object producing the noise (like vehicles on the highway) 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 level, 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, or 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 along I-496 from Lansing Rd to Grand River 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 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 a given 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 mitigation 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 a mitigation 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 for fiscal year 2021, 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 a 10 dBA noise reduction, and that 50% of benefited receptors must achieve a 7dBA 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

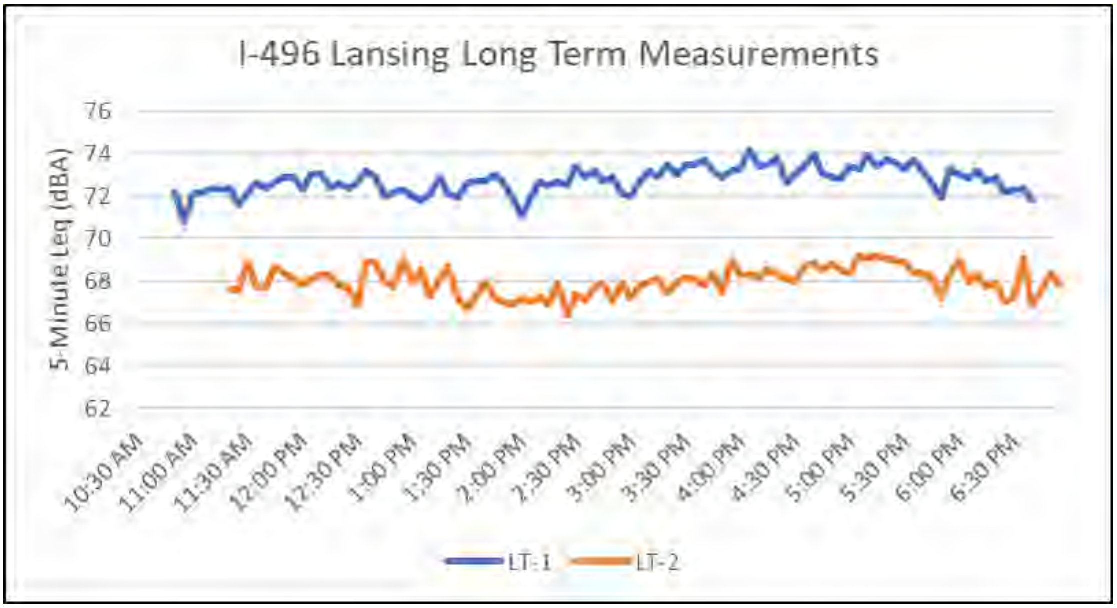
A number of field noise measurements were conducted for this project. In general, the noise measurement procedures in the field follow recommended standard procedures, including those outlined in the FHWA's Measurement of Highway Related Noise, May 1996, and the MDOT noise handbook. Specifically, the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

Two long term measurements were conducted with a 5-minute interval, one at each end of the project site. Initial plans called for 24-hour measurements to be conducted, but overnight rainstorms made this infeasible. Long term measurements were approximately 8 hours in length between approximately 11:00 am and 7:00 pm. The 5-minute levels for LT-1 and LT-2 are shown in Figure 3-1.

Figure 3-1 Long-Term Noise Measurement Data



Only ANSI (American National Standards Institute) Class I sound level meters were used for both short-term and long-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 and counted. The traffic counts can be found in Table 3-3.

All field data was recorded on field data sheets, which included the time, name and location of the measurement, instrumentation data, observed meteorological data, field calibration data, a measurement site diagram, GPS coordinates, and notes as to 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 developed in this project 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 Traffic Noise Model (TNM) Version 2.5. For each alternative, compare future noise levels (as well as increases in future noise levels over existing noise levels) to appropriate 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 mitigation 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, noise-sensitive receptors are selected 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, cross-roads. The delineated CNEs for this project are described in Section 3 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 where a noise analysis is not required. 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. For residential properties, this would normally be an exterior activity area between the structure and the proposed project roadway, such as an exterior patio, deck, pool 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 the FHWA policy and 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 utilities 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 dwelling units that receive benefits. To maintain reasonableness, the total CPBU cannot exceed $49,301.00 for fiscal year 2021. Barriers must also achieve the MDOT noise reduction design goal of 10 dBA reduction for at least one benefited receptor, and 7dBA reduction at 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 the 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 per 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, below.
- Existing terrain lines (topography) and buildings were modeled where appropriate.
- All TNM model runs were detail checked for accuracy by an independent noise analyst.
- All TNM model runs are available upon request

It is also noted that although the arterial service roads located between the I-496 travel lanes and ramps, Martin Luther King Jr Blvd, and the residential areas were not part of the project improvements, they are contributing noise sources in the adjacent neighborhoods and so were included in the TNM noise models.

3.8 Project Traffic Data

Predicted traffic data for the existing and Future Build were provided by the Michigan Department of Transportation. A summary of the traffic data used for this analysis can be found in Table 3-1.

Table 3-1 Existing and Future Traffic Volumes

	Existing Traffic (vehicles per hour)				**Future Traffic (vehicles per hour)**			
	2020 Peak Hour				**2040 Peak Hour**			
	I-496		**Frontage Roads[1]**		**I-496**		**Frontage Roads[1]**	
	EB	**WB**	**EB**	**WB**	**EB**	**WB**	**EB**	**WB**
Speed (mph) [2]	70/65/65	70/65/65	30/30/30	30/30/30	70/65/65	70/65/65	30/30/30	30/30/30
Total	3691	3407	1565	1462	4120	3803	1738	1623
Auto and Light Trucks	3601	3324	1527	1426	4020	3710	1696	1584
Medium Duty Trucks	47	43	20	19	53	48	22	21
Heavy Duty Trucks	43	39	18	17	48	44	20	19

Notes:
1. Frontage Roads include St. Joseph St. and Malcom X St.
2. Modeled speeds are for Autos/Medium Trucks/Heavy Trucks
Source MDOT Traffic Memo

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 in CNE-4, and CNE-8 appear to be former commercial or industrial land uses.

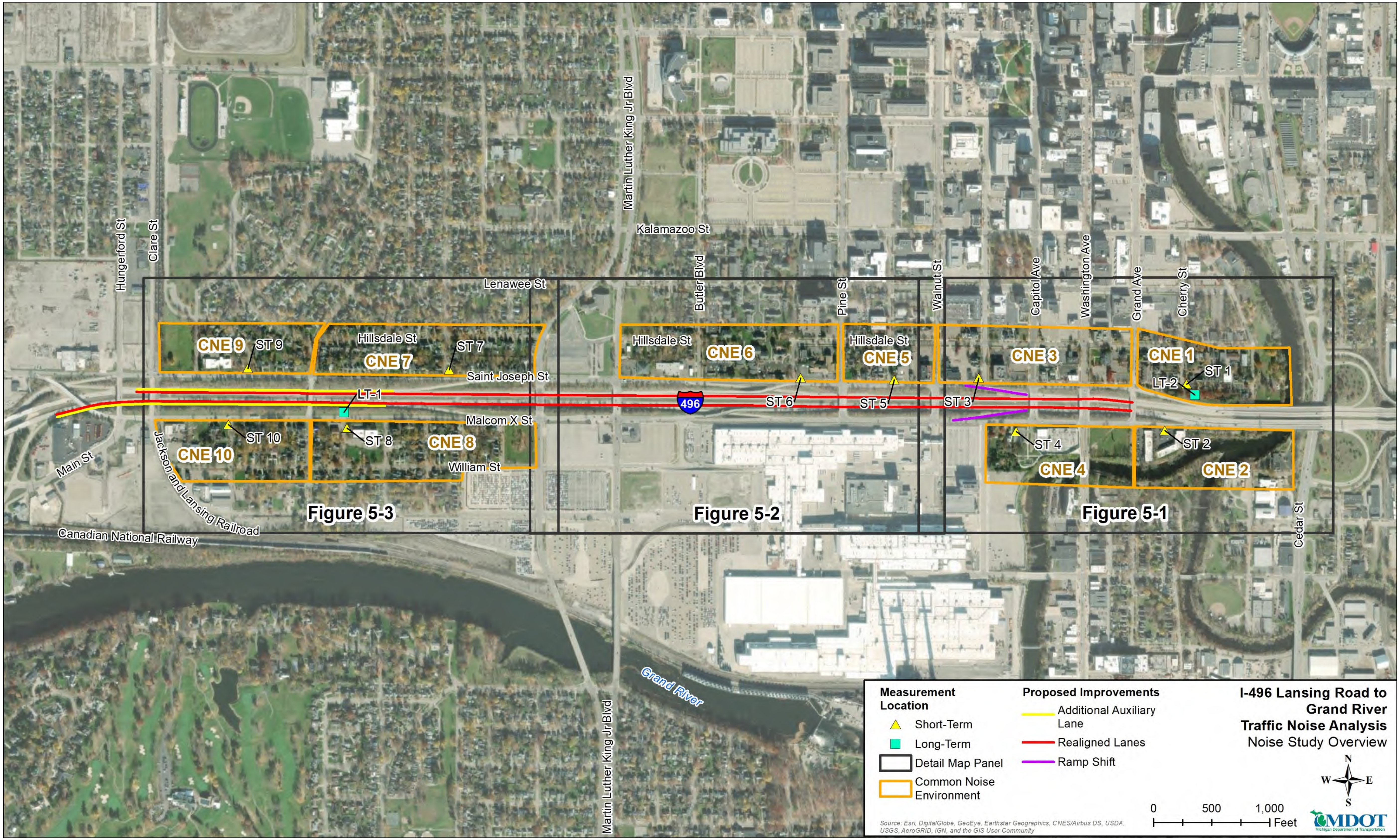
3.9.2 Common Noise Environments

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 which 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 all the defined CNEs.

Table 3-2 Common Noise Environments

CNE	Description	Land Use	Measurement ID
CNE-1	Area North of I-496, between Grand Ave and the Grand River	Single family residential, commercial, park	ST-1, LT-2
CNE-2	Area South of I-496, between Grand Ave and the Grand River	Multi-family residential, park	ST-2
CNE-3	Area North of I-496, between Walnut St and Grand Ave	Commercial, single family residential	ST-3
CNE-4	Area South of I-496 between Townsend St and Grand Ave	Park, historical buildings, undeveloped	ST-4
CNE-5	Area North of I-496, between Pine St and Walnut St	Commercial, single family residential	ST-5
CNE-6	Area North of I-496, between MLK Blvd Northbound and Pine St	Single and multi-family residential, commercial	ST-6
CNE-7	Area North of I-496, between Everett Dr and MLK Blvd Northbound	single family residential, church parking lot	ST-7
CNE-8	Area South of I-496, between Everett Dr and MLK Blvd Southbound	Single family residential, undeveloped, churches, school	ST-8
CNE-9	Area North of I-496, between Clare St and Everett Dr	Single family residential, School, park	ST-9
CNE-10	Area South of I-496, between Clare St and Everett Dr	Single family residential, industrial	ST-10, LT-1

Figure 3-2 Common Noise Environments and Noise Measurement Sites



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

3.9.3 Existing Noise Environment

3.9.3.1 Field Noise Measurements

Multiple noise measurements were conducted for this project on October 21-23, 2020. 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 2.3. Appendix A includes measurement-related materials.

A total of ten short-term (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 (TNM) was used to predict noise levels for the future build alternative as well as existing noise levels at receptor locations where noise levels are dominated by traffic noise on project roadways. To demonstrate that the noise model is predicting noise levels within a reasonable margin of error, the noise model runs are 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 current noise levels are dominated by project roadways. For this project, noise model validation was possible for all six short- term 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	Traffic			Measured Leq, dBA	Modeled Leq, dBA	Difference
ST-1, 621 Cherry St	**Type**	**I-496 EB**	**I-496 WB**	66.7	65.9	-0.8
	Auto	1156	1044			
	Medium Truck	24	4			
	Heavy Truck	44	48			
ST-2, 300 E Main St	**Type**	**I-496 EB**	**I-496 WB**	70.7	71.9	+1.2
	Auto	1035	1418			
	Medium Truck	34	23			
	Heavy Truck	71	83			
ST-3, 330 West Joseph St	**Type**	**I-496 EB**	**I-496 WB**	68.9	67.9	-1.0
	Auto	1592	1440			
	Medium Truck	4	12			
	Heavy Truck	32	40			
ST-4, 213 W Malcom X St	**Type**	**I-496 EB**	**I-496 WB**	64.8	66.3	+1.5
	Auto	1540	132			
	Medium Truck	36	12			
	Heavy Truck	44	20			
ST-5, 426 W St Joseph St	**Type**	**I-496 EB**	**I-496 WB**	69.2	67.7	-1.5
	Auto	1828	1608			
	Medium Truck	8	28			
	Heavy Truck	24	24			
ST-6, 600 W St Joseph St	**Type**	**I-496 EB**	**I-496 WB**	70.3	68.9	-1.4
	Auto	1508	696			
	Medium Truck	20	16			
	Heavy Truck	52	36			
ST-7, 623 S Jenison Ave	**Type**	**I-496 EB**	**I-496 WB**	68.9	66.0	-2.9
	Auto	1560	1068			
	Medium Truck	0	60			
	Heavy Truck	60	24			
ST-8, 1715 W Malcom X St	**Type**	**I-496 EB**	**I-496 WB**	61.6	62.6	+1.0
	Auto	1216	588			
	Medium Truck	52	16			
	Heavy Truck	68	48			
ST-9, 2101 Bruce Ave	**Type**	**I-496 EB**	**I-496 WB**	65.8	64.4	-1.4
	Auto	1260	816			
	Medium Truck	0	12			
	Heavy Truck	36	24			
ST-10, 2109 Malcolm X St	**Type**	**I-496 EB**	**I-496 WB**	63.2	63.2	0.0
	Auto	408	768			
	Medium Truck	0	24			
	Heavy Truck	0	12			

As shown in Table 3-3, all calculated differences between modeled and measured noise levels are less than 3.0 dBA, therefore the noise models in those locations are considered validated.

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 both 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 peak hour noise level of 66 dBA is considered to approach the NAC for Category B of 67 dBA and is identified as an impact, but 65 dBA does not. 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.

Future build alternative noise levels, along with existing noise levels, were predicted using the FHWA TNM Version 2.5. 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, CNE-2, CNE-3 and CNE-4), 5-2 (CNE-5 and CNE-6), and 5-3 (CNE-7, CNE-8, CNE-9 and CNE-10) contain detailed aerial-based figures 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	46	46	53.0 - 70.5	53.6 - 71.8	12	0	12
CNE-2	15	15	53.5 - 67.1	54.0 - 68.3	4	0	4
CNE-3	6	6	47.0 - 65.9	47.8 - 66.3	0	0	0
CNE-4	7	7	55.1 - 67.2	55.6 - 67.5	2	0	2
CNE-5	15	15	50.7 - 69.4	51.2 - 69.9	5	0	5
CNE-6	116	116	47.0 - 71.8	47.4 – 72.0	28	0	28
CNE-7	66	66	48.4 - 73.6	48.6 - 74.1	35	0	35
CNE-8	56	57*	48.5 - 71.6	48.8 - 71.6	16	0	16
CNE-9	26	26	48.6 - 68.2	49.0 - 68.4	9	0	9
CNE-10	24	24	47.6 - 67.9	48.0 - 68.3	10	0	10
*Note: CNE 8 contains an activity category C land use for which analysis determined 2 DUEs for receptor 08-02 for the purpose of cost-effectiveness calculation in determining reasonableness. Other activity category C land uses were deemed inapplicable for additional DUEs.							

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

In order for mitigation 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 utilities 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 for fiscal year 2021, 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 a 10 dBA noise reduction, and that 50% of benefited receptors must 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 and 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’s locations and resulting sound levels are provided in Table 5-1. The details of the barrier analysis including feasibility and reasonableness results 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 existing and predicted future build noise levels as well as the noise levels with barrier per modeled receptor location. The table also includes the information with regard to benefited receptors and barrier design goal achievement.

Table 5-1 Noise Wall Descriptions

Barrier ID	Location	Existing Leq (dBA)	Future Leq Range (dBA)		Noise Reduction (dBA)	Barrier Descriptions (feet)	
			No Wall	With Wall		Length	Avg Height
Wall 1	Directly North of the WB I-496 Off ramp between the Grand River Bridge and Grand Ave	53-70	54-70	53-68	0-10	677	18
Wall 2	North of Malcom X St between Grand Ave and the Grand River Bridge	54-67	54-68	54-68	0-5	436	20
Wall 4	North of Malcom X Blvd Between Walnut St and Capitol Ave	55-67	56-68	55-64	0-4	803	20
Wall 5	South of St Joseph St between Pine St and Walnut St	51-70	51-70	50-69	0-3	649	20
Wall 6	South of St Joseph St between MLK Blvd and Pine St	47-72	47-72	47-70	0-11	662	18
Wall 7	South of St Joseph St between Everett Dr and MLK Blvd	48-74	48-74	48-71	0-7	1952	20
Wall 8	North of Malcom X St between Everett Dr and MLK Blvd	49-72	49-72	48-68	0-8	1950	20
Wall 9	South of St Joseph St between Clare St and Everett Dr	49-68	49-68	49-66	0-4	1186	20
Wall 10	North of Malcom X St between Clare St and Everett Dr	49-68	49-68	47-66	0-6	1228	20

Table 5-2 Barrier Analysis Results

Barrier ID	Number of Attenuated Locations					Cost	Cost/Benefitted	Feasible	Reasonable	Recommended
	≥ 10 dBA	≥ 7 dBA		≥ 5 dBA (Benefitted Receptors*)						
		#	% of Benefit	#	% of Impacted					
Wall 1	1	6	55%	11	75%	$540,630.00	$49,148.18	Yes	Yes	Meets Criteria
Wall 2	0	0	0%	3	0%	$392,445.00	$130,815.00	No	No	No
Wall 4	0	0	-	0	0%	$723,330.00	-	No	No	No
Wall 5	0	0	-	0	0%	$584,145.00	-	No	No	No
Wall 6	6	15	65%	23	54%	$536,265.00	$23,315.87	No	Yes	No
Wall 7	0	13	41%	32	69%	$1,757,295.00	$54,915.47	No	No	No
Wall 8	0	10	43%	23	69%	$1,757,340.00	$76,407.09	No	No	No
Wall 9	0	0	-	0	0%	$1,067,445.00	-	No	No	No
Wall 10	0	0	0%	10	60%	$1,105,380.00	$110,538.00	No	No	No

*Note: Not all benefitted receptors are impacted. % of impacted was calculated using only those receptors which were both impacted and received benefit

5.3.1 CNE-1 Noise Abatement Analysis

CNE-1 contains 46 modelled receptors representing 45 single family residences and one park. 12 receptors were determined to be impacted under future build conditions, and a DUE calculation for the park was deemed inapplicable for the cost-effectiveness portion of the reasonableness determination since benefits do not reach the park. A barrier was analyzed along the I-496 WB off ramp, Wall 1. The western terminus of the wall at this location was limited slightly in order to maintain the viewshed for a historic building in that area at the request of the State Historic Preservation Officer. Wall 1 was found to meet MDOT feasibility and reasonableness standards. This barrier is shown in Figure 5-1 and detailed analysis metrics can be found in Tables 5-1 and 5-2.

5.3.2 CNE-2 Noise Abatement Analysis

CNE-2 contains 15 modelled receptors representing two multifamily complexes and one park. 4 Receptors were determined to be impacted under future build conditions, a DUE calculation for the park was deemed inapplicable for the cost-effectiveness portion of the reasonableness determination, since benefits do not reach the park. A barrier was analyzed North of Malcom X St, Wall 2. Wall 2 failed to meet MDOT feasibility requirements, as no impacts received a 5 dB reduction. Thus, this barrier is not recommended. This barrier is shown in Figure 5-1 and detailed analysis metrics can be found in Tables 5-1 and 5-2.

5.3.3 CNE-3 Noise Abatement Analysis

CNE-3, shown in Figure 5-1, contained no impacted receptors; thus no abatement was considered.

5.3.4 CNE-4 Noise Abatement Analysis

CNE-4 contained 7 modelled receptors representing various public outdoor spaces, all activity category C. Two of these receptors were found to be impacted, and a DUE calculation was deemed inapplicable for the cost-effectiveness portion of the reasonableness determination, since no benefits reach the receptors. A barrier was considered North of Malcom X St (with a gap for the EB on ramp). This barrier (Wall 4), failed to meet MDOT feasibility requirements, as no receptors received a 5 dB noise reduction. Thus, this barrier is not recommended. This barrier is shown in Figure 5-1 and detailed analysis metrics can be found in Tables 5-1 and 5-2.

5.3.5 CNE-5 Noise Abatement Analysis

CNE-5 contains 15 modelled receptors representing 15 single family residences. 5 of these receptors were found to be impacted. A barrier was analyzed South of St Joseph St, but failed to meet MDOT feasibility standards as no receptors received a 5 dB noise reduction. This barrier is not recommended. This barrier is shown in Figure 5-2 and detailed analysis metrics can be found in Tables 5-1 and 5-2

5.3.6 CNE-6 Noise Abatement Analysis

CNE-6 contains 116 modelled receptor units representing 115 single family residences and multi-family dwelling units, as well as one park. 28 receptors were found to be impacted, and a DUE calculation was deemed inapplicable for the cost-effectiveness portion of the reasonableness determination, since no benefits reach the park. A barrier system south of St Joseph St. was modelled that determined to meet acoustic performance requirements, however, this barrier was found to be not feasible due to constructability and safety issues along the shoulder of St Joseph St (not constructable due to lack of room to construct a noise wall between St. Joseph St. and the existing retaining wall, along with unsafe driving conditions due to obstruction of sight). Thus, the barrier is not feasible and is not recommended. This analyzed barrier location is shown in Figure 5-2 and detailed analysis metrics can be found in Tables 5-1 and 5-2.

5.3.7 CNE-7 Noise Abatement Analysis

CNE-7 contains 66 modelled receptors representing 66 single family residences and dwelling units. 35 of these receptors were found to be impacted, and a barrier was analyzed South of St Joseph St with a gap for the WB on ramp. This barrier achieved 5 dB of reduction at 69% of impacted receptors, failing to meet the 75% requirement for MDOT feasibility. Thus, this barrier is not recommended. This barrier is shown in Figure 5-3 and detailed analysis metrics can be found in Tables 5-1 and 5-2.

