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| Noise Analysis Template |
| For use in project level environmental documentation |
|  |
| NDDOT – Environmental and Transportation Services (ETS) |
| June 2015 |

|  |
| --- |
| The following template is meant to encourage consistency between Noise Analysis for project level environmental documents. Information contained below should be treated as guidance and does not need to be replicated exactly. Instead, it should serve as a guide to outline the necessary information to be included in such reports. However, elements in gray highlighted text must be included in the report. Maintaining the following structure will facilitate report preparation by ETS staff and consultants and increase the efficiency of the required review and approval of submitted reports by the NDDOT – Environmental and Transportation Services. |

**Template Legend**

Gray highlighted text = required elements

Yellow highlighted text = exhibit references needing link updates, if sample text used

*Italics = ETS provided guidance on background or type of information needed in section*

Normal text = sample language provided by ETS

|  |  |
| --- | --- |
| **NOISE ANALYSIS**  **23 USC § 409**  **NDDOT Reserves All Objections** | Traffic Noise Analysis  **Project No. PCN**  4-083(130)920 20749  Minot – US 83 NW Bypass  badge2  **83**  **Prepared by**  **NORTH DAKOTA DEPARTMENT OF TRANSPORTATION**  **BISMARCK, NORTH DAKOTA**  <http://www.dot.nd.gov>/  **DIRECTOR**  **Grant Levi, P.E.**  **PROJECT DEVELOPMENT DIRECTOR**  **Robert A. Fode, P.E.**  **Principal Author:** (Consulting Firm or name, NDDOT Division Name)  **Environmental Reviewer** (Name, NDDOT Division Name)  **June 2015** |

23 USC § 409

NDDOT Reserves All Objections

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Executive Summary

*1-page preferred, should not exceed 2-pages*

### Project Objectives

* Brief summary of project
* Highway or Project Location, RP limits
* Project Boundaries
* Action triggering Type1 study

## Current Noise Environment

* Brief summary of adjacent land uses
* Brief summary of existing impacts,
* Table(s) preferred
  + Measurement/Receptor Location
  + Speed Limit (if corridor speed varies)

## Noise Impacts of Alternatives

* Brief comparison of Build vs. No Build impacts
* Table(s) preferred
* Potentially Impacted Noise Sensitive Areas (NSAs)

## Abatement (Recommended/Not Recommended)

* If abatement is recommended - brief summary of wall(s) heights and general alignments
* If not recommended - why abatement is not recommended.

# Introduction

## Project Description

* Typically provided by the project office, but can be summarized to include only relevant design features
* Vicinity map, including project area and state map reference maps comparing alternatives (if applicable)

## Type 1 Trigger for Noise Analysis

A traffic noise analysis is required by law[[1]](#footnote-2) for federally funded projects and required by NDDOT policy[[2]](#footnote-3) for projects requiring federal authorization that:

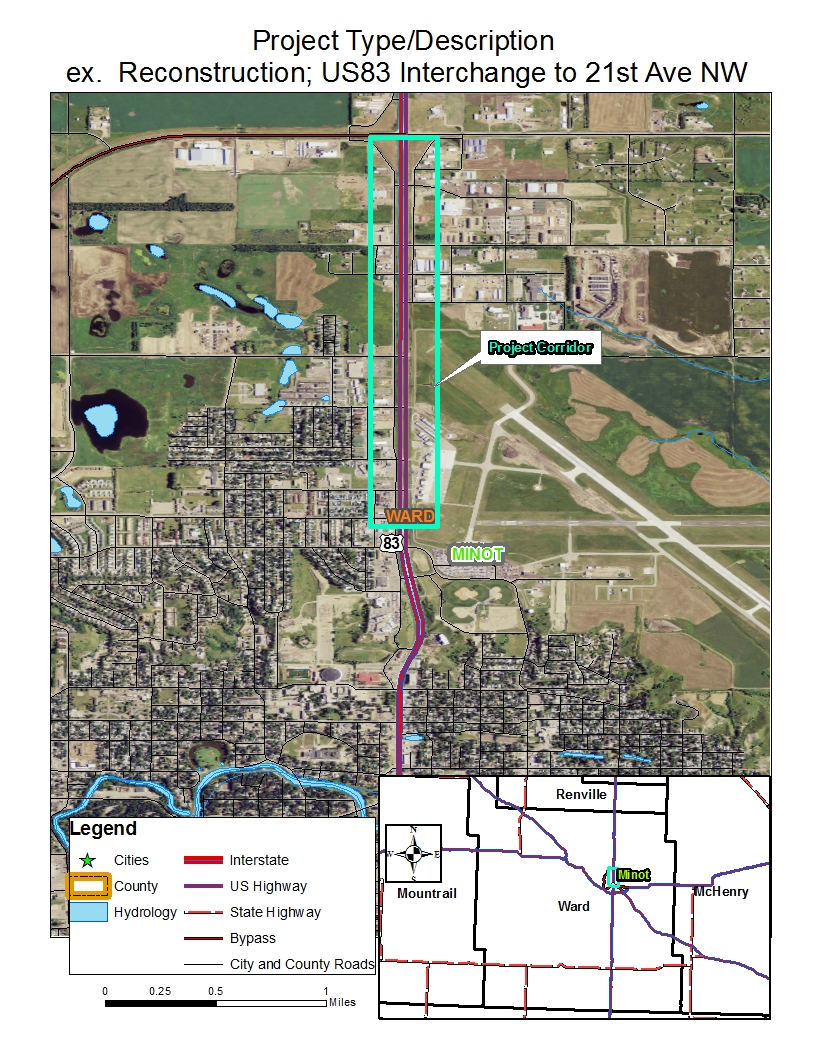
* Involve construction of a new highway,
* Significantly change the horizontal or vertical alignment,
* Increase the number of through traffic lanes on an existing highway, or
* Alter terrain to create new line-of-sight to traffic for noise sensitive receivers.
* Alteration of interchanges, weigh stations, or rest stops

