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GLOSSARY

A-Weighted Sound Level	The sound level obtained using the "A" weighting characteristic of a sound meter. The "A" weighting approximates the ear's sensitivity to sounds of various frequencies.
Acoustics	The branch of physics dealing with sound and sound waves.
Ambient Noise	All-encompassing noise associated with a given environment; usually a composite of sounds from many sources, near and far.
Attenuation	Any decrease in sound level; can be caused by increased distance, diffraction around a barrier, etc.
Cost effectiveness criteria	Limits used to determine when a noise barrier is economical in terms of tangible benefits produced by money spent.
Daytime	The hours from 7 a.m. to 10 p.m.
Decibel (db)	A measure used to express the relative level of a sound in comparison with a standard reference level. The higher the sound level in decibels, the more intense or loud the sound.
Design Year	The future year used to estimate the probable traffic volume for which a highway is designed. A time, 10 to 20 years, from the start of construction is usually used.
Diffraction	The bending of sound waves around an obstacle, such as a barrier. The process reduces the effectiveness of the shadow zone. (See also Shadow Zone)
Existing Noise Levels	See ambient noise.

Freeway or expressway	A divided, controlled-access highway with four or more lanes.
Frequency	The rate of vibration expressed in number of cycles per second (hertz or Hz). Frequency corresponds roughly to pitch in the human perception of sound
L10	The sound level that is exceeded 10 percent of the time (the 90th percentile) for the period under consideration.
L10(h)	The hourly value of L10.
Leq	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 period.
Leq(h)	The hourly value of Leq.
Nighttime	The hours from 10:00 p.m. to 7:00 a.m.
Noise	Undesirable or unwanted sound; as defined by Minnesota Pollution Control Agency Regulations (NPC-1), "any sound not occurring in the natural environment, including but not limited to sounds emanating from aircraft and highways, and industrial, commercial and residential sources."
Noise Wall or Barrier	Any natural or man-made objects such as noise walls, berms or mounds, buildings etc. that affect the sound propagation by interrupting the direct line of sight between the noise source and receiver.
Shadow Zone	As it relates to barriers, an area of decreased sound energy governed principally by the properties of diffraction and transmission loss.

Substantial Change	A substantial increase or decrease in noise level is a change of 5 dBA or more.
Tire/Pavement Noise	The noise produced by the interaction between the rolling tires of a vehicle and the pavement, and separate from other sources (engine, exhaust, etc.)
Traffic Noise Impacts	Impacts occur when the predicted noise levels or when measured traffic noise levels exceed the MPCA noise level standards, FHWA noise abatement criteria, or when predicted traffic noise levels substantially exceed the existing noise levels.
Type I Projects	A proposed federal or federal-aid highway project for the construction of a highway on new location or the physical alteration of an existing highway which significantly changes either the horizontal or vertical alignment or increases the number of through-traffic lanes.
Type II Projects	A proposed federal or federal-aid highway project for noise abatement on an existing highway.

1995 LEGISLATIVE DIRECTIVE

161.125 Sound abatement along highways.

Subdivision 1. Implementation. The Commissioner of Transportation shall implement a noise abatement study and noise abatement measures within or along the perimeter of freeways and expressways in incorporated areas contingent on the availability of funding, in accordance with section 116.07, subdivision 2a. The Commissioner shall report to the legislature by February 1, 1997, on noise abatement studies and measures undertaken during the previous calendar year and planned for the next three years under this subdivision. The study must include a survey of all applicable noise standards and feasible noise abatement measures, and an evaluation of their ability to protect citizens.

Subd. 2. Repealed, 1977 c 454 s 49

Subd. 3. Sound abatement measures. For the purpose of this section, sound abatement measures include but are not limited to the following:

(a) traffic management measures, including reduced speed limits or exclusion and rerouting of excessively noisy vehicles;

(b) design and construction measures, including use of sound absorbing road surface materials, landscaping and planning, acquisition of buffer zones or noise insulation of buildings on abutting property;

(c) enforcement of the motor vehicle source noise limits of the Pollution Control Agency and of the Federal Bureau of Motor Carrier Safety; and

(d) other measures designed for the purpose of reducing motor vehicle source noise or reducing the effects of that noise. The Commissioner of Public Safety shall cooperate with the Commissioner of Transportation in implementing any sound abatement measures that include law enforcement activities.