5.3.8 CNE-8 Noise Abatement Analysis

CNE-8 contains 56 receptors representing 51 single family residences, one school (4 receptors), and one church. 16 of these receptors were found to be impacted, and a DUE calculation for the northern school receptor was calculated for the cost-effectiveness portion of the reasonableness determination. Other activity category C receptors were deemed inapplicable for a DUE calculation since benefits do not reach the receptors south of the school, and the benefited area of the church is less than the area of a typical residential lot. A barrier was analyzed North of Malcom X St with a gap for the EB off ramp. This barrier achieved 5 dB of reduction at 69% of impacted receptors, failing to meet the 75% requirement for MDOT feasibility. Thus, this barrier is not recommended. This barrier is shown in Figure 5-3 and detailed analysis metrics can be found in Tables 5-1 and 5-2.

5.3.9 CNE-9 Noise Abatement Analysis

CNE-9 contains 26 receptors representing 24 single family residences, one school, and one park. 9 of these receptors were found to be impacted, and a DUE calculation was deemed inapplicable for the cost-effectiveness portion of the reasonableness determination, since no benefits reach either activity category C receptor. A barrier was analyzed South of St Joseph St. This barrier achieved 5 dB of reduction at 0% of impacted receptors. This fails to meet the 75% requirement for MDOT feasibility; thus the barrier is not recommended. This barrier is shown in Figure 5-3 and detailed analysis metrics can be found in Tables 5-1 and 5-2.

5.3.10 CNE-10 Noise Abatement Analysis

CNE-10 contains 24 receptors representing 24 single family residences. 10 of these receptors were found to be impacted, and a barrier was analyzed North of Malcom X St. This barrier achieved 5 dB of reduction at 60% of impacted receptors. This fails to meet the 75% requirement for MDOT feasibility; thus the barrier is not recommended. This barrier is shown in Figure 5-3 and the detailed analysis metrics can be found in Tables 5-1 and 5-2.

5.4 Viewpoints of Benefited Receptors

The final step to determine if recommended noise abatement is reasonable and feasible is to determine the viewpoints of the benefited receptors (owners and residents) to determine if a majority are in favor of the proposed abatement (as described in Section 6.4 of the MDOT noise manual.).

MDOT began conducting public informational meetings to discuss the new project, noise abatement and Design-Build process on March 31,2021. MDOT held this virtual event along with additional meetings on June 29, 2021 and July 14, 2021 via Microsoft Teams Live to discuss the project with the public and gain input. The June 29th meeting was held with the City of Lansing City Council. Other constituents were notified via email. For the July 14th meeting, all impacted neighborhood associations were notified and a mailer about the project was sent to all residents.

After the draft noise report was posted, MDOT conducted a public information meeting on November 30, 2021, at the Michigan Chamber of Commerce building in Lansing. At this meeting, CNE maps were available for review. A mailer was sent to all impacted residents and businesses inviting them to the public meeting to provide the opportunity for the public to express their views regarding specific location, design, socio-economic effects, and environmental impacts associated with the noise analysis. A press release with background information and link to the draft report was distributed to the community and posted on the MDOT website. A YouTube video providing an overview of the project, noise analysis, DB process and proposed detours was posted to the project website. MDOT presented construction noise information at Lansing city council meetings and the city of Lansing awarded the construction noise waiver on October 26, 2021. The draft traffic noise analysis report was posted to MDOT’s noise abatement website for public comment. A record of comments and responses are provided in Appendix E.

MDOT’s policy is to install noise abatement measures found to be feasible and reasonable that are associated with transportation improvements. CNE-1 advanced to the public participation phase in December 2021 to determine viewpoints of benefited receptors for final determination of inclusion in the project. Voting was conducted for the benefiting receptor addresses. The voting was facilitated by certified US mail. All benefited owners and residents received a ballot, a cover letter that stated any unreturned vote would be assumed a YES vote, and a design guide with detailed aesthetics information. Undeliverable ballots were redelivered to allow for voting and response. MDOT offered virtual, phone and in-person meetings to owners and residents. A flyer advising that ballots were being mailed was posted at each benefited receptor residence. No ballots were returned, but since any unreturned ballot is considered a Yes vote, the balloting was determined to be in favor of the noise abatement. No public involvement was needed for aesthetics, and texture due to the agreement with SHPO that only one option of the wall met the reasoning of avoiding adverse effects to historical properties. This acoustic profile is in alignment with similar aesthetic treatments in the area.

Figure 5-1 Acoustical Analysis for CNE-1, CNE-2, CNE-3, and CNE-4

Figure 5-2 Acoustical Analysis for CNE-5 and CNE-6

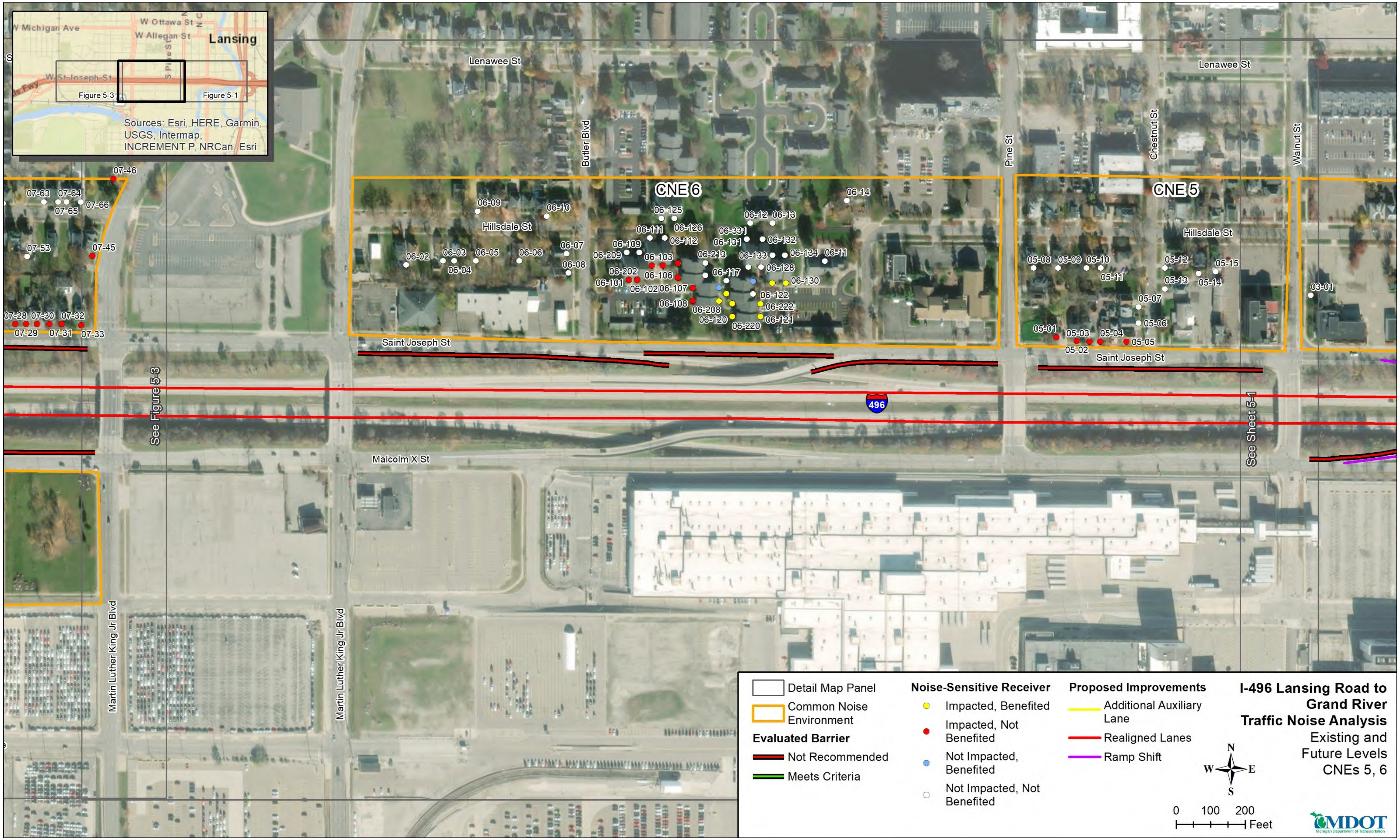
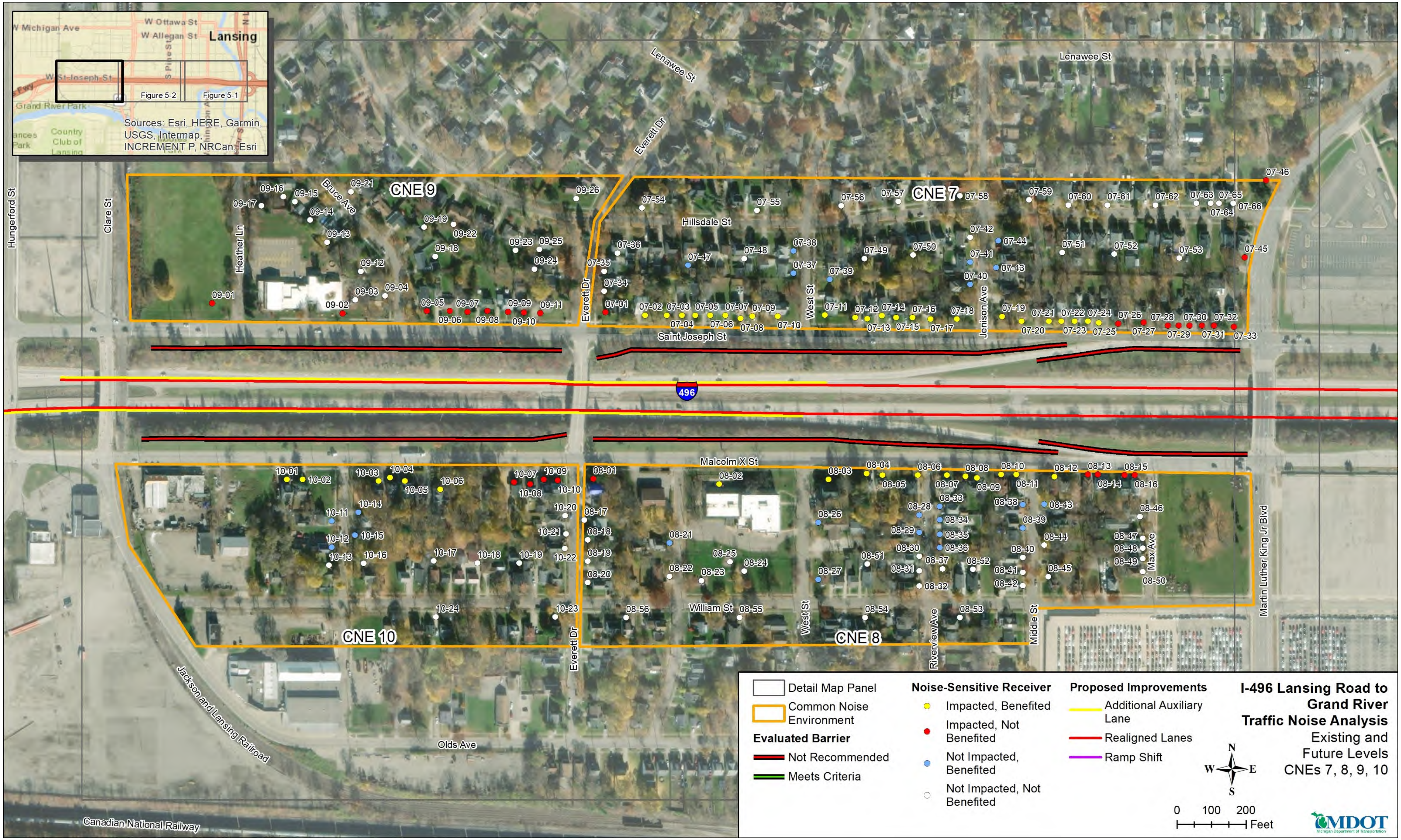


Figure 5-3 Acoustical Analysis for CNE-7, CNE-8, CNE-9 and CNE-10



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 required 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.
- 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 mitigation/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 at 50 feet (dBA)	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

*AUF = Acoustical Usage Factor
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 mitigation 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 (preferably towards the east end of the project, further from sensitive receivers).
- 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.

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 about the future planning and development of currently undeveloped lands near the proposed project right-of-way. There are two identified undeveloped areas in the project study area, one in CNE-4, and one in CNE-8, both of which appear to be former commercial/industrial land uses.

Table 7-1 shows noise impact distance for the 66 dB and 71 dB levels (NAC categories B/C and E, respectively) from I-496 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

Project Roadway	**Distance from the Edge of Pavement**	
	71 dB Distance	66 dB Distance
I-496	192 ft	268 ft

8. Conclusions and Recommendations

The noise analysis for the proposed project included a total of twelve measurement locations and 376 predicted representative noise levels for 376 dwelling units in the project area. The project was split into ten separate CNEs for noise impact analysis within the study area.

Nine of the ten CNEs contained receptors with predicted future noise levels approaching or exceeding the NAC. Noise abatement was considered in nine locations. One of these barriers were found to be feasible and reasonable. The remaining eight were disqualified for failing to meet either or both feasibility and reasonableness requirement as defined by MDOT policy. The barrier in CNE 1 meets MDOT criteria. This barrier would be advanced to the public participation phase to determine viewpoints of benefited receptors for final determination of reasonableness and inclusion in the project.

9. Statement of Likelihood

Based on the studies thus far accomplished, the Michigan Department of Transportation intends to install highway traffic noise abatement in the form of barriers presented in Table 5-1 in this document. The preliminary indications of likely abatement measures are based on preliminary design for barrier cost(s) and noise abatement as illustrated in Table 5-2 in this document. If it subsequently develops during final design that these conditions have substantially changed, the abatement measures might not be provided. A final decision of the installation and aesthetics of the abatement measures(s) will be made upon completion of the project’s final design and the Context Sensitive Design process.

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 information:

- Noise measurement short-term data summary table
- Noise measurement photo log
- Noise measurement field data sheets

Short Term Measurement Summary

	Location	*Average Leq (dBA)*	*Leq Range (dBA)*	*Start (hh:mm)*	*Stop (hh:mm)*	*Duration (hh:mm)*
ST-1	621 Cherry St Front Sidewalk	66.7	65.3-67.8	14:50	15:06	00:16
ST-2	300 E Main Parking Lot	70.7	69.0-72.3	11:45	12:01	00:16
ST-3	330 St Joseph St Parking Lot	68.9	67.3-72.7	16:23	16:39	00:16
ST-4	213 Malcom X St Driveway	64.8	63.6-65.9	14:14	14:29	00:15
ST-5	426 St Joseph St Sidewalk	69.2	67.2-71.2	16:52	17:08	00:16
ST-6	600 St Joseph St Sidewalk	70.3	67.7-74.2	13:38	13:53	00:15
ST-7	623 Jenison Ave Sidewalk	68.9	66.4-70.8	17:26	17:41	00:15
ST-8	1715 Malcom X Sidewalk	61.6	60.1-63.5	13:02	13:18	00:16
ST-9	2101 Bruce Ave Sidewalk	65.8	63.3-68.7	17:53	18:08	00:15
ST-10	2109 Malcom X Vacant Lot	63.2	59.3-65.6	18:21	18:36	00:15

Noise Measurement Photo Log

LT-01 Near Malcom X St and Nipp Ave

LT-01 Facing East

LT-01 Facing West

LT-02 Near St Joseph St and Cherry St

LT-02 Facing South East

LT-02 Facing South West

ST-01 621 Cherry St

ST-01 Facing South

ST-01 Facing North

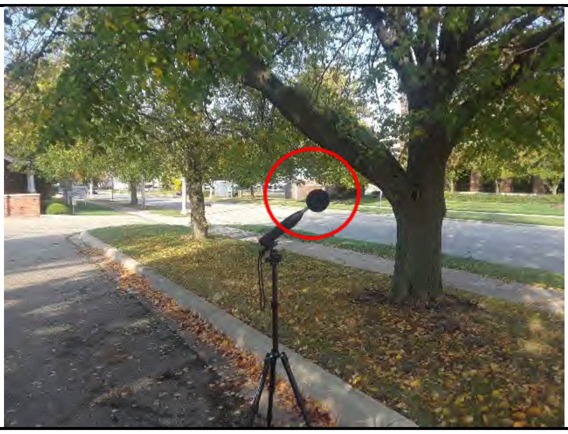
ST-02 300 E Main St

ST-02 Facing North East

ST-02 Facing South East

ST-03 Townsend St and St Joseph St

ST-03 Facing South West



ST-03 Facing North East

ST-04 213 Malcom X St

ST-04 Facing North East

ST-02 Facing South West

ST-05 Chestnut St and St Joseph St


ST-05 Facing South East


ST-05 Facing North West

ST-06 Sycamore St and St Joseph St


ST-06 Facing North


ST-06 Facing South West

ST-07 623 Jenison Ave


ST-07 Facing North


ST-07 Facing South East

ST-08 1715 Malcolm X St

	
ST-08 Facing South	ST-08 Facing North

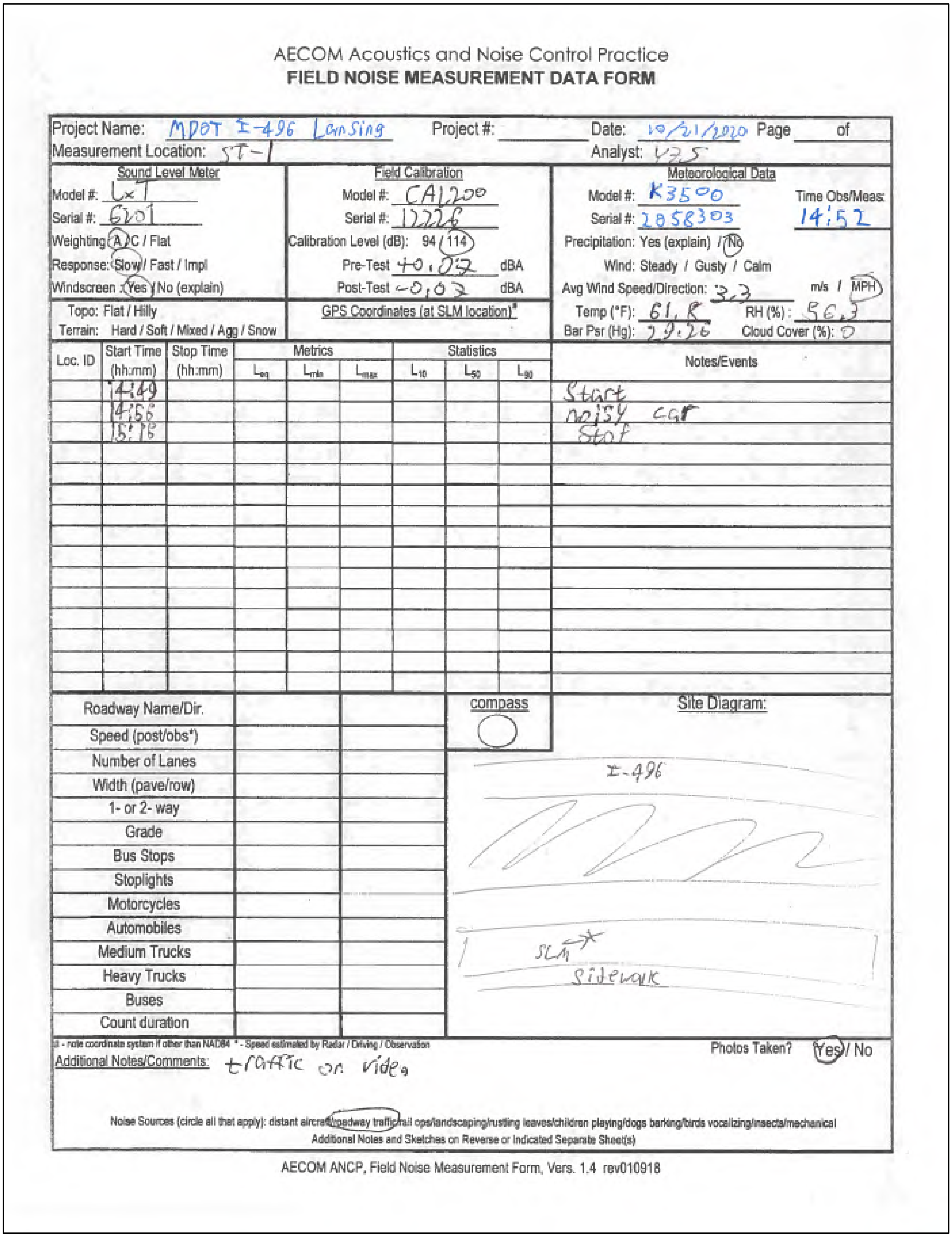
ST-09 2101 Bruce Ave

	
ST-09 Facing North	ST-09 Facing South

ST-10 2101 Bruce Ave

	
ST-10 Facing North	ST-10 Facing South

Field Data Sheets



AECOM Acoustics and Noise Control Practice

FIELD NOISE MEASUREMENT DATA FORM

Project Name: MDOT I-496 Lansing Project #: ______ Date: 10/21/2020 Page ___ of ___

Measurement Location: ST-1 Analyst: YZS

Sound Level Meter

Model #: LxT

Serial #: 6201

Weighting: [✓ A] / C / Flat

Response: [✓ Slow] / Fast / Impl

Windscreen: [✓ Yes] / No (explain)

Field Calibration

Model #: CAL200

Serial #: 12226

Calibration Level (dB): 94 / [✓ 114]

Pre-Test +0.02 dBA

Post-Test -0.02 dBA

Meteorological Data

Model #: K3500

Serial #: 2058303

Time Obs/Meas: 14:52

Precipitation: Yes (explain) / [✓ No]

Wind: Steady / Gusty / Calm

Avg Wind Speed/Direction: 3.3 m/s / [✓ MPH]

