I-96 Flex Route Traffic Noise Analysis Technical Memorandum

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Michigan Department of Transportation

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1 Executive Summary

This report evaluates the potential noise impacts of the proposed improvements to the Interstate Highway 96 (I-96) corridor from Kent Lake Road to the Interstate Highway 275 (I-275)/Interstate Highway 696 (I-696)/Michigan State Highway 5 (M-5) interchange in conformance with corresponding Federal regulations and guidance, and the National Environmental Policy Act (NEPA).

The location of this project is shown in Figure 1.

Figure 1. I-96 Flex Route Study Corridor

The proposed improvements include the addition of Active Traffic Management (ATM) solutions as well as reconstruction of the median shoulder in each direction to serve as a temporary through-lane during certain periods of the day. The project is being studied as a Type I project because of the addition of an a through-traffic lane. This report evaluates the potential noise impacts of the proposed improvements of the project in conformance with corresponding Federal regulations and guidance, and NEPA. The noise analysis presents the existing and future acoustical environment at various receptors located in the I-96 noise study area.

The determination of noise abatement measures and locations complies with the Federal Highway Administration's (FHWA) Procedures for Abatement of Highway Traffic Noise and Construction Noise as presented in the Code of Federal Regulations, Title 23 Part 772 (23 CFR 722), and the Michigan Department of Transportation (MDOT): *Highway Noise Analysis and Abatement Handbook*, dated July 2011 (Handbook). The Handbook complies with the State Transportation Commission Policy 10136 Noise Abatement, dated July 31, 2003.

Existing noise level measurements were conducted on August 23, 2018 at eight representative sites in the project vicinity. Fifteen-minute measurements were taken at each site. Measurement locations are shown in Appendix A. Traffic was counted and classified concurrently during each noise measurement by vehicle type: cars, medium trucks, heavy trucks, buses, and motorcycles. The measured noise levels are then compared to modeled noise levels based on the traffic counts. The model is validated if measured highway traffic noise levels and predicted highway traffic noise levels for the existing conditions using the concurrent traffic counts are within +/- 3 dB(A)[1]. This modeling, as required by the FHWA, is performed with TNM version 2.5.

FHWA's TNM version 2.5, was used to model existing (2017) and design year (2040) worst hourly traffic noise levels within the I-96 noise analysis study area. 109 receptors (Category B, C, and D) were modeled. Appendix A shows the modeled receptors and highlights the receptors along the project corridor that are impacted, that is, they approach or exceed the FHWA Noise Abatement Criteria (NAC). Predicted future design year (2040) noise levels adjacent to the proposed improvements would approach or exceed the NAC at 37 receptors (28 residential receptors, one day care center receptor, one television studio receptor and seven trail receptors). The noise levels at these 37 impacted receptors would range from 66.2 to 76.0 dB(A) L_{eq}(h). Changes in L_{eq} noise levels under the future Build condition will range from 0.2 to 1.2 dB(A) compared to existing conditions. Therefore, none of the predicted future noise levels would substantially exceed existing noise levels (MDOT has defined a substantial increase as being a 10 dB(A) or greater increase between existing and design year noise level).

Eight noise barriers (NB) have been evaluated for this noise study. See Table 1 and Appendix A.

NB1, NB3, NB4, and NB7 meet preliminary feasibility criteria but did not meet the reasonableness criteria as the design goal for these barriers was not met. NB2, NB5, NB6, and NB8 meet preliminary feasibility criteria but did not meet the reasonableness criteria as the cost per benefited receptor for each barrier exceeds the cost per benefited unit cost established by MDOT. Descriptions and analysis of each barrier is described below:

- NB1 is located on the north side of I-96 between the westbound Milford Road off ramp and South Hill Road and was designed to mitigate residential uses and the Huron Valley Trail. NB1 meets preliminary feasibility criteria but did not meet the reasonableness criteria as the design goal for this barrier was not met (50 percent of the benefited receptors did not receive a noise reduction of 7 dB(A)).

- NB2 is located on the north side of I-96 between South Hill Road and the eastern terminus of South Hill Court and was designed to mitigate residential uses. NB2 meets preliminary feasibility criteria but did not meet the reasonableness criteria as the cost per benefited receptor ($303,739) exceeds the cost per benefited unit cost established by MDOT ($46,967)[2].

- NB3 is located on the north side of I-96 from approximately 900 feet west of Old Plank Road to Old Plank Road and was designed to mitigate residential uses. NB3 meets preliminary feasibility criteria but did not meet the reasonableness criteria as the design goal for this barrier was not met (did not achieve a 10 dB(A) or more reduction for at least one benefited receptor).

- NB4 is located on the north side of I-96 between Old Plank Road and approximately 1,800 feet east of Old Plank Road and was designed to mitigate residential uses. NB4 meets preliminary feasibility criteria but did not meet the reasonableness criteria as the design goal for this barrier was not met (did not achieve a 10 dB(A) or more reduction for at least one benefited receptor).

- NB5 is located on the north side of I-96 to the east and west of Taft Road and was designed to mitigate residential uses. NB5 meets preliminary feasibility criteria but did not meet the reasonableness criteria as the cost per benefited receptor ($598,680) exceeds the cost per benefited unit cost established by MDOT ($46,967).

[1] *Highway Noise Analysis and Abatement Handbook*, Michigan Department of Transportation, 2011, page 16.
[2] Thomas Hanf email regarding "Re: Noise and Air Quality Guidance – I-375". MDOT Air Quality & Noise Abatement, April 17, 2018.

- NB6 is located on the south side of I-96 between Beck Road and Wixom Road and was designed for residential uses and a day care center. NB6 meets preliminary feasibility criteria but did not meet the reasonableness criteria as the cost per benefited receptor ($237,165) exceeds the cost per benefited unit cost established by MDOT ($46,967).

- NB7 is located on the south side of I-96 between Milford Road and just east of the Huron Valley Trail passing under I-96 and was designed to mitigate a trail receptor. NB7 meets preliminary feasibility criteria but did not meet the reasonableness criteria as the design goal for this barrier was not met (did not achieve a 10 dB(A) or more reduction for at least one benefited receptor).

- NB8 is located on the south side of I-96 between Milford Road and Kent Lake Road (two sections designed) and was designed for receptors along the Huron Valley Trail. This barrier meets preliminary feasibility criteria but did not meet the reasonableness criteria as the cost per benefited receptor ($604,926) exceeds the cost per benefited unit cost established by MDOT ($46,967).

Table 1. Noise Barrier Summary

Noise Barrier ID	Receiver IDs	Feasible[1]	Meets Design Goal[2]	Benefited Receptors	Length (ft)	Height (ft)	Square Footage (Sq ft)	Barrier Cost ($45 per sq ft)	Cost per Benefited Receptor	Reasonable
NB1	B-1 to B-20, B-28 to B-43, NN-1	Yes	No	27	4,085	24	98,033	$4,411,485	NA[3]	No
NB2	B-21 to B-27, B-44 to B-62	Yes	Yes	4	1,399	12 – 24	26,999	$1,214,955	$303,739	No
NB3	C-1 to C-3	Yes	No	2	1,114	24	26,742	$1,203,390	NA[3]	No
NB4	C-4 to C-7	Yes	No	2	997	24	23,930	$1,076,850	NA[3]	No
NB5	J-3 to J-7	Yes	Yes	2	1,130	20 - 24	26,608	$1,197,360	$598,680	No
NB6	Z-1, Z-2, AA-1	Yes	Yes	3	1,108	10 - 18	15,811	$711,495	$237,165	No
NB7	NN-2	Yes	No	1	1,314	24	31,545	$1,419,525	NA[3]	No
NB8	NN-3 to NN-6, OO-1 to OO-10	Yes	Yes	5	3,946	6 - 24	67,214	$3,024,630	$604,926	No

1 MDOT requires that noise barriers achieve a 5-dB reduction at 75 percent of the impacted receptors. If a barrier cannot achieve this, abatement is considered to not be acoustically feasible.

2 The design year attenuation requirement for Michigan is to provide a noise reduction of 10 dB(A) for at least one benefited receptor and at least a 7 dB(A) reduction for 50 percent or more of the benefited receptor sites.

3 NA – Noise barrier is not feasible or does not meet the design goal.

MDOT's noise policy states that all noise abatement measures determined to be feasible and reasonable shall be incorporated into the transportation improvement project. Based on the study completed, preliminary abatement measures for the project do not meet the MDOT's reasonableness criteria for the impacted units.

2 Purpose of this Report

This report evaluates the potential noise impacts of the proposed improvements to the Interstate Highway 96 (I-96) corridor from Kent Lake Road to the Interstate Highway 275 (I-275)/Interstate Highway 696 (I-696)/Michigan State Highway 5 (M-5) interchange in conformance with corresponding Federal regulations and guidance, and the National Environmental Policy Act (NEPA).

2.1 Project Description

I-96 ATM is a project to install intelligent transportation systems (ITS) equipment on trusses and cantilevers over the roadway at approximately ½ mile spacing on I-96 from east of Kent Lake Road to the I-275/I-696/M-5 interchange, as well as adding ramp meters to the on ramps within the project corridor. The project also includes reconstruction of the median shoulders and barrier wall, installation of additional median drainage structures and an HMA overlay of the mainline lanes and outside shoulders. The reconstruction of the median shoulders will provide an extra travel lane in each direction that will only be activated during peak hour periods in the morning and afternoon.

The project is in Oakland County, Michigan. Project location is shown in Figure 1.

2.2 Noise Analysis Overview

The noise analysis presents the existing and future acoustical environment at various receptors located in the study area.

The determination of noise abatement measures and locations complies with the Federal Highway Administration's (FHWA) Procedures for Abatement of Highway Traffic Noise and Construction Noise as presented in the Code of Federal Regulations, Title 23 Part 772 (23 CFR 722), and the Michigan Department of Transportation (MDOT): *Highway Noise Analysis and Abatement Handbook*, dated July 2011 (Handbook). The Handbook complies with the State Transportation Commission Policy 10136 Noise Abatement, dated July 31, 2003.

Existing noise level measurements were conducted on August 23, 2018 at eight representative sites in the project vicinity. Fifteen-minute measurement were taken at each site. Traffic classification counts along I-96 were taken at each site concurrent with the noise measurements.

FHWA's Traffic Noise Model version 2.5 (TNM) was used to model existing (2017) and future (2040) Build design hour traffic noise levels within the study area.

Eight noise barriers (NB) have been evaluated for this noise study. See Table 1 and Appendix A.

MDOT's policy is to install feasible and reasonable noise barriers associated with transportation improvements. Based on the noise analysis completed, mitigation of noise impacts for the proposed I-96 project would not be feasible and reasonable for the analyzed noise barrier locations.

3 Traffic Noise Concepts, Policy and Guidelines

3.1 Basic Noise Information

Noise is defined as unwanted and disruptive sound. The ear is sensitive to pressure variation and perceives it as sound. The intensity of these pressure variations causes the ear to discern different levels of loudness. These pressure differences are most commonly measured in decibels.

The decibel (dB) is the unit of measurement for sound. The decibel scale audible to humans spans approximately 140 dB. A level of zero decibels corresponds to the lower limit of audibility, while 140 dB produces a sensation more akin to pain than sound. The decibel scale is a logarithmic representation of the actual sound pressure variations. Therefore, a 26 percent change in the energy level only changes the sound level 1-dB. The human ear would not detect this change except in an acoustical laboratory. A doubling of the energy level would result in a 3-dB increase, which would be barely perceptible in the natural environment. A tripling in energy sound level would result in a clearly noticeable change of 5-dB in the sound level. A change of 10 times the energy level would result in a 10-dB change in the sound level. This would be perceived as a doubling (or halving) of the apparent loudness. Table 2 provides a comparison of sound level changes with relative loudness.

The human ear has a non-linear sensitivity to noise. To account for this in noise measurements, electronic weighting scales are used to define the relative loudness of different frequencies. The “A” weighting scale is widely used in environmental work because it closely resembles the non-linearity of human hearing. Therefore, the unit of measurement for an A-weighted noise level is dB(A).

Table 2. Logarithmic Nature of Sound

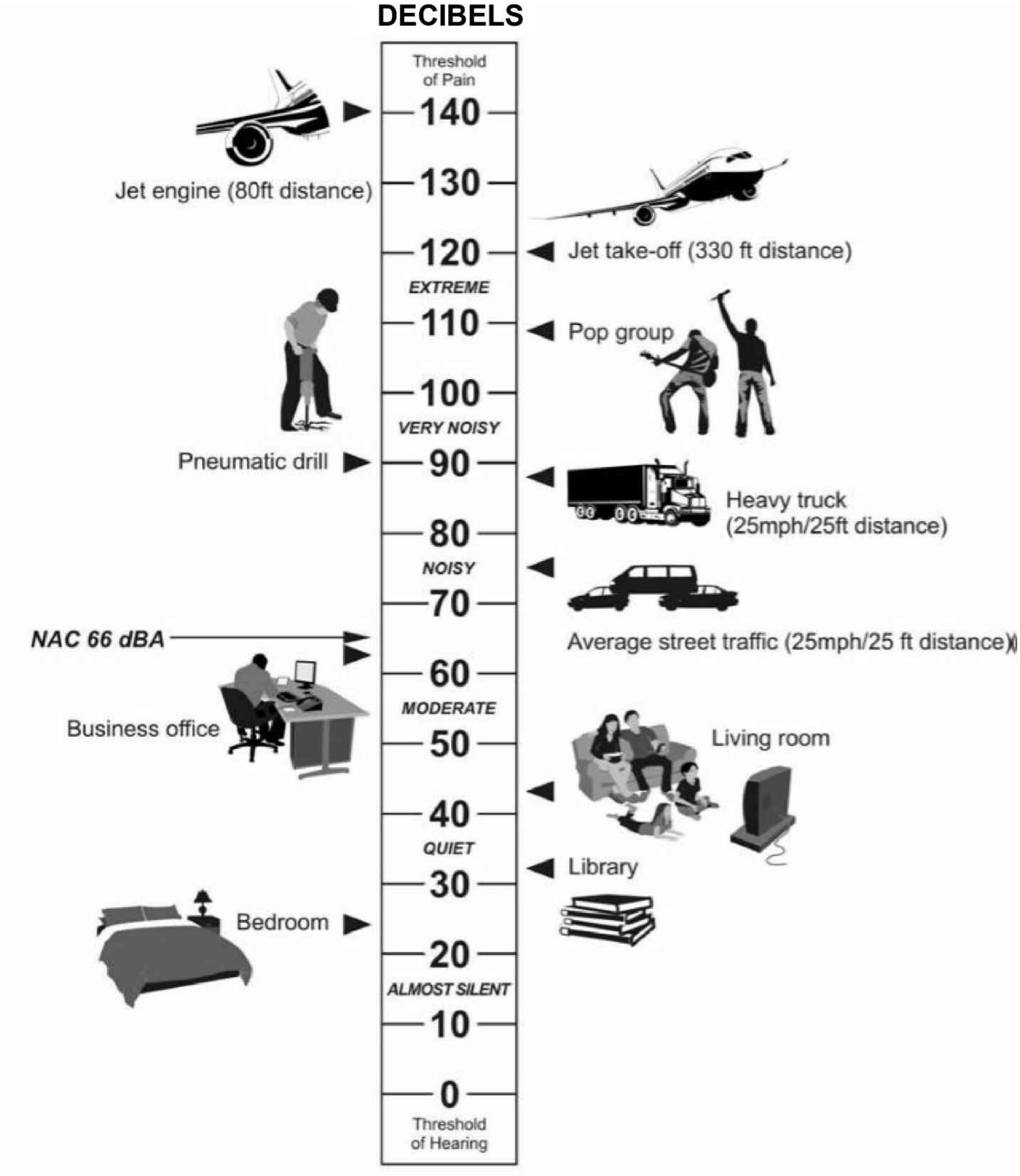
Change in L_{eq} (1h) Sound Level Relative Loudness in the Natural Environment	Change in L_{eq} (1h) Sound Level Relative Loudness in the Natural Environment
+/- 3 dB(A)	Barely Perceptible Change
+/- 5 dB(A)	Readily Perceptible Change
+/- 10 dB(A)	Considered Twice or Half as Loud

Traffic noise is not constant. It varies as each vehicle passes through a certain location. The time-varying characteristics of environmental noise are analyzed statistically to determine the duration and intensity of noise exposure. In an urban environment, noise is made up of two distinct components. One is ambient or background noise. Wind noise and distant traffic noise make up the ambient acoustical environment surrounding the project. These sounds are not readily recognized but combine to produce a non-irritating ambient sound level. This background sound level varies throughout the day, being lowest at night and highest during the day. The other component of urban noise is intermittent and louder than the background noise. Transportation noise and local industrial noise are examples of this type of noise. It is for these reasons that environmental noise is analyzed statistically.