1975 c 203 s 20; 1976 c 164 s 1; 1976 c 166 s 7; 1977 c 454 s 13,14; 1978 c 791 s 18; 1981 c 357 s 49; 1983 c 326 s 1; 1995 c 265 art 2 s 16
161.13 MS 1957 u Repealed, 1959 c 500 art 6 s 13

EXECUTIVE SUMMARY

INTRODUCTION

The Minnesota Legislature, in 1995, requested that the Minnesota Department of Transportation (Mn/DOT) conduct a study to:

- Survey highway noise conditions along freeways and expressways inside incorporated areas in Minnesota.
- Identify areas where state and federal noise standards are exceeded.
- Assess the feasibility, reasonableness and cost effectiveness of implementing noise mitigation measures.
- Report back to the Minnesota Legislature on measures taken and planned to reduce and minimize the effects of highway noise along freeways and expressways in incorporated areas of Minnesota.

This report summarizes the Metro Division update, performed in 2001 and 2002, to the statewide Noise Abatement Study that was conducted in 1996. This update only includes the 8 county metro area. It includes background information on the subject of highway noise and an overview of noise standards and mitigation measures used in the Metro area. The methodologies used to analyze noise levels and determine cost effective mitigation opportunities are summarized. Results, conclusions and next steps are presented for addressing mitigation needs in priority areas.

The approach and methodologies for conducting much of the study were developed jointly by Mn/DOT and the Minnesota Pollution Control Agency (MPCA).

This report will be shared with the Minnesota Legislature consistent with Section 161.125, Chapter 161, *Laws of Minnesota* and other transportation partners involved in highway related noise activities.

Study results provide a framework for identifying where funding for noise mitigation can be targeted to achieve the most cost effective benefits for state residents.

OVERVIEW OF METHODOLOGY AND STUDY RESULTS

Noise monitoring was conducted following standardized measurement procedures outlined in MPCA administrative rules. Procedures developed by Mn/DOT and MPCA were used to rank different residential areas in terms of the severity of highway noise impacts and the number of residences impacted. In addition, an estimate of cost effectiveness was used to identify optimal areas for investment in highway noise mitigation measures.

Based on this analysis, the 70 highest impacted areas that offer, potentially, the most cost effective opportunities for future noise mitigation are identified.

SUMMARY OF NEXT STEPS

The future is less certain for noise mitigation retrofit (Type II) projects located along existing freeways and expressways where construction and major reconstruction projects have not been identified. Restrictions on the eligibility of Type II projects for federal funding means that retrofit noise mitigation projects will have to rely entirely on state funding. The availability of state funds and the status of competing transportation priorities will influence the extent to which progress can be made in addressing the high and medium priority areas identified in this report.

Based on the noise analysis that was conducted, the following next steps have been identified:

1. Mn/DOT will move ahead with preliminary design and final design studies to ensure that proposed noise wall construction in the seven priority areas from the previous priority list is feasible, reasonable and cost effective.

2. Mn/DOT will begin working with municipalities, residents and area transportation partners in those priority areas where noise wall construction is being proposed. This work will include an assessment of the public's acceptance of the proposed noise wall(s).

3. For noise walls proposed for construction after the year 2001, site selection will be based on this priority study and Mn/DOT will identify funding by working through the State Transportation Improvement Program (STIP) investment process. Mn/DOT will have discretionary authority over the use of state funds.

   As a part of this effort:

   a. Federal and state funds will continue to be sought for any noise mitigation needed in conjunction with proposed new highway construction and major reconstruction projects.

   b. A Mn/DOT funded only program will be initiated and managed through the STIP investment process for funding retrofit highway noise mitigation projects along existing freeways and expressways.

4. Mn/DOT will continue working with local units of government to coordinate land use planning adjacent to transportation facilities.

MINNESOTA HIGHWAY NOISE ABATEMENT STUDY

BACKGROUND

Noise pollution was one of the many environmental concerns that led to the passage of the National Environmental Policy Act (NEPA) in 1969. As a consequence of NEPA, Congress passed the Federal-Aid Highway Act of 1970, which directed the Secretary of the Department of Transportation (U.S.DOT) to promulgate guidelines designed to ensure that possible adverse environmental effects, including noise, and the cost of eliminating or minimizing such adverse affects be considered in the development of all projects on federal-aid transportation systems. This Act further specified that,

> *"(I) The Secretary, after consultation with appropriate Federal, State and local officials, shall develop and promulgate standards for highway noise levels compatible with different land uses and after July 1, 1972, shall not approve plans and specifications for any proposed project on any Federal-aid system for which location approval has not yet been secured unless he determines that such plans and specifications include adequate measures to implement the appropriate noise level standards".*

To implement the above requirements, the Federal Highway Administration (FHWA) of the U.S.DOT, issued Policy and Procedural Memorandum 90-2, entitled "Noise Standards and Procedures", in April 1972. The Federal-Aid Highway Act of 1973, revised Section (I) of the Federal-Aid Highway Act of 1970 (noted above) to permit FHWA to develop and promulgate standards for the control of traffic noise on existing highways.