Description of Type 1 activity on this project

## Noise Relevant Project Information

* List of items relevant to traffic noise analysis for existing, No-Build, and Build conditions, including:
  + Year for Existing and Build/No-Build conditions
  + Type of roadway (elevated, depressed, at-grade)
  + Number of lanes
  + Changes to existing access
  + Travel speeds (existing and posted)
  + Traffic Counts
    - Existing
    - Projected

*This information is needed to understand how the project will affect the noise environment for adjacent land uses.*

Exhibit 1: Project Vicinity

Vicinity map shall have the following

* *Scale*
* *North arrow*
* *Title that includes Project Name and Route ID*
* *Name of map maker and date*
* *Broader context (county, region, state, etc.)*
* *Labeled roadways*

Exhibit 2: Build Alternatives

*If applicable and/or not part of Exhibit 1*

*Build Alternative map needs the following:*

* *Scale*
* *North arrow*
* *Title that includes SR and Project Name*
* *Name of map maker and date and date*
* *Labeled roadways*
* *Comparison to existing*

# Characteristics of Sound and Noise

## Definition of Sound

* General description of sound and dBA/dB(A) metric

Sound is created when objects vibrate, resulting in a minute variation in surrounding atmospheric pressure, called sound pressure. The human response to sound depends on the magnitude of a sound as a function of its frequency and time pattern (EPA, 1974). Magnitude is a measure of the physical sound energy in the air. The range of magnitude the ear can hear, from the faintest to the loudest sound, is so large that sound pressure is expressed on a logarithmic scale in units called decibels (dB). Loudness refers to how people subjectively judge a sound and varies between people.

Sound is measured using the logarithmic decibel scale, so doubling the number of noise sources, such as the number of cars on a roadway, increases noise levels by 3 dBA. Therefore, when you combine two noise sources with similar sound characteristics emitting 60 dBA, the combined noise level is 63 dBA, not 120 dBA. The human ear can barely perceive a 3 dBA increase, while a 5 dBA increase is about one and one-half times as loud. A 10 dBA increase appears to be a doubling in noise level to most listeners. A tenfold increase in the number of noise sources will add 10 dBA.

In addition to magnitude, humans also respond to a sound's frequency or pitch. The human ear is very effective at perceiving frequencies between 1,000 and 5,000 Hz, with less efficiency outside this range. Environmental noise is composed of many frequencies. A-weighting (dBA) of sound levels is applied electronically by a sound level meter and combines the many frequencies into one sound level that simulates how an average person hears sounds of low to moderate magnitude

## Definition of Noise

* General description of noise

Noise is unwanted or unpleasant sound. Noise is a subjective term because, as described above, sound levels are perceived differently by different people. Magnitudes of typical noise levels are presented in Exhibit X.

## Traffic Noise Sources

* General description of traffic noise and noise sources

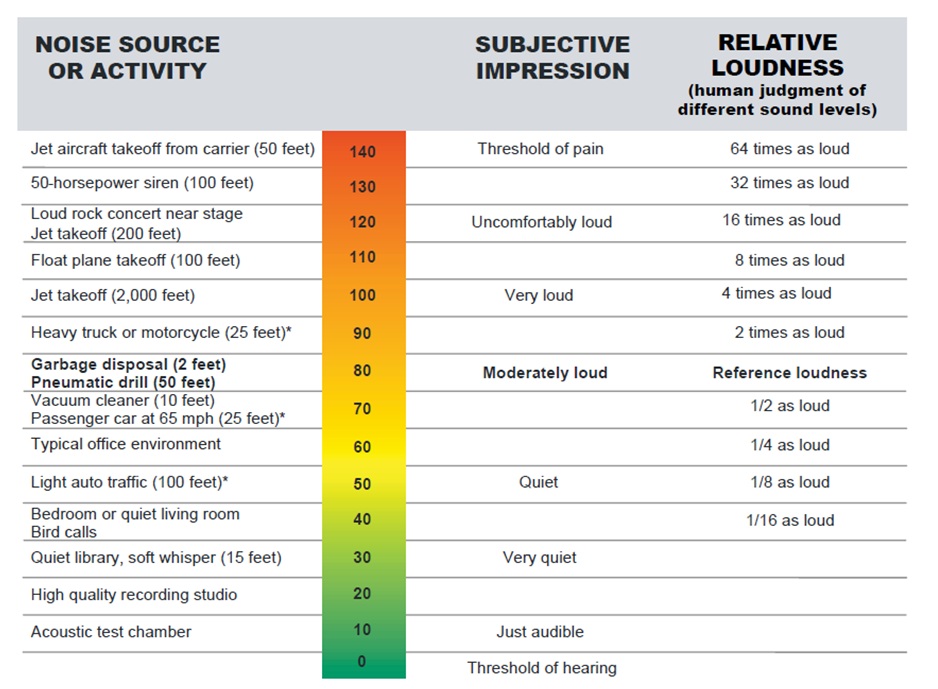
An increase in traffic volumes, vehicle speeds, or the amount of heavy trucks will increase traffic noise levels. Traffic noise is a combination of noises from the engine, exhaust, aerodynamic noise and tires. Defective mufflers, truck compression braking, steep grades, the terrain and vegetation near the roadway, shielding by barriers and buildings and the distance from the road can also contribute to the traffic noise heard at the roadside.