Temp (°F): 61.8

RH (%): 56.3

Bar Psr (Hg): 29.26

Cloud Cover (%): 0

Topo: Flat / Hilly

Terrain: Hard / Soft / Mixed / Agg / Snow

GPS Coordinates (at SLM location)*

Loc. ID	Start Time (hh:mm)	Stop Time (hh:mm)	Metrics			Statistics			Notes/Events
			L_{eq}	L_{min}	L_{max}	L_{10}	L_{50}	L_{90}	
	14:49								Start
	14:56								noisy car
	15:18								Stop

Roadway Name/Dir.		
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

Site Diagram:

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

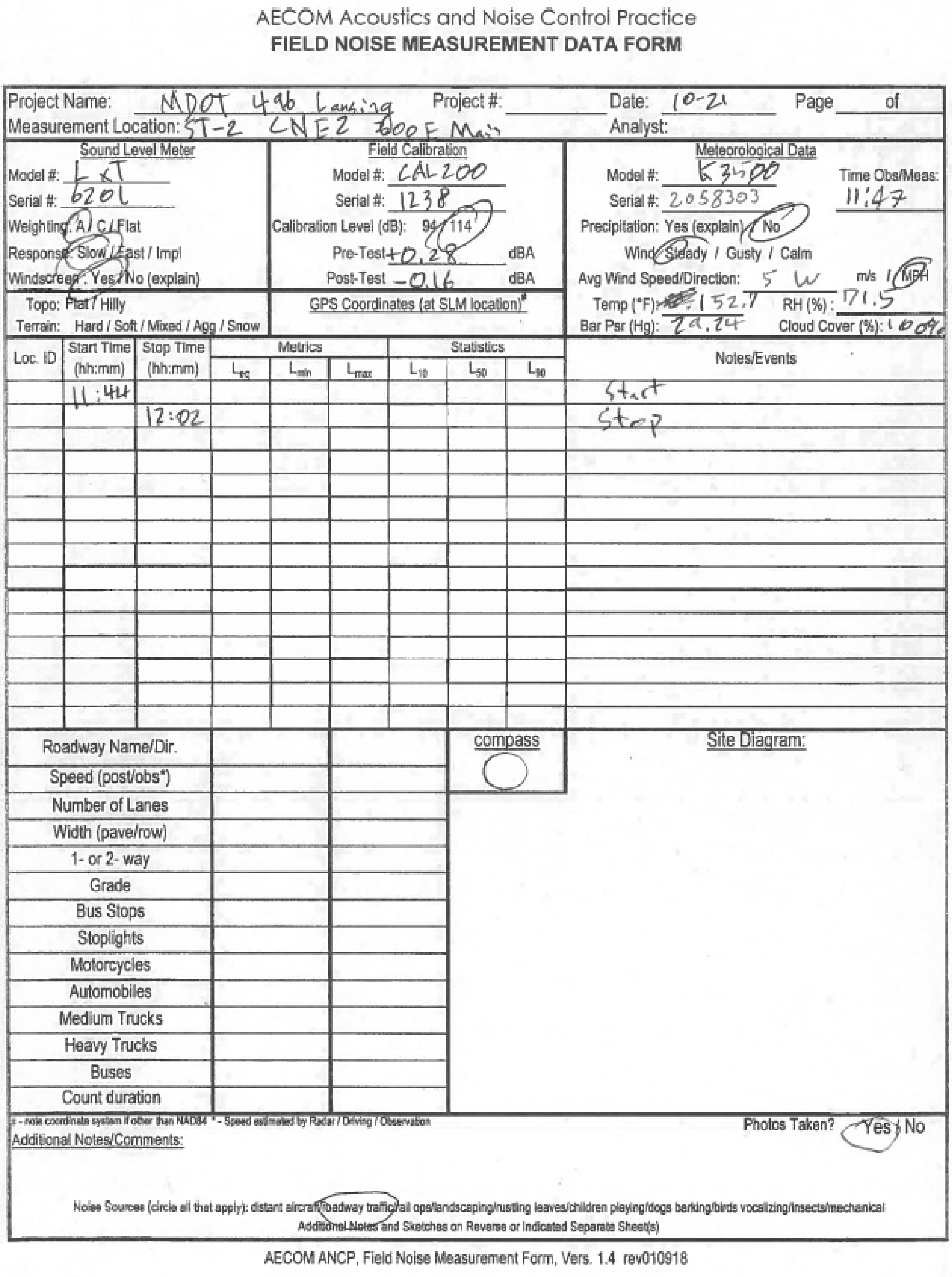
Photos Taken? [✓ Yes] / No

Additional Notes/Comments: traffic on video

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. 1.4 rev010918



AECOM Acoustics and Noise Control Practice

FIELD NOISE MEASUREMENT DATA FORM

Project Name: MDOT 496 Lansing Project #: Date: 10-21 Page of

Measurement Location: ST-2 CNE2 600 E Main Analyst:

Sound Level Meter

Model #: LxT

Serial #: 6201

Weighting: [✓ A] / C / Flat

Response: [✓ Slow] / Fast / Impl

Windscreen: [✓ Yes] / No (explain)

Topo: Flat / Hilly

Terrain: Hard / Soft / Mixed / Agg / Snow

Field Calibration

Model #: CAL200

Serial #: 1238

Calibration Level (dB): 94 / [✓ 114]

Pre-Test +0.28 dBA

Post-Test -0.16 dBA

GPS Coordinates (at SLM location)*

Meteorological Data

Model #: K3500

Serial #: 2058303

Time Obs/Meas: 11:47

Precipitation: Yes (explain) / [✓ No]

Wind: [✓ Steady] / Gusty / Calm

Avg Wind Speed/Direction: 5 W m/s / [✓ MPH]

Temp (°F): 52.7 RH (%): 71.5

Bar Psr (Hg): 29.24 Cloud Cover (%): 100%

Loc. ID	Start Time (hh:mm)	Stop Time (hh:mm)	Metrics L_{eq}	Metrics L_{min}	Metrics L_{max}	Statistics L_{10}	Statistics L_{50}	Statistics L_{90}	Notes/Events
	11:44								Start
		12:02							Stop

Roadway Name/Dir.		
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

Site Diagram:

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

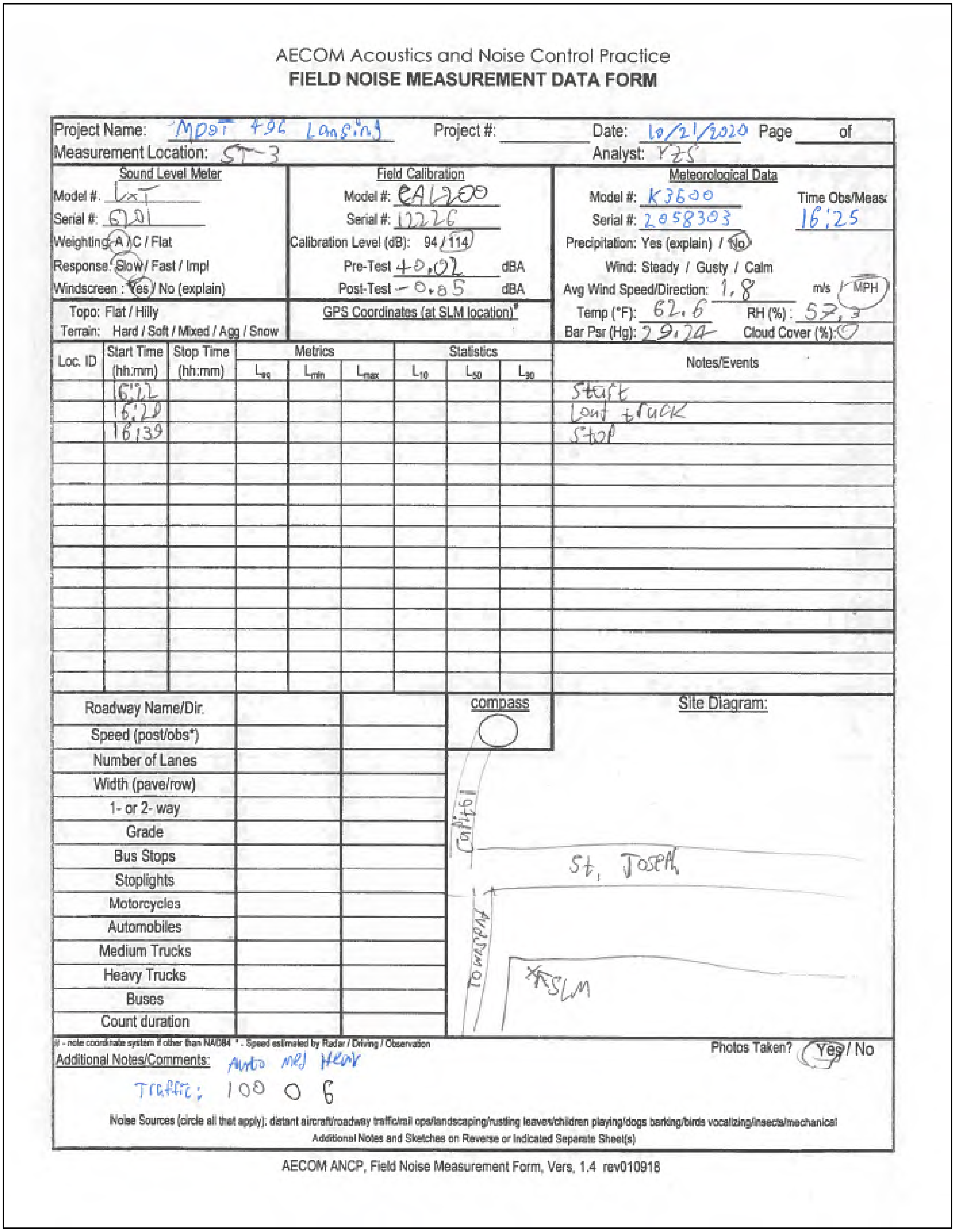
Photos Taken? [✓ Yes] / No

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. 1.4 rev010918



AECOM Acoustics and Noise Control Practice

FIELD NOISE MEASUREMENT DATA FORM

Project Name: MDOT 496 Lansing Project #: ____ Date: 10/21/2020 Page ___ of ___

Measurement Location: ST-3 Analyst: YZS

Sound Level Meter

Model #: LxT

Serial #: 6321

Weighting: [✓ A] / C / Flat

Response: [✓ Slow] / Fast / Impl

Windscreen: [✓ Yes] / No (explain)

Field Calibration

Model #: CAL200

Serial #: 12226

Calibration Level (dB): 94 / [✓ 114]

Pre-Test +0.02 dBA

Post-Test -0.05 dBA

Meteorological Data

Model #: K3600

Serial #: 2058303

Time Obs/Meas: 16:25

Precipitation: Yes (explain) / [✓ No]

Wind: Steady / Gusty / Calm

Avg Wind Speed/Direction: 1.8 m/s / [✓ MPH]

Temp (°F): 62.6 RH (%): 57.3

Bar Psr (Hg): 29.74 Cloud Cover (%): 0

Topo: Flat / Hilly

Terrain: Hard / Soft / Mixed / Agg / Snow

GPS Coordinates (at SLM location)#

Loc. ID	Start Time (hh:mm)	Stop Time (hh:mm)	Metrics L_{eq}	Metrics L_{min}	Metrics L_{max}	Statistics L_{10}	Statistics L_{50}	Statistics L_{90}	Notes/Events
	16:22								Start
	16:28								Loud truck
	16:39								Stop

Roadway Name/Dir.		
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

Site Diagram:

Capitol

St. Joseph

Townsend

X SLM

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

Photos Taken? [✓ Yes] / No

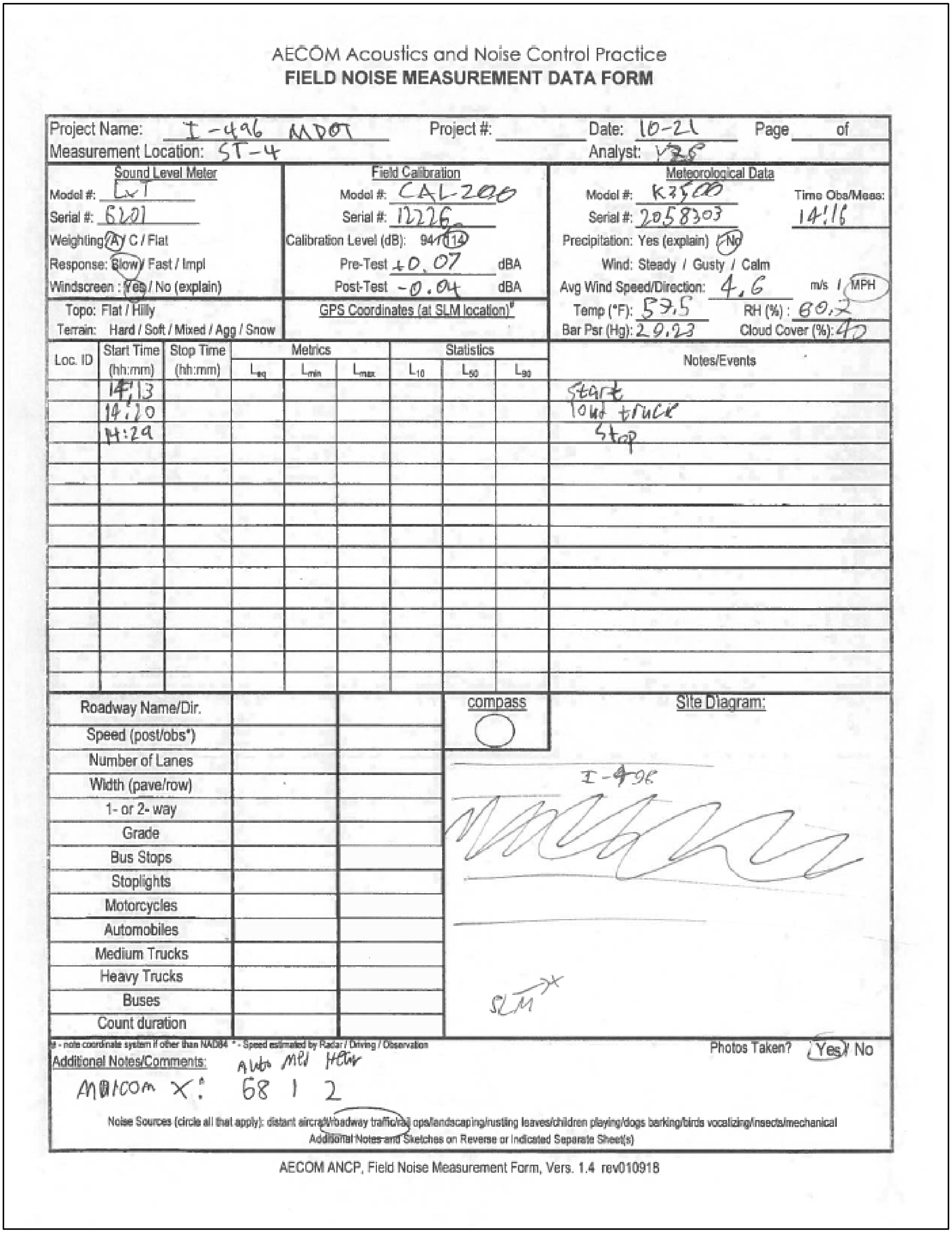
Additional Notes/Comments: Auto Med Heav

Traffic: 100 0 6

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. 1.4 rev010918



AECOM Acoustics and Noise Control Practice

FIELD NOISE MEASUREMENT DATA FORM

Project Name: I-496 MDOT Project #: Date: 10-21 Page of

Measurement Location: ST-4 Analyst: V26

Sound Level Meter

Model #: LxT

Serial #: 6201

Weighting: [✓ A] / C / Flat

Response: [✓ Slow] / Fast / Impl

Windscreen : [✓ Yes] / No (explain)

Topo: Flat / Hilly

Terrain: Hard / Soft / Mixed / Agg / Snow

Field Calibration

Model #: CAL-200

Serial #: 12226

Calibration Level (dB): 94 / [✓ 114]

Pre-Test +0.07 dBA

Post-Test -0.04 dBA

GPS Coordinates (at SLM location)#

Meteorological Data

Model #: K3500

Serial #: 2058303

Time Obs/Meas: 14:16

Precipitation: Yes (explain) / [✓ No]

Wind: Steady / Gusty / Calm

Avg Wind Speed/Direction: 4.6 m/s / [✓ MPH]

Temp (°F): 57.5 RH (%) : 60.2

Bar Psr (Hg): 29.23 Cloud Cover (%): 40

Loc. ID	Start Time (hh:mm)	Stop Time (hh:mm)	Metrics			Statistics			Notes/Events
			L_{eq}	L_{min}	L_{max}	L_{10}	L_{50}	L_{90}	
	14:13								start
	14:20								loud truck
	14:29								stop

Roadway Name/Dir.		
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

Site Diagram:

I-496

SLM

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

Photos Taken? [✓ Yes] / No

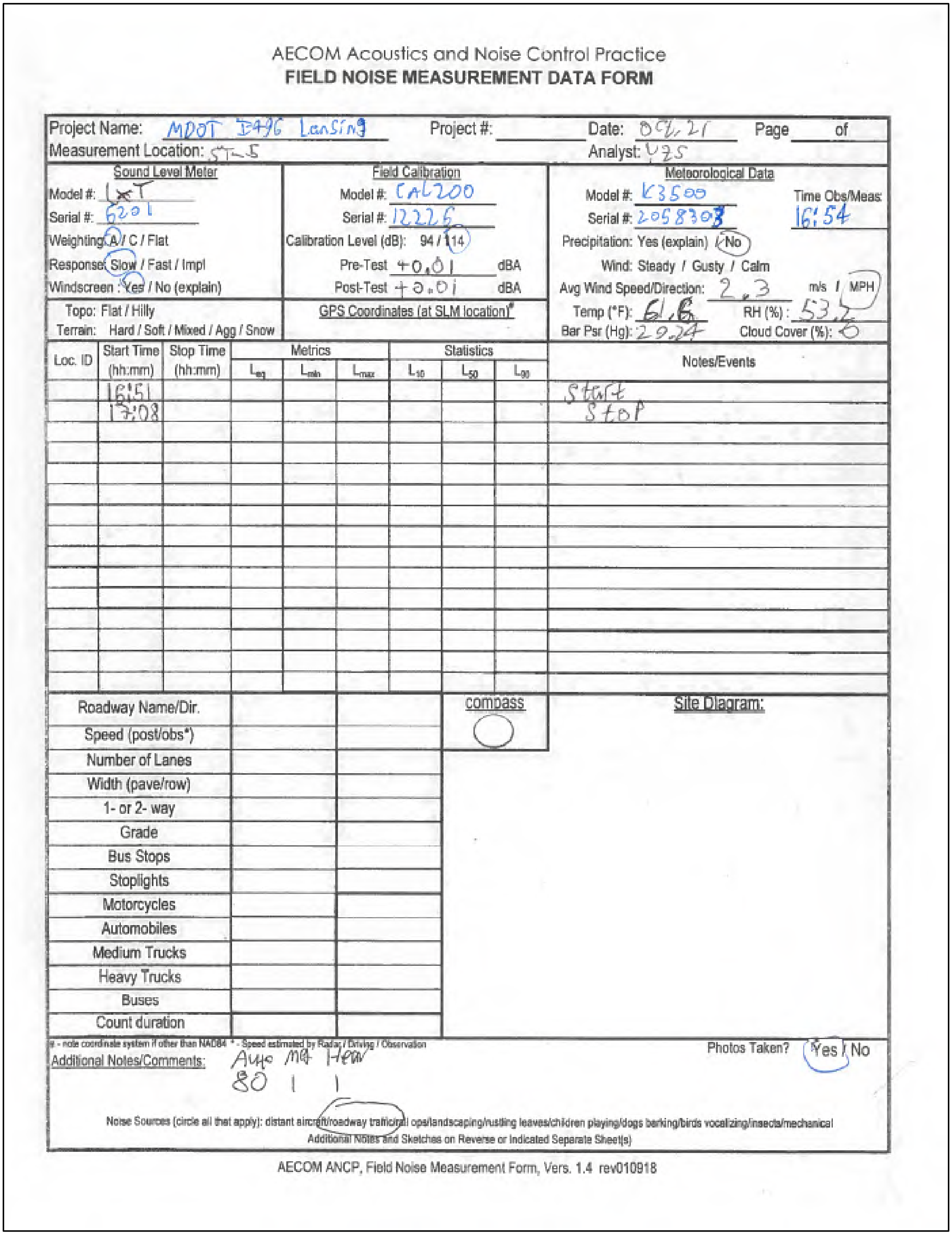
Additional Notes/Comments: Auto Med Heavy

Malcom X: 68 1 2

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. 1.4 rev010918



AECOM Acoustics and Noise Control Practice

FIELD NOISE MEASUREMENT DATA FORM

Project Name: MDOT I-496 Lansing Project #: ______ Date: Oct, 21 Page ____ of ____

Measurement Location: ST-5 Analyst: VZS

Sound Level Meter

Model #: LxT

Serial #: 6201

Weighting: [✓ A] / C / Flat

Response: [✓ Slow] / Fast / Impl

Windscreen : [✓ Yes] / No (explain)

Field Calibration

Model #: CAL200

Serial #: 12226

Calibration Level (dB): 94 / [✓ 114]

Pre-Test +0.01 dBA

Post-Test +0.01 dBA

Meteorological Data

Model #: K3500

Serial #: 2058308

Time Obs/Meas: 16:54

Precipitation: Yes (explain) [✓ No]

Wind: Steady / Gusty / Calm

Avg Wind Speed/Direction: 2.3 m/s / [✓ MPH]

Temp (°F): 61.6 RH (%) : 53.2

Bar Psr (Hg): 29.24 Cloud Cover (%): 0

Topo: Flat / Hilly

Terrain: Hard / Soft / Mixed / Agg / Snow

GPS Coordinates (at SLM location)#

Loc. ID	Start Time (hh:mm)	Stop Time (hh:mm)	Metrics			Statistics			Notes/Events
			L_{eq}	L_{min}	L_{max}	L_{10}	L_{50}	L_{90}	
	16:51								Start
	17:08								Stop