It is necessary to use a method of measure that will account for the time-varying nature of sound when studying environmental noise. The equivalent sound pressure level (L_{eq}) is defined as the continuous steady sound level that would have the same total A-weighted sound energy as the real fluctuating sound measured over a given period of time. As a result, the three characteristics of noise combine to form a single descriptor (L_{eq} in dB(A)) that is used to evaluate human response to noise and has been chosen for use in this study. The time-period used to determine traffic noise levels is one hour and uses the descriptor L_{eq}(1h).

Traffic noise at a receiver is influenced by the following major factors: distance from the traffic to the receiver, volume of traffic, speed of traffic, vehicle mix, and acoustical shielding. Tire sound levels increase with vehicle speed but also depend upon road surface, vehicle weight, tread design and wear. Change in any of these can vary noise levels. At lower speeds, especially in trucks and buses, the dominant noise source is the engine and related accessories. Figure 2 provides sound levels of typical noise sources.

Figure 2. Sound Levels of Typical Noise Sources



Adopted from "Environmental Criteria for Road Traffic Noise", Environmental Protection Authority, South Sydney, NSW, May 1999, Page 38.

3.2 Federal Regulations and Guidance

The FHWA's *Procedures for Abatement of Highway Traffic Noise and Construction Noise* as presented in the Code of Federal Regulations, Title 23 Part 772 (23 CFR 772). This regulation, plus other guidance documents written to explain the regulation, sets forth the process for performing a traffic noise analysis. The process includes the following:

1) Identification of highway traffic noise impacts
2) Examination of potential abatement measures
3) Gathering of public input approval for feasible and reasonable abatement measure
4) Incorporation of feasible and reasonable highway traffic noise abatement measures into the highway project
5) Coordination with local officials to provide helpful information on compatible land use planning and control
6) Identification and incorporation of necessary measures to abate construction noise

The highway traffic noise impact identification process involves a review of the existing land use activity categories that parallel the highway corridor and determining existing and future noise levels within those areas. Existing land use of developed lands is identified by inspecting aerial photography and performing site reconnaissance. Highway traffic noise analyses are also performed for undeveloped lands that have received a building permit.

After the existing and proposed land uses are established, ambient noise levels are measured along the corridor with simultaneous traffic counts. The measured noise levels are then compared to modeled noise levels based on the traffic counts. The model is validated if measured highway traffic noise levels and predicted highway traffic noise levels for the existing conditions are within +/- 3 dB(A)[3]. This modeling, as required by the FHWA, is performed with TNM version 2.5. Once the model is validated, TNM is used to model the existing and the future build loudest hour for traffic noise analysis.

The FHWA Noise Abatement Criteria (NAC), which is presented in 23 CFR 772, establishes the NAC for various land uses, and is presented in Table 3. A traffic noise impact is defined as a future noise level that approaches or exceeds the NAC; or a future noise level that creates a substantial noise increase over existing noise levels. An approaching noise level is defined as being at least one dB(A) less than the noise level value listed in the NAC for Activity Category A through G. The FHWA allows states to define a substantial noise increase as an increase of anywhere between 5 and 15 dB(A).

[3] *Highway Noise Analysis and Abatement Handbook*, Michigan Department of Transportation, 2011, page 16.

Table 3. Noise Abatement Criteria (NAC)

Activity Category	Activity Criteria[1 2]		Evaluation Locator	Activity Description
	$L_{eq}(h)$[3]	L10(h)[4]		
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, daycare 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, daycare centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E[5]	72	75	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F.
F	N/A	N/A	N/A	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	N/A	N/A	N/A	Undeveloped lands that are not permitted.

[1] MDOT identifies a significant noise impact as a 10 dB(A) increase between the existing and predicted design year sound levels, or a measured or modeled noise level 1 dB(A) less than the NAC standard

[2] Either $L_{eq}(h)$ or L10(h) (but not both) may be used on a project. MDOT uses $L_{eq}(h)$. The $L_{eq}(h)$ and L10(h) Activity Criteria values are for impact determination only and are not design standards for noise abatement measures.

[3] L_{eq} is the equivalent steady-state sound level which in a stated period of time contains the same acoustic energy as the time-varying sound level during the same time period, with $L_{eq}(h)$ being the hourly value of L_{eq}.

[4] L10 is the sound level that is exceeded 10 percent of the time (90th percentile) for the period under consideration, with L10 being the hourly value of L10.

[5] Includes undeveloped lands permitted for this activity category

Source: *Highway Noise Analysis and Abatement Handbook*, Michigan Department of Transportation, 2011.

After traffic noise impacts were identified, potential abatement alternatives were examined. The following abatement alternatives, which are listed in 23 CFR 772.15(c) are permitted and can be evaluated where applicable:

1) Construction of noise barriers including acquisition of property rights, either within or outside the highway right-of-way
2) Traffic management measures
3) Alteration of horizontal and vertical alignments
4) Acquisition of real property or interests therein to serve as a buffer zone to preempt development
5) Noise insulation of Activity Category D land use activities listed in Table 3

At a minimum, state highway agencies are required to consider noise abatement in the form of noise barriers.

FHWA defines feasible highway traffic noise abatement as objective engineering considerations (e.g., can a barrier be built given the topography of the location; can a substantial noise reduction be achieved given certain access, drainage, safety, or maintenance requirements; are other noise sources present in the area, etc.). An abatement measure must achieve a noise reduction of at least 5 dB(A) to be considered feasible, according 23 CFR 772.13 (d)(1)(i). MDOT's feasibility criteria are provided in Section 5.1 of this document.

The FHWA lists three required reasonableness factors when considering noise barriers: cost effectiveness, viewpoints of benefiting receptors, and achievement of noise reduction design goals. For reasonableness, 23 CFR 772.13 (d)(2)(iii) requires state departments of transportation to define design year reduction goals somewhere between 7 and 10 dB(A). FHWA lists **optional reasonableness factors** that can be added to but not overrule the required reasonableness factors.

3.3 State Rules and Procedures

The Handbook is the State's tool for implementing 23 CFR 772. The Handbook expands on 23 CFR 772 by refining definitions and establishing milestones within the design phase for the completion of noise impact analysis and mitigation development.

The Handbook includes the following definitions:

Noise Impact: A substantial noise increase or a predicted design year noise level that is 1 dB(A) less, equal to, or greater than the NAC level.

Substantial Noise Increase: A 10 dB(A) or greater increase between the existing noise level and the design year predicted noise level.

Feasible Noise Barrier: A barrier that has no construction impediments, meets safety requirements for the traveling public, and provides at least 5 dB(A) noise reduction at 75 percent of the impacted receptors.

Reasonable Noise Barrier: A barrier that is cost effective, favorable to the majority of benefited receptors, and achieves noise reduction design goals by meeting or exceeding the reasonableness factor.

Cost Effective Noise Barrier: A noise barrier analyzed for environmental clearance with a preliminary construction cost that is not more than three percent above the allowable cost per benefited receptor unit (CPBU) of $46,967 (year 2018)[4], assuming a $45.00 per square foot noise barrier construction cost.

Benefited Receptor: A receptor that receives a 5 dB(A) or greater traffic noise reduction as a result of a proposed noise barrier.

Design Year Reduction Goal: Noise reduction of 10 dB(A) for at least one benefited receptor and provide at least a 7 dB(A) reduction for 50 percent or more of the benefited receptor sites.

Permitted Development: Any presently undeveloped lands that have received a building permit from the local township or city.

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[4] Thomas Hanf email regarding "Re: Noise and Air Quality Guidance – I-375". MDOT Air Quality & Noise Abatement, April 17, 2018.

4 Noise Analysis

4.1 FHWA Traffic Noise Model (TNM)

TNM version 2.5 is FHWA's computer program for highway traffic noise prediction and analysis. The following parameters are used in this model to calculate an hourly L_{eq}(1h) at a specific receiver location:

- Distance between roadway and receiver
- Relative elevations of roadway and receiver
- Hourly traffic volume in light-duty (two axles, four tires), medium-duty (two axles, six tires), and heavy-duty (three or more axles) vehicles
- Vehicle speed
- Ground absorption
- Topographic features, including retaining walls and berms

Highway noise sources have been divided into five types of vehicles; automobiles (A), medium trucks (MT), heavy trucks (HT), Buses (B) and Motorcycles (MC). Each vehicle type is defined as follows[5]:

- Automobiles – all vehicles with two axles and four tires, includes passenger vehicles and light trucks, less than 10,000 pounds
- Medium trucks – all vehicles having two axles and six tires, vehicle weight between 10,000 and 26,000 pounds
- Heavy trucks – all vehicles having three or more axles, vehicle weight greater than 26,000 pounds
- Buses – all vehicles designed to carry more than nine passengers
- Motorcycles – all vehicles with two or three tires and an open-air driver/passenger compartment

Noise levels produced by highway vehicles can be attributed to three major categories:

- Running gear and accessories (tires, drive train, fan and other auxiliary equipment)
- Engine (intake and exhaust noise, radiation from engine casing)
- Aerodynamic and body noise

4.2 Analysis

4.2.1 Land Use and Field Measurement Levels

The I-96 noise analysis area includes residential, day care center, television studio, active sport area, medical facility, trail, school, motel, office, restaurant, retail, and industrial areas. The criteria stated in Table 3 helps to determine if the proposed project will produce noise levels that approach or exceed the NAC throughout the corridor.

The project corridor was divided into common noise environments (CNE) to facilitate the analysis of highway noise of areas of like land uses. The CNE listed boundaries are identified in Table 4 and illustrated in Appendix A.

[5] G.S. Anderson, C.S.Y. Lee, G.G. Fleming and C. Menge, "FHWA Traffic Noise Model®, Version 1.0 User's Guide", Federal Highway Administration, January 1998, p.60.

Table 4. Project Area Common Noise Environments

CNE	Site Description
A	***Retail and industrial*** uses bounded by I-96 on the south, Milford Road on the west and Alta Equipment Company on the east.
B	***Residential*** uses bounded by I-96 on the south, Alta Equipment Company on the west, and Walnut Drive on the east.
C	***Residential*** uses north of I-96 and centered around Old Plank Road.
D	***Active sports area***. North of I-96. Lyon Oaks Golf Course.
E	***Retail*** use bounded by I-96 on the south, along Assembly Park Drive, and west of Wixom Road.
F	***Hotel*** and ***office*** uses north of I-96, east of Wixom Road, and along Alpha Drive.
G	***Retail*** use north of I-96, east of Beck Road, and along Twelve Mile Road.
H	***Residential*** uses north of I-96, east of CNE G, and along Twelve Mile Road.
I	***Medical facility*** north of I-96, east of CNE H, and along Twelve Mile Road.
J	***Residential*** uses north of I-96, to the east and west of Taft Road.
K	***Restaurants*** and ***motel*** uses north of I-96, west of Novi Road along Fountain Walk Avenue.
L	***Office*** uses south of I-96, east of Meadowbrook Road, and north of Bridge Street.
M	***School*** (Walsh College – Novi Campus) south of I-96, west of Meadowbrook Road, along Gardenbrook Road.
N	***Office*** uses south of I-96, west of Meadowbrook Road, along Gardenbrook Road, west of CNE M.
O	***Industrial*** use south of I-96, east of Delwal Drive.
P	***Hotel*** south of I-96, along Crescent Boulevard.
Q	***Restaurant*** uses south of I-96, east of Novi Road, along Crescent Boulevard.
R	***Retail*** use south of I-96, south of Crescent Boulevard.
S	***Restaurant*** uses south of I-96, west of Novi Road, along Crescent Boulevard.
T	***Industrial*** uses south of I-96, along Grand River Avenue from Novi Road to Taft Road.
U	***Hotel*** and ***other developed land*** (Suburban Collection Showplace) uses south of I-96, along Suburban Collection Showplace Drive.
V	***Retail and industrial*** uses south of I-96, east of Beck Road.
W	***Restaurant*** uses south of I-96, west of Beck Road, along Grand River Avenue.
X	***Retail*** use south of I-96, west of Beck Road, along Grand River Avenue.
Y	***Retail*** use south of I-96, at the eastern terminus of West Twelve Mile Road.
Z	***Residential*** uses south of I-96, along West Twelve Mile Road, between CNE Y and AA.
AA	***Day care center*** use south of I-96, along West Twelve Mile Road, west of CNE Z.
BB	***Retail and industrial*** uses south of I-96, west of CNE AA, along West Twelve Mile Road.
CC	***Retail*** uses south of I-96, west of Wixom Road, adjacent to SW quadrant of I-96 interchange.
DD	***Hotel*** use south of I-96, west of Wixom Road along Meijer access road.
EE	***Industrial*** uses south of I-96, along Grand River Avenue, centered on Grand Oaks Court, Center Oaks Court, and Oakland Oaks Court.
FF	***Television studio*** use south of I-96, along Clever Court.
GG	***Industrial*** uses south of I-96, along Grand River Avenue, west of Clever Court, east of Old Plank Road.
HH	***Office*** use south of I-96, along Grand River Avenue, just west of Old Plank Road.
II	***Industrial*** use south of I-96, along Grand River Avenue, west of CNE HH, east of CNE JJ along Lyon Center Drive East.
JJ	***Restaurant*** use south of I-96, along Lyon Center Drive East, west of CNE II.
KK	***Retail*** uses south of I-96, along Lyon Center Drive East, west of CNE JJ.
LL	***Restaurant*** uses south of I-96, along Lyon Center Drive East, west of CNE KK.
MM	***Retail*** uses south of I-96, along Lyon Center Drive East, east of Milford Road.
NN	***Trail*** uses north and south of I-96, running along the right-of-way on the south side from the eastern side of Lyon Center Drive to Kent Lake Road.
OO	***Residential*** uses north of Grand River Avenue along Bramley Circle and Topping Court, just west of James F. Atchison Memorial Park.

Existing noise level measurements were conducted on August 23, 2018 at eight representative sites in the project corridor. A 15-minute measurement was taken at each site. The measurements were made in accordance with MDOT guidelines using an integrating sound level analyzer meeting ANSI and IEC Type 1 specifications. Sound level analyzer calibration certification documentation is provided in Appendix B. Traffic classification counts were taken concurrently with the noise measurements. The locations of the field measurement sites are presented in Appendix A. The data collected at the eight sites are presented in Table 5.

Table 5. Measured Existing Noise Levels

Field Site #	Site Description	Date	Start Time	Duration	Traffic[1]							Noise Level, dB(A) L_{eq}(h)
					Direction	Auto	Med Truck	Heavy Truck	Buses	MC	Speed mph	
1	James F. Atchison Memorial Park along the Huron Valley Trail near eastbound I-96 off-ramp to Milford Road.	8/23/18	9:16 am	15 min	Eastbound I-96	685	37	73	4	3	20	69.5
					Westbound I-96	629	20	63	6	0	65	
2	Residential area 160' east of the eastern terminus of South Hill Court, adjacent to right-of-way fence.	8/23/18	9:46 am	15 min	Eastbound I-96	717	29	65	2	1	65	73.2
					Westbound I-96	701	18	59	0	0	65	
3	In line with the eastern edge of the Michigan Public Television Studio building at the right-of-way fence.	8/23/18	10:20 am	15 min	Eastbound I-96	757	33	62	0	2	65	74.2
					Westbound I-96	595	28	77	2	0	65	
4	Near residential land uses at the eastern terminus of Twelve Mile Road at the right-of-way fence.	8/23/18	10:50 am	15 min	Eastbound I-96	790	34	67	1	1	65	75.3
					Westbound I-96	772	23	106	2	0	65	
5	On southern edge of an electrical tower off of Twelve Mile Road (north side of I-96), east of Beck Road, adjacent to right-of-way fence.	8/23/18	11:18 am	15 min	Eastbound I-96	967	49	80	0	2	65	78.4
					Westbound I-96	970	35	101	3	0	65	
6	On south side of I-96 in line west side of hotel (Hyatt Place), adjacent to right-of-way fence.	8/23/18	11:42 am	15 min	Eastbound I-96	1,058	46	81	0	0	65	69.8
					Westbound I-96	998	30	96	1	2	65	
7	On north side of I-96 in line with Cabaret Drive adjacent to right-of-way fence. Approximately 510' east of railroad.	8/23/18	12:14 pm	15 min	Eastbound I-96	1,068	54	79	1	1	65	69.1
					Westbound I-96	1,112	41	90	0	1	65	
8	On south side of I-96 at terminus of Crescent Boulevard on the north sidewalk along Crescent Boulevard.	8/23/18	12:40 pm	15 min	Eastbound I-96	1,184	62	68	2	3	65	69.7
					Westbound I-96	1,166	35	84	2	3	65	

1) Automobiles – all vehicles with two axles and four tires, includes passenger vehicles and light trucks, less than 10,000 pounds; Medium trucks – all vehicles having two axles and six tires, vehicle weight between 10,000 and 26,000 pounds; Heavy trucks – all vehicles having three or more axles, vehicle weight greater than 26,000 pounds; Buses – all vehicles designed to carry more than nine passengers; and Motorcycles – all vehicles with two or three tires and an open-air driver/passenger compartment.