Exhibit 3: Typical Noise Levels

*Beranek (1988) and U.S. EPA (1974)*

## Sound Propagation

* General description of sound propagation, line-of-sight, and terrain affects

Sound propagation, or how far the sound travels, is affected by the terrain and the elevation of the receiver relative to the noise source. Noise levels can be reduced by breaking the line of sight between the receiver and the noise source.

* Level ground: noise travels in a straight path between the source and receiver.



*Level Ground*

* Depressed source/elevated receiver: terrain may act like a partial noise barrier and reduce noise levels if it crests between the source and receiver.



*Depressed source/elevated receiver*

* Elevated source/depressed receiver: the edge of the roadway acts as a partial noise barrier. Even a short barrier, like a concrete safety barrier, can reduce noise.



*Elevated source/depressed receiver*

## Line and Point Sources

* General description of line and point source sound attenuation

Noise levels decrease with distance from the noise source. For a line source, like highway, noise levels decrease 3 dBA for every doubling of distance, e.g., from 50’ to 100’, between the source and the receiver over hard ground (concrete, pavement) or 4.5 dBA over soft ground (grass). For point source, like most construction noise, the levels decrease between 6 and 7.5 dBA for every doubling of distance.

## Noise Level Descriptors

* General description of L metrics
* Include use of 15-minute Leq to represent 1-hour here or in Methodology chapter

The equivalent sound level (Leq) is a measure of the average noise level during a specified period of time. A one-hour period, or hourly Leq [Leq(h)], is used to measure highway noise. Leq is a measure of total noise during a time period that places more emphasis on occasional high noise levels that accompany general background noise levels. For example, if you have two different sounds, and one contains twice as much energy, but lasts only half as long as the other, the two would have the same Leq noise levels.

Either the total noise energy or the highest instantaneous noise level can describe short-term noise levels, such as those from a single truck passing by. The sound exposure level (SEL) is a measure of total sound energy from an event, and is useful in determining what the Leq would be over a period in time when several noise events occur. Lmax is the maximum sound level that occurs during a single event and is related to impacts on speech interference and sleep disruption. Lmin is the minimum sound level during a period of time.

With Ln, “n” is the percent of time that a sound level is exceeded and is used describe the range of sound levels recorded during the measurement period. For example, the L10 level is the noise level that is exceeded 10% of the time. Sound varies in the environment and people will generally find a higher, but constant, sound level more tolerable than a quiet background level interrupted by higher sound level events. For example, steady traffic noise from a highway is normally less bothersome than occasional aircraft flyovers in an otherwise quiet area.

## Noise Regulations and Impact Criteria

* Description of NAC and land use categories

Traffic noise impacts occur when predicted Leq(h) noise levels approach or exceed noise abatement criteria (NAC) established by the FHWA, or substantially exceed existing noise levels[[3]](#footnote-4). NDDOT considers a noise impact to occur if predicted Leq(h) noise levels approach within 1 dBA of the noise abatement criteria. The FHWA noise abatement criteria specify exterior Leq(h) noise levels for various land activity categories as described in Table 2. NDDOT also considers an increase of 15 dBA or more to be a substantial increase and a traffic noise impact.

Exhibit 4: 23 CFR Part 772 Noise Abatement Criteria (NAC) Hourly A Weighted Sound Level in Decibels (dBA)[[4]](#footnote-5)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Activity Category | L­eq (h)­­­­­­­­­­­­­ | L10(h) | Analysis Location | Description of Activity Category |
| 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 (single and multi-family units) |
| C | 67 | 70 | Exterior | Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools , television studios, trails, and trail crossings |
| D | 52 | 55 | Interior | Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios. |
| E\* | 72 | 75 | Exterior | Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F. |
| F |  |  |  | Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing |
| G |  |  |  | Undeveloped lands that are not permitted |

\*Activity Category E: The NDDOT considers mancamps to be Activity Category E.

# Traffic Noise Analysis Methodology

## Determination of the Traffic Noise Study Area

The extent of noise analysis area should include all receptors impacted by the project. The FHWA does not establish a fixed distance to define the noise impact analysis area. Historically, absolute noise impacts (those areas with noise levels approaching or exceeding the NAC – 66 dBA [FHWA NAC Level minus 1 dBA for approach or exceed as defined in the NDDOT noise policy] for residential land uses) rarely exist beyond about 500 feet from the roadway. It is also established that the FHWA Traffic Noise Model is less reliable at predicting noise levels beyond this range (TNM Validation Study, 2004), so a 500 foot screening distance from the edge of the proposed highway is established as a default value for the area of potential impact. However, in some areas with low existing noise levels (say below 55 dBA during the loudest hour), substantial increase noise impacts could exist without the predicted project noise level approaching or exceeding the NAC, so in these areas a more extensive analysis area may be required.

In general, noise-sensitive receivers are selected to represent potentially impacted land uses within the Project area.

* Describe the noise study area
  1. How the study area was established (i.e. description of method)
  2. Study area boundaries including description of physical distance from roadway.

A noise sensitive area, or NSA, is generally defined as a geographical area covering multiple properties with similar land uses and noise environments and that might benefit from a single noise abatement measure, such as a noise wall. An NSA might represent a single isolated property or an entire neighborhood. The delineated NSAs for this Project are described in Exhibit 5.