Roadway Name/Dir.		
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

Site Diagram:

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

Additional Notes/Comments: Auto MT HT

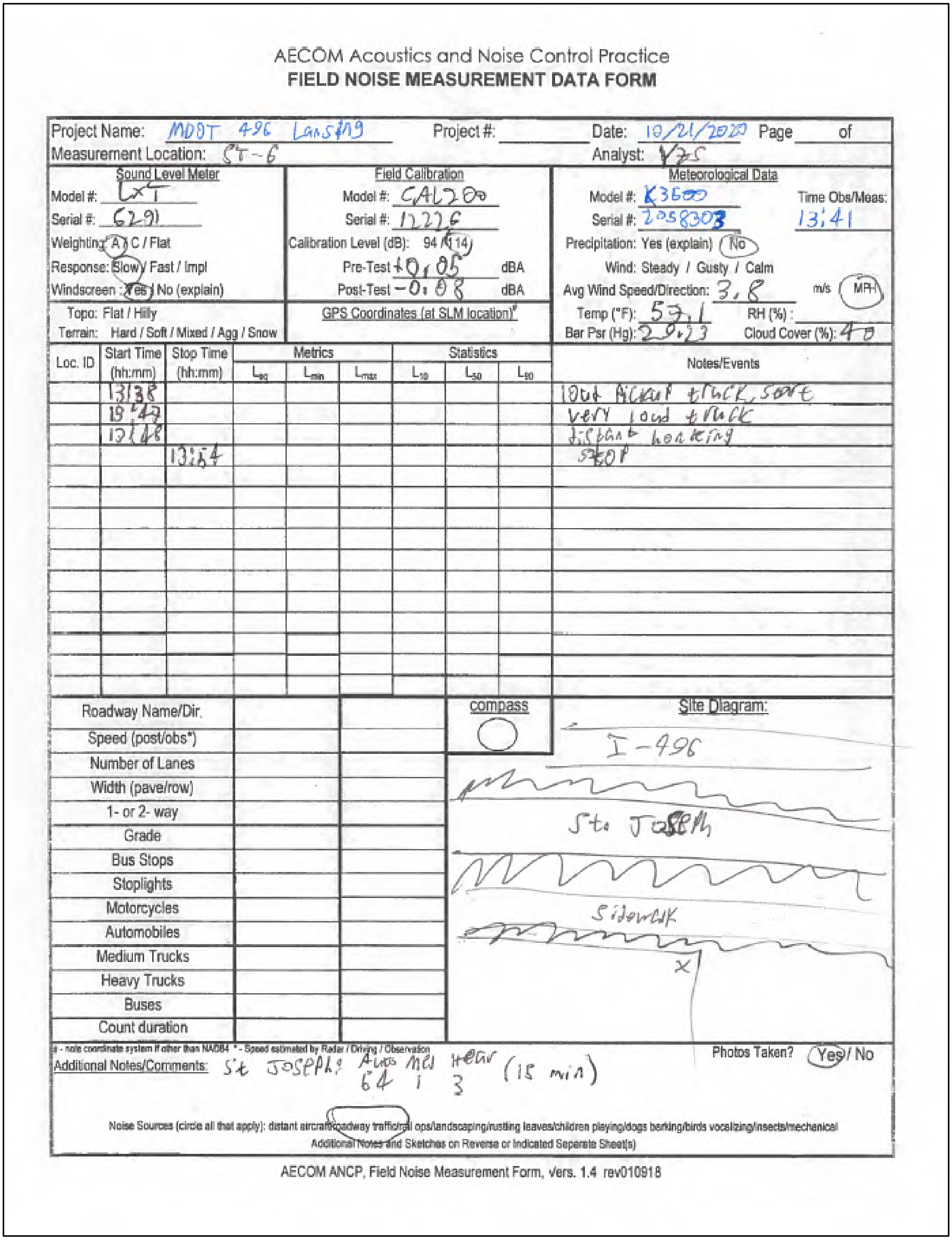
80 1 1

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. 1.4 rev010918



AECOM Acoustics and Noise Control Practice

FIELD NOISE MEASUREMENT DATA FORM

Project Name: MDOT 496 Lansing
Project #:
Date: 10/21/2020
Page of
Measurement Location: ST-6
Analyst: VJS

Sound Level Meter
Model #: LxT
Serial #: 6291
Weighting: [✓ A] / C / Flat
Response: [✓ Slow] / Fast / Impl
Windscreen: [✓ Yes] / No (explain)

Field Calibration
Model #: CAL200
Serial #: 12276
Calibration Level (dB): 94 / [✓ 114]
Pre-Test +0.05 dBA
Post-Test −0.08 dBA

Meteorological Data
Model #: K3500
Serial #: 2058303
Time Obs/Meas: 13:41
Precipitation: Yes (explain) / [✓ No]
Wind: Steady / Gusty / Calm
Avg Wind Speed/Direction: 3.8 m/s / [✓ MPH]
Temp (°F): 57.1
RH (%):
Bar Psr (Hg): 29.23
Cloud Cover (%): 40

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

GPS Coordinates (at SLM location)ᵠ

Loc. ID	Start Time (hh:mm)	Stop Time (hh:mm)	Metrics			Statistics			Notes/Events
			L_{eq}	L_{min}	L_{max}	L_{10}	L_{50}	L_{90}	
	13:38								loud pickup truck, some
	19:47								very loud truck
	13:48								distant honking
		13:54							stop

Roadway Name/Dir.		
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

Site Diagram:

I-496

St. Joseph

Sidewalk

X

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

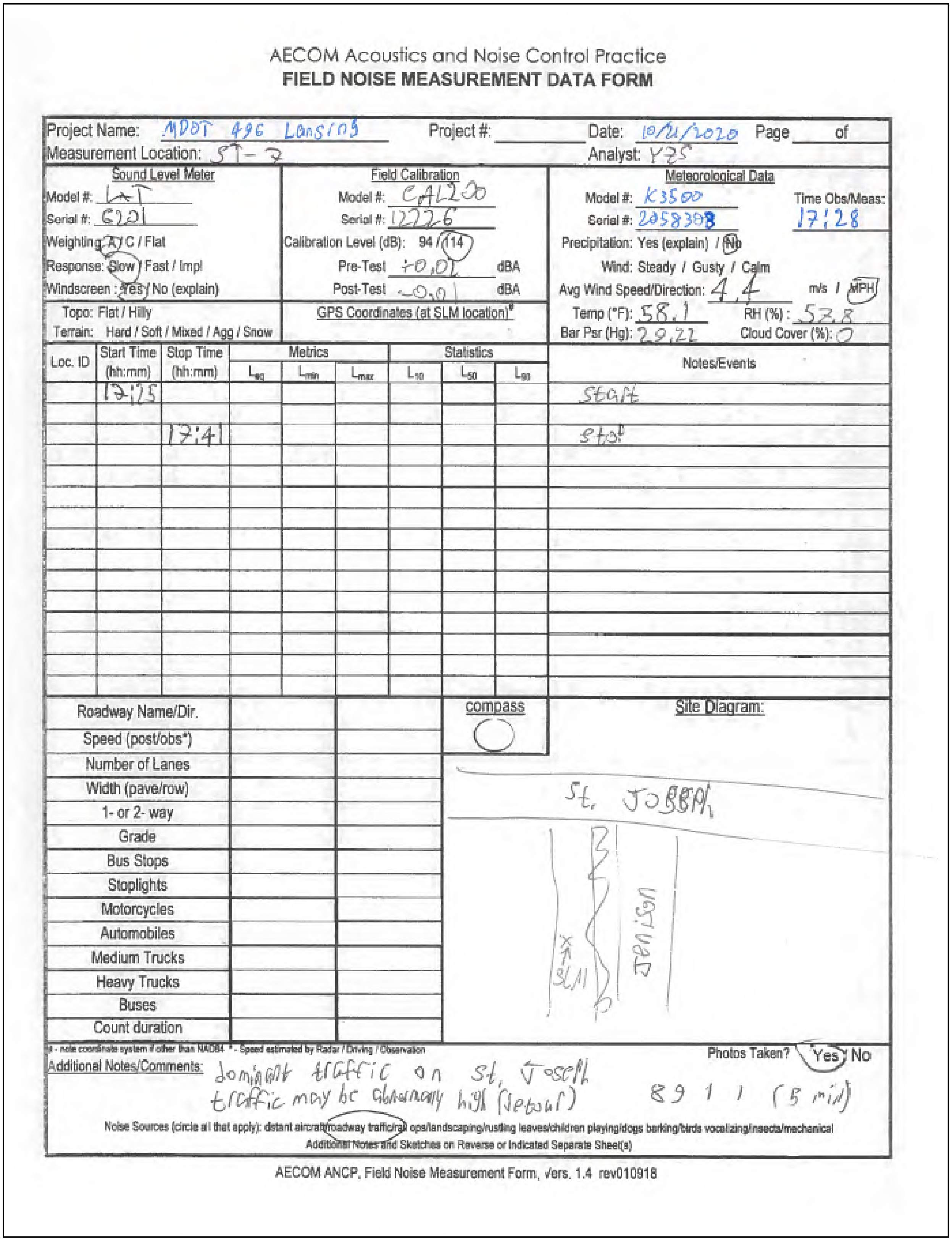
Photos Taken? [✓ Yes] / No

Additional Notes/Comments: St. Joseph: Auto Med Heav (15 min)
64 1 3

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. 1.4 rev010918



AECOM Acoustics and Noise Control Practice

FIELD NOISE MEASUREMENT DATA FORM

Project Name: MDOT 496 Lansing Project #: ______ Date: 10/21/2020 Page ___ of

Measurement Location: ST-7 Analyst: YZS

Sound Level Meter

Model #: LxT

Serial #: 6201

Weighting: [✓ A] / C / Flat

Response: [✓ Slow] / Fast / Impl

Windscreen: [✓ Yes] / No (explain)

Field Calibration

Model #: CAL200

Serial #: 12226

Calibration Level (dB): 94 / [✓ 114]

Pre-Test +0.02 dBA

Post-Test -0.01 dBA

Meteorological Data

Model #: K3500

Serial #: 2058308

Time Obs/Meas: 17:28

Precipitation: Yes (explain) / [✓ No]

Wind: Steady / Gusty / Calm

Avg Wind Speed/Direction: 4.4 m/s / [✓ MPH]

Temp (°F): 58.1 RH (%): 52.8

Bar Psr (Hg): 29.22 Cloud Cover (%): 0

Topo: Flat / Hilly

Terrain: Hard / Soft / Mixed / Agg / Snow

GPS Coordinates (at SLM location)#

Loc. ID	Start Time (hh:mm)	Stop Time (hh:mm)	Metrics			Statistics			Notes/Events
			L_{eq}	L_{min}	L_{max}	L_{10}	L_{50}	L_{90}	
	17:25								start
		17:41							stop

Roadway Name/Dir.		
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

Site Diagram:

St. JOSEPH

Jenison

SLM

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

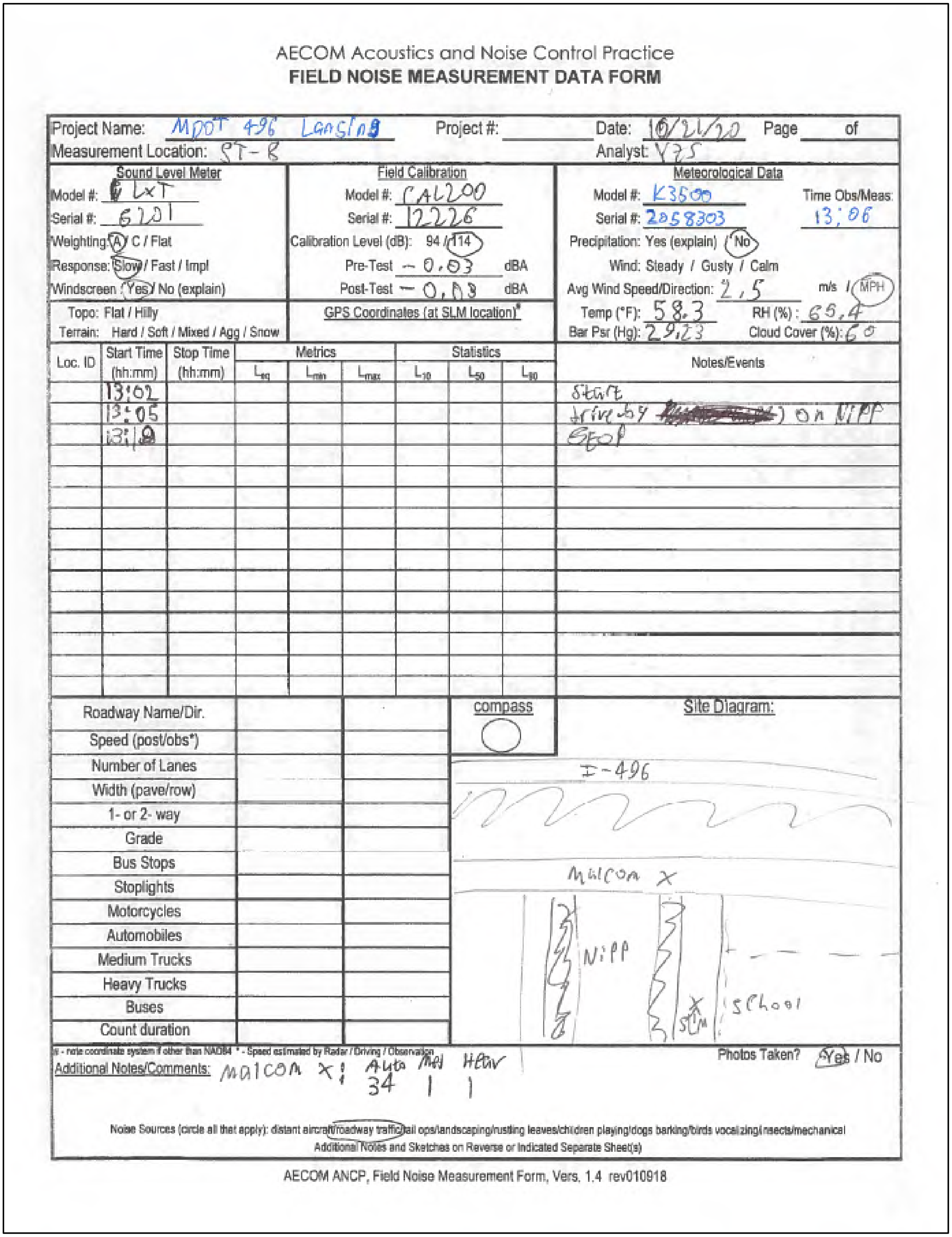
Photos Taken? [✓ Yes] / No

Additional Notes/Comments: dominant traffic on St. Joseph traffic may be abnormally high (detour) 89 1 1 (5 min)

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. 1.4 rev010918



AECOM Acoustics and Noise Control Practice

FIELD NOISE MEASUREMENT DATA FORM

Project Name: MDOT 496 Lansing Project #: ______ Date: 10/21/20 Page ___ of ___

Measurement Location: ST-8 Analyst: YZS

Sound Level Meter

Model #: LxT

Serial #: 6201

Weighting: [✓ A] / C / Flat

Response: [✓ Slow] / Fast / Impl

Windscreen: [✓ Yes] / No (explain)

Topo: Flat / Hilly

Terrain: Hard / Soft / Mixed / Agg / Snow

Field Calibration

Model #: CAL200

Serial #: 12226

Calibration Level (dB): 94 / [✓ 114]

Pre-Test -0.03 dBA

Post-Test -0.03 dBA

GPS Coordinates (at SLM location)*

Meteorological Data

Model #: K3500

Serial #: 2058303

Time Obs/Meas: 13:06

Precipitation: Yes (explain) / [✓ No]

Wind: Steady / Gusty / Calm

Avg Wind Speed/Direction: 2.5 m/s / [✓ MPH]

Temp (°F): 58.3 RH (%): 65.4

Bar Psr (Hg): 29.23 Cloud Cover (%): 60

Loc. ID	Start Time (hh:mm)	Stop Time (hh:mm)	Metrics			Statistics			Notes/Events
			L_{eq}	L_{min}	L_{max}	L_{10}	L_{50}	L_{90}	
	13:02								start
	13:05								drive by [illegible]) on Nipp
	13:10								stop

Roadway Name/Dir.		
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

Site Diagram:

I-496

Malcom X

Nipp

SLM

school

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

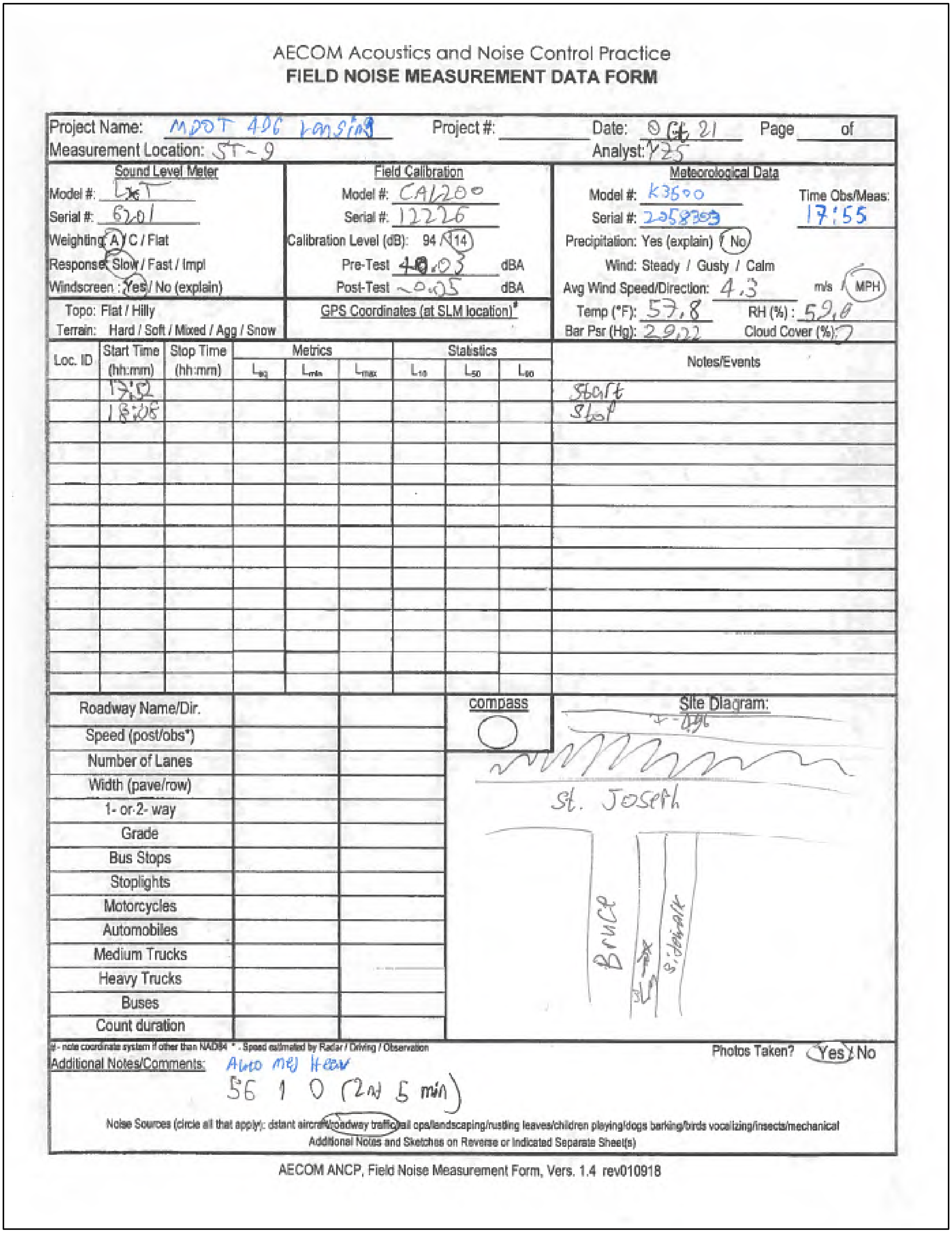
Photos Taken? [✓ Yes] / No

Additional Notes/Comments: Malcom X: Auto 34 Med 1 Heav 1

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. 1.4 rev010918



AECOM Acoustics and Noise Control Practice

FIELD NOISE MEASUREMENT DATA FORM

Project Name: MDOT 496 Lansing Project #: ______ Date: Oct 21 Page ___ of ___

Measurement Location: ST-9 Analyst: YZS

Sound Level Meter

Model #: LxT

Serial #: 6201

Weighting: [✓ A] / C / Flat

Response: [✓ Slow] / Fast / Impl

Windscreen: [✓ Yes] / No (explain)

Topo: Flat / Hilly

Terrain: Hard / Soft / Mixed / Agg / Snow

Field Calibration

Model #: CAL200

Serial #: 12226

Calibration Level (dB): 94 / [✓ 114]

Pre-Test 40.03 dBA

Post-Test ~0.05 dBA

GPS Coordinates (at SLM location)#

Meteorological Data

Model #: K3500

Serial #: 2058303

Time Obs/Meas: 17:55

Precipitation: Yes (explain) / [✓ No]

Wind: Steady / Gusty / Calm

Avg Wind Speed/Direction: 4.3 m/s / [✓ MPH]

Temp (°F): 57.8 RH (%): 52.0

Bar Psr (Hg): 29.22 Cloud Cover (%): ?