Source: HNTB Corporation, August 23, 2018

4.2.2 Field Measurements versus Modeled Noise Levels

TNM was used to validate the model by comparing the measured noise levels to the predicted noise levels. Traffic was counted and classified concurrently during the noise measurement by vehicle type: cars, medium trucks, heavy trucks, buses and motorcycles. The model is validated if the measured highway traffic noise levels and predicted highway traffic noise levels for the existing conditions using the concurrent traffic counts are within +/- 3 dB(A)[6]. Comparing the modeled noise levels to the measured noise levels validates the model for use on the specific project. All the modeled data compared within 3 dB(A) of the measured levels, which satisfies the MDOT requirement for validating the predicted noise level. The site by site comparison is presented in Table 6.

Table 6. Comparison of Measured and Modeled Noise Levels

Field Site	Appendix A Map Page#	Noise Level, dB(A) L_{eq}(1h)		Difference in Noise Level, dB(A) L_{eq}(1h) (Modeled Minus Measured)
		Measured	Modeled	
FS-1	2	69.5	71.6	2.1
FS-2	3	73.2	75.3	2.1
FS-3	4	74.2	75.8	1.6
FS-4	5, 6	75.3	76.5	1.2
FS-5	6	78.4	77.3	-1.1
FS-6	6	69.8	71.7	1.9
FS-7	7	69.1	70.5	1.4
FS-8	7	69.7	70.3	0.6

Source: HNTB Corporation, August 2018

4.2.3 Traffic Noise Levels and Noise Impact Analysis

FHWA's TNM version 2.5, was used to model existing (2017) and design year (2040) worst hourly traffic noise levels within the I-96 noise analysis study area.

Existing I-96 traffic data exhibits congestion in the eastbound or westbound direction during the morning and afternoon peak travel periods. Due to this, a theoretical free-flow traffic capacity was developed for both existing (2017) and design year (2040) worst hourly traffic[7]. The traffic volumes were distributed to three lanes for the existing model, and four lanes for the future model.

Modeled receptors were placed in accordance with FHWA requirements in areas with evidence of frequent human use. This area is typically located between the highway and any structure, such as a residence. MDOT considers this area within 35 feet from the back of a residence as the back-yard area. Modeling receptors along the Huron Valley Trail was discussed with MDOT staff and a methodology for modeling impacts along the trail was developed. Appendix C provides further explanation for the modeling trail locations along the Huron Valley Trail.

109 receptors (Category B, C, and D) were modeled. These receptors were selected to model noise impacts as shown in Appendix A.

The existing and design year noise levels of modeled sites are presented in Table 7.

[6] *Highway Noise Analysis and Abatement Handbook*, Michigan Department of Transportation, 2011, page 16.
[7] Thomas Hanf email regarding "Re: I-96 Kensington Road to I-275/I-696/M-5". MDOT Air Quality & Noise Abatement, September 28, 2018.

Table 7. Impact Analysis Results, dB(A) L_{eq}(1h)

Receiver ID	Noise Abatement Criteria (NAC)			Receptors	Noise Level – dB(A) L_{eq}(1h)			
	Description	Category	Criteria, L_{eq}(h)		Existing (2017)	Future (2040)		
						NL	Change from Existing	Impact (Y/N)
A-1	Retail	F	-	-	-	-	-	-
A-2	Industrial	F	-	-	-	-	-	-
A-3	Industrial	F	-	-	-	-	-	-
B-1	Residential	B	67	1	63.9	64.4	0.5	No
B-2	**Residential**	B	67	1	65.8	66.2	0.4	Yes
B-3	Residential	B	67	1	65.0	65.4	0.4	No
B-4	Residential	B	67	1	64.4	64.9	0.5	No
B-5	Residential	B	67	1	64.1	64.5	0.4	No
B-6	Residential	B	67	1	63.5	64.0	0.5	No
B-7	Residential	B	67	1	62.2	62.8	0.6	No
B-8	**Residential**	B	67	1	66.0	66.5	0.5	Yes
B-9	**Residential**	B	67	1	66.1	66.6	0.5	Yes
B-10	**Residential**	B	67	1	66.0	66.5	0.5	Yes
B-11	**Residential**	B	67	1	66.2	66.6	0.4	Yes
B-12	**Residential**	B	67	1	66.7	67.2	0.5	Yes
B-13	**Residential**	B	67	1	67.5	67.8	0.3	Yes
B-14	**Residential**	B	67	1	68.7	69.6	0.9	Yes
B-15	**Residential**	B	67	1	67.3	68.2	0.9	Yes
B-16	Residential	B	67	1	64.0	64.7	0.7	No
B-17	Residential	B	67	1	63.7	64.3	0.6	No
B-18	Residential	B	67	1	63.1	63.8	0.7	No
B-19	Residential	B	67	1	62.3	63.0	0.7	No
B-20	**Residential**	B	67	1	67.0	67.9	0.9	Yes
B-21	Residential	B	67	1	62.5	63.2	0.7	No
B-22	Residential	B	67	1	59.8	60.4	0.6	No
B-23	**Residential**	B	67	1	66.7	67.0	0.3	Yes
B-24	**Residential**	B	67	1	70.1	70.3	0.2	Yes
B-25	**Residential**	B	67	1	71.1	71.3	0.2	Yes
B-26	**Residential**	B	67	1	68.9	69.2	0.3	Yes
B-27	**Residential**	B	67	1	69.8	70.0	0.2	Yes
B-28	Residential	B	67	1	61.7	62.2	0.5	No
B-29	Residential	B	67	1	62.1	62.5	0.4	No
B-30	Residential	B	67	1	60.8	61.3	0.5	No
B-31	Residential	B	67	1	60.3	60.8	0.5	No
B-32	Residential	B	67	1	61.6	62.0	0.4	No
B-33	Residential	B	67	1	59.5	59.9	0.4	No
B-34	Residential	B	67	1	60.7	61.2	0.5	No
B-35	Residential	B	67	1	60.4	60.9	0.5	No

Boldface indicates receptors with noise levels that approach, equal or exceed the NAC and create an impact.

E* – Category E receiver with "no exterior use". Noise levels presented for informational purposes only. There are no impacts.

D – Building Type – Masonry, Window Condition – Double Glazed, Noise Reduction Due to Exterior of the Structure – 35 dB

Receiver ID	Noise Abatement Criteria (NAC)			Receptors	Noise Level – dB(A) L_{eq}(1h)			
	Description	Category	Criteria, L_{eq}(h)		Existing (2017)	Future (2040)		
						NL	Change from Existing	Impact (Y/N)
B-36	Residential	B	67	1	60.4	60.8	0.4	No
B-37	Residential	B	67	1	61.6	62.0	0.4	No
B-38	Residential	B	67	1	60.3	60.7	0.4	No
B-39	Residential	B	67	1	59.8	60.5	0.7	No
B-40	Residential	B	67	1	58.7	59.3	0.6	No
B-41	Residential	B	67	1	59.4	60.0	0.6	No
B-42	Residential	B	67	1	58.2	58.9	0.7	No
B-43	Residential	B	67	1	57.3	58.0	0.7	No
B-44	Residential	B	67	1	58.1	58.7	0.6	No
B-45	Residential	B	67	1	57.6	58.2	0.6	No
B-46	Residential	B	67	1	57.3	57.8	0.5	No
B-47	Residential	B	67	1	56.8	57.4	0.6	No
B-48	Residential	B	67	1	56.5	57.1	0.6	No
B-49	Residential	B	67	1	56.0	56.5	0.5	No
B-50	Residential	B	67	1	55.5	56.0	0.5	No
B-51	Residential	B	67	1	54.9	55.4	0.5	No
B-52	Residential	B	67	1	56.7	57.2	0.5	No
B-53	Residential	B	67	1	58.4	58.8	0.4	No
B-54	Residential	B	67	1	58.2	58.6	0.4	No
B-55	Residential	B	67	1	59.7	60.1	0.4	No
B-56	Residential	B	67	1	60.3	60.8	0.5	No
B-57	Residential	B	67	1	59.3	59.7	0.4	No
B-58	Residential	B	67	1	58.6	59.0	0.4	No
B-59	Residential	B	67	1	57.0	57.5	0.5	No
B-60	Residential	B	67	1	56.2	56.7	0.5	No
B-61	Residential	B	67	1	55.1	55.7	0.6	No
B-62	Residential	B	67	1	54.5	55.0	0.5	No
C-1	Residential	B	67	1	66.9	68.1	1.2	Yes
C-2	Residential	B	67	1	70.3	71.2	0.9	Yes
C-3	Residential	B	67	1	61.0	61.9	0.9	No
C-4	Residential	B	67	1	70.4	71.2	0.8	Yes
C-5	Residential	B	67	1	63.5	64.3	0.8	No
C-6	Residential	B	67	1	67.5	67.7	0.2	Yes
C-7	Residential	B	67	1	62.2	62.6	0.4	No
D-1	Active sport area	C	67	1	61.2	61.7	0.5	No
E-1	Retail	F	-	-	-	-	-	-
F-1	Motel (no exterior use)	E*	-	0	59.5	60.0	0.5	No
F-2	Motel (no exterior use)	E*	-	0	61.4	61.8	0.4	No
F-3	Office (no exterior use)	E*	-	0	67.4	67.7	0.3	No

Boldface indicates receptors with noise levels that approach, equal or exceed the NAC and create an impact.

E* – Category E receiver with "no exterior use". Noise levels presented for informational purposes only. There are no impacts.

D – Building Type – Masonry, Window Condition – Double Glazed, Noise Reduction Due to Exterior of the Structure – 35 dB

Receiver ID	Noise Abatement Criteria (NAC)			Receptors	Noise Level – dB(A) L_{eq}(1h)			
	Description	Category	Criteria, L_{eq}(h)		Existing (2017)	Future (2040)		
						NL	Change from Existing	Impact (Y/N)
F-4	Office (no exterior use)	E*	-	0	69.6	69.9	0.3	No
F-5	Office (no exterior use)	E*	-	0	70.9	71.2	0.3	No
F-6	Office (no exterior use)	E*	-	0	71.1	71.4	0.3	No
F-7	Office (no exterior use)	E*	-	0	70.8	71.2	0.4	No
G-1	Retail	F	-	-	-	-	-	-
H-1	Residential	B	67	1	59.7	60.3	0.6	No
H-2	Residential	B	67	1	58.9	59.5	0.6	No
I-1	Medical facility	C	67	1	59.5	60.4	0.9	No
J-1	Residential	B	67	1	62.1	62.9	0.8	No
J-2	Residential	B	67	1	54.3	54.9	0.6	No
J-3	Residential	B	67	1	72.2	72.5	0.3	Yes
J-4	Residential	B	67	1	69.8	70.0	0.2	Yes
J-5	Residential	B	67	1	60.8	61.3	0.5	No
J-6	Residential	B	67	1	59.0	59.5	0.5	No
J-7	Residential	B	67	1	57.5	58.0	0.5	No
K-1	Restaurant	E	72	1	63.7	64.2	0.5	No
K-2	Restaurant	E	72	1	63.1	63.6	0.5	No
K-3	Motel/Restaurant (no exterior use)	E*	-	0	68.8	69.2	0.4	No
K-4	Restaurant (no exterior use)	E*	-	0	63.2	63.6	0.4	No
L-1	Office (no exterior use)	E*	-	0	73.0	73.3	0.3	No
L-2	Office (no exterior use)	E*	-	0	72.6	73.2	0.6	No
L-3	Office (no exterior use)	E*	-	0	72.6	73.2	0.6	No
M-1	School (no exterior use)	D	52	1	41.0	42.2	1.2	No
N-1	Office (no exterior use)	E*	-	0	72.1	73.2	1.1	No
N-2	Office	E	72	1	65.0	65.9	0.9	No
O-1	Industrial	F	-	0	61.3	62.4	1.1	No
P-1	Motel	E	72	1	65.7	66.6	0.9	No
Q-1	Restaurant (no exterior use)	E*	-	0	73.4	74.2	0.8	No
Q-2	Restaurant (no exterior use)	E*	-	0	72.2	72.9	0.7	No
Q-3	Restaurant (no exterior use)	E*	-	0	63.4	64.2	0.8	No
Q-4	Restaurant (no exterior use)	E*	-	0	59.9	60.6	0.7	No
R-1	Retail	F	-	-	-	-	-	-
S-1	Restaurant	E	72	1	61.2	61.8	0.6	No
S-2	Restaurant	E	72	1	59.2	59.8	0.6	No
T-1	Industrial	F	-	-	-	-	-	-
T-2	Industrial	F	-	-	-	-	-	-
T-3	Industrial	F	-	-	-	-	-	-
T-4	Industrial	F	-	-	-	-	-	-
U-1	Motel (no exterior use)	E*	-	0	71.6	71.8	0.2	No

Boldface indicates receptors with noise levels that approach, equal or exceed the NAC and create an impact.

E* – Category E receiver with "no exterior use". Noise levels presented for informational purposes only. There are no impacts.

D – Building Type – Masonry, Window Condition – Double Glazed, Noise Reduction Due to Exterior of the Structure – 35 dB

Receiver ID	Noise Abatement Criteria (NAC)			Receptors	Noise Level – dB(A) L_{eq}(1h)			
	Description	Category	Criteria, L_{eq}(h)		Existing (2017)	Future (2040)		
						NL	Change from Existing	Impact (Y/N)
U-2	Other Developed Land (no exterior use)	E*	-	0	67.9	68.5	0.6	No
V-1	Industrial	F	-	-	-	-	-	-
V-2	Industrial	F	-	-	-	-	-	-
V-3	Industrial	F	-	-	-	-	-	-
W-1	Restaurant (no exterior use)	E*	-	0	65.5	66.4	0.9	No
X-1	Retail	F	-	-	-	-	-	-
Y-1	Retail	F	-	-	-	-	-	-
Z-1	**Residential**	B	67	1	74.4	**75.1**	0.7	**Yes**
Z-2	**Residential**	B	67	1	74.7	**75.3**	0.6	**Yes**
AA-1	**Day Care Center**	C	67	1	70.0	**70.3**	0.3	**Yes**
BB-1	Retail	F	-	-	-	-	-	-
BB-2	Retail	F	-	-	-	-	-	-
BB-3	Retail	F	-	-	-	-	-	-
BB-4	Retail	F	-	-	-	-	-	-
CC-1	Retail	F	-	-	-	-	-	-
CC-2	Retail	F	-	-	-	-	-	-
DD-1	Motel (no exterior use)	E*	-	0	61.8	62.8	1.0	No
EE-1	Industrial	F	-	-	-	-	-	-
EE-2	Industrial	F	-	-	-	-	-	-
EE-3	Industrial	F	-	-	-	-	-	-
EE-4	Industrial	F	-	-	-	-	-	-
EE-5	Industrial	F	-	-	-	-	-	-
EE-6	Industrial	F	-	-	-	-	-	-
EE-7	Industrial	F	-	-	-	-	-	-
EE-8	Industrial	F	-	-	-	-	-	-
EE-9	Industrial	F	-	-	-	-	-	-
EE-10	Industrial	F	-	-	-	-	-	-
EE-11	Industrial	F	-	-	-	-	-	-
EE-12	Industrial	F	-	-	-	-	-	-
FF-1	**Television Studio**	C	67	1	73.2	**74.0**	0.8	**Yes**
GG-1	Retail	F	-	-	-	-	-	-
GG-2	Retail	F	-	-	-	-	-	-
GG-3	Retail	F	-	-	-	-	-	-
GG-4	Retail	F	-	-	-	-	-	-
GG-5	Industrial	F	-	-	-	-	-	-
GG-6	Industrial	F	-	-	-	-	-	-
HH-1	Office	E	72	1	60.6	61.5	0.9	No
II-1	Industrial	F	-	-	-	-	-	-
II-2	Industrial	F	-	-	-	-	-	-

Boldface indicates receptors with noise levels that approach, equal or exceed the NAC and create an impact.