* Include aerial with noise study area identified
  1. Reference appropriate Exhibit where study area is defined, if included elsewhere

Exhibit 5: Noise Sensitive Areas 1

|  |  |  |  |
| --- | --- | --- | --- |
| Noise Sensitive Area | Description | NAC Activity Category | Short-Term Measurement ID |
| NSA 1 |  |  |  |
| NSA 2 |  |  |  |
| NSA 3 |  |  |  |
| NSA 4 |  |  |  |

Within each NSA, several representative noise measurement and noise prediction locations may be identified. Typically, each NSA would have one short-term measurement location and multiple modeled noise prediction locations. The number and locations of the receivers (measurement and modeling locations) within each NSA are selected to adequately represent all of the noise-sensitive property units (dwellings) within that NSA, and these properties may include Activity Categories A through E in Exhibit 4 (including residential, noise sensitive commercial, parks, places of worship, hotels, etc.). Activity Categories F and G (agriculture, retail, industrial, transportation, utilities, and undeveloped land), typically would not have associated NSAs or receiver locations. For residential properties in particular, more isolated residences would generally be modeled as individual receivers, while residences and multi-family dwellings in more dense neighborhoods may be modeled with multiple receivers for each predicted receiver location.

Land Uses with filed building permits are considered to be developed and would be included in the study and represented by a prediction location.

State what governmental entity was contacted

Were any building permits found?

If so, what is the permitted activity and what NSA are they within?

Are there any outdoor use areas associated with the planned landuse?

All receiver locations (short-term measurement locations and all modeled locations) are located to represent an exterior area of frequent human use. For residential properties, this would normally be an exterior activity area between the structure and the proposed project roadway. If no specific outdoor activity area is identified, a position at approximately 10 to 20 feet from the building façade exposed to the project roadway would be used. For commercial and other non-residential properties, some other exterior area of frequent human use would be selected.

## Traffic Noise Measurement

* Describe the use of 15-minute Leq to represent 1-hour here or in Characteristics chapter (Measurement of Highway Related Noise Section 4.4 and 5.4)
  + It is recommended the measurements be made only when wind speeds are below 12 mph.
* Clarify that measurements are not used to describe Existing conditions
  + Unless Type I activity is a new roadway where none previously existed

15-minute Leq measurements were collected at locations representative of all sound level environments within the study area during free-flowing traffic conditions.

**FHWA’s Measurement of Highway Related Noise Table:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Temporal Nature** | **Greatest Anticipated Range** | | |
| **10 dB** | **10 – 30 dB** | **>30 dB** |
| Steady | 2 minutes | N/A | N/A |
| **Nonsteady fluctuating** | **5 minutes** | **15 minutes** | **30 minutes** |
| Nonsteady intermittent | For at least | For at least | For at least |
| 10 events | 10 events | 10 events |

Ambient noise levels were measured to identify major noise sources in the project area and validate the noise model. Traffic noise measurements are not used to describe Existing conditions on existing alignment project. Existing noise levels are modeled using the loudest noise hour for the existing case after the noise model has been validated.

## Traffic Noise Model Validation

* Describe validation process
  + Any complications with validations
  + Non-traffic noise sources
  + Reference table in appendix with traffic counts, speeds and vehicle mix info for validation points
* Provide visual showing validation points
* Describe how validation was within +/- 3.0 dBA for each receiver, or why they were not.
  + Table preferred

To ensure that the noise model used to predict traffic noise impacts accurately reflects the sound levels in the project area, a model is constructed using the same traffic volumes, speed, and vehicle types that were present during the sound level measurements. Modeled values must be within ±3.0 dBA of the measured levels for the model to be validated.

FHWA's Traffic Noise Model (TNM) Version 2.5 (FHWA, 2004) was used for validation and to predict future Leq(h) traffic noise levels. TNM calculates precise estimates of noise levels at discrete points. The model estimates the sound levels from a series of straight-line roadway segments. TNM also considers the effects of existing barriers, topography, vegetation, and atmospheric absorption. Noise from sources other than traffic is not included so when non-traffic noise is present, such as aircraft noise, TNM may under predict the actual noise level. To create the model, design files outlining major roadways, topographical features, and sensitive receptors were imported into the TNM model as background features and the corresponding values were entered manually. Aerial photographs and site visits were used to verify site conditions.

Exhibit 6 describes the validation locations and the comparison of measured to model values. Recorded traffic information during the measurements is included in Appendix A. Exhibit X shows the receiver locations.

Noise measurements were conducted for this project from (insert date) to (insert date).

* Indicate if these included both long-term (24 hour) and short-term (15 to 20 minutes) measurements.
* A total of (how many short-term measurements) were conducted as summarized in Exhibit 6 below.

Exhibit 6: Noise Model Validation Result

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Location | Date | Start Time | Duration | Measured Leq (dBA) | Modeled Leq (dBA) | Difference (dBA) |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

Are all calculated differences between modeled and measured levels less than 3.0 dBA. If so, the noise models in those locations are considered validated.

Exhibit 7: Traffic Noise Measurement and *Study area map needs the following:*

* *Scale*
* *North arrow*
* *Title that includes SR and Project Name*
* *Name of map maker and date*
* *Labeled roadways*
* *Project limits with Reference Points*
* *Clearly marked study area limits; both project limits and 500’ boundary*
* *Aerial photo is strongly preferred*
* *Multiple study area maps can be used to clearly identify all of the NSA locations.*

## Traffic Noise Modeling – Predicted Traffic Noise Levels

* Aerial showing receiver locations
  + Describe how color/shape/number of symbol distinguishes measured from modeled locations
  + Receptor locations should be identified by their location in the direction of travel of the existing traffic. For example, for a project being developed for a northbound highway, receptor locations would be identified either N or S.
* Describe modeled noise levels for Existing, No Build, and Build conditions
  + Include information for ALL alternatives
  + Table(s) comparing condition to each other is/are preferred
* Traffic information including speed, volumes, and vehicle mix referenced to appendix containing this information for each condition and alternative
  + Decision to use AM or PM peak – same for all conditions and alternatives
* If the analyst is using a single receiver location within TNM 2.5 to reflect multiple receptors locations this should be clearly explained and documented. The information will be required for the cost effectiveness of the reasonableness determination.