Loc. ID	Start Time (hh:mm)	Stop Time (hh:mm)	Metrics L_{eq}	Metrics L_{min}	Metrics L_{max}	Statistics L_{10}	Statistics L_{50}	Statistics L_{90}	Notes/Events
	17:52								Start
	18:08								Stop

Roadway Name/Dir.		
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

Site Diagram:

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

Photos Taken? [✓ Yes] / No

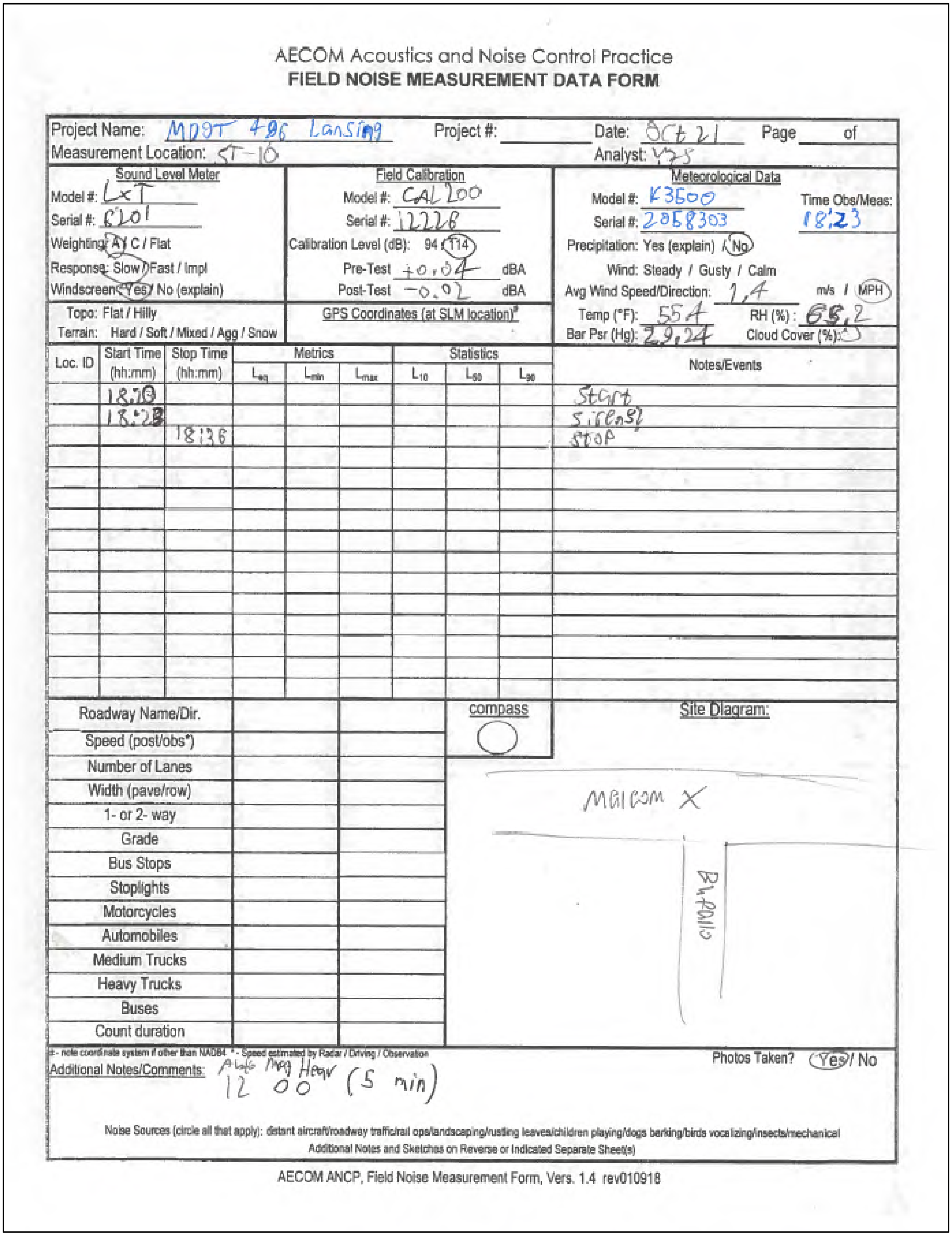
Additional Notes/Comments: Auto Med Heav

56 1 0 (2nd 5 min)

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. 1.4 rev010918



AECOM Acoustics and Noise Control Practice

FIELD NOISE MEASUREMENT DATA FORM

Project Name: MDOT 496 Lansing Project #: ______ Date: Oct 21 Page ___ of

Measurement Location: ST-10 Analyst: YZS

Sound Level Meter	Field Calibration	Meteorological Data
Model #: LxT	Model #: CAL200	Model #: K3500 — Time Obs/Meas: 18:23
Serial #: 6201	Serial #: 12226	Serial #: 2058303
Weighting: [✓ A] / C / Flat	Calibration Level (dB): 94 / [✓ 114]	Precipitation: Yes (explain) / [✓ No]
Response: [✓ Slow] / Fast / Impl	Pre-Test +0.04 dBA	Wind: Steady / Gusty / Calm
Windscreen: [✓ Yes] / No (explain)	Post-Test -0.02 dBA	Avg Wind Speed/Direction: 1.4 m/s / [✓ MPH]
Topo: Flat / Hilly	GPS Coordinates (at SLM location)‡	Temp (°F): 55.4 RH (%): 68.2
Terrain: Hard / Soft / Mixed / Agg / Snow		Bar Psr (Hg): 29.24 Cloud Cover (%): 0

Loc. ID	Start Time (hh:mm)	Stop Time (hh:mm)	Metrics			Statistics			Notes/Events
			L_{eq}	L_{min}	L_{max}	L_{10}	L_{50}	L_{90}	
	18:13								Start
	18:23								Sirens?
		18:36							Stop

Roadway Name/Dir.		
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

Site Diagram:

Malcom X

Buffalo

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

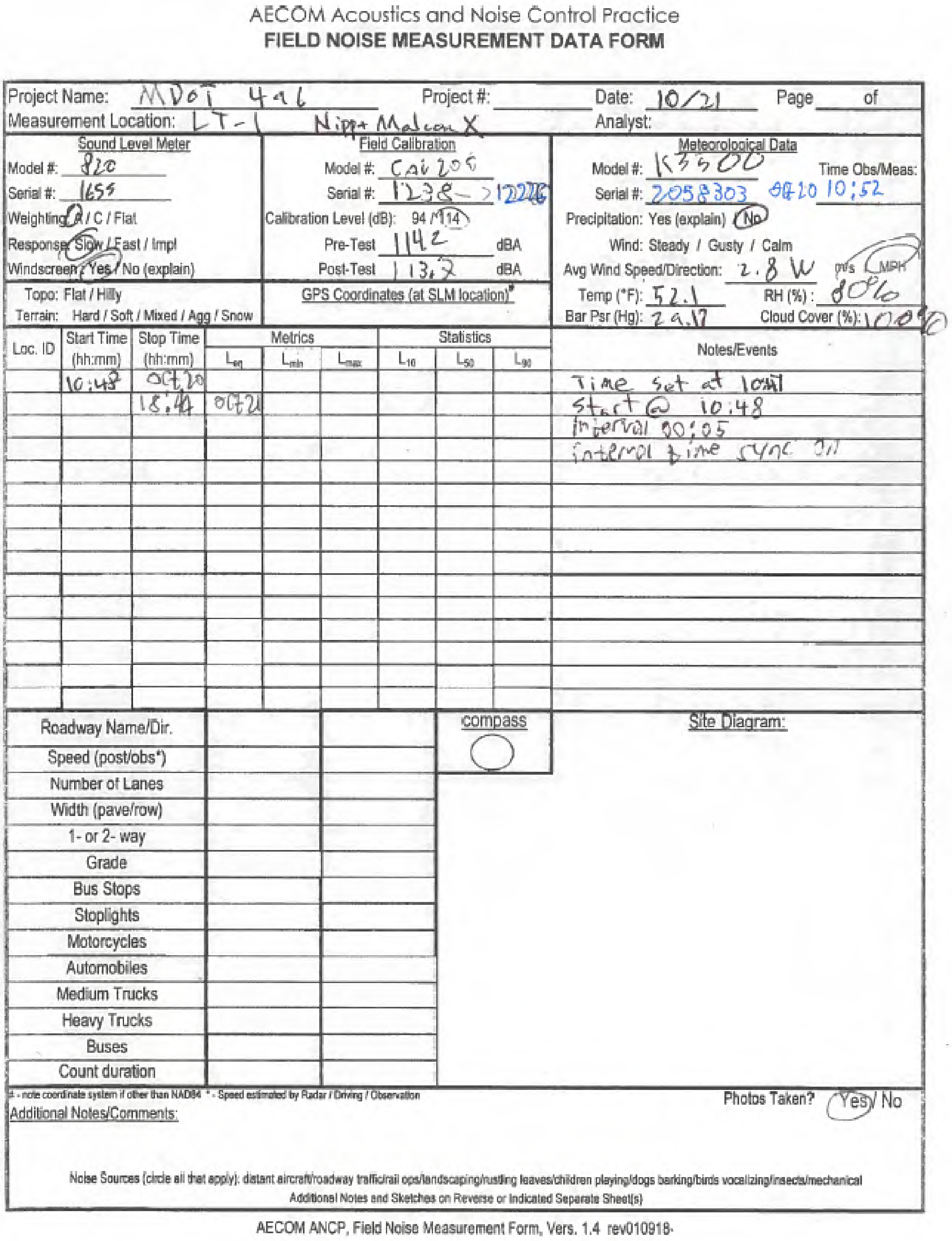
Additional Notes/Comments: Auto Neg Hear 12 00 (5 min)

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. 1.4 rev010918



AECOM Acoustics and Noise Control Practice

FIELD NOISE MEASUREMENT DATA FORM

Project Name: MDOT 496 Project #: ______ Date: 10/21 Page ___ of

Measurement Location: LT-1 Nipp+ Malcom X Analyst:

Sound Level Meter

Model #: 820

Serial #: 1655

Weighting: [✓ A] / C / Flat

Response: [✓ Slow] / Fast / Impl

Windscreen: [✓ Yes] / No (explain)

Field Calibration

Model #: Cal 200

Serial #: 1238 -> 12226

Calibration Level (dB): 94 / [✓ 114]

Pre-Test 114.2 dBA

Post-Test 113.2 dBA

Meteorological Data

Model #: K3500

Serial #: 2058303

Time Obs/Meas: Oct20 10;52

Precipitation: Yes (explain) [✓ No]

Wind: Steady / Gusty / Calm

Avg Wind Speed/Direction: 2.8 W m/s [✓ MPH]

Temp (°F): 52.1

RH (%): 80%

Bar Psr (Hg): 29.17

Cloud Cover (%): 100%

Topo: Flat / Hilly

Terrain: Hard / Soft / Mixed / Agg / Snow

GPS Coordinates (at SLM location)#

Loc. ID	Start Time (hh:mm)	Stop Time (hh:mm)	Metrics			Statistics			Notes/Events
			L_{eq}	L_{min}	L_{max}	L_{10}	L_{50}	L_{90}	
	10:48	Oct 20							Time set at 10:41
		18:44	Oct 21						Start @ 10:48
									interval 00:05
									internal time sync on

Roadway Name/Dir.		
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

Site Diagram:

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

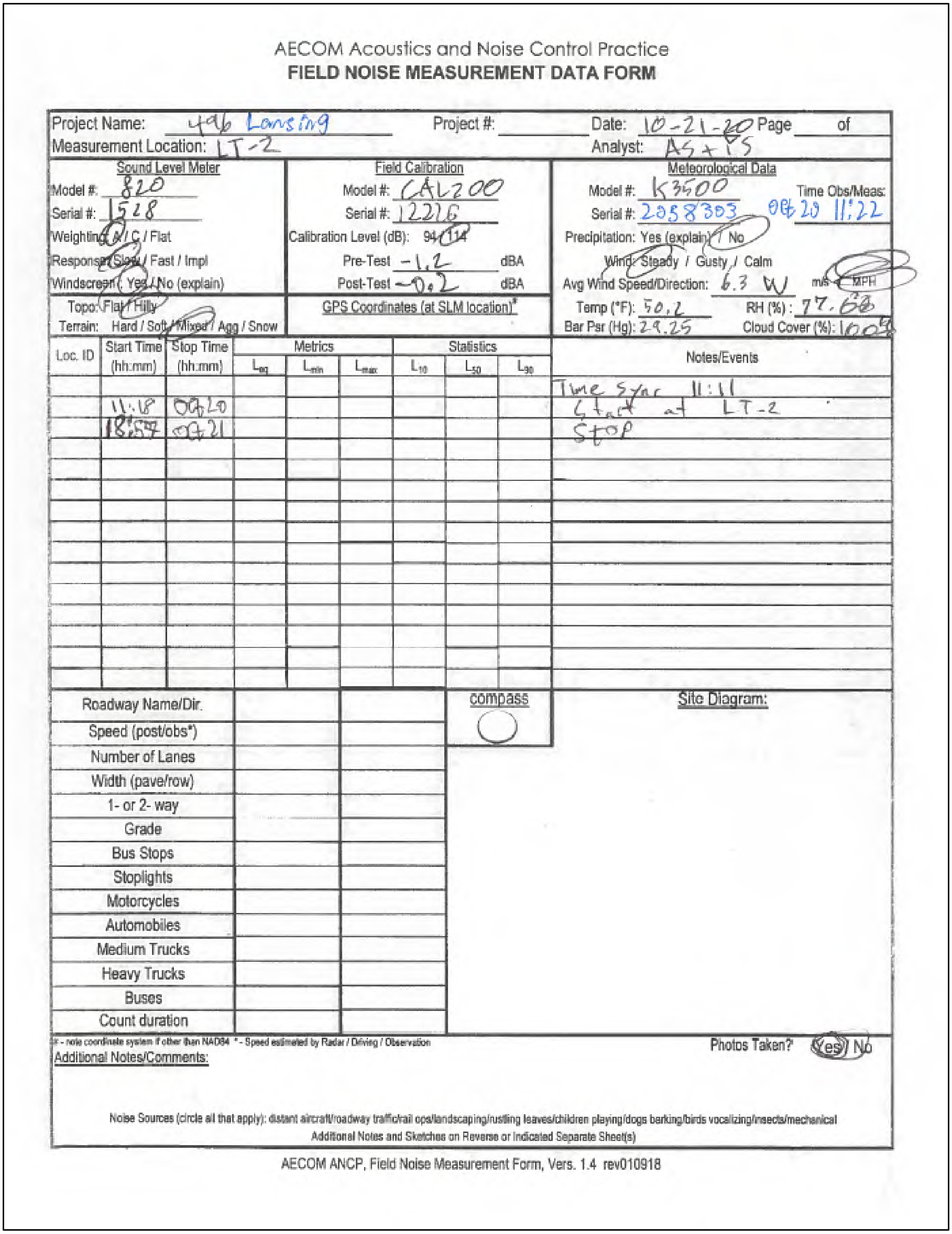
Photos Taken? [✓ Yes] / No

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. 1.4 rev010918



AECOM Acoustics and Noise Control Practice

FIELD NOISE MEASUREMENT DATA FORM

Project Name: 496 Lansing Project #: ____ Date: 10-21-20 Page ____ of

Measurement Location: LT-2 Analyst: AS + PS

Sound Level Meter	Field Calibration	Meteorological Data
Model #: 820	Model #: CAL200	Model #: K3500 Time Obs/Meas:
Serial #: 1528	Serial #: 12216	Serial #: 2058303 Oct 20 11:22
Weighting: [✓ A] / C / Flat	Calibration Level (dB): 94 / [✓ 114]	Precipitation: Yes (explain) / [✓ No]
Response: [✓ Slow] / Fast / Impl	Pre-Test -1.2 dBA	Wind: [✓ Steady] / Gusty / Calm
Windscreen: [✓ Yes] / No (explain)	Post-Test -0.2 dBA	Avg Wind Speed/Direction: 6.3 W m/s / [✓ MPH]
Topo: [✓ Flat] / Hilly	GPS Coordinates (at SLM location)*	Temp (°F): 50.2 RH (%): 77.68
Terrain: Hard / Soft / [✓ Mixed] / Agg / Snow		Bar Psr (Hg): 29.25 Cloud Cover (%): 100%

Loc. ID	Start Time (hh:mm)	Stop Time (hh:mm)	Metrics L_{eq}	Metrics L_{min}	Metrics L_{max}	Statistics L_{10}	Statistics L_{50}	Statistics L_{90}	Notes/Events
									Time Sync 11:11
	11:18	Oct 20							Start at LT-2
	18:57	Oct 21							Stop

Roadway Name/Dir.		
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

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. 1.4 rev010918

Equipment Calibration Certificates

Calibration Certificate

Certificate Number 2020007216
Customer:
AECOM
Suite 1200
401 West A Street
San Diego, CA 92101, United States

Model Number	LxT1	*Procedure Number*	D0001.8384		
Serial Number	0006201	*Technician*	Kyle Holm		
Test Results	Pass	*Calibration Date*	29 Jun 2020		
Initial Condition	As Manufactured	*Calibration Due*			
Description	SoundTrack LxT Class 1 Class 1 Sound Level Meter Firmware Revision: 2.403	*Temperature*	23.64	°C	± 0.25 °C
		Humidity	52.4	%RH	± 2.0 %RH
		Static Pressure	85.77	kPa	± 0.13 kPa

Evaluation Method — *Tested with:* — *Data reported in dB re 20 μPa*

Larson Davis PRMLxT1L. S/N 069982
PCB 377B02. S/N 322051
Larson Davis CAL200, S/N 9079
Larson Davis CAL291, S/N 0108

Compliance Standards — Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8378:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61252:2002	ANSI S1.11 (R2009) Class 1
IEC 61260:2001 Class 1	ANSI S1.25 (R2007)
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005.
Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2015.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

This report may not be reproduced, except in full, unless permission for the publication of an approved abstract is obtained in writing from the organization issuing this report.

Correction data from Larson Davis LxT Manual for SoundTrack LxT & SoundExpert LxT, I770.01 Rev J Supporting Firmware Version 2.301, 2015-04-30

LARSON DAVIS - A PCB PIEZOTRONICS DIV.
1681 West 820 North
Provo, UT 84601, United States
716-684-0001

LARSON DAVIS
A PCB PIEZOTRONICS DIV.

2020-6-29T14:40:11 — **Page 1 of 3** — D0001.8406 Rev D

Calibration Certificate

Certificate Number 2020007219

Customer:

AECOM
Suite 1200
401 West A Street
San Diego, CA 92101, United States

Model Number	LxT1
Serial Number	0006202
Test Results	Pass
Initial Condition	As Manufactured
Description	SoundTrack LxT Class 1 Class 1 Sound Level Meter Firmware Revision: 2.403

Procedure Number	D0001.8384		
Technician	Kyle Holm		
Calibration Date	29 Jun 2020		
Calibration Due			
Temperature	23.64	°C	± 0.25 °C
Humidity	52.1	%RH	± 2.0 %RH
Static Pressure	85.78	kPa	± 0.13 kPa

Evaluation Method *Tested with:* *Data reported in dB re 20 μPa.*

Larson Davis PRMLxT1L. S/N 069963
PCB 377B02. S/N 322055
Larson Davis CAL200, S/N 9079
Larson Davis CAL291. S/N 0108

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8378:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61252:2002	ANSI S1.11 (R2009) Class 1
IEC 61260:2001 Class 1	ANSI S1.25 (R2007)
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005.
Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2015.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

This report may not be reproduced, except in full, unless permission for the publication of an approved abstract is obtained in writing from the organization issuing this report.

Correction data from Larson Davis LxT Manual for SoundTrack LxT & SoundExpert LxT, I770.01 Rev J Supporting Firmware Version 2.301, 2015-04-30

LARSON DAVIS - A PCB PIEZOTRONICS DIV.
1681 West 820 North
Provo, UT 84601, United States
716-684-0001

LARSON DAVIS
A PCB PIEZOTRONICS DIV.

2020-6-29T14:38:46 **Page 1 of 3** D0001.8406 Rev C

Calibration Certificate

Certificate Number 2020007201

Customer:

AECOM
Suite 1200
401 West A Street
San Diego, CA 92101, United States

Model Number	LxT1
Serial Number	0006200
Test Results	Pass
Initial Condition	As Manufactured
Description	SoundTrack LxT Class 1 Class 1 Sound Level Meter Firmware Revision: 2.403

Procedure Number	D0001.8384		
Technician	Kyle Holm		
Calibration Date	29 Jun 2020		
Calibration Due			
Temperature	23.62	°C	± 0.25 °C
Humidity	53.3	%RH	± 2.0 %RH
Static Pressure	85.72	kPa	± 0.13 kPa

Evaluation Method *Tested with:* *Data reported in dB re 20 μPa.*

Larson Davis PRMLxT1L. S/N 069981
PCB 377B02. S/N 322050
Larson Davis CAL200, S/N 9079
Larson Davis CAL291, S/N 0108

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8378

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61252:2002	ANSI S1.11 (R2009) Class 1
IEC 61260:2001 Class 1	ANSI S1.25 (R2007)
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST) or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005.

Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2015.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

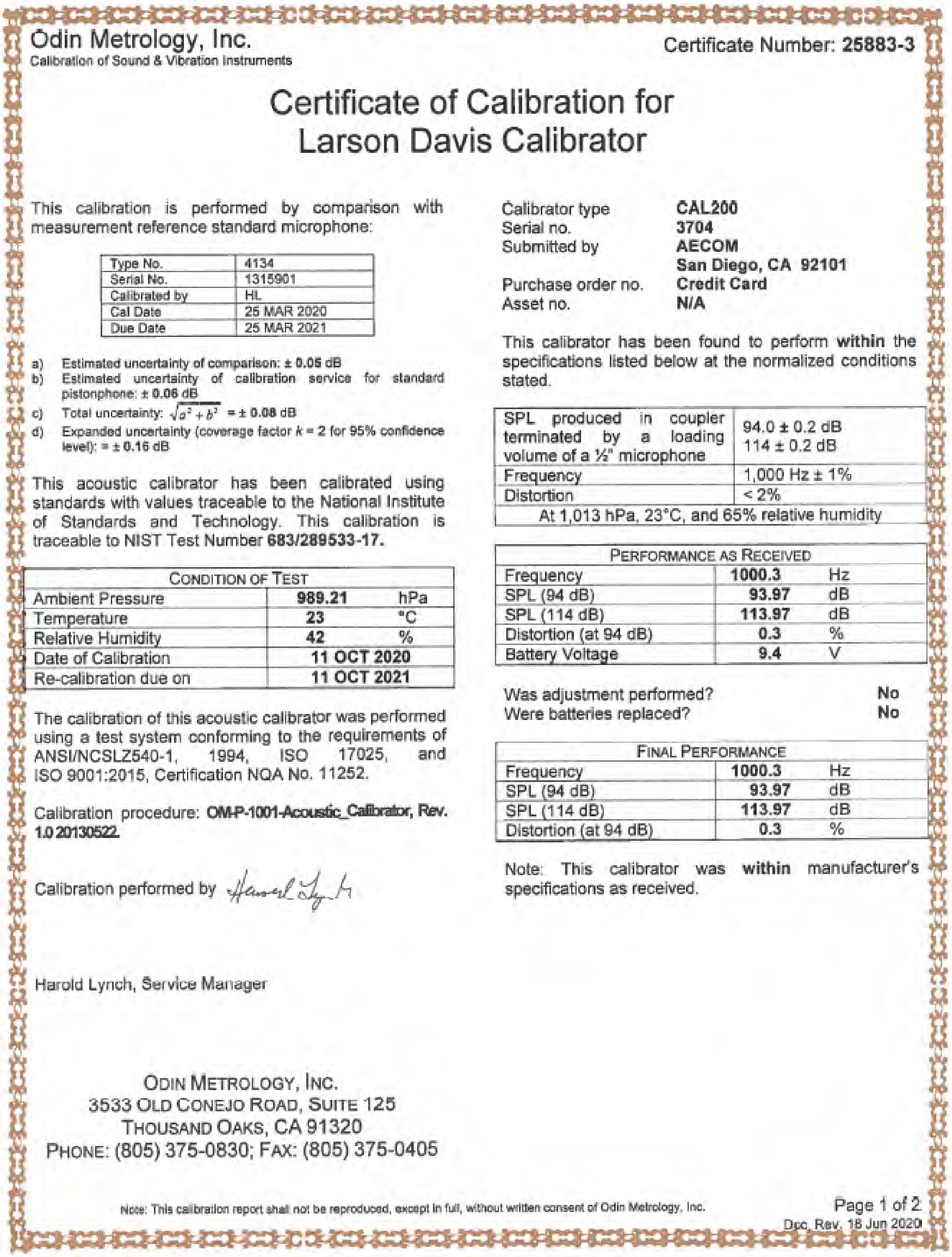
This report may not be reproduced, except in full, unless permission for the publication of an approved abstract is obtained in writing from the organization issuing this report.

Correction data from Larson Davis LxT Manual for SoundTrack LxT & SoundExpert LxT, I770.01 Rev J Supporting Firmware Version 2.301, 2015-04-30

LARSON DAVIS - A PCB PIEZOTRONICS DIV.
1681 West 820 North
Provo, UT 84601, United States
716-684-0001

LARSON DAVIS
A PCB PIEZOTRONICS DIV.

2020-6-29T13:12:02 **Page 1 of 3** D0001.8406 Rev D



Odin Metrology, Inc.
Calibration of Sound & Vibration Instruments

Certificate Number: **25883-3**

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	25 MAR 2020
Due Date	25 MAR 2021

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	**989.21**	hPa
Temperature	**23**	°C
Relative Humidity	**42**	%
Date of Calibration	**11 OCT 2020**	
Re-calibration due on	**11 OCT 2021**	

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 Harold Lynch

Harold Lynch, Service Manager

ODIN METROLOGY, INC.
3533 OLD CONEJO ROAD, SUITE 125
THOUSAND OAKS, CA 91320
PHONE: (805) 375-0830; FAX: (805) 375-0405

Calibrator type **CAL200**
Serial no. **3704**
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	**1000.3**	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	**1000.3**	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.

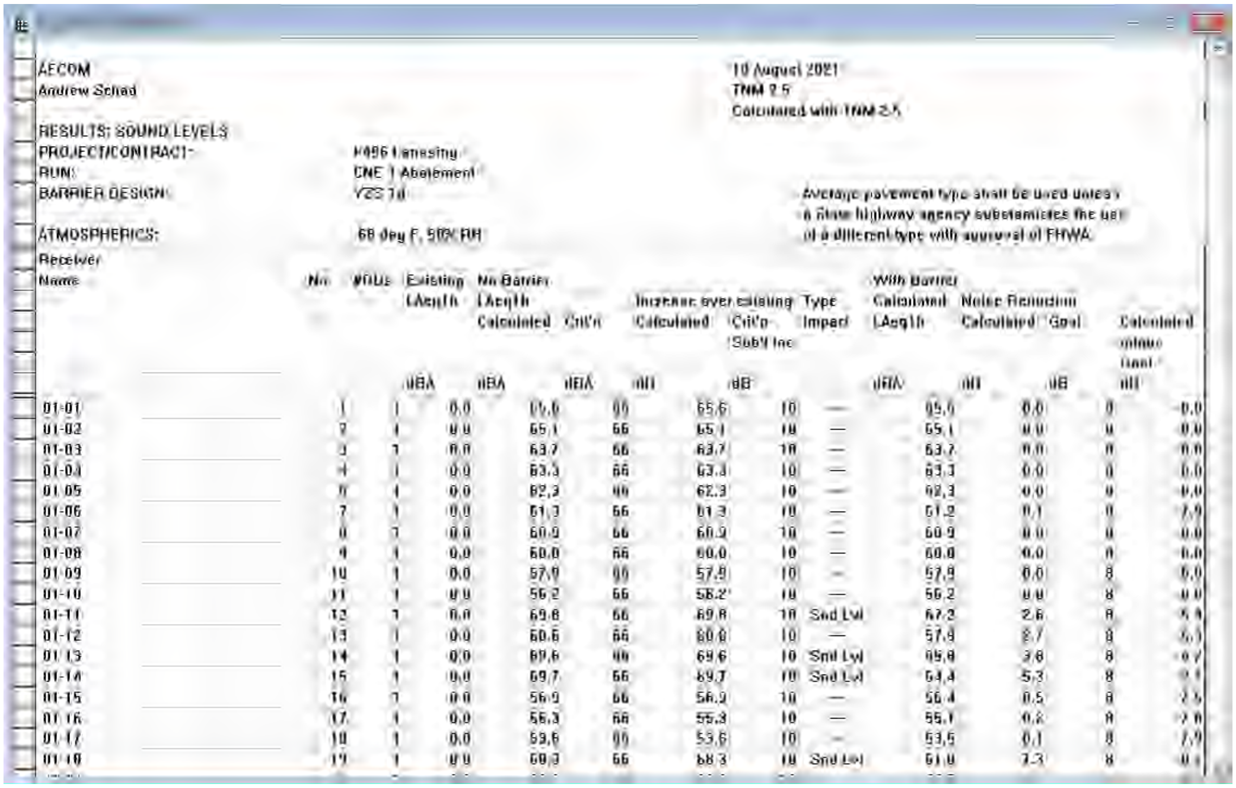
Note: This calibration report shall not be reproduced, except in full, without written consent of Odin Metrology, Inc.

Page 1 of 2
Doc. Rev. 18 Jun 2020

Appendix B Sample TNM Input/Output Files

Sample TNM output tables are provided for CNE 1 Abatement analysis. Additional input and output files are available upon request.

CNE 1 TNM Sound Level Prediction Output Table



AECOM
Andrew Schad

10 August 2021
TNM 2.5
Calculated with TNM 2.5

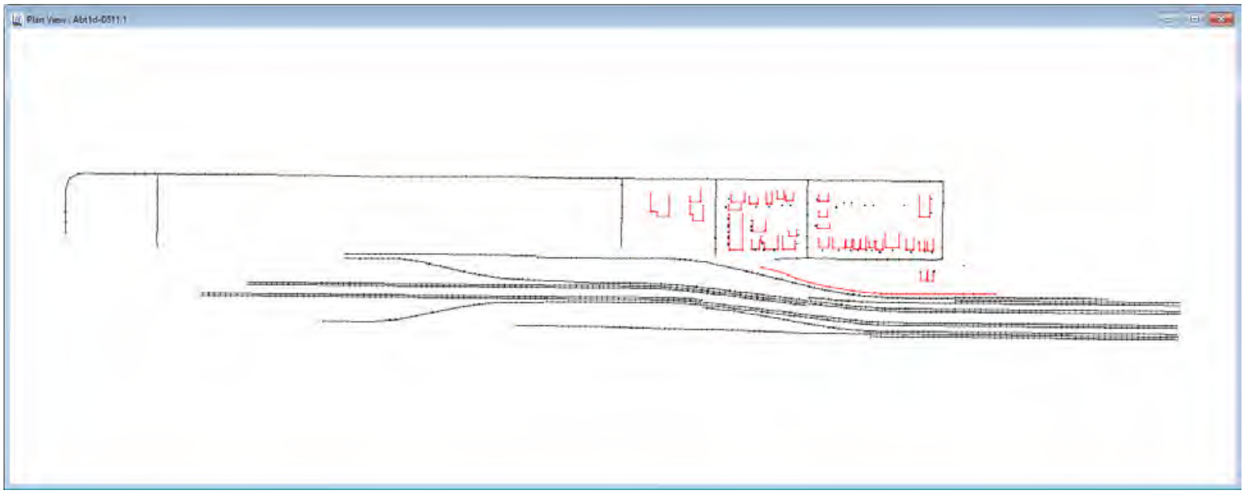
RESULTS: SOUND LEVELS
PROJECT/CONTRACT: I496 Lansing
RUN: CNE 1 Abatement
BARRIER DESIGN: V2S 1d

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

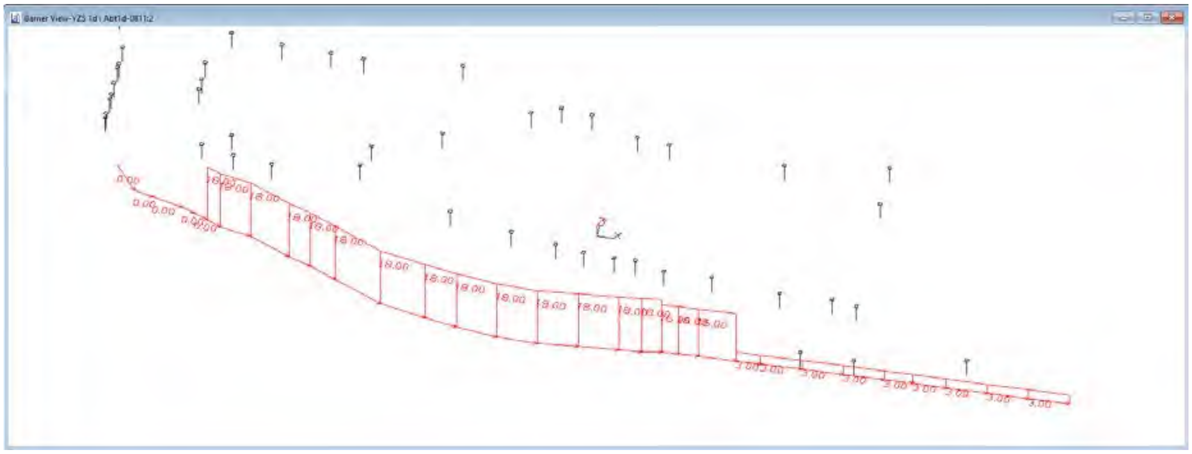
ATMOSPHERICS: 68 deg F, 50% RH

Receiver Name	No.	#DUs	Existing LAeq1h	No Barrier LAeq1h Calculated	Crit'n	Increase over existing Calculated	Crit'n Sub'l Inc	Type Impact	With Barrier Calculated LAeq1h	Noise Reduction Calculated	Goal	Calculated minus Goal
			dBA	dBA	dBA	dB	dB		dBA	dB	dB	dB
01-01	1	1	0.0	65.6	66	65.6	10	—	65.6	0.0	8	-8.0
01-02	2	1	0.0	65.1	66	65.1	10	—	65.1	0.0	8	-8.0
01-03	3	1	0.0	63.7	66	63.7	10	—	63.7	0.0	8	-8.0
01-04	4	1	0.0	63.3	66	63.3	10	—	63.3	0.0	8	-8.0
01-05	6	1	0.0	62.3	66	62.3	10	—	62.3	0.0	8	-8.0
01-06	7	1	0.0	61.3	66	61.3	10	—	61.2	0.1	8	-7.9
01-07	8	1	0.0	60.9	66	60.9	10	—	60.9	0.0	8	-8.0
01-08	9	1	0.0	60.0	66	60.0	10	—	60.0	0.0	8	-8.0
01-09	10	1	0.0	57.9	66	57.9	10	—	57.9	0.0	8	-8.0
01-10	11	1	0.0	56.2	66	56.2	10	—	56.2	0.0	8	-8.0
01-11	12	1	0.0	69.8	66	69.8	10	Snd Lvl	67.2	2.6	8	-5.4
01-12	13	1	0.0	60.6	66	60.6	10	—	57.9	2.7	8	-5.3
01-13	14	1	0.0	69.6	66	69.6	10	Snd Lvl	65.8	3.8	8	-4.2
01-14	15	1	0.0	69.7	66	69.7	10	Snd Lvl	64.4	5.3	8	-2.7
01-15	16	1	0.0	56.9	66	56.9	10	—	56.4	0.5	8	-7.5
01-16	17	1	0.0	55.3	66	55.3	10	—	55.1	0.2	8	-7.8
01-17	18	1	0.0	53.6	66	53.6	10	—	53.5	0.1	8	-7.9
01-18	19	1	0.0	68.3	66	68.3	10	Snd Lvl	61.0	7.3	8	-0.7

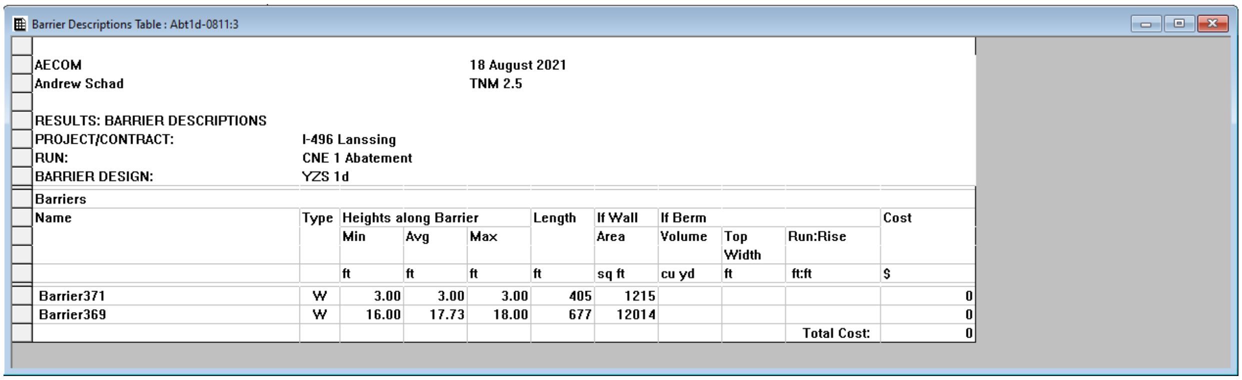
Plan View



Barrier Analysis Screenshot



Barrier Description Table



Barrier Descriptions Table : Abt1d-0811:3

AECOM			18 August 2021							
Andrew Schad			TNM 2.5							
RESULTS: BARRIER DESCRIPTIONS										
PROJECT/CONTRACT:	I-496 Lanssing									
RUN:	CNE 1 Abatement									
BARRIER DESIGN:	YZS 1d									
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	$
Barrier371	W	3.00	3.00	3.00	405	1215				0
Barrier369	W	16.00	17.73	18.00	677	12014				0
									Total Cost:	0

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	67	65	**66**	+1
01-02	Residential	B	1	67	65	65	+1
01-03	Residential	B	1	67	63	64	+1
01-04	Residential	B	1	67	63	63	+1
01-05	Residential	B	1	67	62	62	+1
01-06	Residential	B	1	67	61	61	+1
01-07	Residential	B	1	67	60	61	+1
01-08	Residential	B	1	67	59	60	+1
01-09	Residential	B	1	67	57	58	+1
01-10	Residential	B	1	67	56	56	+1
01-12	Residential	B	1	67	60	**70**	+1
01-13	Residential	B	1	67	**69**	61	+1
01-14	Residential	B	1	67	**69**	**70**	+1
01-15	Residential	B	1	67	56	**70**	+1
01-16	Residential	B	1	67	55	57	+1
01-17	Residential	B	1	67	53	55	+1
01-18	Residential	B	1	67	**67**	54	+1
01-19	Residential	B	1	67	64	**68**	+2
01-20	Residential	B	1	67	55	**66**	+1
01-21	Residential	B	1	67	56	56	+1
01-22	Residential	B	1	67	59	57	+1
01-23	Residential	B	1	67	59	61	+1
01-24	Residential	B	1	67	**69**	60	+1
01-25	Residential	B	1	67	**68**	**70**	+1
01-26	Residential	B	1	67	**66**	**68**	+1
01-27	Residential	B	1	67	66	**67**	+1
01-28	Residential	B	1	67	65	**66**	+1
01-29	Residential	B	1	67	65	**66**	+1
01-30	Residential	B	1	67	65	**66**	+1
01-31	Residential	B	1	67	65	65	+1
01-32	Residential	B	1	67	66	65	+1
01-33	Residential	B	1	67	**66**	65	+1
01-34	Residential	B	1	67	**67**	65	+1
01-35	Residential	B	1	67	59	65	+1
01-36	Residential	B	1	67	56	60	+1
01-37	Residential	B	1	67	57	57	+1
01-38	Residential	B	1	67	58	58	+1
01-39	Residential	B	1	67	58	59	+1
01-40	Residential	B	1	67	58	59	+1
01-41	Residential	B	1	67	58	59	+1
01-42	Residential	B	1	67	59	59	+1
01-43	Residential	B	1	67	62	59	+1
01-44	Residential	B	1	67	63	62	+1
01-45	Park	C	1	67	**71**	63	+1
01-46	Residential	B	1	67	64	64	+1
01-47	Residential	B	1	67	60	60	+1
CNE 2							
02-01	Residential	B	1	67	62	62	+1
02-02	Residential	B	1	67	58	58	+1
02-03	Residential	B	1	67	55	56	+1
02-04	Residential	B	1	67	54	54	+1
02-05	Residential	B	1	67	**67**	**68**	+1
02-06	Residential	B	1	67	63	64	+1

Receptor Number	Land Use	Activity Category	Units	FHWA/MDOT NAC	Existing	Build	Change
02-07	Residential	B	1	67	60	60	+1
02-08	Residential	B	1	67	62	63	+1
02-09	Residential	B	1	67	59	60	+1
02-10	Residential	B	1	67	63	64	+1
02-12	Residential	B	1	67	63	64	+1
02-13	Residential	B	1	67	65	**66**	+1
02-14	Residential	B	1	67	65	**66**	+1
02-15	Park	C	1	67	**67**	**68**	+1
02-16	Residential	B	1	67	62	63	+1
CNE 3							
03-01	Residential	B	1	67	62	62	+0
03-02	Residential	B	1	67	57	57	+1
03-03	Residential	B	1	67	60	61	+1
03-04	Residential	B	1	67	**66**	**66**	+0
03-05	Residential	B	1	67	47	48	+1
03-06	Residential	B	1	67	54	54	+1
CNE 4							
04-01	Park	C	1	67	**67**	**68**	+0
04-02	Park	C	1	67	**67**	**67**	+0
04-03	Park	C	1	67	61	61	+0
04-04	Park	C	1	67	57	57	+1
04-05	Park	C	1	67	57	57	+1
04-06	Park	C	1	67	56	56	+1
04-07	Park	C	1	67	55	56	+1
CNE 5							
05-01	Residential	B	1	67	**69**	**70**	+1
05-02	Residential	B	1	67	**69**	**70**	+1
05-03	Residential	B	1	67	**69**	**70**	+0
05-04	Residential	B	1	67	**69**	**69**	+1
05-05	Residential	B	1	67	**69**	**69**	+0
05-06	Residential	B	1	67	61	62	+0
05-07	Residential	B	1	67	58	58	+1
05-08	Residential	B	1	67	53	53	+0
05-09	Residential	B	1	67	51	51	+1
05-10	Residential	B	1	67	55	55	+1
05-11	Residential	B	1	67	54	54	+0
05-12	Residential	B	1	67	53	53	+0
05-13	Residential	B	1	67	55	55	+1
05-14	Residential	B	1	67	54	54	+0
05-15	Residential	B	1	67	56	56	-0
CNE 6							
06-01	Residential	B	1	67	**68**	**68**	-0
06-02	Residential	B	1	67	63	62	-0
06-03	Residential	B	1	67	58	58	0
06-04	Residential	B	1	67	58	58	+0
06-05	Residential	B	1	67	58	58	+0
06-06	Residential	B	1	67	59	59	+0
06-07	Residential	B	1	67	59	59	+0
06-08	Residential	B	1	67	61	61	+0
06-09	Residential	B	1	67	55	55	+0
06-10	Residential	B	1	67	55	55	+0
06-11	Residential	B	1	67	50	50	+0
06-12	Residential	B	1	67	49	49	+0
06-13	Residential	B	1	67	49	49	+0
06-14	Park	C	1	67	51	51	+0
06-101	Residential	B	1	67	63	64	+0
06-102	Residential	B	1	67	63	63	+0
06-103	Residential	B	1	67	59	59	+0
06-104	Residential	B	1	67	60	61	+0
06-105	Residential	B	1	67	59	59	+0