E* – Category E receiver with "no exterior use". Noise levels presented for informational purposes only. There are no impacts.

D – Building Type – Masonry, Window Condition – Double Glazed, Noise Reduction Due to Exterior of the Structure – 35 dB

Receiver ID	Noise Abatement Criteria (NAC)			Receptors	Noise Level – dB(A) L_{eq}(1h)			
	Description	Category	Criteria, L_{eq}(h)		Existing (2017)	Future (2040)		
						NL	Change from Existing	Impact (Y/N)
II-3	Industrial	F	-	-	-	-	-	-
II-4	Industrial	F	-	-	-	-	-	-
II-5	Industrial	F	-	-	-	-	-	-
II-6	Industrial	F	-	-	-	-	-	-
II-7	Industrial	F	-	-	-	-	-	-
II-8	Industrial	F	-	-	-	-	-	-
II-9	Retail	F	-	-	-	-	-	-
JJ-1	Restaurant (no exterior use)	E*	-	0	73.2	73.5	0.3	No
KK-1	Retail	F	-	-	-	-	-	-
KK-2	Retail	F	-	-	-	-	-	-
KK-3	Retail	F	-	-	-	-	-	-
LL-1	Restaurant (no exterior use)	E*	-	0	72.1	72.6	0.5	No
LL-2	Restaurant (no exterior use)	E*	-	0	69.8	70.2	0.4	No
MM-1	Retail	F	-	-	-	-	-	-
MM-2	Retail	F	-	-	-	-	-	-
NN-1	Trail	C	67	1	66.5	66.8	0.3	Yes
NN-2	Trail	C	67	1	66.4	66.8	0.4	Yes
NN-3	Trail	C	67	2	66.2	66.6	0.4	Yes
NN-4	Trail	C	67	1	67.2	67.4	0.2	Yes
NN-5	Trail	C	67	1	66.4	67.4	1.0	Yes
NN-6	Trail	C	67	1	65.6	66.4	0.8	Yes
OO-1	Residential	B	67	1	68.4	69.3	0.9	Yes
OO-2	Residential	B	67	1	67.8	68.5	0.7	Yes
OO-3	Residential	B	67	1	69.6	70.3	0.7	Yes
OO-4	Residential	B	67	1	68.9	69.7	0.8	Yes
OO-5	Residential	B	67	1	75.4	76.0	0.6	Yes
OO-6	Residential	B	67	1	58.3	58.9	0.6	No
OO-7	Residential	B	67	1	57.9	58.5	0.6	No
OO-8	Residential	B	67	1	59.7	60.4	0.7	No
OO-9	Residential	B	67	1	61.6	62.5	0.9	No
OO-10	Residential	B	67	1	63.2	64.2	1.0	No

Boldface indicates receptors with noise levels that approach, equal or exceed the NAC and create an impact.

E* – Category E receiver with "no exterior use". Noise levels presented for informational purposes only. There are no impacts.

D – Building Type – Masonry, Window Condition – Double Glazed, Noise Reduction Due to Exterior of the Structure – 35 dB

4.3 Impact Assessment

A traffic noise impact is defined as a future noise level that approaches[8] or exceeds the NAC; or a future noise level that creates a substantial noise increase over existing noise levels. MDOT identifies a significant noise impact as a 10 dB(A) increase between the existing and predicted design year sound levels, or a measured or modeled noise level 1 dB(A) less than the NAC standard.

Predicted future design year (2040) noise levels adjacent to the proposed improvements would approach or exceed the NAC at 37 receptors (28 residential receptors, one day care center receptor, one television studio receptor and seven trail receptors). The noise levels at these 37 impacted receptors would range from 66.2 to 76.0 dB(A) L_{eq}(h).

Changes in L_{eq} noise levels under the future Build condition will range from 0.2 to 1.2 dB(A) compared to existing conditions. Therefore, none of the predicted future noise levels would substantially exceed existing noise levels.

[8] A noise level 'approaches' when the noise level is 1 dB(A) less than the NAC standard.

5 Noise Abatement Measures

5.1 Federal and State Abatement Guidance

The Handbook has established the criteria for determining where noise abatement must be provided.[9]

The policy is summarized as follows:

- Where adverse noise impacts are expected to occur, noise abatement will be considered and will be implemented if found feasible and reasonable for existing developments, and future developments that were approved before the date of public knowledge of the project. Approved means that a building permit has been received. After the date of public knowledge, MDOT is not responsible for providing noise abatement for new developments. The date of the clearance of the Categorical Exclusion will be the date of public knowledge. The provision of noise abatement for new developments becomes the responsibility of local governments and private developers.

- All sites will be considered; however, it is generally known that commercial and industrial sites prefer that there be no interference with the view to their establishments. Therefore, when commercial and residential sites expected to convert to a commercial or industrial land use (e.g., some of the residential units have converted to commercial/industrial, or the area has been rezoned commercial) are found to be reasonable and feasible, they will be asked if they want noise abatement. If they do not want it, it will not be provided.

- Feasible – This refers to engineering considerations such as: constructability of a noise barrier on the existing topography; achievement of substantial noise reductions; the presence of other noise sources in the area; and the ability to maintain access, drainage, safety, utilities in the area. While every reasonable effort should be made to obtain a substantial noise reduction, a noise abatement measure is not feasible if it cannot achieve at least a 5 dB(A) noise reduction for 75 percent of impacted receivers during design year traffic noise.

- Reasonable - Noise mitigation will be considered reasonable if:
    - During the environmental clearance phase, the preliminary cost per benefiting unit is less than three percent above allowable per benefiting unit level ($46,967 in 2018 dollars);
    - The public viewpoint reasonableness factor for the environmental clearance phase receives generally positive comments from the benefiting units; and
    - The noise barrier provides a design year traffic noise reduction of 10 dB(A) for at least one benefited unit and at least a 7 dB(A) for 50 percent or more of the benefited units.

Highway traffic noise abatement alternatives, which are listed in 23 CFR 772.15(c) include:

1) Construction of noise barriers including acquisition of property rights, either within or outside the highway right-of-way;
2) Traffic management measures;
3) Alteration of horizontal and vertical alignments;
4) Acquisition of real property or interests therein to serve as a buffer zone to preempt development;
5) Noise insulation of Activity Category D land use facilities listed in Table 3.

Upon review of the listed abatement alternatives, it has been determined that:

- Reductions of speed limits, although acoustically beneficial, are seldom practical unless the design speed of the proposed roadway is also reduced;
- Restriction or prohibition of trucks is extremely undesirable;

[9] The Handbook and other MDOT resources can be found at https://www.michigan.gov/mdot/0,4616,7-151-9621_11041_25846---,00.html.

- Design criteria, project limits, and the existing alignment and land use preclude substantial horizontal and vertical alignment shifts that could potentially produce noticeable changes in the projected acoustical environment;
- Cost restrictions typically prohibit the acquisition of property for any reason; and
- The construction of noise berms is neither feasible nor reasonable because of the amount of space that would be required.

Therefore, the construction of noise barriers within the existing Right-of-Way was the only mitigation measure that received in-depth evaluation.

5.2 Abatement Analysis

Abatement analysis was completed for eight noise barriers. At a minimum, the Handbook requires that noise barriers be analyzed as a noise abatement measure. To satisfy this requirement, a noise barrier has been evaluated for the CNE areas with impacted noise receptors as a part of this noise study. Noise barrier locations are shown in Appendix A.

Based on the future design year noise levels, eight noise barriers adjacent to impacted receptor areas were modeled:

- NB1 is located on the north side of I-96 between the westbound Milford Road off ramp and South Hill Road and was designed to mitigate residential uses and the Huron Valley Trail.
- NB2 is located on the north side of I-96 between South Hill Road and the eastern terminus of South Hill Court and was designed to mitigate residential uses.
- NB3 is located on the north side of I-96 approximately 900 feet west of Old Plank Road to Old Plank Road and was designed to mitigate residential uses.
- NB4 is located on the north side of I-96 between Old Plank Road and approximately 1,800 feet east of Old Plank Road and was designed to mitigate residential uses.
- NB5 is located on the north side of I-96 to the east and west of Taft Road and was designed to mitigate residential uses.
- NB6 is located on the south side of I-96 between Beck Road and Wixom Road and was designed for residential uses and a day care center.
- NB7 is located on the south side of I-96 between Milford Road and just east of the Huron Valley Trail pass under I-96 and was designed to mitigate a trail receptor.
- NB8 is located on the south side of I-96 between Milford Road and Kent Lake Road (two sections designed) and was designed for receptors along the Huron Valley Trail.

CNE FF has a television studio that exceeds the NAC. A noise barrier was not analyzed for this receptor for the following reason: The length of noise barrier is a function of the distance the receptor is from the noise source and the elevation change between the receptor and noise source. It is not uncommon for the length of the noise barrier to be four times the distance from the receptor to the noise source. Therefore, a receptor 250 feet (the approximate distance from the television studio to the centerline) from the centerline of the noise source would require a noise barrier at least 1,000 feet long. If the noise barrier was only 10 feet tall the cost would be $450,000. The cost for one receptor exceeds MDOTs reasonableness criteria of an upper cost limit of $46,967 (2018) per benefited receptor. Therefore, a noise barrier for this single receptor would not be reasonable and mitigation was not analyzed for this location.

The results of each evaluated barrier, including future L_{eq}(1h) noise levels without and with a barrier, barrier length and height, and the noise reduction provided by the barrier are presented in Table 8. The noise reduction for individual receptors based on the analyzed noise barrier design in Table 8 is shown in Table 9.

Table 8. Evaluated Noise Barriers

Noise Barrier ID	Receiver IDs	Existing Noise Levels dB(A)	Range of Future Noise Levels dB(A)		Noise Reduction dB(A)	Barrier Characteristics	
			w/o Barrier	With Barrier		Length (ft)	Height (ft)
NB1	B-1 to B-20, B-28 to B-43, NN-1	57.3 – 68.7	58.0 – 69.6	55.0 – 66.1	1.0 – 10.3	4,085	24
NB2	B-21 to B-27, B-44 to B-62	54.5 – 71.1	55.0 – 71.3	54.1 – 64.4	0.5 – 10.0	1,399	12 – 24
NB3	C-1 to C-3	61.0 – 70.3	61.9 – 71.2	58.6 – 65.7	3.3 – 6.0	1,114	24
NB4	C-4 to C-7	62.2 – 70.4	62.6 – 71.2	59.6 – 63.5	1.9 – 7.7	997	24
NB5	J-3 to J-7	57.5 – 72.2	58.0 – 72.5	56.5 – 62.6	1.5 – 10.0	1,130	20 – 24
NB6	Z-1, Z-2, AA-1	70.0 – 74.7	70.3 – 75.3	65.1 – 67.4	5.2 – 10.2	1,108	10 – 18
NB7	NN-2	66.4	66.8	61.6	5.2	1,314	24
NB8	NN-3 to NN-6, OO-1 to OO-10	57.9 – 75.4	58.5 – 76.0	57.1 – 66.1	0.3 – 11.5	3,946	6 – 24

Table 9. Noise Reduction Results by Receptor

Receiver ID	Description	Category	Criteria, $L_{eq}(h)$	Receptors	Future without Barrier	Future with Barrier	Noise Barrier Reduction	Benefited Receptor
NB1								
B-1	Residential	B	67	1	64.4	57.6	6.8	Yes
B-2	**Residential**	B	67	1	**66.2**	60.0	6.2	Yes
B-3	Residential	B	67	1	65.4	59.6	5.8	Yes
B-4	Residential	B	67	1	64.9	59.2	5.7	Yes
B-5	Residential	B	67	1	64.5	58.7	5.8	Yes
B-6	Residential	B	67	1	64.0	58.0	6.0	Yes
B-7	Residential	B	67	1	62.8	57.3	5.5	Yes
B-8	**Residential**	B	67	1	**66.5**	59.2	7.3	Yes
B-9	**Residential**	B	67	1	**66.6**	58.7	7.9	Yes
B-10	**Residential**	B	67	1	**66.5**	58.1	8.4	Yes
B-11	**Residential**	B	67	1	**66.6**	57.8	8.8	Yes
B-12	**Residential**	B	67	1	**67.2**	58.2	9.0	Yes
B-13	**Residential**	B	67	1	**67.8**	58.4	9.4	Yes
B-14	**Residential**	B	67	1	**69.6**	59.3	10.3	Yes
B-15	**Residential**	B	67	1	**68.2**	59.3	8.9	Yes
B-16	Residential	B	67	1	64.7	59.1	5.6	Yes
B-17	Residential	B	67	1	64.3	60.0	4.3	No
B-18	Residential	B	67	1	63.8	60.3	3.5	No
B-19	Residential	B	67	1	63.0	60.0	3.0	No
B-20	**Residential**	B	67	1	**67.9**	63.8	4.1	No
B-28	Residential	B	67	1	62.2	56.5	5.7	Yes
B-29	Residential	B	67	1	62.5	56.7	5.8	Yes
B-30	Residential	B	67	1	61.3	55.9	5.4	Yes
B-31	Residential	B	67	1	60.8	55.4	5.4	Yes
B-32	Residential	B	67	1	62.0	56.6	5.4	Yes
B-33	Residential	B	67	1	59.9	55.0	4.9	No
B-34	Residential	B	67	1	61.2	55.7	5.5	Yes
B-35	Residential	B	67	1	60.9	55.6	5.3	Yes
B-36	Residential	B	67	1	60.8	55.4	5.4	Yes
B-37	Residential	B	67	1	62.0	55.7	6.3	Yes
B-38	Residential	B	67	1	60.7	55.5	5.2	Yes
B-39	Residential	B	67	1	60.5	55.9	4.6	No
B-40	Residential	B	67	1	59.3	55.7	3.6	No
B-41	Residential	B	67	1	60.0	56.7	3.3	No
B-42	Residential	B	67	1	58.9	55.8	3.1	No
B-43	Residential	B	67	1	58.0	55.1	2.9	No
NN-1	**Trail**	C	67	1	**66.8**	61.1	5.7	Yes

Boldface indicates receptors with noise levels that approach, equal or exceed the NAC and create an impact.

Receiver ID	Description	Category	Criteria, $L_{eq}(h)$	Receptors	Future without Barrier	Future with Barrier	Noise Barrier Reduction	Benefited Receptor
NB2								
B-21	Residential	B	67	1	63.2	62.4	0.8	No
B-22	Residential	B	67	1	60.4	59.4	1.0	No
B-23	**Residential**	B	67	1	67.0	63.4	3.6	No
B-24	**Residential**	B	67	1	70.3	60.9	9.4	Yes
B-25	**Residential**	B	67	1	71.3	61.3	10.0	Yes
B-26	**Residential**	B	67	1	69.2	60.9	8.3	Yes
B-27	**Residential**	B	67	1	70.0	64.4	5.6	Yes
B-44	Residential	B	67	1	58.7	58.2	0.5	No
B-45	Residential	B	67	1	58.2	57.6	0.6	No
B-46	Residential	B	67	1	57.8	57.1	0.7	No
B-47	Residential	B	67	1	57.4	56.5	0.9	No
B-48	Residential	B	67	1	57.1	56.0	1.1	No
B-49	Residential	B	67	1	56.5	55.3	1.2	No
B-50	Residential	B	67	1	56.0	54.8	1.2	No
B-51	Residential	B	67	1	55.4	54.1	1.3	No
B-52	Residential	B	67	1	57.2	55.2	2.0	No
B-53	Residential	B	67	1	58.8	56.3	2.5	No
B-54	Residential	B	67	1	58.6	56.1	2.5	No
B-55	Residential	B	67	1	60.1	57.1	3.0	No
B-56	Residential	B	67	1	60.8	58.1	2.7	No
B-57	Residential	B	67	1	59.7	57.7	2.0	No
B-58	Residential	B	67	1	59.0	57.9	1.1	No
B-59	Residential	B	67	1	57.5	56.7	0.8	No
B-60	Residential	B	67	1	56.7	55.9	0.8	No
B-61	Residential	B	67	1	55.7	54.9	0.8	No
B-62	Residential	B	67	1	55.0	54.2	0.8	No
NB3								
C-1	**Residential**	B	67	1	68.1	62.1	6.0	Yes
C-2	**Residential**	B	67	1	71.2	65.7	5.5	Yes
C-3	Residential	B	67	1	61.9	58.6	3.3	No
NB4								
C-4	**Residential**	B	67	1	71.2	63.5	7.7	Yes
C-5	Residential	B	67	1	64.3	62.4	1.9	No
C-6	**Residential**	B	67	1	67.7	62.5	5.2	Yes
C-7	Residential	B	67	1	62.6	59.6	3.0	No

Boldface indicates receptors with noise levels that approach, equal or exceed the NAC and create an impact.