Additional receivers were added to the model to represent the outdoor use areas for all noise sensitive locations within the study area. The modeled receiver locations are shown in Exhibit 7 as (X).

Predicted noise levels were based on peak hour traffic volumes to estimate future noise levels (Appendix B) for the current and design, or future, year (Year*)* traffic with(Build) and without the project (No Build).

# Traffic Noise Levels

## Description of Study Area

Exhibit x presents the predicted existing (enter year) and future year (enter year) noise levels for all modeled receivers in the Project area.

Describe the predicted existing noise levels and the future noise level ranges.

The study area is described in Exhibit X.

Modeled noise sensitive receivers (N*X* – N*XX and SX - SX*) are shown in Exhibit X.

## Operational Traffic Noise

Clearly describe the number of traffic noise impacts in Existing and Build conditions for each alternative

* Existing condition traffic noise impacts - XX
* Build condition traffic noise impacts – XX

## Identification of Noise Impacts Approaching or Exceeding the Noise Abatement Criteria

An “Approach or Exceed” noise impact occurs when the predicted future noise level at an identified noise receiver location approaches or exceeds the FHWA NAC (67 dBA) within 1 dBA (66 dBA). For example, a residential receptor would be evaluated for impact at 65.5 dBA, not 67.0 dBA. All potential impacts identified in the study area are identified as approaching or exceeding the FHWA NAC impact criteria within 1 dBA.

State if there were any potential substantial increase impacts identified in the project area

## Identification of Substantial Increase Impacts

A “Substantial Increase” noise impact occurs when the predicted future noise level at an identified noise receiver location exceeds the predicted conditions noise level by 15 dBA or more.

State if there were any receivers that were found to have a substantial increase impact.

Exhibit 8: Modeled Noise Levels

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | |  | Predicted Noise Level (Leq, dBA) | | | |
| NSA | Receiver  ID | Use  Category | NAC  (Leq, dBA) | Dwelling Units | Existing Year  (Leq, dBA) | | Future Build Year  (Leq, dBA) | Delta\* | Impact Type |
|  | N1 | C | 67 |  |  | |  |  |  |
|  | N2 | B | 67 |  |  | |  |  |  |
|  | N3 | D | 52 |  |  | |  |  |  |
|  | N4 | A | 57 |  |  | |  |  |  |
|  | N5 | B | 67 |  |  | |  |  |  |
|  | S1 | B | 67 |  |  | |  |  |  |
|  | S2 | C | 67 |  |  | |  |  |  |
|  | S3 | E | 72 |  |  | |  |  |  |
|  | S4 | B | 67 |  |  | |  |  |  |
|  | S5 | B | 67 |  |  | |  |  |  |

## INFORMATION FOR LOCAL OFFICIALS

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

This technical noise report will serve as the primary information source to help local officials avoid future incompatible land use planning with regard to noise generated by this project. In particular, refer to Exhibit X below for noise impact distances for various undeveloped regions of the project.

Exhibit 9: Potential Noise Impact Distance for Undeveloped Areas

|  |  |  |
| --- | --- | --- |
| Undeveloped Area Location | Potential Noise Impact Distance (ft) | |
| 65.5 dBA | 70.5 dBA |
| Description of area |  |  |
| Description of area |  |  |

# 

# Traffic Noise Abatement

## Traffic Noise Abatement – Background

According to FHWA and NDDOT policies, when noise impacts are identified, noise abatement must be considered and evaluated. Other potential noise abatement measures might include truck or speed restrictions, alignment changes, and depressed roadways.

* Briefly state if traffic noise abatement was considered for the project, or why not. Other forms of abatement should be discussed only if they were evaluated and/or recommended for the project.
* Abatement shall be considered at locations which minimize environmental impacts and are acoustically feasible.
* Abatement was not considered for this project because there are no traffic noise impacts.

Noise abatement measures were evaluated at impacted NSA’s for feasibility and reasonableness. The following section describes the feasibility results of the barrier assessments for each impacted NSA.

## Feasibility

Feasibility is a combination of acoustic and engineering considerations. All of the following must occur for abatement (e.g. noise barrier) to be considered feasible. Careful evaluation is needed regarding barrier placement, taking into consideration acoustics and maintenance of the barrier. Acoustically, the best locations for barriers are usually either close to the receiver, or close to the noise source, depending on the terrain.

* Abatement must be physically constructible.
* The noise abatement measures must provide at least a 5 dBA reduction in highway noise for 80% of first row impacted receptors, assuring that every reasonable effort will be made to assess outdoor use areas as appropriate.

NSA 1

* Describe feasibility
* Describe what abatement was evaluated
  + If wall, height, length, alignment
  + Include a graphic of wall/abatement evaluated; if appropriate (see Exhibit 10). Multiple exhibits may be needed based on the number of alternatives being evaluated.
  + The analyst shall determine and describe an acoustically feasible abatement location.