Receptor Number	Land Use	Activity Category	Units	FHWA/MDOT NAC	Existing	Build	Change
06-106	Residential	B	1	67	61	62	+0
06-107	Residential	B	1	67	62	62	0
06-108	Residential	B	1	67	65	65	+1
06-109	Residential	B	1	67	51	51	+0
06-110	Residential	B	1	67	51	51	+0
06-111	Residential	B	1	67	51	52	+0
06-112	Residential	B	1	67	51	51	+0
06-113	Residential	B	1	67	51	51	+0
06-114	Residential	B	1	67	51	51	+0
06-115	Residential	B	1	67	56	55	-0
06-116	Residential	B	1	67	60	60	+0
06-117	Residential	B	1	67	54	54	+0
06-118	Residential	B	1	67	59	59	+0
06-119	Residential	B	1	67	63	63	+0
06-120	Residential	B	1	67	**67**	**67**	+0
06-121	Residential	B	1	67	65	65	0
06-122	Residential	B	1	67	61	62	+0
06-123	Residential	B	1	67	54	55	+0
06-124	Residential	B	1	67	56	57	+0
06-125	Residential	B	1	67	52	52	+0
06-126	Residential	B	1	67	52	52	+0
06-127	Residential	B	1	67	54	54	+0
06-128	Residential	B	1	67	50	50	+0
06-129	Residential	B	1	67	59	59	+0
06-130	Residential	B	1	67	60	60	+0
06-131	Residential	B	1	67	48	48	+0
06-132	Residential	B	1	67	48	48	+0
06-133	Residential	B	1	67	48	48	+0
06-134	Residential	B	1	67	47	47	+0
06-201	Residential	B	1	67	**68**	**68**	+0
06-202	Residential	B	1	67	**68**	**68**	+0
06-203	Residential	B	1	67	64	64	+0
06-204	Residential	B	1	67	65	65	+0
06-205	Residential	B	1	67	64	64	+0
06-206	Residential	B	1	67	**67**	**67**	+1
06-207	Residential	B	1	67	**68**	**68**	+1
06-208	Residential	B	1	67	**71**	**71**	+0
06-209	Residential	B	1	67	53	53	+0
06-210	Residential	B	1	67	53	53	+0
06-211	Residential	B	1	67	53	53	+0
06-212	Residential	B	1	67	52	52	+0
06-213	Residential	B	1	67	51	51	+0
06-214	Residential	B	1	67	51	51	+0
06-215	Residential	B	1	67	62	62	0
06-216	Residential	B	1	67	**66**	**67**	+1
06-217	Residential	B	1	67	61	61	+0
06-218	Residential	B	1	67	**66**	**66**	+1
06-219	Residential	B	1	67	**70**	**70**	+0
06-220	Residential	B	1	67	**72**	**72**	+0
06-221	Residential	B	1	67	**70**	**71**	+0
06-222	Residential	B	1	67	**67**	**68**	+0
06-223	Residential	B	1	67	58	59	+0
06-224	Residential	B	1	67	61	61	+0
06-225	Residential	B	1	67	54	54	+0
06-226	Residential	B	1	67	55	55	+0
06-227	Residential	B	1	67	58	58	+0
06-228	Residential	B	1	67	55	55	-0
06-229	Residential	B	1	67	64	64	+0
06-230	Residential	B	1	67	65	65	+0
06-231	Residential	B	1	67	49	50	+0

Receptor Number	Land Use	Activity Category	Units	FHWA/MDOT NAC	Existing	Build	Change
06-232	Residential	B	1	67	48	49	+0
06-233	Residential	B	1	67	47	48	+0
06-234	Residential	B	1	67	48	49	+0
06-301	Residential	B	1	67	**71**	**71**	+0
06-302	Residential	B	1	67	**71**	**71**	+0
06-303	Residential	B	1	67	**67**	**68**	+1
06-304	Residential	B	1	67	**68**	**69**	+1
06-305	Residential	B	1	67	**67**	**68**	+1
06-306	Residential	B	1	67	**70**	**70**	+0
06-307	Residential	B	1	67	**70**	**70**	+0
06-308	Residential	B	1	67	**71**	**71**	+0
06-309	Residential	B	1	67	58	58	+0
06-310	Residential	B	1	67	57	57	+0
06-311	Residential	B	1	67	57	57	+0
06-312	Residential	B	1	67	56	56	+0
06-313	Residential	B	1	67	55	55	+0
06-314	Residential	B	1	67	55	55	+0
06-315	Residential	B	1	67	65	65	+0
06-316	Residential	B	1	67	**68**	**68**	+0
06-317	Residential	B	1	67	64	64	+0
06-318	Residential	B	1	67	**68**	**68**	+0
06-319	Residential	B	1	67	**70**	**70**	+0
06-320	Residential	B	1	67	**72**	**72**	+0
06-321	Residential	B	1	67	**71**	**72**	+0
06-322	Residential	B	1	67	**70**	**70**	+1
06-323	Residential	B	1	67	61	62	+0
06-324	Residential	B	1	67	64	64	+0
06-325	Residential	B	1	67	57	57	+0
06-326	Residential	B	1	67	59	59	+0
06-327	Residential	B	1	67	61	61	+0
06-328	Residential	B	1	67	59	59	+0
06-329	Residential	B	1	67	**67**	**68**	+0
06-330	Residential	B	1	67	**68**	**68**	+0
06-331	Residential	B	1	67	52	52	+0
06-332	Residential	B	1	67	51	51	+0
06-333	Residential	B	1	67	52	52	+0
06-334	Residential	B	1	67	52	52	+0
CNE 7							
07-01	Residential	B	1	67	**68**	**69**	+1
07-02	Residential	B	1	67	**69**	**70**	+1
07-03	Residential	B	1	67	**69**	**70**	+1
07-04	Residential	B	1	67	**69**	**70**	+1
07-05	Residential	B	1	67	**69**	**70**	+1
07-06	Residential	B	1	67	**69**	**70**	+1
07-07	Residential	B	1	67	**69**	**70**	+1
07-08	Residential	B	1	67	**70**	**71**	+1
07-09	Residential	B	1	67	**69**	**70**	+1
07-10	Residential	B	1	67	**69**	**70**	+1
07-11	Residential	B	1	67	**69**	**70**	+2
07-12	Residential	B	1	67	**69**	**71**	+1
07-13	Residential	B	1	67	**70**	**71**	+1
07-14	Residential	B	1	67	**69**	**70**	+1
07-15	Residential	B	1	67	**69**	**71**	+1
07-16	Residential	B	1	67	**70**	**71**	+1
07-17	Residential	B	1	67	**70**	**71**	+1
07-18	Residential	B	1	67	**71**	**72**	+1
07-19	Residential	B	1	67	**69**	**70**	+1
07-20	Residential	B	1	67	**71**	**72**	+1
07-21	Residential	B	1	67	**72**	**72**	+1
07-22	Residential	B	1	67	**72**	**72**	+0

Receptor Number	Land Use	Activity Category	Units	FHWA/MDOT NAC	Existing	Build	Change
07-23	Residential	B	1	67	**72**	**72**	+0
07-24	Residential	B	1	67	**72**	**72**	+1
07-25	Residential	B	1	67	**72**	**72**	+0
07-26	Residential	B	1	67	**71**	**72**	+1
07-27	Residential	B	1	67	**71**	**71**	+1
07-28	Residential	B	1	67	**72**	**72**	+1
07-29	Residential	B	1	67	**72**	**72**	+1
07-30	Residential	B	1	67	**72**	**72**	+1
07-31	Residential	B	1	67	**72**	**73**	+1
07-32	Residential	B	1	67	**72**	**73**	+1
07-33	Residential	B	1	67	**74**	**74**	+1
07-34	Residential	B	1	67	62	62	+0
07-35	Residential	B	1	67	58	58	+0
07-36	Residential	B	1	67	52	52	+1
07-37	Residential	B	1	67	60	61	+1
07-38	Residential	B	1	67	57	58	+1
07-39	Residential	B	1	67	59	61	+1
07-40	Residential	B	1	67	60	60	+1
07-41	Residential	B	1	67	56	57	+1
07-42	Residential	B	1	67	54	54	+1
07-43	Residential	B	1	67	58	59	+1
07-44	Residential	B	1	67	54	55	+1
07-45	Residential	B	1	67	**69**	**69**	+0
07-46	Residential	B	1	67	**68**	**68**	+1
07-47	Residential	B	1	67	54	54	+1
07-48	Residential	B	1	67	52	52	+1
07-49	Residential	B	1	67	50	51	+1
07-50	Residential	B	1	67	53	53	+0
07-51	Residential	B	1	67	55	55	+0
07-52	Residential	B	1	67	51	52	+0
07-53	Residential	B	1	67	58	59	+0
07-54	Residential	B	1	67	49	49	+0
07-55	Residential	B	1	67	49	50	+0
07-56	Residential	B	1	67	52	53	+1
07-57	Residential	B	1	67	48	49	+0
07-58	Residential	B	1	67	51	51	+1
07-59	Residential	B	1	67	51	51	+0
07-60	Residential	B	1	67	50	50	+0
07-61	Residential	B	1	67	52	53	+1
07-62	Residential	B	1	67	55	55	+0
07-63	Residential	B	1	67	60	60	+0
07-64	Residential	B	1	67	61	61	+1
07-65	Residential	B	1	67	61	62	+0
07-66	Residential	B	1	67	64	64	+0
CNE 8							
08-01	Residential	B	1	67	**68**	**69**	+1
08-02	School	C	1	67	**67**	**68**	+1
08-03	Residential	B	1	67	**69**	**70**	+1
08-04	Residential	B	1	67	**72**	**72**	0
08-05	Residential	B	1	67	**71**	**71**	+0
08-06	Residential	B	1	67	**71**	**71**	+0
08-07	Residential	B	1	67	**71**	**71**	0
08-08	Residential	B	1	67	**71**	**71**	+0
08-09	Residential	B	1	67	**70**	**71**	+0
08-10	Residential	B	1	67	**71**	**71**	+0
08-11	Residential	B	1	67	**71**	**71**	+0
08-12	Residential	B	1	67	**71**	**71**	-0
08-13	Residential	B	1	67	**72**	**71**	-1
08-14	Residential	B	1	67	**72**	**71**	-1
08-15	Residential	B	1	67	**71**	**71**	-1

Receptor Number	Land Use	Activity Category	Units	FHWA/MDOT NAC	Existing	Build	Change
08-16	Residential	B	1	67	**72**	**71**	-1
08-17	Residential	B	1	67	59	60	+1
08-18	Residential	B	1	67	54	55	+0
08-19	Residential	B	1	67	53	53	+0
08-20	Residential	B	1	67	52	53	+1
08-21	Residential	B	1	67	56	57	+1
08-22	Residential	B	1	67	52	52	+1
08-23	School	C	1	67	53	53	+1
08-24	School	C	1	67	53	53	+0
08-25	School	C	1	67	53	54	+0
08-26	Church	C	1	67	59	60	+1
08-27	Residential	B	1	67	54	54	+0
08-28	Residential	B	1	67	60	60	0
08-29	Residential	B	1	67	56	56	-0
08-30	Residential	B	1	67	54	54	+0
08-31	Residential	B	1	67	52	52	0
08-32	Residential	B	1	67	51	51	0
08-33	Residential	B	1	67	61	61	-0
08-34	Residential	B	1	67	59	59	-0
08-35	Residential	B	1	67	56	56	-0
08-36	Residential	B	1	67	54	54	-0
08-37	Residential	B	1	67	53	53	+0
08-38	Residential	B	1	67	61	61	0
08-39	Residential	B	1	67	57	57	0
08-40	Residential	B	1	67	55	55	+0
08-41	Residential	B	1	67	54	54	+0
08-42	Residential	B	1	67	53	54	+0
08-43	Residential	B	1	67	62	62	-0
08-44	Residential	B	1	67	57	57	0
08-45	Residential	B	1	67	55	55	+0
08-46	Residential	B	1	67	62	62	+0
08-47	Residential	B	1	67	60	60	+0
08-48	Residential	B	1	67	60	60	+0
08-49	Residential	B	1	67	58	59	+0
08-50	Residential	B	1	67	58	58	+0
08-51	Residential	B	1	67	54	54	+0
08-52	Residential	B	1	67	52	52	+0
08-53	Residential	B	1	67	49	49	+0
08-54	Residential	B	1	67	49	49	+0
08-55	Residential	B	1	67	52	52	+0
08-56	Residential	B	1	67	49	50	+0
CNE 9							
09-01	Park	C	1	67	**66**	**66**	-0
09-02	School	C	1	67	**68**	**68**	0
09-03	School	C	1	67	65	65	0
09-04	Residential	B	1	67	63	63	-0
09-05	Residential	B	1	67	**68**	**67**	-0
09-06	Residential	B	1	67	**68**	**68**	-0
09-07	Residential	B	1	67	**68**	**68**	0
09-08	Residential	B	1	67	**68**	**68**	+0
09-09	Residential	B	1	67	**68**	**68**	+0
09-10	Residential	B	1	67	**68**	**68**	+0
09-11	Residential	B	1	67	**68**	**68**	+0
09-12	Residential	B	1	67	58	58	0
09-13	Residential	B	1	67	54	54	0
09-14	Residential	B	1	67	53	53	+0
09-15	Residential	B	1	67	53	53	+0
09-16	Residential	B	1	67	53	53	+0
09-17	Residential	B	1	67	54	54	+0
09-18	Residential	B	1	67	53	53	+0

Receptor Number	Land Use	Activity Category	Units	FHWA/MDOT NAC	Existing	Build	Change
09-19	Residential	B	1	67	51	51	+0
09-20	Residential	B	1	67	49	49	+0
09-21	Residential	B	1	67	52	52	+0
09-22	Residential	B	1	67	52	52	+0
09-23	Residential	B	1	67	53	53	+0
09-24	Residential	B	1	67	53	54	+0
09-25	Residential	B	1	67	51	51	+0
09-26	Residential	B	1	67	52	52	+0
CNE-10							
10-01	Residential	B	1	67	**67**	**67**	+0
10-02	Residential	B	1	67	**67**	**67**	+0
10-03	Residential	B	1	67	**67**	**67**	+0
10-04	Residential	B	1	67	**68**	**68**	+0
10-05	Residential	B	1	67	**67**	**67**	+0
10-06	Residential	B	1	67	**66**	**66**	+0
10-07	Residential	B	1	67	**68**	**68**	+0
10-08	Residential	B	1	67	**67**	**67**	+0
10-09	Residential	B	1	67	**68**	**68**	+0
10-10	Residential	B	1	67	**68**	**68**	+0
10-11	Residential	B	1	67	59	59	+0
10-12	Residential	B	1	67	55	55	+0
10-13	Residential	B	1	67	53	54	+0
10-14	Residential	B	1	67	60	61	+0
10-15	Residential	B	1	67	56	57	+0
10-16	Residential	B	1	67	54	54	+0
10-17	Residential	B	1	67	54	54	+0
10-18	Residential	B	1	67	49	49	+0
10-19	Residential	B	1	67	49	50	+0
10-20	Residential	B	1	67	59	60	+0
10-21	Residential	B	1	67	56	57	+1
10-22	Residential	B	1	67	53	54	+1
10-23	Residential	B	1	67	48	49	+0
10-24	Residential	B	1	67	48	48	+0

Appendix D Noise Barrier Analysis Detail

Table D-1 Existing and Predicted Future Build Noise Levels and Barrier Analysis

Receptor Number	Land Use	Category	Units	FHWA/MDOT NAC	Build	Noise Level w/Barr	Noise Reduction	Benefit?
Wall 1								
01-01	Residential	B	1	67	66	66	0	
01-02	Residential	B	1	67	65	65	0	
01-03	Residential	B	1	67	64	64	0	
01-04	Residential	B	1	67	63	63	0	
01-05	Residential	B	1	67	62	62	0	
01-06	Residential	B	1	67	61	61	0	
01-07	Residential	B	1	67	61	61	0	
01-08	Residential	B	1	67	60	60	0	
01-09	Residential	B	1	67	58	58	0	
01-10	Residential	B	1	67	56	56	0	
01-12	Residential	B	1	67	61	58	3	
01-13	Residential	B	1	67	70	66	4	
01-14	Residential	B	1	67	70	64	5	Y
01-15	Residential	B	1	67	57	56	1	
01-16	Residential	B	1	67	55	55	0	
01-17	Residential	B	1	67	54	54	0	
01-18	Residential	B	1	67	68	61	7	Y
01-19	Residential	B	1	67	66	56	10	Y
01-20	Residential	B	1	67	56	55	1	
01-21	Residential	B	1	67	57	56	2	
01-22	Residential	B	1	67	61	57	3	
01-23	Residential	B	1	67	60	54	6	Y
01-24	Residential	B	1	67	70	62	8	Y
01-25	Residential	B	1	67	68	61	8	Y
01-26	Residential	B	1	67	67	61	7	Y
01-27	Residential	B	1	67	66	61	6	Y
01-28	Residential	B	1	67	66	61	5	Y
01-29	Residential	B	1	67	66	61	5	Y
01-30	Residential	B	1	67	65	61	4	
01-31	Residential	B	1	67	65	62	3	
01-32	Residential	B	1	67	65	63	2	
01-33	Residential	B	1	67	65	64	1	
01-34	Residential	B	1	67	65	65	1	
01-35	Residential	B	1	67	60	53	7	Y
01-36	Residential	B	1	67	57	53	4	
01-37	Residential	B	1	67	58	56	3	
01-38	Residential	B	1	67	59	57	2	
01-39	Residential	B	1	67	59	57	2	
01-40	Residential	B	1	67	59	57	2	
01-41	Residential	B	1	67	59	58	2	
01-42	Residential	B	1	67	59	57	2	
01-43	Residential	B	1	67	62	62	0	
01-44	Residential	B	1	67	63	63	0	
01-45	Park	C	1	67	68	68	0	
01-46	Residential	B	1	67	64	64		

Receptor Number	Land Use	Category	Units	FHWA/MDOT NAC	Build	Noise Level w/Barr	Noise Reduction	Benefit?
01-47	Residential	B	1	67	60	60	0	
Wall 2								
02-01	Residential	B	1	67	62	61	1	
02-02	Residential	B	1	67	58	58	1	
02-03	Residential	B	1	67	56	56	0	
02-04	Residential	B	1	67	54	54	0	
02-05	Residential	B	1	67	68	63	4	
02-06	Residential	B	1	67	64	59	5	Y
02-07	Residential	B	1	67	60	56	5	Y
02-08	Residential	B	1	67	63	58	5	Y
02-09	Residential	B	1	67	60	60	0	
02-10	Residential	B	1	67	64	64	0	
02-12	Residential	B	1	67	64	64	0	
02-13	Residential	B	1	67	66	66	0	
02-14	Residential	B	1	67	66	66	0	
02-15	Park	C	1	67	68	68	0	
02-16	Park	C	1	67	63	63	0	
Wall 4								
04-01	Park	C	1	67	68	64	3	
04-02	Park	C	1	67	67	64	4	
04-03	Park	C	1	67	61	58	3	
04-04	Park	C	1	67	57	56	2	
04-05	Park	C	1	67	57	56	1	
04-06	Park	C	1	67	56	55	1	
04-07	Park	C	1	67	56	55	1	
Wall 5								
05-01	Residential	B	1	67	70	69	1	
05-02	Residential	B	1	67	70	68	2	
05-03	Residential	B	1	67	70	68	2	
05-04	Residential	B	1	67	69	67	2	
05-05	Residential	B	1	67	69	67	2	
05-06	Residential	B	1	67	62	59	3	
05-07	Residential	B	1	67	58	56	2	
05-08	Residential	B	1	67	53	53	0	
05-09	Residential	B	1	67	51	50	1	
05-10	Residential	B	1	67	55	54	1	
05-11	Residential	B	1	67	54	53	1	
05-12	Residential	B	1	67	53	52	1	
05-13	Residential	B	1	67	55	54	1	
05-14	Residential	B	1	67	54	53	1	
05-15	Residential	B	1	67	56	56	0	
05-01	Residential	B	1	67	70	69	1	
05-02	Residential	B	1	67	70	68	2	
05-03	Residential	B	1	67	70	68	2	
05-04	Residential	B	1	67	69	67	2	
Wall 6								

Receptor Number	Land Use	Category	Units	FHWA/MDOT NAC	Build	Noise Level w/Barr	Noise Reduction	Benefit?
06-02	Residential	B	1	67	62	62	0	
06-03	Residential	B	1	67	58	58	0	
06-04	Residential	B	1	67	58	58	0	
06-05	Residential	B	1	67	58	57	0	
06-06	Residential	B	1	67	59	59	0	
06-07	Residential	B	1	67	59	59	1	
06-08	Residential	B	1	67	61	61	1	
06-09	Residential	B	1	67	55	55	0	
06-10	Residential	B	1	67	55	55	0	
06-101	Residential	B	1	67	64	63	1	
06-102	Residential	B	1	67	63	62	1	
06-103	Residential	B	1	67	59	57	2	
06-104	Residential	B	1	67	61	60	1	
06-105	Residential	B	1	67	59	59	1	
06-106	Residential	B	1	67	62	61	1	
06-107	Residential	B	1	67	62	61	1	
06-108	Residential	B	1	67	65	62	3	
06-115	Residential	B	1	67	55	51	5	Y
06-116	Residential	B	1	67	60	54	6	Y
06-118	Residential	B	1	67	59	54	5	Y
06-119	Residential	B	1	67	63	60	3	
06-120	Residential	B	1	67	67	62	5	Y
06-121	Residential	B	1	67	65	61	4	
06-122	Residential	B	1	67	62	59	3	
06-123	Residential	B	1	67	55	54	0	
06-124	Residential	B	1	67	57	55	2	
06-129	Residential	B	1	67	59	57	2	
06-130	Residential	B	1	67	60	57	3	
06-201	Residential	B	1	67	68	66	2	
06-202	Residential	B	1	67	68	66	2	
06-203	Residential	B	1	67	64	60	4	
06-204	Residential	B	1	67	65	63	3	
06-205	Residential	B	1	67	64	62	2	
06-206	Residential	B	1	67	67	64	3	
06-207	Residential	B	1	67	68	65	4	
06-208	Residential	B	1	67	71	66	4	
06-215	Residential	B	1	67	62	53	10	Y
06-216	Residential	B	1	67	67	56	11	Y
06-218	Residential	B	1	67	66	56	11	Y
06-219	Residential	B	1	67	70	64	7	Y
06-220	Residential	B	1	67	72	64	7	Y
06-221	Residential	B	1	67	71	62	9	Y
06-222	Residential	B	1	67	68	61	7	Y
06-223	Residential	B	1	67	59	57	2	
06-224	Residential	B	1	67	61	58	4	
06-229	Residential	B	1	67	64	59	5	Y
06-230	Residential	B	1	67	65	60	5	Y
06-301	Residential	B	1	67	71	70	2	
06-302	Residential	B	1	67	71	69	2	
06-303	Residential	B	1	67	68	64	4	