Receiver ID	Description	Category	Criteria, L_{eq}(h)	Receptors	Future without Barrier	Future with Barrier	Noise Barrier Reduction	Benefited Receptor
NB5								
J-3	**Residential**	B	67	1	72.5	62.5	10.0	Yes
J-4	**Residential**	B	67	1	70.0	62.6	7.4	Yes
J-5	Residential	B	67	1	61.3	58.3	3.0	No
J-6	Residential	B	67	1	59.5	57.3	2.2	No
J-7	Residential	B	67	1	58.0	56.5	1.5	No
NB6								
Z-1	**Residential**	B	67	1	75.1	74.1	1.0	No
Z-2	**Residential**	B	67	1	75.3	67.4	7.9	Yes
AA-1	**Day Care Center**	C	67	1	70.3	65.1	5.2	Yes
NB7								
NN-2	**Trail**	C	67	1	66.8	61.6	5.2	Yes
NB8								
NN-3	**Trail**	C	67	2	66.6	58.7	7.9	Yes
NN-4	**Trail**	C	67	1	67.4	62.4	5.0	Yes
NN-5	**Trail**	C	67	1	67.4	60.0	7.4	Yes
NN-6	**Trail**	C	67	1	66.4	66.1	0.3	No
OO-1	**Residential**	B	67	1	69.3	62.6	6.7	Yes
OO-2	**Residential**	B	67	1	68.5	61.4	7.1	Yes
OO-3	**Residential**	B	67	1	70.3	62.8	7.5	Yes
OO-4	**Residential**	B	67	1	69.7	62.9	6.8	Yes
OO-5	**Residential**	B	67	1	76.0	64.5	11.5	Yes
OO-6	Residential	B	67	1	58.9	57.5	1.4	No
OO-7	Residential	B	67	1	58.5	57.1	1.4	No
OO-8	Residential	B	67	1	60.4	58.7	1.7	No
OO-9	Residential	B	67	1	62.5	60.7	1.8	No
OO-10	Residential	B	67	1	64.2	62.6	1.6	No

Boldface indicates receptors with noise levels that approach, equal or exceed the NAC and create an impact.

Table 10. Noise Barrier Designs Analyzed

Noise Barrier ID	Receiver IDs	Feasible[1]	Meets Design Goal[2]	Benefited Receptors	Length (ft)	Height (ft)	Square Footage (Sq ft)	Barrier Cost ($45 per sq ft)	Cost per Benefited Receptor	Reasonable
NB1	B-1 to B-20, B-28 to B-43, NN-1	Yes	No	27	4,085	24	98,033	$4,411,485	NA[3]	No
NB2	B-21 to B-27, B-44 to B-62	Yes	Yes	4	1,399	12 – 24	26,999	$1,214,955	$303,739	No
NB3	C-1 to C-3	Yes	No	2	1,114	24	26,742	$1,203,390	NA[3]	No
NB4	C-4 to C-7	Yes	No	2	997	24	23,930	$1,076,850	NA[3]	No
NB5	J-3 to J-7	Yes	Yes	2	1,130	20 - 24	26,608	$1,197,360	$598,680	No
NB6	Z-1, Z-2, AA-1	Yes	Yes	3	1,108	10 - 18	15,811	$711,495	$237,165	No
NB7	NN-2	Yes	No	1	1,314	24	31,545	$1,419,525	NA[3]	No
NB8	NN-3 to NN-6, OO-1 to OO-10	Yes	Yes	5	3,946	6 - 24	67,214	$3,024,630	$604,926	No

1 MDOT requires that noise barriers achieve a 5-dB reduction at 75 percent of the impacted receptors. If a barrier cannot achieve this, abatement is considered to not be acoustically feasible.

2 The design year attenuation requirement for Michigan is to provide a noise reduction of 10 dB(A) for at least one benefited receptor and at least a 7 dB(A) reduction for 50 percent or more of the benefited receptor sites.

3 NA – Noise barrier is not feasible or does not meet the design goal.

Whether the barrier meets the design goal, total estimated cost (based on $45.00 per square foot), the number of benefited receptors (i.e. residential, commercial, or equivalent), the cost per benefited receiver, feasibility determination, and reasonableness determination for each of the barriers is presented in Table 10. The location of the evaluated noise barriers are shown in Appendix A.

NB1 meets preliminary feasibility criteria but did not meet the reasonableness criteria as the design goal for this barrier was not met (50 percent of the benefited receptors did not receive a noise reduction of 7 dB(A)).

NB2 meets preliminary feasibility criteria but did not meet the reasonableness criteria as the cost per benefited receptor ($303,739) exceeds the cost per benefited unit cost established by MDOT ($46,967).

NB3 meets preliminary feasibility criteria but did not meet the reasonableness criteria as the design goal for this barrier was not met (did not achieve a 10 dB(A) or more reduction for at least one benefited receptor).

NB4 meets preliminary feasibility criteria but did not meet the reasonableness criteria as the design goal for this barrier was not met (did not achieve a 10 dB(A) or more reduction for at least one benefited receptor).

NB5 meets preliminary feasibility criteria but did not meet the reasonableness criteria as the cost per benefited receptor ($598,680) exceeds the cost per benefited unit cost established by MDOT ($46,967).

NB6 meets preliminary feasibility criteria but did not meet the reasonableness criteria as the cost per benefited receptor ($237,165) exceeds the cost per benefited unit cost established by MDOT ($46,967).

NB7 meets preliminary feasibility criteria but did not meet the reasonableness criteria as the design goal for this barrier was not met (did not achieve a 10 dB(A) or more reduction for at least one benefited receptor).

NB8 meets preliminary feasibility criteria but did not meet the reasonableness criteria as the cost per benefited receptor ($604,926) exceeds the cost per benefited unit cost established by MDOT ($46,967).

6 Undeveloped Lands

The distances to 66 and 71 dB(A) L_{eq}(1h), which vary along the project corridor, were developed to assist local planning authorities in developing land use control over the remaining undeveloped lands along the project to prevent further development of incompatible land uses. Undeveloped areas exist throughout the corridor. Appendix A provides setback distances for 66 and 71 dB(A) for areas throughout the corridor.

It is recommended that any future development proposed in the project be modeled with accurate survey data to avoid creating incompatible land uses adjacent to the project.

7 Conclusions and Recommendations

NB1, NB3, NB4, and NB7 meet preliminary feasibility criteria but did not meet the reasonableness criteria as the design goal for these barriers was not met. NB2, NB5, NB6, and NB8 meet preliminary feasibility criteria but did not meet the reasonableness criteria as the cost per benefited receptor for each barrier exceeds the cost per benefited unit cost established by MDOT. Additionally, based on the scattered locations of noise impacts along the corridor, noise barriers are not reasonable for individual receptors.

7.1 Statement of Likelihood

Based on the studies thus far accomplished, MDOT does not intend to install highway traffic noise abatement as discussed in this document. The preliminary assessment is based on preliminary design for barrier cost(s) and noise abatement as discussed in this document. If it subsequently develops during final design that these conditions have substantially changed, abatement measures will be reanalyzed.

7.2 Construction Noise

In addition to noise from traffic, construction activities themselves can produce increased noise of a temporary nature. MDOT will be sensitive to local needs and may adjust work practices to reduce inconvenience to the public.

The major construction elements of this project are expected to be demolition, hauling, grading, and paving. Construction of the proposed improvements will result in a temporary increase in the ambient noise level along I-96. General construction noise impacts for passerby and those individuals living or working near the project can be expected particularly from demolition, earth moving, and paving operations. Equipment associated with construction generally includes backhoes, graders, pavers, concrete trucks, compressors, and other miscellaneous heavy equipment. Considering the relatively short-term nature of construction noise, impacts are not expected to be substantial. The transmission loss characteristics of nearby structures are believed to be sufficient to moderate the effects of intrusive construction noise.

8 References

Anderson, G. S., C.S.Y. Lee, G.G. Fleming and C. Menge, "FHWA Traffic Noise Model®, Version 1.0 User's Guide", Federal Highway Administration, January 1998, p. 60.

FHWA, Noise Policy FAQs – Frequently Asked Questions https://www.fhwa.dot.gov/environment/noise/regulations_and_guidance/faq_nois.cfm#D4e

FHWA, *Procedures for Abatement of Highway Traffic Noise and Construction Noise,* Code of Federal Regulations, Title 23 Part 772 (23 CFR 722).

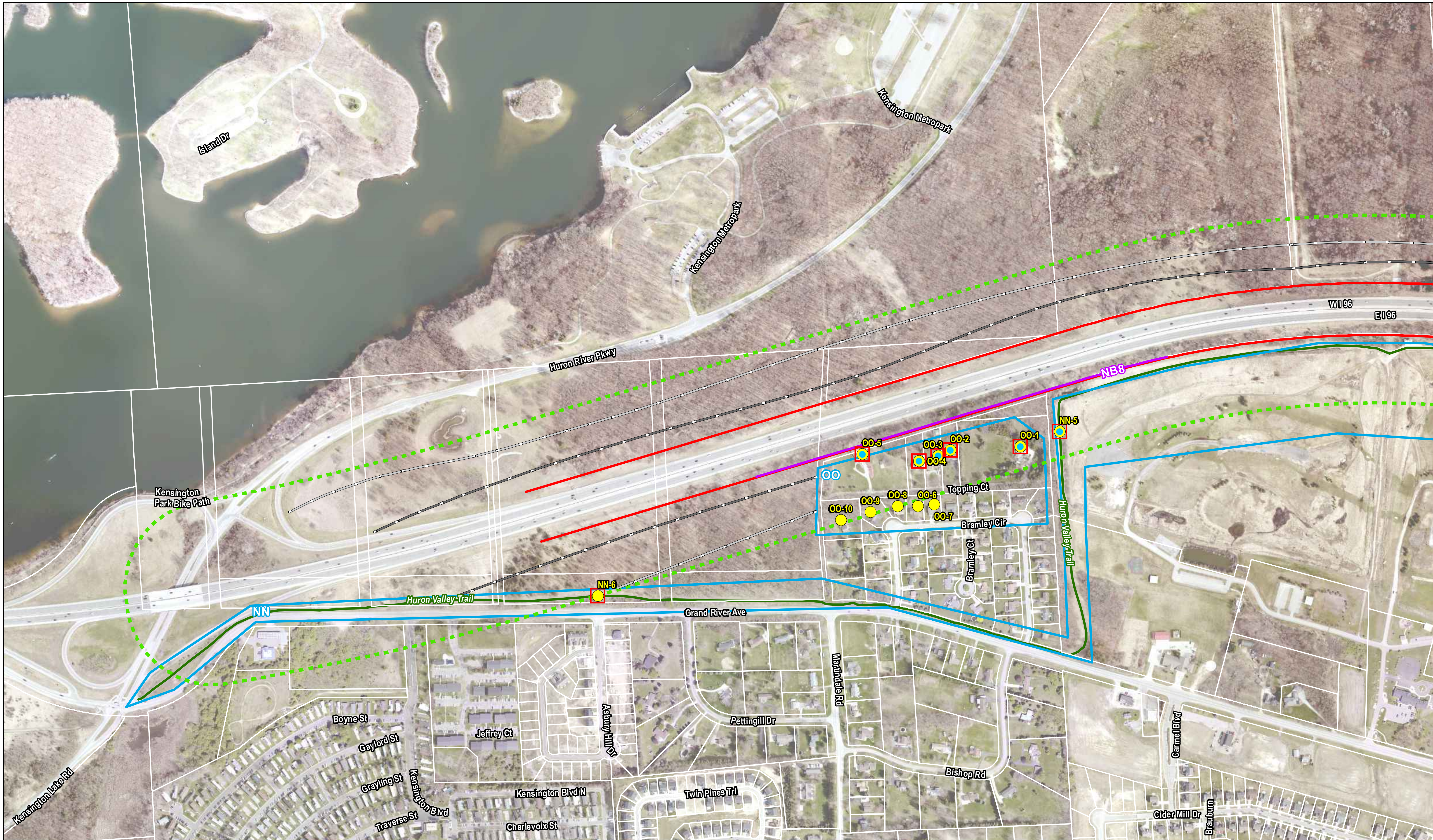
FHWA, *Recommended Best Practices for the Use of the Traffic Noise Model, Code of Federal Regulations*, December 8, 2015.

Hanf, Thomas. Email regarding "Re: I-96 Kensington Road to I-275/I-696/M-5". MDOT Air Quality & Noise Abatement, September 28, 2018.

Hanf, Thomas. Email regarding "Re: Noise and Air Quality Guidance – I-375". MDOT Air Quality & Noise Abatement, April 17, 2018.

Michigan Department of Transportation. Highway Noise Analysis and Abatement Handbook, July 2011.

Appendix A: Traffic Noise Study Exhibits



MDOT
Michigan Department of Transportation
HNTB

1/7/2019

Benefitted
Future Impact
Modeled Receiver
Field Site
66 dB(A) Setback
71 dB(A) Setback
Noise Barriers Analyzed
Existing ROW
Huron Valley Trail
CNE
500' Buffer

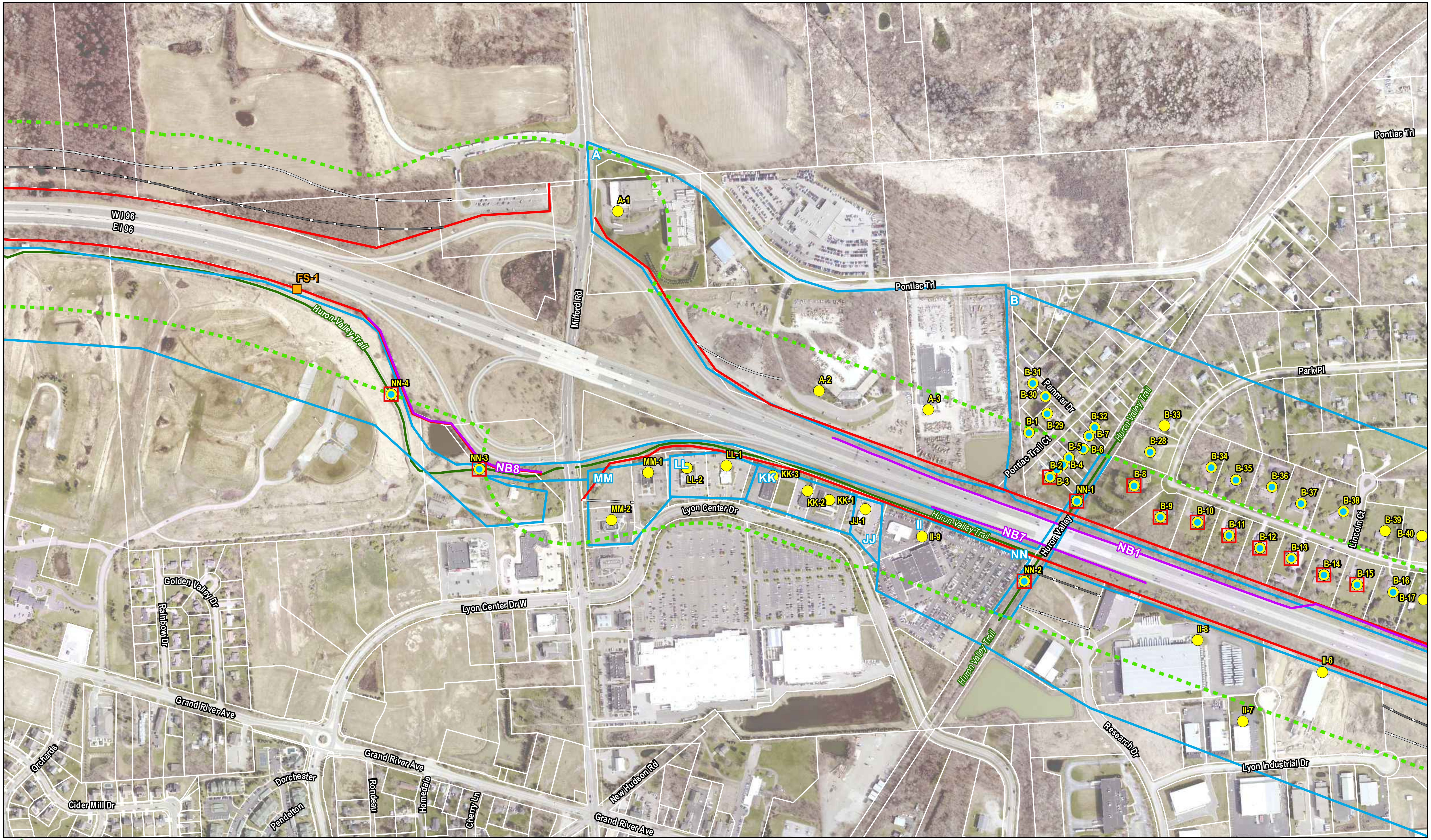
N

0 250 500 1,000 Feet

Appendix A, Page 1 of 8

Traffic Noise Study

I-96 ATM Project
Oakland County, Michigan



MDOT Michigan Department of Transportation

HNTB

1/7/2019

Legend			
Benefitted	Field Site	Noise Barriers Analyzed	CNE
Future Impact	66 dB(A) Setback	Existing ROW	500' Buffer
Modeled Receiver	71 dB(A) Setback	Huron Valley Trail	