For this project, a noise barrier was evaluated at LOCATION(s) to determine whether abatement could sufficiently reduce traffic noise levels. A minimum feasible barrier height of X’-XX’ tall and X’ long will reduce traffic noise levels by at least 5 dBA for 80% of first row receiver locations in the noise study area. Additional noise wall dimensions were evaluated as part of the reasonableness determination.

Feasibility is described by noise reductions at each receiver (Exhibit 10) for the barrier in Exhibit 11. This barrier alignment appears to be constructible. Verification of constructability will be confirmed by the project engineering office during final design.

Exhibit 10: Feasibility Analysis

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Receiver  ID | Use  Category | Dwelling Units | Row | Predicted Existing Noise Level (Leq, dBA) | Predicted Future Build Noise Level (Leq, dBA) | Predicted with Barrier Noise Level (Leq, dBA) | Acoustically Feasible | |
| Insertion Loss\* (dBA) | 80% 1st Row ≥ 5 |
|  |  |  |  |  |  |  |  | X % |
|  |  |  |  |  |  |  |  |
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|  |  |  |  |  |  |  | *Feasible?* | Yes/No |

*Impacts are noted by red and bold values.*

*\*Based on unrounded noise levels*

Exhibit 11: Evaluated Noise Wall Alignment(s)

*Noise wall alignment map needs the following:*

* *Scale*
* *North arrow*
* *Title that includes SR and Project Name*
* *Name of map maker and date*
* *Labeled roadways*
* *Clearly marked study area limits; both project limits and 500’ boundary*
* *Aerial photo is strongly preferred*
* *Clearly identified modeled receiver locations that includes labels (e.g., N# or S#)*
* *Line showing recommended noise wall location*

## Reasonableness

* Describe reasonableness
* If abatement is feasible - describe analysis of min. feasible abatement
  + If reasonable, include maximum reasonable abatement and “optimized” abatement that attempt to meet NDDOT 10 dBA goal
  + Include graphic of wall/abatement evaluated, if appropriate (see Exhibit 10)
* If abatement was not feasible, describe why reasonableness was not evaluated

If not reasonable – Example: *Reasonableness was not evaluated for this project because a barrier could not 1) achieve sufficient noise reductions, and/or 2) was not constructible for the following reasons…*

Since abatement is feasible, the reasonableness of abatement was evaluated. Abatement measures will only be constructed by the department if they have been determined to be reasonable by satisfying two of the three criteria below. The viewpoints of the property owner and residents of the benefited receptors will be solicited after abatement has been determined to be cost effective and meets the noise reduction design goal.

1. Noise Reduction Design Goal

The NDDOT design goal for abatement on all projects is at least 10 dBA of noise reduction for 80% of benefited front row receivers. Noise walls cannot be recommended if they do not achieve the design goal. NDDOT makes a reasonable effort to get 10 dBA or greater insertion loss (noise reduction) at the first row of receivers for all projects where abatement is recommended.

Exhibit 12 describes the allowable cost per receiver and the cost of the minimum barrier size to achieve the design goal. A barrier that gets 10 dBA of reduction for the majority of 1st row receivers was also evaluated.

*Additional/Optimized noise walls can also be described. If a noise wall larger than min feasible/reasonable is recommended, it must be justified with quantitative descriptors.*

2. Cost Effectiveness

The cost of noise abatement sufficient to provide at least the noise reduction design goal reductions must be equal to or less than the allowable cost of abatement for each noise wall location analyzed. Based on noise wall costs from 2011, the current average costs for NDDOT is $20,000 per benefitted receptor (8 dBA or greater reduction). The cost is applied to the allowed wall surface area (ft2) and need of right of way to generate the allowable cost per benefitted receptor described in Exhibit 12.

For this project, a standard noise wall design was evaluated and costs are used to describe the cost effectiveness. The allowable cost per receiver, based on Build condition traffic noise levels is described in Exhibit 12.

* Describe cost-effectiveness which includes wall size (ft2) and right-of-way.
* Table is required that includes each receiver per NDDOT reasonableness table

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Abatement  Locations | Receiver  Number | Land Use Category | Benefited Receptors | Existing (Leq) (dBA) | Build  (Leq) (dBA) | Insertion  Loss (dBA) |
|
| Area 1 | N1 | C |  |  |  |  |
|  | N2 | B |  |  |  |  |
|  | N3 | D |  |  |  |  |
| Area 2 | N4 | A |  |  |  |  |
|  | N5 | B |  |  |  |  |
| Area 3 | S1 | B |  |  |  |  |
|  | S2 | C |  |  |  |  |
|  | S3 | E |  |  |  |  |
|  | S4 | B |  |  |  |  |
|  | S5 | B |  |  |  |  |

Exhibit 12: Reasonableness Evaluation for NSA X

Exhibit 13: Cost Effectiveness

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Abatement  Locations | Receiver  Number | Land Use Category | Benefited Receptors | Existing (Leq) (dBA) | Build  (Leq) (dBA) | Reasonableness Allowance | | Design Goal | |
| Cost Per Benefited Receptor | Insertion Loss (dBA) | 80% 1st Row ≥ 10 | Total Cost |
| Area 1 | N1 | C |  |  |  |  |  | X % |  |
|  | N2 | B |  |  |  |  |  |  |  |
|  | N3 | D |  |  |  |  |  |  |  |
| Area 2 | N4 | A |  |  |  |  |  | X % |  |
|  | N5 | B |  |  |  |  |  |  |  |
|  | S1 | B |  |  |  |  |  |  |  |
| Area 3 | S2 | C |  |  |  |  |  |  |  |
|  | S3 | E |  |  |  |  |  |  |  |
|  | S4 | B |  |  |  |  |  |  |  |
|  | S5 | B |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | *Feasible?* | Yes/No |  |

### 3. Viewpoints of Property Owners and Residents of the Benefited Receptors.

Public involvement must occur when traffic noise abatement is recommended for Type I projects in accordance with NDDOT Policy and 23CFR772. Public opinion must be considered when making a determination of reasonableness for traffic noise abatement. The procedure for soliciting the viewpoints of property owners and residents of the benefitted receptors should be performed in accordance with NDDOT Noise Policy and Guidance. Public involvement may occur through a variety of public outreach meetings related to NDDOT projects.