NOISE ABATEMENT CRITERIA AND STANDARDS

The FHWA established noise abatement criteria for different types of land uses that apply to all hours of the day and night. The FHWA noise abatement criteria are intended to provide guidance for where noise abatement should be considered. The FHWA noise abatement criteria use an hourly L10 for describing highway noise. To be in compliance, the L10 hourly noise levels must not exceed the FHWA noise abatement criteria. Current FHWA noise abatement criteria for different types of land uses are shown in the following table.

FHWA Noise Abatement Criteria		
Category	L10 dBA	Land Use
A	60	Special areas requiring serenity
B	70	Residential and recreational areas
C	75	Commercial and industrial areas
D	NA	Undeveloped areas
E	55*	Residential, hospitals, libraries, etc.*

(Applies to interior noise levels. All other land uses are exterior levels)*

Initially, federal funds could be used for noise mitigation on both new highway construction and major reconstruction projects and along existing freeways and expressways where noise levels were found to exceed FHWA noise abatement criteria. Over the years, the use of federal funds for noise mitigation along existing routes has

become more limited. The National Highway System Designation Act of 1995 restricts federal participation in the construction of noise walls to those projects that were approved before November 28, 1995 or are proposed along lands where land development or substantial construction predated the existence of any highway.

While the federal government in the early 1970's was enacting environmental laws and regulations, similar actions were occurring at the state level. In 1973 the Minnesota State Legislature enacted the Minnesota Environmental Policy Act and so declared that,

> *"...it is the continuing responsibility of the state government to use all practicable means consistent with other essential considerations of state policy to improve and coordinate state plans, functions, programs and resources to the end that the state may...", among the goals, "...minimize noise, particularly in urban areas..."*

In assigning state agency authority for the regulation of noise the Legislature directed the MPCA to adopt state noise standards (M.S. 116.07, Subdivision 2). In 1974 Minnesota adopted state noise standards.

The Minnesota state standards that were adopted identify maximum outdoor hourly noise levels for various land-use activities. Minnesota's noise standards are based on an hourly L10 noise descriptor, that sets the level which may not be exceeded for more than 10 percent of the time (6 minutes), and an L50 noise descriptor which sets the level that may not be exceeded more than 50 percent of the time (30 minutes). In addition, Minnesota's MPCA noise standards include different noise level standards for daytime hours (7:00 a.m. to 10:00 p.m.) and nighttime hours (10:00 p.m. - 7:00 a.m.). Minnesota state noise standards are shown in the following table:

Minnesota Pollution Control Agency State Noise Standards					
Land Use	Code	Day (7:00 a.m. - 10:00 p.m.) dBA		Night (10:00 p.m. - 7:00 a.m.) dBA	
Residential	NAC-1	L10 of 65	L50 of 60	L10 of 55	L50 of 50
Commercial	NAC-2	L10 of 70	L50 of 65	L10 of 70	L50 of 65
Industrial	NAC-3	L10 of 80	L50 of 75	L10 of 80	L50 of 75

There are several key differences between FHWA noise abatement criteria and Minnesota's noise standards.

- First, Minnesota's noise standards for residential areas are 5 dBA to 15 dBA more restrictive than the noise abatement criteria used by the FHWA.
- A second important difference is that Minnesota's noise standards distinguish between time periods of the day and night and the nighttime standards are more restrictive than the daytime standards. By definition, Minnesota's nighttime noise standards continue the quieter nighttime noise standards into morning rush hour commuting times when traffic volumes are heavy on most urban freeways and expressways. As a result, achieving compliance with the standards between 6:00 a.m. - 7:00 a.m. is extremely difficult or not feasible.

FEASIBLE NOISE MITIGATION MEASURES

A number of mitigation measures have been studied and implemented across the country to minimize highway noise impacts on adjacent residential areas. The principal measures that have been considered for mitigating highway noise impacts include:

- Traffic management strategies
- Pavement materials and/or highway surface treatments
- Vegetation plantings
- Earth berms
- Buffer zones
- Land use planning
- Acoustical insulation of buildings
- Control or reduction in vehicle source emissions
- Noise walls

It should be noted that effective land use planning and earth berms are potentially the most cost effective noise mitigation strategies available. However effective land use planning isn't generally an available option where retrofit noise mitigation is being considered. Retrofit noise mitigation usually entails mitigation in areas where the land use is already determined. Berms require large amounts of right of way for their construction. In areas where retrofit noise mitigation is the goal, there usually isn't enough right of way available to make berms a viable option.