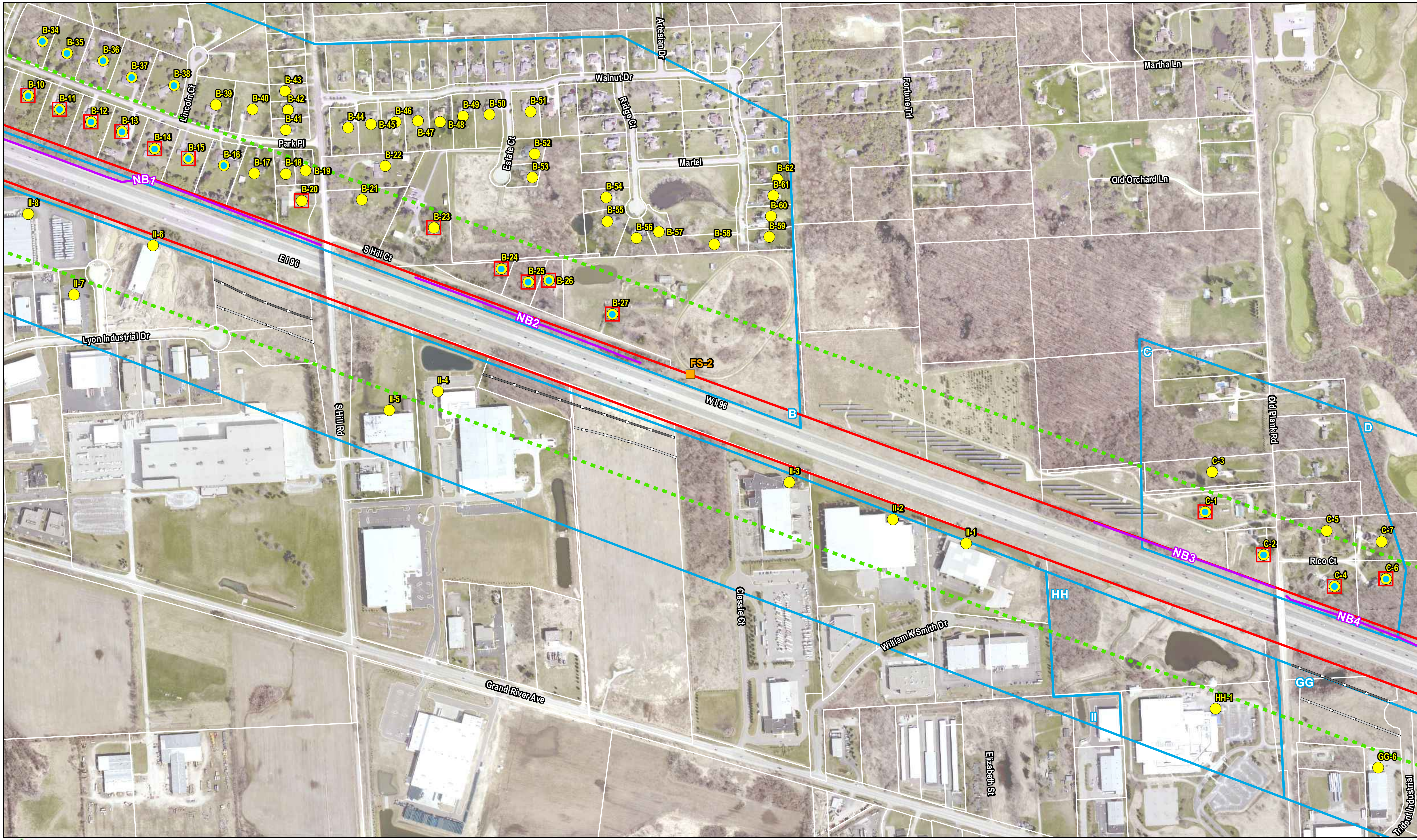
N

0 250 500 1,000 Feet

Appendix A, Page 2 of 8

Traffic Noise Study

I-96 ATM Project
Oakland County, Michigan



MDOT
Michigan Department of Transportation

HNTB

1/7/2019

Benefitted

Future Impact

Modeled Receiver

Field Site

66 dB(A) Setback

71 dB(A) Setback

Noise Barriers Analyzed

Existing ROW

Huron Valley Trail

A CNE

500' Buffer

N

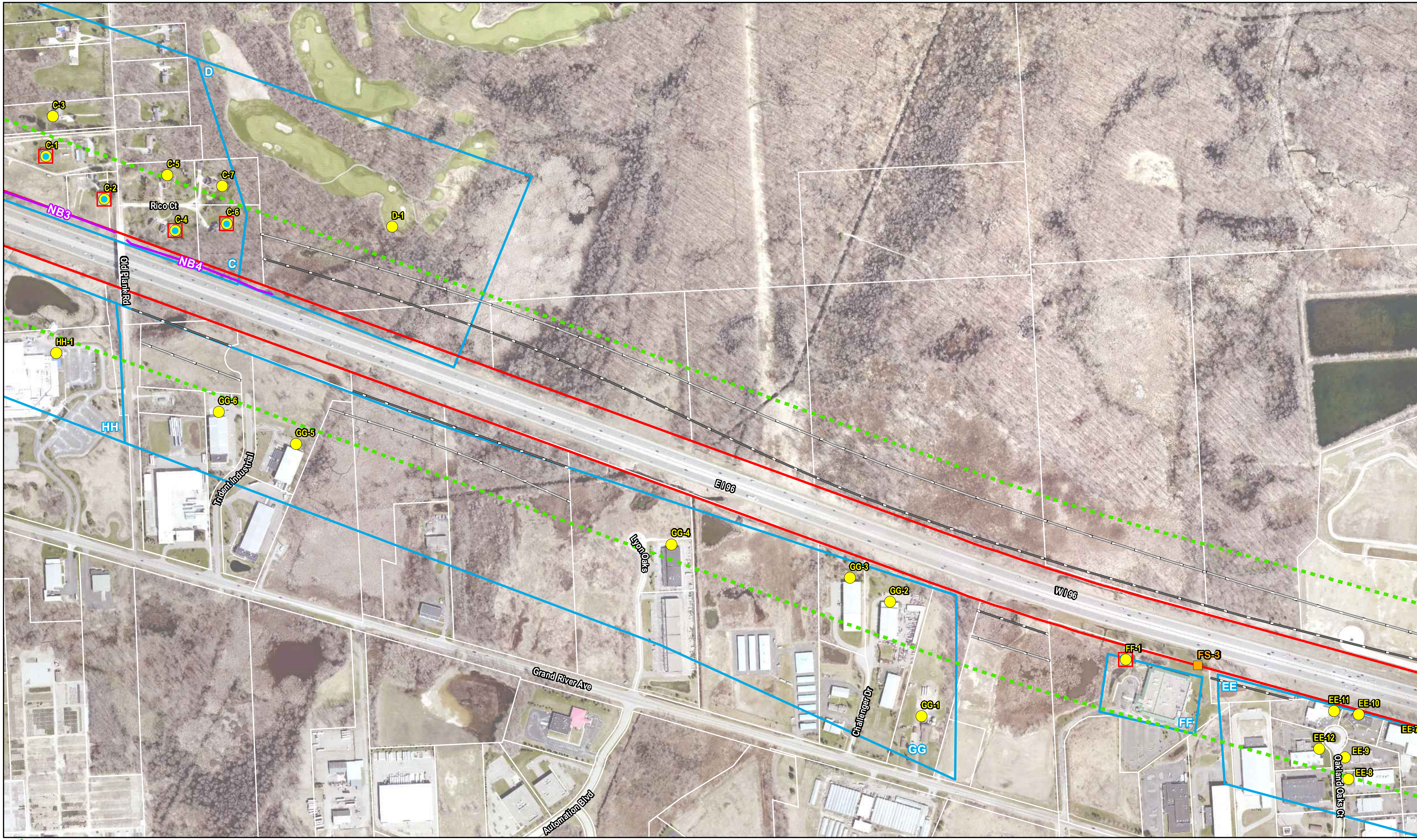
0 250 500 1,000 Feet

Appendix A, Page 3 of 8

Traffic Noise Study

I-96 ATM Project

Oakland County, Michigan



MDOT
Michigan Department of Transportation

HNTB

1/7/2019

Benefitted	Field Site	Noise Barriers Analyzed	CNE
Future Impact	66 dB(A) Setback	Existing ROW	500' Buffer
Modeled Receiver	71 dB(A) Setback	Huron Valley Trail	

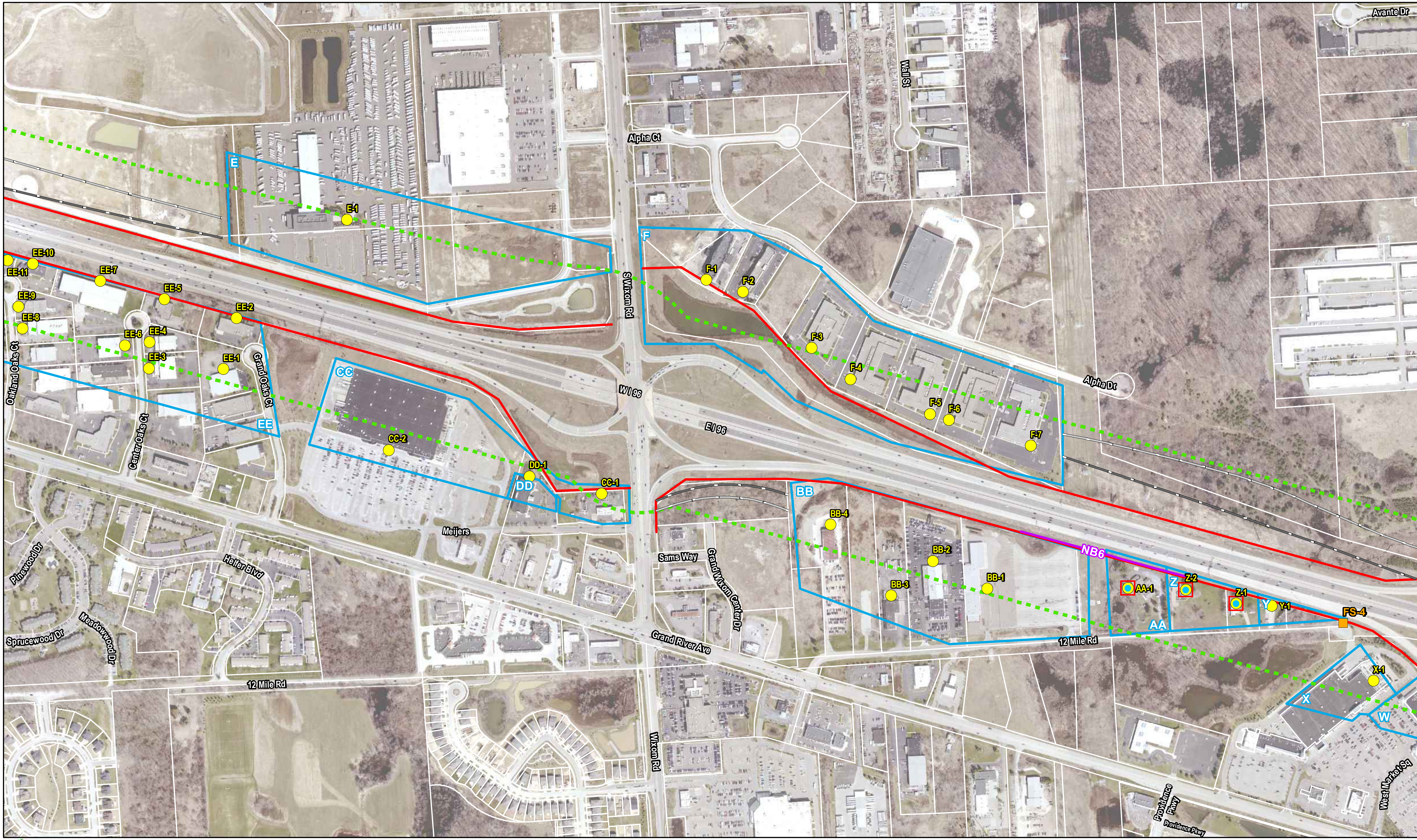
N

0 250 500 1,000 Feet

Appendix A, Page 4 of 8

Traffic Noise Study

I-96 ATM Project
Oakland County, Michigan



Benefitted

Field Site

Noise Barriers Analyzed

CNE

Future Impact

66 dB(A) Setback

Existing ROW

500' Buffer

Modeled Receiver

71 dB(A) Setback

Huron Valley Trail

N

0 250 500 1,000 Feet

Appendix A, Page 5 of 8

Traffic Noise Study

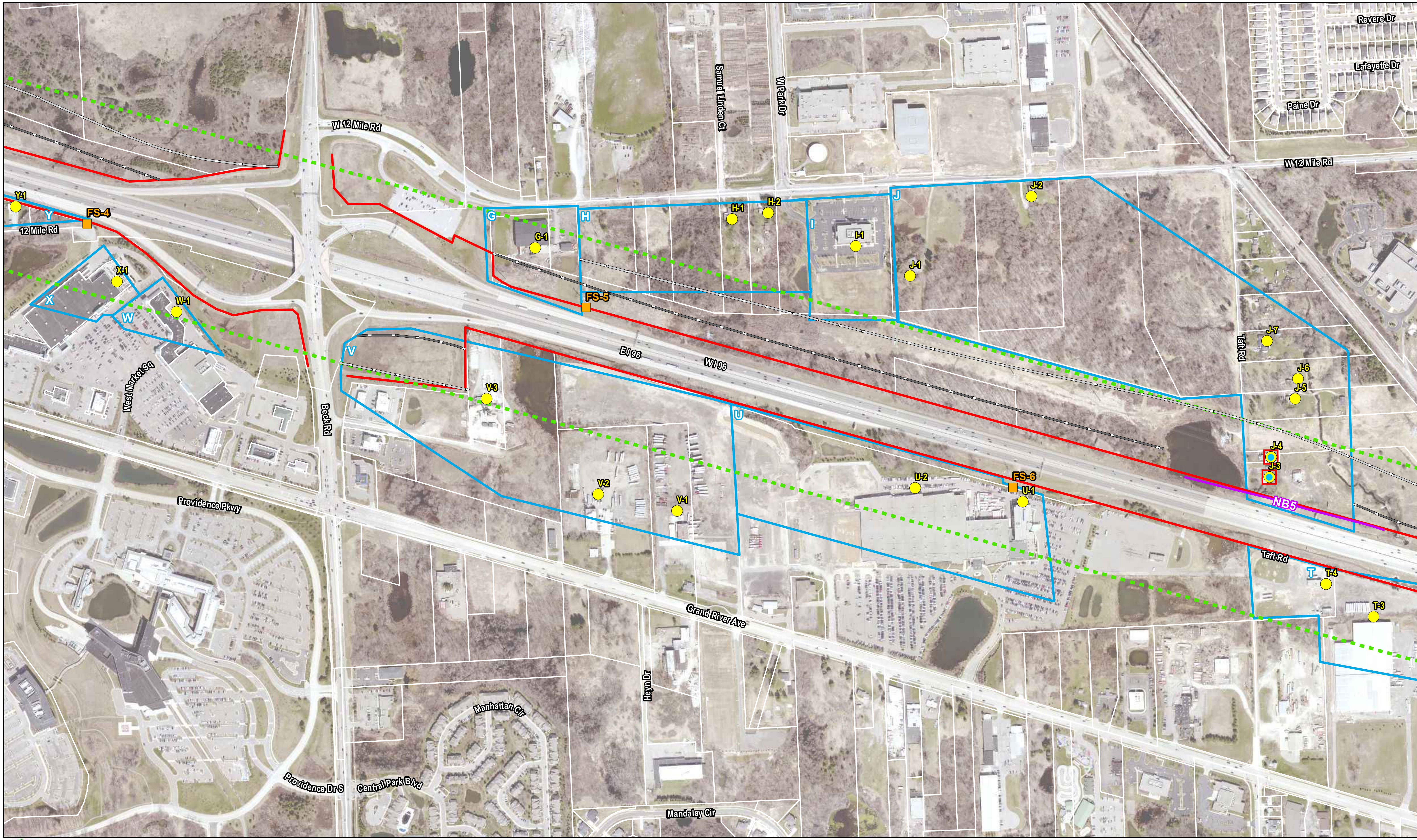
I-96 ATM Project

Oakland County, Michigan

MDOT Michigan Department of Transportation

HNTB

1/7/2019



MDOT Michigan Department of Transportation

HNTB

1/7/2019

- Benefitted
- Future Impact
- Modeled Receiver
- Field Site
- 66 dB(A) Setback
- 71 dB(A) Setback
- Noise Barriers Analyzed
- Existing ROW
- Huron Valley Trail
- CNE
- 500' Buffer