Noise abatement will be incorporated if 80% or more of the front row of eligible property owner’s and residents support the proposed noise abatement and the abatement measure has met the noise reduction design goal and is cost effective.

Outreach must occur before the abatement can be constructed.

* If outreach occurs,
  + Describe public outreach
  + How public opinion was solicited
  + Whether outreach was determined that abatement was/was not desired
* If outreach has not occurred, clarify that outreach has not occurred because the first two of the three previous criterion have not been met.

## Recommendation for Traffic Noise Abatement

Barrier design in TNM is an iterative process. While only final barrier designs are presented in the noise report, thousands of combinations of barrier lengths and panel heights were evaluated in order to determine the best possible candidate for feasibility and reasonableness at each potentially impacted NSA.

* Clarify recommendation for/against abatement and clarify reasons why

Traffic noise abatement is/is not recommend because… If recommended, the final noise wall design, costs and benefits are reiterated.

The recommended noise wall is approximately:

* Height = XX
* Length = XX
* Cost/Benefited Receptor = XX

The planning level noise wall design is shown in Exhibit XX.

# Construction Noise

## Construction Noise Background

* Describe general information on construction noise

Construction creates temporary noise. Construction is usually carried out in reasonably discrete steps, each with its own mix of equipment and noise characteristics. For example, roadway construction involves demolition, construction, and paving.

The most constant noise source at construction sites is usually engine noise. Mobile equipment generally operates intermittently or in cycles of operation, while stationary equipment, such as generators and compressors, generally operates at fairly constant sound levels. Trucks are present during most phases of construction and are not confined to the project site, so noise from trucks may affect more people than other construction noise. Other common noise sources include impact equipment, which could be pneumatic, hydraulic, or electric powered.

Noise levels during the construction period depend on the type, amount, and location of construction activities.

* The type of construction methods establishes the maximum noise levels.
* The amount of construction activity establishes how often certain construction noises occur throughout the day.
* The location of construction equipment relative to adjacent properties determines the effect of distance in reducing construction noise levels.

## Construction Noise Abatement

* Describe general/standard abatement considerations and any particular abatement requirements for this project
* Include description/examples of construction noise (see table below)

Construction noise can be reduced by using enclosures or walls to surround noisy equipment, installing mufflers on engines, substituting quieter equipment or construction methods, minimizing time of operation, and locating equipment farther away from noise sensitive receivers, e.g., homes. To reduce construction noise at nearby receptors, the following abatement measures can be incorporated into construction plans and contractor specifications:

* Limiting construction activities to between 7 a.m. and 10 p.m. would reduce construction noise levels during sensitive nighttime hours
* Using haul vehicles with rubber bed-liners would reduce noise from loading trucks
* Equipping trucks with ambient backup alarms would reduce the noise for equipment backing
* Equipping construction equipment engines with adequate mufflers, intake silencers, and engine enclosures would reduce their noise by 5 to 10 dBA (U.S. EPA, 1971)
* Constructing temporary noise barriers or curtains around stationary equipment that must be located close to residences would decrease noise levels at nearby sensitive receptors

Additional methods for reducing construction noise levels that may be incorporated by the project engineering office or required by a jurisdiction include the following:

* Specifying the quietest equipment available would reduce noise by 5 to 10 dBA
* Turning off construction equipment during prolonged periods of nonuse would eliminate noise from construction equipment during those periods
* Requiring contractors to maintain all equipment and train their equipment operators would reduce noise levels and increase efficiency of operation
* Locating stationary equipment away from receiving properties would decrease noise from that equipment in relation to the increased distance

NDDOT incorporates a number of provisions that are to be used on NDDOT projects to reduce the impacts of construction noise. This includes but is not limited to:

* limiting work hours,
* installation of mufflers on equipment, and
* requirements to receive the appropriate operation approvals from the appropriate local officials

Exhibit 14: Construction Equipment



# References

1. U.S. Department of Transportation, Federal Highway Administration directive "Highway Traffic Noise: Analysis and Abatement,” Revised December 2010.
2. North Dakota Department of Transportation, Noise Policy and Guidance (2011)
3. U.S. Department of Transportation, Federal Highway Administration “Highway Traffic Noise: Analysis and Abatement Guidance,” Revised December 2010.
4. United States Code of Federal Regulations (CFR) Part 772 (23 CFR Part 772), July 2010
5. U.S. Department of Transportation, Federal Highway Administration, 1996. *Measurement of Highway-Related Noise*. Washington D.C.
6. U.S. Department of Transportation, Federal Highway Administration, 1998. *FHWA Traffic Noise Model User’s Guide*. Washington D.C.
7. U.S. Department of Transportation, Federal Transit Administration, 1995. *Transit Noise and Vibration Impact Assessment*. Washington D.C.
8. U.S. Environmental Protection Agency, 1971. Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances. Washington, D.C.
9. U.S. Environmental Protection Agency, 1974. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety. Report Number 550/9-74-004.