In areas where retrofit noise mitigation is being considered, the already existing circumstances usually make noise walls the most cost effective approach to noise mitigation. However, even noise walls are not effective at mitigating highway noise impacts in all cases. Highway noise walls must have sufficient height, length and

uninterrupted construction to be effective, which requires controlled highway access and the availability of adequate right of way. In addition, noise mitigation measures are not permitted where they would jeopardize highway safety.

Additional information on these measures is included in the Appendix of this report.

MINNESOTA'S EXPERIENCE WITH HIGHWAY NOISE MITIGATION

The Minnesota Highway Department[1] first began receiving complaints regarding highway generated noise during the period of the late 1960's and early 1970's, when noise related laws and regulations were being adopted at both the federal and state levels.

In response to such citizen and government agency concerns, the Department began adopting policy directives incorporating noise considerations into highway planning, design and construction activities.

Mn/DOT began constructing noise walls and barriers in conjunction with new construction and major reconstruction projects in the mid-1970's. In 1975, the Minnesota State Legislature directed the Commissioner to provide retrofit noise abatement along existing interstate freeways in the Twin Cities metropolitan area where the ambient noise levels exceeded FHWA noise abatement criteria. To accomplish this task, the Commissioner was authorized to expend one percent of the Department's revenues derived from an increase in the state motor vehicle gas tax. The money generated from this provision, coupled with matching federal-aid interstate funds resulted in a potential noise abatement program of 10 to 12 million dollars annually.

[1] The Minnesota Highway Department was merged into a newly established Minnesota Department of Transportation by legislative action in 1976.

In 1978, the Minnesota Legislature placed a moratorium on the construction of any additional retrofit highway noise walls along already completed trunk and interstate highways except for those projects for which construction had been programmed as of March 1, 1978. During this time period, noise mitigation measures continued to be incorporated as needed into the planning and design of new highway construction and major reconstruction projects.

The moratorium on the construction of highway noise walls along already completed highways expired in 1980. Previous funding available for retrofit noise abatement projects was shifted to other needs. As a result, between 1980 and 1994, no Type II projects were constructed.

In 1994, specific legislation was adopted authorizing Mn/DOT to construct a noise wall along a section of Trunk Highway 280 in St. Paul. It was becoming clear that some type of program for noise mitigation along existing highways would be needed.

In 1995, to assure optimal use of investments in highway noise mitigation, the Legislature directed the Commissioner of Transportation to carry out a noise abatement study to identify areas where noise levels exceed standards and to develop a priority list for directing state resources in noise mitigation.

The remaining portions of this report summarize the update to the 1997 Minnesota Highway Noise Abatement Study for the Metro area that was undertaken by Mn/DOT in cooperation with the MPCA in 2001-2002.

STUDY METHODOLOGY

Mn/DOT conducted noise monitoring at over 277 residential areas adjacent to freeways and expressways in incorporated areas in the Metro area.

The overall study methodology was developed jointly by Mn/DOT and the MPCA. Noise monitoring was conducted using the procedures outlined in Minnesota Rules Chapter 7030.0060. A more detailed summary of the methodology is included in the Appendix of this report.

The following summarizes the major steps used in the 2001-2002 Metro Division Highway Noise Abatement Study:

1. Residential areas located along freeways and expressways inside incorporated areas of the metro area where barrier construction appeared feasible were identified.

2. Representative noise level measurements were taken at sites in each of the identified residential areas. Those areas, which do not exceed state daytime noise standards, were dropped from further analysis.

3. Using a methodology developed by Mn/DOT and the MPCA, scores were calculated for each of the residential areas based on the average noise levels experienced and their residential density. Scoring results were used to group residential areas into high, medium and low categories for potential highway noise mitigation.

4. Cost effectiveness considerations were also factored into the analysis. For each residential area, the estimated cost of constructing the proposed noise wall was calculated. Using FHWA cost effectiveness guidelines, adjusted for inflation, it

was concluded by both Mn/DOT and the MPCA that the implementation of noise mitigation would only be reasonable in areas where the cost effectiveness was less than or equal to $3,250 per dBA reduction per residence.