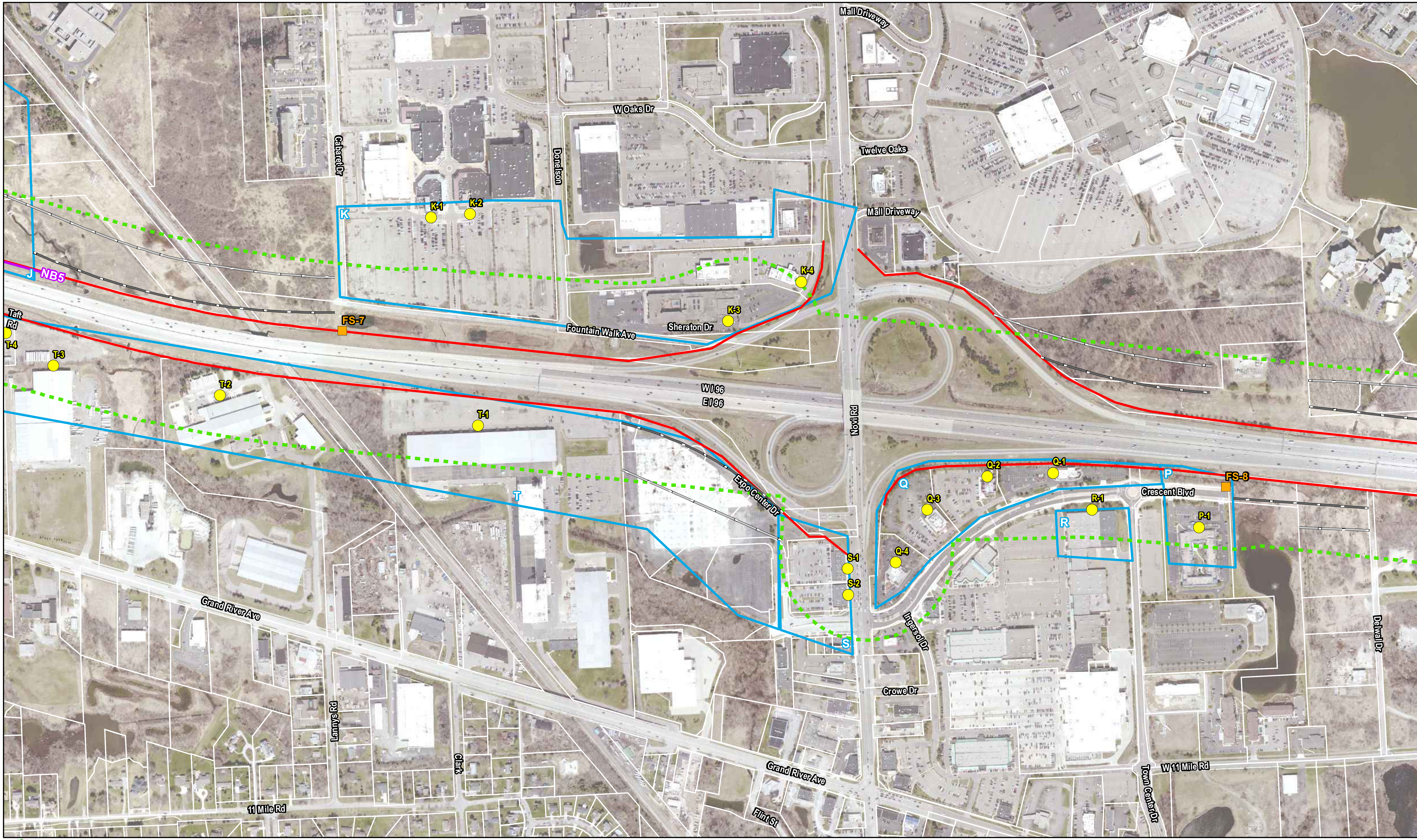
N

0 250 500 1,000 Feet

Appendix A, Page 6 of 8

Traffic Noise Study

I-96 ATM Project
Oakland County, Michigan



MDOT Michigan Department of Transportation

HNTB

1/7/2019

Benefitted
Future Impact
Modeled Receiver
Field Site
66 dB(A) Setback
71 dB(A) Setback
Noise Barriers Analyzed
Existing ROW
Huron Valley Trail
A CNE
500' Buffer

N

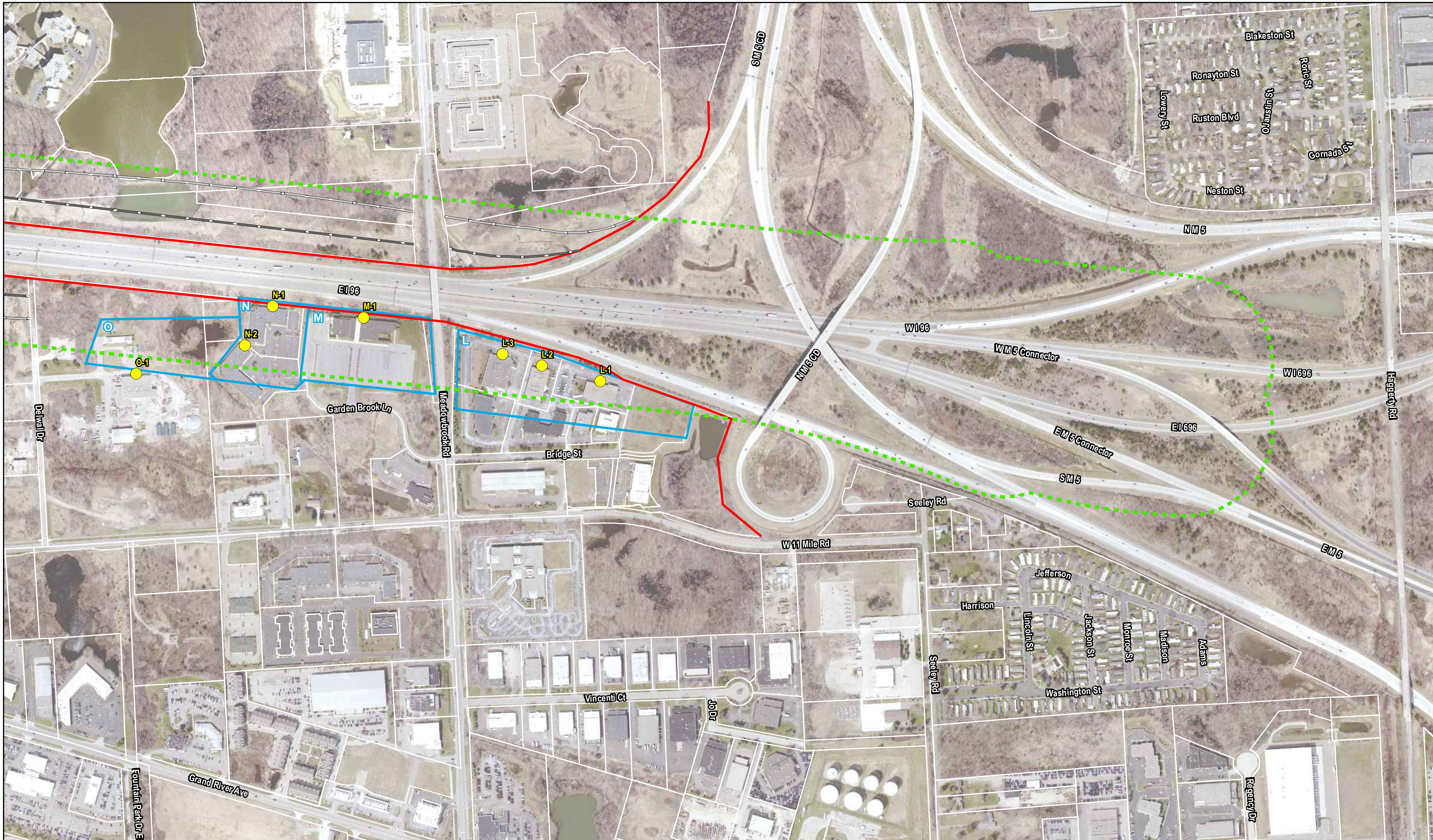
0 250 500 1,000 Feet

Appendix A, Page 7 of 8

Traffic Noise Study

I-96 ATM Project

Oakland County, Michigan



Benefitted

Field Site

Noise Barriers Analyzed

CNE

Future Impact

66 dB(A) Setback

Existing ROW

500' Buffer

Modeled Receiver

71 dB(A) Setback

Huron Valley Trail

MDOT Michigan Department of Transportation

HNTB

1/7/2019

N

0 250 500 1,000 Feet

Appendix A, Page 8 of 8

Traffic Noise Study

I-96 ATM Project

Oakland County, Michigan

Appendix B: Calibration Certification

Scantek, Inc.
CALIBRATION LABORATORY

ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP®
CALIBRATION
NVLAP Lab Code: 200625-0

Calibration Certificate No.38003

Instrument:	**Acoustical Calibrator**	*Date Calibrated:* **3/7/2017** *Cal Due:* **3/7/2018**		
Model:	**1251**	*Status:*	**Received**	**Sent**
Manufacturer:	**Norsonic**	*In tolerance:*	**X**	**X**
Serial number:	**30825**	*Out of tolerance:*		
Class (IEC 60942):	**1**	*See comments:*		
Barometer type:		*Contains non-accredited tests:* __**Yes** _X_ **No**		
Barometer s/n:				

Customer: **HNTB Corporation**
Tel/Fax: **414-359-2300 / 414-359-2314**
Address: **11414 West Park Place, Suite 300**
Milwaukee, WI 53224

Tested in accordance with the following procedures and standards:
Calibration of Acoustical Calibrators, Scantek Inc., Rev. 10/1/2010

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	25747	Jul 6, 2016	Scantek, Inc./ NVLAP	Jul 6, 2017
DS-360-SRS	Function Generator	61646	Aug 12, 2015	ACR Env./ A2LA	Aug 12, 2017
34401A-Agilent Technologies	Digital Voltmeter	MY41022043	Aug 16, 2016	ACR Env. / A2LA	Aug 16, 2017
DPI 141-Druck	Pressure Indicator	790/00-04	Dec 22, 2016	ACR Env./ A2LA	Dec 22, 2018
HMP233-Vaisala Oyj	Humidity & Temp. Transmitter	V3820001	Oct 1, 2015	ACR Env./ A2LA	Apr 1, 2017
8903A-HP	Audio Analyzer	2514A05691	Dec 19, 2016	ACR Env./ A2LA	Dec 19, 2019
PC Program 1018 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
4134-Brüel&Kjær	Microphone	950698	Nov 10, 2016	Scantek, Inc. / NVLAP	Nov 10, 2017
1203-Norsonic	Preamplifier	14059	Feb 13, 2017	Scantek, Inc./ NVLAP	Feb 13, 2018

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK)

Calibrated by:	Jeremy Gotwalt	**Authorized signatory:**	Steven E. Marshall
Signature	[signature]	Signature	[signature]
Date	3/7/17	Date	3/8/2017

Document stored as: Z:\Calibration Lab\Cal 2017\NOR1251_30825_M1.doc

Results summary: Device was tested and complies with following clauses of mentioned specifications:

CLAUSES[1] FROM STANDARDS REFERENCED IN PROCEDURES:	MET[2]	NOT MET	COMMENTS
Manufacturer specifications			
Manufacturer specifications: Sound pressure level	X		
Manufacturer specifications: Frequency	X		
Manufacturer specifications: Total harmonic distortion	X		
Current standards			
ANSI S1.40:2006 B.3 / IEC 60942: 2003 B.2 - Preliminary inspection	X		
ANSI S1.40:2006 B.4.4 / IEC 60942: 2003 B.3.4 - Sound pressure level	X		
ANSI S1.40:2006 A.5.4 / IEC 60942: 2003 A.4.4 - Sound pressure level stability	-	-	
ANSI S1.40:2006 B.4.5 / IEC 60942: 2003 B.3.5 - Frequency	X		
ANSI S1.40:2006 B.4.6 / IEC 60942: 2003 B.3.6 - Total harmonic distortion	X		

1 The results of this calibration apply only to the instrument type with serial number identified in this report.

2 The tests marked with (*) are not covered by the current NVLAP accreditation.

Main measured parameters [3]**:**

Measured[4]/Acceptable[5] Tone frequency (Hz):	Measured[4]/Acceptable[5] Total Harmonic Distortion (%):	Measured [4]/Acceptable Level[5] (dB):
1000.20 ± 1.0/1000.0 ± 10.0	0.44 ± 0.10/ < 3	114.06 ± 0.12/114.0 ± 0.4

3 The stated level is valid at reference conditions.

4 The above expanded uncertainties for frequency and distortion are calculated with a coverage factor k=2; for level k=2.00

5 Acceptable parameters values are from the current standards

Environmental conditions:

Temperature (°C)	Barometric pressure (kPa)	Relative Humidity (%)
23.9 ± 1.0	100.86 ± 0.002	42.4 ± 2.2

Tests made with following attachments to instrument:

Calibrator ½" Adaptor Type: Norsonic Type 1443
Other:

Adjustments: Unit was not adjusted.
Comments: The instrument was tested and met all specifications found in the referenced procedures.

Note: The instrument was tested for the parameters listed in the table above, using the test methods described in the listed standards. All tests were performed around the reference conditions. The test results were compared with the manufacturer's or with the standard's specifications, whichever are larger.
Compliance with any standard cannot be claimed based solely on the periodic tests.

Measured Data: in Acoustical Calibrator Test Report # 38003 of one page.