Receptor Number	Land Use	Category	Units	FHWA/MDOT NAC	Build	Noise Level w/Barr	Noise Reduction	Benefit?
06-304	Residential	B	1	67	69	66	3	
06-305	Residential	B	1	67	68	66	2	
06-306	Residential	B	1	67	70	67	3	
06-307	Residential	B	1	67	70	67	3	
06-308	Residential	B	1	67	71	67	4	
06-315	Residential	B	1	67	65	54	11	Y
06-316	Residential	B	1	67	68	57	11	Y
06-318	Residential	B	1	67	68	57	11	Y
06-319	Residential	B	1	67	70	64	6	Y
06-320	Residential	B	1	67	72	65	7	Y
06-321	Residential	B	1	67	72	64	8	Y
06-322	Residential	B	1	67	70	62	8	Y
06-323	Residential	B	1	67	62	59	3	
06-324	Residential	B	1	67	64	59	5	Y
06-329	Residential	B	1	67	68	61	7	Y
06-330	Residential	B	1	67	68	61	7	Y
Wall 7								
07-01	Residential	B	1	67	69	66	3	
07-02	Residential	B	1	67	70	65	5	Y
07-03	Residential	B	1	67	70	64	5	Y
07-04	Residential	B	1	67	70	64	6	Y
07-05	Residential	B	1	67	70	64	6	Y
07-06	Residential	B	1	67	70	64	6	Y
07-07	Residential	B	1	67	70	64	6	Y
07-08	Residential	B	1	67	71	64	6	Y
07-09	Residential	B	1	67	70	64	6	Y
07-10	Residential	B	1	67	70	64	7	Y
07-11	Residential	B	1	67	70	63	7	Y
07-12	Residential	B	1	67	71	64	7	Y
07-13	Residential	B	1	67	71	64	7	Y
07-14	Residential	B	1	67	70	63	7	Y
07-15	Residential	B	1	67	71	64	7	Y
07-16	Residential	B	1	67	71	64	7	Y
07-17	Residential	B	1	67	71	64	7	Y
07-18	Residential	B	1	67	72	65	7	Y
07-19	Residential	B	1	67	70	64	7	Y
07-20	Residential	B	1	67	72	65	6	Y
07-21	Residential	B	1	67	72	66	6	Y
07-22	Residential	B	1	67	72	66	6	Y
07-23	Residential	B	1	67	72	67	6	Y
07-24	Residential	B	1	67	72	67	5	Y
07-25	Residential	B	1	67	72	68	5	Y
07-26	Residential	B	1	67	72	68	4	
07-27	Residential	B	1	67	71	68	3	
07-28	Residential	B	1	67	72	69	3	
07-29	Residential	B	1	67	72	69	3	
07-30	Residential	B	1	67	72	70	2	

Receptor Number	Land Use	Category	Units	FHWA/MDOT NAC	Build	Noise Level w/Barr	Noise Reduction	Benefit?
07-31	Residential	B	1	67	73	71	2	
07-32	Residential	B	1	67	73	71	2	
07-33	Residential	B	1	67	74	73	1	
07-34	Residential	B	1	67	62	61	1	
07-35	Residential	B	1	67	58	57	1	
07-36	Residential	B	1	67	52	49	3	
07-37	Residential	B	1	67	61	54	7	Y
07-38	Residential	B	1	67	58	51	7	Y
07-39	Residential	B	1	67	61	54	7	Y
07-40	Residential	B	1	67	60	55	5	Y
07-41	Residential	B	1	67	57	52	5	Y
07-42	Residential	B	1	67	54	50	4	
07-43	Residential	B	1	67	59	53	6	Y
07-44	Residential	B	1	67	55	49	6	Y
07-45	Residential	B	1	67	69	69	0	
07-46	Residential	B	1	67	68	68	0	
07-47	Residential	B	1	67	54	49	5	Y
07-48	Residential	B	1	67	52	48	4	
07-49	Residential	B	1	67	51	50	2	
07-50	Residential	B	1	67	53	49	4	
07-51	Residential	B	1	67	55	52	4	
07-52	Residential	B	1	67	52	51	1	
07-53	Residential	B	1	67	59	57	2	
Wall 8								
08-01	Residential	B	1	67	69	66	2	
08-02	School	C	1	67	68	62	6	Y
08-03	Residential	B	1	67	70	62	8	Y
08-04	Residential	B	1	67	72	64	8	Y
08-05	Residential	B	1	67	71	63	8	Y
08-06	Residential	B	1	67	71	63	8	Y
08-07	Residential	B	1	67	71	64	8	Y
08-08	Residential	B	1	67	71	63	8	Y
08-09	Residential	B	1	67	71	63	8	Y
08-10	Residential	B	1	67	71	64	7	Y
08-11	Residential	B	1	67	71	65	7	Y
08-12	Residential	B	1	67	71	65	6	Y
08-13	Residential	B	1	67	71	67	4	
08-14	Residential	B	1	67	71	67	4	
08-15	Residential	B	1	67	71	67	3	
08-16	Residential	B	1	67	71	68	3	
08-17	Residential	B	1	67	60	59	1	
08-18	Residential	B	1	67	55	55	0	
08-19	Residential	B	1	67	53	52	1	
08-20	Residential	B	1	67	53	51	2	
08-21	Residential	B	1	67	57	52	5	Y

Receptor Number	Land Use	Category	Units	FHWA/MDOT NAC	Build	Noise Level w/Barr	Noise Reduction	Benefit?
08-22	Residential	B	1	67	52	49	3	
08-23	School	C	1	67	53	49	4	
08-24	School	C	1	67	53	49	4	
08-25	School	C	1	67	54	49	4	
08-26	Church	C	1	67	60	54	6	Y
08-27	Residential	B	1	67	54	49	5	Y
08-28	Residential	B	1	67	60	54	6	Y
08-29	Residential	B	1	67	56	51	5	Y
08-30	Residential	B	1	67	54	49	4	
08-31	Residential	B	1	67	52	49	3	
08-32	Residential	B	1	67	51	48	3	
08-33	Residential	B	1	67	61	54	6	Y
08-34	Residential	B	1	67	59	53	6	Y
08-35	Residential	B	1	67	56	50	6	Y
08-36	Residential	B	1	67	54	49	5	Y
08-37	Residential	B	1	67	53	50	4	
08-38	Residential	B	1	67	61	55	6	Y
08-39	Residential	B	1	67	57	53	5	Y
08-40	Residential	B	1	67	55	51	4	
08-41	Residential	B	1	67	54	51	3	
08-42	Residential	B	1	67	54	51	2	
08-43	Residential	B	1	67	62	54	8	Y
08-44	Residential	B	1	67	57	52	4	
08-45	Residential	B	1	67	55	52	3	
08-46	Residential	B	1	67	62	60	2	
08-47	Residential	B	1	67	60	59	2	
08-48	Residential	B	1	67	60	59	1	
08-49	Residential	B	1	67	59	58	1	
08-50	Residential	B	1	67	58	58	1	
08-51	Residential	B	1	67	54	51	4	
08-52	Residential	B	1	67	52	49	4	
Wall 9								
09-01	Park	C	1	67	66	63	3	
09-02	School	C	1	67	68	64	4	
09-03	School	C	1	67	65	61	4	
09-04	Residential	B	1	67	63	59	4	
09-05	Residential	B	1	67	67	64	4	
09-06	Residential	B	1	67	68	64	4	
09-07	Residential	B	1	67	68	64	4	
09-08	Residential	B	1	67	68	64	4	
09-09	Residential	B	1	67	68	65	3	
09-10	Residential	B	1	67	68	65	3	
09-11	Residential	B	1	67	68	66	3	
09-12	Residential	B	1	67	58	54	4	
09-13	Residential	B	1	67	54	53	1	

Receptor Number	Land Use	Category	Units	FHWA/MDOT NAC	Build	Noise Level w/Barr	Noise Reduction	Benefit?
09-14	Residential	B	1	67	53	52	1	
09-15	Residential	B	1	67	53	52	1	
09-16	Residential	B	1	67	53	52	1	
09-17	Residential	B	1	67	54	52	2	
09-18	Residential	B	1	67	53	51	2	
09-19	Residential	B	1	67	51	50	1	
09-20	Residential	B	1	67	49	49	0	
09-21	Residential	B	1	67	52	50	2	
09-22	Residential	B	1	67	52	52	1	
09-23	Residential	B	1	67	53	53	1	
09-24	Residential	B	1	67	54	52	1	
09-25	Residential	B	1	67	51	52	0	
09-26	Residential	B	1	67	52	55	0	
CNE 10								
10-01	Residential	B	1	67	67	62	6	Y
10-02	Residential	B	1	67	67	62	6	Y
10-03	Residential	B	1	67	67	61	6	Y
10-04	Residential	B	1	67	68	62	6	Y
10-05	Residential	B	1	67	67	62	6	Y
10-06	Residential	B	1	67	66	61	5	Y
10-07	Residential	B	1	67	68	64	3	
10-08	Residential	B	1	67	67	65	3	
10-09	Residential	B	1	67	68	66	2	
10-10	Residential	B	1	67	68	66	2	
10-11	Residential	B	1	67	59	54	6	Y
10-12	Residential	B	1	67	55	50	5	Y
10-13	Residential	B	1	67	54	50	4	
10-14	Residential	B	1	67	61	55	5	Y
10-15	Residential	B	1	67	57	51	6	Y
10-16	Residential	B	1	67	54	50	4	
10-17	Residential	B	1	67	54	50	4	
10-18	Residential	B	1	67	49	49	1	
10-19	Residential	B	1	67	50	47	2	
10-20	Residential	B	1	67	60	59	1	
10-21	Residential	B	1	67	57	57	0	
10-22	Residential	B	1	67	54	53	0	

Appendix E. Response to Public Comments

Comment Received	Commentor Name	MDOT Response
I live in an apartment complex at 920 S Washington Ave (CNE 4). Noise from the freeway is already distracting and can be anxiety inducing to noise sensitive people, even with windows closed. There are a number of low income and elderly residents at this location. Why was this location not monitored for the noise analysis? There are 9 stories on this building, and the adjacent apartments have 7 stories. Only Category C properties were measured according to the noise report, but apartments fall in Category B (residential) properties, correct? Regarding the selection of noise receptors: "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" these residential buildings are within approximately 600 feet of the mainline. Given the height of the apartment complexes south of the Grand River, I think it was an error to not include receptors.	Carla Ahlschwede	thank you for your input on the upcoming I-496 freeway project. Your traffic noise comments and questions raise good points. MDOT follows state and federal guidelines when performing traffic noise studies. The traffic noise studies consist of two separate and yet interconnected parts. First the study looks to identify existing and future traffic noise levels to determine if residences meet the MDOT traffic noise impact level of 66 decibels or more for a one-hour average. If residential traffic noise impacts are not identified, a traffic noise barrier is not analyzed for the residences. If traffic noise impacts are identified for the residences, a noise barrier is analyzed for the impacted residences which is the second part of the traffic noise study. In common noise environment 4 (CNE 4), which is located directly north of the apartment complex at 920 S Washington Ave, the traffic noise impacts are limited to 2 park sites (04-01 and 04-02) directly adjacent to Malcolm X Street. The next receivers, 04-03 through 04-07 located further south of Malcolm X Street, are below the traffic noise impact levels for residences. Additionally, receiver 02-16 in CNE 2 and located furthest south of Malcolm X Street and still north of the apartment complex, also falls below MDOT's traffic noise impact level for residences. Since the apartment complex at 920 S Washington Ave is located further south of I-496 than any of the non-impacted receivers, it indicates that the apartment complex also is non-impacted by the I-496 traffic noise. Therefore, the traffic noise study did not continue further south to the apartment complex. The traffic noise study analyzed the land-use in the CNEs to identify traffic noise impacts. The land-use classification for the park space in CNE4 is category C with an FHWA impact level of 67 decibels (66 for MDOT). The same MDOT 66 decibel impact level is used for residences in category B. Had the impact levels continued south through the park land in CNE 4, the noise analysis would have continued further south probably including the apartment complex, and the complex would have been analyzed using category B for residences.
I'm concerned not only about the possibility of noise during construction, but mostly for the necessary shift in traffic to our residential neighborhood streets. How will MDOT work with LPD and/or MSP to step up	Jessica Pearson	Thank you for your input. It has been shared with the project team. MDOT coordinates with local authorities during detours and construction. If you

Comment Received	**Commentor Name**	**MDOT Response**
patrols and enforcement for the likely increase in speeding vehicles?		have any questions or need more information, please reach out anytime.
I am concerned about the noise and possible increased traffic on Jenison Ave since it is a pass through.	Tammy Shabluk	Thank you for your input. It has been shared with the project team. MDOT coordinates with local authorities during detours and construction. If you have any questions or need more information, please reach out anytime.
I understand the noise abatement wall along the Grand Ave exit ramp will be terminating just before the facade of the Kerr house. I have a few questions: 1. I have been told the surface is going to simulate brick course work (per SHPO and the Section 106 Review Process). Is this correct? 2. How will it terminate? Will it just stop? Or will the wall get shorter gradually? The gradual sloping of the wall would be a more visually appealing option and provide a nice approach to the downtown area. I have seen similar designs in cities like Minneapolis/St Paul and elsewhere. We may not be as big, but should be allowed the same respect.	Mary Toshach	Thanks for reaching out. I attached the design guide that shows what the proposed wall will look like and how it terminates with a capstone style design, pending a vote and input from residents and owners who were identified as benefiting receptors. A benefiting receptor is a residence that will receive a benefit from the proposed noise wall. You are correct that the surface is brick per SHPO- I believe it's brick but can find out if it's a simulated brick vs real brick. We are mailing this design guide along with a ballot for the benefiting receptors to vote on whether or not to construct the noise wall. We plan to mail it on Tuesday, so you should receive it Wednesday or Thursday. What is your address? I can check that you are one of the benefiting receptors. I can also email you the packet, in addition to mailing it. We are also setting up a meeting to answer any questions you may have. I will email you the meeting link as soon as we finalize it. We are also available to meet in person, virtually or by phone to answer questions and provide more information on the proposed noise wall. Let me know if you have any questions or need more information, please let me know.

Comment Received	**Commentor Name**	**MDOT Response**
I have reviewed the designs and have some suggestions to improve the appearance and reduce the visual impact the wall will have on the Printers Row Condominium Association. Also a few question regarding the maintenance of the overgrown property north of the proposed wall. Following is an outline and I will send images tonight (after I get home and have an opportunity to scan) 1. Ending the 16’ wall abruptly will be visually and environmentally detrimental. I suggest transitioning the termination gradually (stepped down) to be more visually appealing and to offer better airflow through the area and sunlight to the condos east of the Kerr House. We get strong winds blowing through here and the addition of a solid 16’ wall could exacerbate (or create) a wind tunnel. 2. It would be better to start the step down transition or end the wall about mid point (or before) the curve of the parking lot. While I would like to see some barrier at that narrow spot, a 16’ wall is not the answer. We have had vehicles leave and come onto the property by driving over it and pedestrians cross over it as a short cut. This is obviously hazardous and needs to be addressed. Therefore, keeping a wall, but having it step down will solve an aesthetic issue and help reduce traffic accidents and save lives. 3. The area to the east, which is a combination of City and MDOT property (I think) has been a continuous problem with lack of mowing; overgrown underbrush and trash. It has frequently been utilized as an encampment by the homeless, resulting in the accumulation of trash, sewage and drug paraphernalia. It would be beneficial for all if an agreement could be developed regarding maintenance and “enforcement” or monitoring between the City and State. When purchasing our condo we were aware of the noise from the highway, but when living in an urban area that is to be expected. Sound barrier walls provide benefit for neighborhoods close to freeways, but they also are prone to causing isolation and eventual deterioration. It is a Catch 22, and I am not opposed to the wall, just want a better looking option. As indicated I will be forwarding the images this weekend. Thank you for your time	Mary Toshach	Hi Mary, Thank you for reaching out and sharing your input and perspective. Regarding the proposed wall, only the property owners and residents at the locations receiving the benefit (called benefiting receptors) are involved in decisions that determine construction and aesthetics. The MDOT noise abatement handbook has more information on this process. MDOT Final Noise Analysis and Abatement Handbook (michigan.gov). Section 3.3.3.4 has details regarding benefiting residents and property owners, and other sections on public involvement have good information. Let me know if you need more info or have questions. I have reached out to a noise expert regarding your concern about a wind tunnel. I’ll let you know if I get any additional information on this or other aspects of your comments. Regarding #3, we partner with the city in situations like these, so we would be happy to investigate this one further. If we do find encampments in our right of way, we have a process where we post a message giving notice that the location will be cleaned, then partner with the city to perform the cleaning. We have also worked with Housing Services of Mid-Michigan in the past and are able to get them involved in the process as well. Let me know if you have any additional questions and reach out anytime. Thank you,

Comment Received	**Commentor Name**	**MDOT Response**
Monica, Thank you for responses, and I do have more questions. After doing additional research I have found that a sound barrier wall may reduce the noise closest to the wall, but since sound travels in waves and good percentage of those waves travel over the wall and may affect the properties a few blocks in, that may not have been affected by the noise previously. Also, there is the reverberation. Unless the wall is constructed with a sound absorbing material (concrete and brick are not) some of the sound waves will bounce off and travel in the opposite direction. This would obviously affect the apartment building on the other side of the highway. If they have a sound barrier as well, then the sound could continue to reverberate. I believe this was studied recently in Minneapolis (?) and the resulting solution utilizing sound absorbing materials reduced the noise and reverberation. Is the material for our wall built of such a material and just made to look like brick or is it a hard surface. I understand the rationale for only giving “benefiting” parties the opportunity to “vote”. Although it is flawed. A sound barrier has potentially positive and negative effects on property - particularly in an urban area. It has the potential of greatly reducing property values (or enhancing). Federal Highway construction has a long history of disregarding neighborhoods that appear run down, are primarily renter occupied and/or have a large percentage of people of color. Cherry Hill was one the “red lined” in the 1930s and has suffered for years from neglect. Since many property owners do not live there, I feel that all the residents and property owners should have an opportunity to express their opinion. Thank you for listening to my rant.	Mary Toshach (Response sent to Mary and Robert Christensen)	Hello Mary and Robert, I thought it’d be most efficient to email you both since the MDOT noise expert provided answers to your inquiries. I have your email below in bold followed by responses in italicized font. Let me know if you have any questions or feedback. **After doing additional research I have found that a sound barrier wall may reduce the noise closest to the wall, but since sound travels in waves and good percentage of those waves travel over the wall and may affect the properties a few blocks in, that may not have been affected by the noise previously.** *While true that sound travels in waves, a noise barrier wall should not produce a negative traffic noise environment for properties located a few blocks in from the wall. Noise is reduced by the further distance a person is from the noise source because the sound waves lose energy the farther they travel. Think of someone lighting a firecracker right next to you, versus a firecracker exploding a mile away. The distance reduces the level of the noise.* *Noise barriers work by making the sound waves travel farther because instead of traveling in a straight line which is a shortest distance, the waves have to go up and over the wall. Waves travelling over a wall, travel farther than in a straight line, resulting in less energy when they arrive at the residence. As you stated, a noise barrier is most effective at reducing noise for those residences closest to the wall because of the sharp angle and length of soundwaves going up and back down. Residences located further back from the wall would generally be expected to receive little to no noise reduction benefit because at a certain point the angle over the wall creates little additional distance to compared to no wall. However the residences further back should not receive an increase in traffic noise.* **Also, there is the reverberation. Unless the wall is constructed with a sound absorbing material (concrete and brick are not) some of the sound waves will bounce off and travel in the opposite direction. This would obviously affect the apartment building on the other side of the highway. If they have a sound barrier as well,**

Comment Received	Commentor Name	MDOT Response
		then the sound could continue to reverberate. I believe this was studied recently in Minneapolis (?) and the resulting solution utilizing sound absorbing materials reduced the noise and reverberation. *Reflections from barriers have been studied and have not been found to increase a perceivable noise level for residences on the opposite side of a freeway. Studies have shown multiple factors keep the majority of soundwaves from reflecting directly to receivers (residences) on the opposite side of a freeway. 1 to 2 decibel increases are possible on the opposite side of a freeway, however a 3 decibel increase is barely perceptible to the human ear. The reflective noise does not overtake or add significantly to the existing noise being generated by traffic on the freeway.* *Reflections between parallel barriers may cause a degradation in each barrier's performance due to multiple reflections that diffract over the individual barriers. For parallel barriers, it is important to ensure that the distance between the two barriers is at least 10 times their average height. A 10:1 width-to-height (w/h) ratio will result in an imperceptible degradation in performance. Therefore, if two barriers are designed to be parallel to each other, calculations are made to determine if there is potential for degradation in each barrier's performance.* **Is the material for our wall built of such a material and just made to look like brick or is it a hard surface.** *A concrete post-and-panel wall, designed to have a clay brick appearance is planned for the I-496 noise barrier.* **I understand the rationale for only giving "benefiting" parties the opportunity to "vote". Although it is flawed. A sound barrier has potentially positive and negative effects on property - particularly in an urban area. It has the potential of greatly reducing property values (or enhancing). Federal Highway construction has a long history of disregarding neighborhoods that appear run down, are primarily renter occupied and/or have a large percentage of people of color. Cherry Hill was one the "red lined" in the 1930s and has suffered**

Comment Received	**Commentor Name**	**MDOT Response**
		for years from neglect. Since many property owners do not live there, I feel that all the residents and property owners should have an opportunity to express their opinion. *MDOT agrees that noise barriers have pros and cons. However, as you alluded to, the importance of only allowing the traffic noise reduction benefiting residences to vote in favor or not in favor of a noise barrier ensures that those residences with an opportunity for noise reduction have the final say in determining if a proposed noise barrier is constructed for them.*