# Appendix A - Traffic Noise Analysis and Abatement Process

## When are noise reports and/or recommendations final?

The noise abatement process from the preparation of a noise wall to the final noise wall design (or decision not to build) can be confusing. The following process attempts to provide some clarification to project teams and outlines a recommended “standard” process, but acknowledges that variations to this process are likely because of the differences between projects.

## Environmental Noise Reports

The noise analyst works with the project team to model project elements affecting noise that include traffic, topography, and the location of noise sensitive receivers. If traffic noise impacts are discovered through modeling, then abatement is evaluated.

Abatement is compared to the feasibility (constructability, effectiveness) and reasonableness (allowable barrier size/cost) for a “standard” project. If abatement is feasible and reasonable, the report recommends the optimal (cost to benefit) noise barrier.

The traffic noise report can be finalized.

## Design Phase

*Design Phase and Public Involvement steps (below) may be incorporated before report is finalized.*

The project office reviews the recommended noise wall height and horizontal alignment to determine if there are any conflicts that were not realized at the time the discipline report was prepared.

If conflicts from utilities, steep slopes, etc. are present, the details and costs of the conflicts are provided to the noise analyst by the project team. The analyst will consider if a modification to the barrier design can resolve the conflict. The noise analyst will then add any additional (“but for” the noise wall) costs to the reasonableness evaluation.

If noise wall costs including accommodation of conflicts are still less than the allowable costs for the noise wall, the barrier height and/or alignment are re-evaluated and a new barrier will be recommended. If barrier costs plus the new costs exceed the allowable costs, the barrier may not be recommended by the ETS Program.

If a noise wall is recommended, ETS Division will review and confirm noise wall, profiles, alignments and dimensions throughout design process.

## Public Involvement

If abatement is recommended in the Traffic Noise Report, public outreach to determine public desires for abatement must occur. The noise wall discussion may be introduced to the public before the Design Phase, but should happen after the noise wall alignment, height, and length (or other abatement description) is established so that people can understand any effects of the noise wall (or other abatement) on their community.

The final determination whether to construct a noise wall or other abatement that is recommend in the traffic noise analysis, cannot be made until public outreach has occurred.

## Final Steps

Any updates to the Traffic Noise report to clarify changes that occurred during the Design Phase or from Public Involvement can be made at the project engineering offices discretion. Addendum or supplementary memorandum to clarify changes can also be added to the discipline report or project file.

The noise wall is constructed or a letter from the ETS Program is added to the project file clarifying why a noise wall was not constructed.

# 

# Appendix B – Traffic Data

* Validation traffic counts, speeds, vehicle mix data
* Existing, No-build, and Build traffic volumes speeds, vehicle mix data
* Reference document and/or contact for traffic data

Exhibit 15: Measured Traffic Volumes during Validation Measurement

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Traffic during Validation (*Date)*** | | | | | | |
| Measurement Location | Monitored Speed (mph) | Cars | Motorcycles | Medium Trucks | Heavy Trucks | Buses |
| Address (M1) |  |  |  |  |  |  |
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Exhibit 16: Modeled Hourly Traffic Volumes for Existing Build Conditions

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| --- | --- | --- | --- | --- | --- | --- |
| **Existing Conditions (*Year)*** | | | | | | |
| Roadway Segment | Modeled\* Speed (mph) | Cars | Motorcycles | Medium Trucks | Heavy Trucks | Buses |
| 1st Street to  2nd Street |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

\*Document what the modeled speed represents (design/posted/operating)

Exhibit 17: No Build Design Year Traffic 1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **No Build Design Year (Year) Traffic** | | | | | | |
| Roadway Segment | Modeled Speed (mph) | Cars | Motorcycles | Medium Trucks | Heavy Trucks | Buses |
| 1st Street to  2nd Street |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
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Exhibit 18: Build Design Year Traffic

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Build Design Year (Year) Traffic** | | | | | | |
| Roadway Segment | Modeled Speed (mph) | Cars | Motorcycles | Medium Trucks | Heavy Trucks | Buses |
| 1st Street to  2nd Street |  |  |  |  |  |  |
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# Appendix C – TNM Barrier Graphics

# Appendix D - TNM Data

## TNM Data

* include 2 copies of CD-ROMs with all TNM v2.5 files marked as follows:
  + Project Name\_Build
  + Project Name\_NoBuild
  + Project Name\_Existing
  + Project Name\_BarrierX
  + Project Name\_BarrierX

# Appendix E – Field Data Sheets

* Include a site sketch
* Include data sheets from the field that describe the measurement conditions
* Noise meter make and model used
* When the Noise meter was QA/QC
* Note anomalies such as dog barking, train, semi

Exhibit 19: Noise Analysis Field Data Sheet

# Credentials

Name: Jane Doe, Accoustical Engineer

Education: University of XXX, B.S. Engineering

Professional Membership: XXX

Training: TNM 2.5, NHI Highway Traffic Noise, Other

Certificates: Meter Calibration Certificates

Other Information:

1. 23 CFR 772, "Procedures for Abatement of Highway Traffic Noise and Construction Noise" [↑](#footnote-ref-2)
2. NDDOT Noise Policy and Guidance (2011) [↑](#footnote-ref-3)
3. U.S. Department of Transportation, 1982, Noise Abatement Council [↑](#footnote-ref-4)
4. FHWA Traffic Noise Frequently Asked Questions <http://www.fhwa.dot.gov/environment/noise/regulations_and_guidance/faq_nois.pdf> [↑](#footnote-ref-5)