Place of Calibration: Scantek, Inc.
6430 Dobbin Road, Suite C
Columbia, MD 21045 USA
Ph/Fax: 410-290-7726/ -9167
callab@scantekinc.com

Scantek, Inc.
CALIBRATION LABORATORY

ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP®

NVLAP Lab Code: 200625-0

Calibration Certificate No.34247

Instrument:	**Acoustical Calibrator**	*Date Calibrated:* **7/9/2015**	*Cal Due:*		
Model:	**1251**	*Status:*	**Received**	**Sent**	
Manufacturer:	**Norsonic**	*In tolerance:*	X	X	
Serial number:	**30825**	*Out of tolerance:*			
Class (IEC 60942):	**1**	*See comments:*			
Barometer type:		*Contains non-accredited tests:* __Yes _X_ No			
Barometer s/n:					

Customer: **HNTB Corporation**
Tel/Fax: **414-359-2300 / -2314**

Address: **11414 West Park Place, Suite 300**
Milwaukee, WI 53224

Tested in accordance with the following procedures and standards:
Calibration of Acoustical Calibrators, Scantek Inc., Rev. 1/16/2015

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	25747	Jul 2, 2015	Scantek, Inc./ NVLAP	Jul 2, 2016
DS-360-SRS	Function Generator	61646	Nov 11, 2014	ACR Env./ A2LA	Nov11, 2016
34401A-Agilent Technologies	Digital Voltmeter	MY41022043	Nov 11, 2014	ACR Env. / A2LA	Nov 11, 2015
DPI 141-Druck	Pressure Indicator	790/00-04	Nov 18, 2014	ACR Env./ A2LA	Nov 18, 2016
HMP233-Vaisala Oyj	Humidity & Temp. Transmitter	V3820001	Mar 17, 2014	ACR Env./ A2LA	Sep 17, 2015
8903A-HP	Audio Analyzer	2514A05691	Dec 12, 2013	ACR Env./ A2LA	Dec 12, 2016
PC Program 1018 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
4134-Brüel&Kjær	Microphone	906763	Oct 15, 2013	NPL-UK / UKAS	Oct 15, 2015
1203-Norsonic	Preamplifier	14059	Jan 5, 2015	Scantek, Inc./ NVLAP	Jan 5, 2016

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK)

Calibrated by:	Valentin Buzduga	**Authorized signatory:**	Mariana Buzduga
Signature	[signature]	Signature	[signature]
Date	7/09/2015	Date	7/9/2015

Document stored as: Z:\Calibration Lab\Cal 2015\NOR1251_30825_M1.doc

Results summary: Device was tested and complies with following clauses of mentioned specifications:

CLAUSES[1] FROM STANDARDS REFERENCED IN PROCEDURES:	MET[2]	NOT MET	COMMENTS
Manufacturer specifications			
Manufacturer specifications: Sound pressure level	X		
Manufacturer specifications: Frequency	X		
Manufacturer specifications: Total harmonic distortion	X		
Current standards			
ANSI S1.40:2006 B.3 / IEC 60942: 2003 B.2 - Preliminary inspection	X		
ANSI S1.40:2006 B.4.4 / IEC 60942: 2003 B.3.4 - Sound pressure level	X		
ANSI S1.40:2006 A.5.4 / IEC 60942: 2003 A.4.4 - Sound pressure level stability	-	-	
ANSI S1.40:2006 B.4.5 / IEC 60942: 2003 B.3.5 - Frequency	X		
ANSI S1.40:2006 B.4.6 / IEC 60942: 2003 B.3.6 - Total harmonic distortion	X		

1 The results of this calibration apply only to the instrument type with serial number identified in this report.

2 The tests marked with (*) are not covered by the current NVLAP accreditation.

Main measured parameters [3]:

Measured[4]/Acceptable[5] Tone frequency (Hz):	Measured[4]/Acceptable[5] Total Harmonic Distortion (%):	Measured [4]/Acceptable Level[5] (dB):
1000.61 ± 1.0/1000.0 ± 10.0	0.23 ± 0.10/ < 3	114.13 ± 0.12/114.0 ± 0.4

3 The stated level is valid at reference conditions.

4 The above expanded uncertainties for frequency and distortion are calculated with a coverage factor k=2; for level k=2.00

5 Acceptable parameters values are from the current standards

Environmental conditions:

Temperature (°C)	Barometric pressure (kPa)	Relative Humidity (%)
23.3 ± 1.0	100.13 ± 0.003	41.6 ± 2.2

Tests made with following attachments to instrument:

Calibrator ½" Adaptor Type: 1443
Other:

Adjustments: Unit was not adjusted.
Comments: The instrument was tested and met all specifications found in the referenced procedures.

Note: The instrument was tested for the parameters listed in the table above, using the test methods described in the listed standards. All tests were performed around the reference conditions. The test results were compared with the manufacturer's or with the standard's specifications, whichever are larger.
Compliance with any standard cannot be claimed based solely on the periodic tests.

Measured Data: in Acoustical Calibrator Test Report # 34247 of one page.

Place of Calibration: Scantek, Inc.
6430 Dobbin Road, Suite C
Columbia, MD 21045 USA

Ph/Fax: 410-290-7726/ -9167
callab@scantekinc.com

Scantek, Inc.
CALIBRATION LABORATORY
ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP®
NVLAP Lab Code: 200625-0

Calibration Certificate No.35788

Instrument:	**Sound Level Meter**	*Date Calibrated:* **3/14/2016**	*Cal Due:*
Model:	**118**	*Status:*	**Received** / **Sent**
Manufacturer:	**Norsonic**	*In tolerance:*	X / X
Serial number:	**31483**	*Out of tolerance:*	
Tested with:	**Microphone 1225 s/n 52318** **Preamplifier 1206 s/n 30522**	*See comments:*	
		Contains non-accredited tests:	__Yes X No
Type (class):	**1**	*Calibration service:*	__ Basic X Standard
Customer:	**HNTB Corporation**	*Address:*	**11414 West Park Place, Suite 300, Milwaukee, WI 53224**
Tel/Fax:	**414-359-2300 / 414-359-2314**		

Tested in accordance with the following procedures and standards:
Calibration of Sound Level Meters, Scantek Inc., Rev. 6/26/2015
SLM & Dosimeters – Acoustical Tests, Scantek Inc., Rev. 7/6/2011

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	31052	Oct 23, 2015	Scantek, Inc./ NVLAP	Oct 23, 2016
DS-360-SRS	Function Generator	33584	Oct 20, 2015	ACR Env./ A2LA	Oct 20, 2017
34401A-Agilent Technologies	Digital Voltmeter	US36120731	Oct 6, 2015	ACR Env. / A2LA	Oct 6, 2016
HM30-Thommen	Meteo Station	1040170/39633	Oct 23, 2015	ACR Env./ A2LA	Oct 23, 2016
PC Program 1019 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
1251-Norsonic	Calibrator	30878	Nov 10, 2015	Scantek, Inc./ NVLAP	Nov 10, 2016

Jul 24, 2016

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK).

Environmental conditions:

Temperature (°C)	Barometric pressure (kPa)	Relative Humidity (%)
24.1	99.86	39.2

Calibrated by:	Lydon Dawkins	**Authorized signatory:**	Valentin Buzduga
Signature	*Lydon Dawkins*	Signature	*[signature]*
Date	3/14/2016	Date	3/14/2016

Document stored Z:\Calibration Lab\SLM 2016\NOR118_31483_M1.doc

Results summary: Device complies with following clauses of mentioned specifications:

CLAUSES [1] FROM IEC/ANSI STANDARDS REFERENCED IN PROCEDURES:	RESULT[2,3]	EXPANDED UNCERTAINTY (coverage factor 2) [dB]
INDICATION AT THE CALIBRATION CHECK FREQUENCY - IEC61672-3 ED.2 CLAUSE 10	Passed	0.15
SELF-GENERATED NOISE - IEC 61672-3 ED.2 CLAUSE 11	Passed	0.30
FREQUENCY WEIGHTINGS: A NETWORK - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	0.20
FREQUENCY WEIGHTINGS: C NETWORK - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	0.20
FREQUENCY WEIGHTINGS: Z NETWORK - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	0.20
FREQUENCY AND TIME WEIGHTINGS AT 1 KHZ IEC 61672-3 ED.2.0 CLAUSE 14	Passed	0.20
LEVEL LINEARITY ON THE REFERENCE LEVEL RANGE - IEC 61672-3 ED.2 CLAUSE 16	Passed	0.25
TONEBURST RESPONSE - IEC 61672-3 ED.2.0 CLAUSE 18	Passed	0.30
PEAK C SOUND LEVEL - IEC 61672-3 ED.2.0 CLAUSE 19	Passed	0.35
OVERLOAD INDICATION - IEC 61672-3 ED.2.0 CLAUSE 20	Passed	0.25
HIGH LEVEL STABILITY TEST - IEC 61672-3 ED.2.0 CLAUSE 21	Passed	0.10
LONG TERM STABILITY TEST - IEC 61672-3 ED.2.0 CLAUSE 15	Passed	0.10
FILTER TEST 1/1OCTAVE: RELATIVE ATTENUATION - IEC 61260, CLAUSE 4.4 & #5.3	Passed	0.25
FILTER TEST 1/3OCTAVE: RELATIVE ATTENUATION - IEC 61260, CLAUSE 4.4 & #5.3	Passed	0.25
COMBINED ELECTRICAL AND ACOUSTICAL TEST - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	See test report

1 The results of this calibration apply only to the instrument type with serial number identified in this report.

2 Parameters are certified at actual environmental conditions.

3 The tests marked with (*) are not covered by the current NVLAP accreditation.

Comments: The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent testing organization responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2, to demonstrate that the model of sound level meter fully conforms to the requirements in the IEC 61672-2, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1.

Note: The instrument was tested for the parameters listed in the table above, using the test methods described in the listed standards. All tests were performed around the reference conditions. The test results were compared with the manufacturer's or with the standard's specifications, whichever are larger.
Compliance with any standard cannot be claimed based solely on the periodic tests.

Tests made with the following attachments to the instrument:

Microphone: Norsonic 1225 s/n 52318 for acoustical test
Preamplifier: Norsonic 1206 s/n 30522 for all tests
Other: line adaptor ADP005 (18pF) for electrical tests
Accompanying acoustical calibrator: none
Windscreen: Norsonic Nor1451 (ø 60mm)

Measured Data: in Test Report # 35788 of 9 + 1 pages.

Place of Calibration: Scantek, Inc.
6430 Dobbin Road, Suite C
Columbia, MD 21045 USA

Ph/Fax: 410-290-7726/ -9167
callab@scantekinc.com

Scantek, Inc.
CALIBRATION LABORATORY
ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP®
NVLAP Lab Code: 200625-0

Calibration Certificate No.35789

Instrument:	**Microphone**	*Date Calibrated:* **3/14/2016** *Cal Due:*		
Model:	**1225**	*Status:*	**Received**	**Sent**
Manufacturer:	**Norsonic**	*In tolerance:*	X	X
Serial number:	**52318**	*Out of tolerance:*		
Composed of:		*See comments:*		
		Contains non-accredited tests: __Yes _X_ No		
Customer:	**HNTB Corporation**	*Address:* **11414 West Park Place, Suite 300, Milwaukee, WI 53224**		
Tel/Fax:	**414-359-2300/414-359-2314**			

Tested in accordance with the following procedures and standards:
Calibration of Measurement Microphones, Scantek, Inc., Rev. 2/25/2015

Instrumentation used for calibration: N-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	31052	Oct 23, 2015	Scantek, Inc./ NVLAP	Oct 23, 2016
DS-360-SRS	Function Generator	33584	Oct 20, 2015	ACR Env./ A2LA	Oct 20, 2017
34401A-Agilent Technologies	Digital Voltmeter	US36120731	Oct 6, 2015	ACR Env. / A2LA	Oct 6, 2016
HM30-Thommen	Meteo Station	1040170/39633	Oct 23, 2015	ACR Env./ A2LA	Oct 23, 2016
PC Program 1017 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
1253-Norsonic	Calibrator	28326	Nov 10, 2015	Scantek, Inc./ NVLAP	Nov 10, 2016
1203-Norsonic	Preamplifier	14052	Aug 24, 2015	Scantek, Inc./ NVLAP	Aug 24, 2016
4180-Brüel&Kjær	Microphone	2246115	Oct 26, 2015	NPL-UK / UKAS	Oct 26, 2017

Instrumentation and test results are traceable to SI - BIPM through standards maintained by NPL (UK) and NIST (USA)

Calibrated by:	Lydon Dawkins	**Authorized signatory:**	Valentin Buzduga
Signature	Lydon Dawkins	Signature	[signature]
Date	3/14/2016	Date	3/14/2016

Document stored as: Z:\Calibration Lab\Mic 2016\NOR1225_52318_M1.doc

Results summary: Device was tested and complies with following clauses of mentioned specifications:

CLAUSES / METHODS[1] FROM PROCEDURES		MET[2,3]	NOT MET	NOT TESTED	MEASUREMENT EXPANDED UNCERTAINTY (coverage factor 2)
Open circuit sensitivity (insert voltage method, 250 Hz)		X			See below
Frequency response	Actuator response	X			63 – 200Hz: 0.3 dB 200 – 8000 Hz: 0.2 dB 8 – 10 kHz: 0.5 dB 10 – 20 kHz: 0.7 dB 20 – 50 kHz: 0.9 dB 50 – 100 kHz: 1.2 dB
	FF/Diffuse field responses	X			63 – 200Hz: 0.3 dB 200 – 4000 Hz: 0.2 dB 4 – 10 kHz: 0.6 dB 10 – 20 kHz: 0.9 dB 20 – 50 kHz: 2.2 dB 50 – 100 kHz: 4.4 dB
	Scantek, Inc. acoustical method			X	31.5 – 125 Hz: 0.16 dB 250, 1000 Hz: 0.12 dB 2 – 8 kHz: 0.8 dB 12.5 – 16 kHz: 2.4 dB

1 The results of this calibration apply only to the instrument type with serial number identified in this report.

2 Results are normalized to the reference conditions.

3 The tests marked with (*) are not covered by the current NVLAP accreditation.

Note: The free field/diffuse field characteristics were calculated based on the measured actuator response and adjustment coefficients as provided by the manufacturer. The uncertainties reported for these characteristics may include assumed uncertainty components for the adjustment coefficients.

Comments:	The instrument was tested and met all specifications found in the referenced procedures.

Environmental conditions:

Temperature (°C)	Barometric pressure (kPa)	Relative Humidity (%)
23.9 ± 1.1	99.88 ± 0.025	37.8 ± 2.1

Main measured parameters:

Tone frequency (Hz)	Measured[4] /Nominal Open circuit sensitivity (dB re 1V/Pa)	Sensitivity (mV/Pa)
250	-26.24 ± 0.12/ -26.0	48.73

4 The reported expanded uncertainty is calculated with a coverage factor k=2.00

Tests made with following attachments to instrument and auxiliary devices:

Protection grid mounted for sensitivity measurements
Actuator type: G.R.A.S. RA0014

Measured Data: Found on Microphone Test Report # 35789 of one page.

Place of Calibration: Scantek, Inc.
6430 Dobbin Road, Suite C
Columbia, MD 21045 USA

Ph/Fax: 410-290-7726/ -9167
callab@scantekinc.com

Appendix C: Trail Modeling

METHODOLOGY FOR DETERMINING
DWELLING UNIT EQUIVALENT FOR TRAIL

STEPS FOR ANALYZING HURON VALLEY TRAIL (Guidance from Tom Hanf 10/3/2018 email to Michael Zabel).
1. Determine the impacted sections of the trail using the 66 dB(C5) contour (see Appendix C, Page 2 for length of trail within Future 66 dB(A) noise contour)
2. Segment the trail by using the square footage of the properties on Pontiac Trail Court
3. Determine dwelling unit equivalent (DUE)

	Length of Trail within the Future 66 dB(A) noise contour (ft)	Average Trail Width (ft)	Noise Impacted Area (Sq Ft)	Average lot size (Sq Ft)	Dwellling Unit Equivalent (Noise impacted area/Average Lot Size)
	280.0	10	2,800.0	17,324.8	0
	172.0	10	1,720.0	17,324.8	0
	2,838.0	10	28,380.0	17,324.8	2
	545.2	10	5,451.6	17,324.8	0
	4,748.0	10	47,480.0	17,324.8	3
	2,930.0	10	29,300.0	17,324.8	2
TOTAL	11,513.2	10	115,131.6		7

Parcels used to calculate average lot size along Pontiac Trail Court

	49,321.7
	14,233.9
	13,899.5
	13,076.8
	27,473.9
	15,608.3
	10,982.4
	22,823.6
	15,682.2
	8,355.1
	14,960.2
	12,927.4
	7,662.6
	15,539.1
Average	17,324.8

Huron Valley Trail

500' Buffer

Impact

No Impact

0 1,000 2,000 4,000 Feet

N

Huron Valley Trail Impact Analysis

Appendix C, Page 2