Based on this methodology a metro wide inventory of residential areas was developed. This inventory ranks residential areas on the basis of noise impacts experienced and the cost effectiveness of potential noise mitigation.

STUDY RESULTS AND CONCLUSIONS

- A total of 277 residential areas in the metro area were included in the noise analysis.

- All of the 277 residential areas included in the study are located inside the 8-county area served by Mn/DOT's Metro Division. This area includes Anoka, Carver, Chisago, Dakota, Hennepin, Ramsey, Scott and Washington counties.

- Seventy residential areas with the highest noise levels and residential densities were found to be cost effective for noise mitigation. These 70 areas are located along approximately 23 residential miles of freeways and expressways.

- In the Metro Division, 7 of the 70 highest priority areas are included as part of projects already planned for in either Mn/DOT's STIP or Metro Division's TSP.

- Tables on the following pages show the locations and priority rankings of the 70 residential areas identified as top priority areas for possible future noise mitigation.

TABULATION OF THE TOP 70 RANKED METRO AREAS SORTED BY THEIR BARRIER CONSTRUCTION REASONABLENESS RANKING

TABULATION OF THE TOP 70 RANKED METRO AREAS SORTED BY THEIR HIGHWAY LOCATION

NEXT STEPS

Based on study results and conclusions, the following next steps are proposed for addressing highway noise mitigation needs and priorities:

1. **Mn/DOT will move ahead with preliminary design and final design studies to ensure that proposed noise wall construction in the seven priority areas from the previous priority list is feasible, reasonable and cost effective.**

   Factors to be considered include:

   - Right of way
   - Highway safety and maintenance
   - Soils in the project area
   - Driver sight distances near intersections
   - Hydraulics, drainage features and wetland areas
   - Buried utilities or utility relocation needs

2. **Mn/DOT will begin working with municipalities, residents and area transportation partners in those priority areas where noise wall construction is being proposed. This work will include an assessment of the public's acceptance of the proposed noise wall(s).**

   Mn/DOT will notify those municipalities where a noise wall is being proposed. Municipalities are encouraged to hold public meetings to determine if residents in affected communities want the noise mitigation. Municipalities must present Mn/DOT with a City Council resolution stating whether they do want or do not want noise walls constructed in specific residential areas.

Areas, which receive City Council resolutions opposing construction of noise walls, or cannot reach a decision in a reasonable amount of time, will be dropped from Mn/DOT's priority ranking of residential areas for noise mitigation. With a City Council resolution to construct a noise wall, Mn/DOT will proceed working through the STIP process for state funding of the project.

3. **For noise walls proposed for construction after the year 2001, site selection will be based on this priority study and Mn/DOT will identify funding by working through the STIP investment process. Mn/DOT will have discretionary authority over the use of State funds.**

As a part of this effort:

a. Federal and state funds will continue to be sought for any noise mitigation needed in conjunction with proposed new highway construction and major reconstruction projects.
b. A state funded only program will be initiated and managed through the STIP investment process for funding highway noise mitigation retrofit projects along existing freeways and expressways.

The STIP is an overview of the anticipated expenditures for all modes of transportation under the authority of Mn/DOT. It includes information on projects that utilize federal-aid highway and transit funding, as well as a description, financial summary and project listing for other modal programs that are not subject to the federal planning requirements. In addition, the STIP includes the Department's response to federal planning requirements authorized under the Intermodal Surface Transportation Efficiency Act (ISTEA) and necessary information for certifying that air quality analysis has been completed by Metropolitan Planning Organizations and reviewed and accepted by the Minnesota Pollution Control Agency.

Projects and activities identified in the STIP have been developed consistent with the policy statements and directions included in the Department's Statewide Transportation Plan (STP).

4. **Mn/DOT will continue working with local units of government to coordinate land use development in conjunction with transportation facilities.**

Mn/DOT's policy is to assist local governments in promoting compatibility between land use and highways. Residential uses located adjacent to highways often result in complaints about traffic noise. Traffic noise from highways and/or interstates could exceed noise standards established by the Minnesota Pollution Control Agency (MPCA), the U.S. Department of Housing and Urban Development, and the U.S. Department of Transportation. Minnesota Rule 7030.0030 states that municipalities are responsible for taking all reasonable measures to prevent land use activities listed in the MPCA's Noise Area Classification (NAC) where the establishment of the land use would result in violations of established noise standards.

CONCLUSION

This report documents the results of the noise analysis that was undertaken by Mn/DOT's Metro Division to reassess and expand, for the metro area, the noise impact prioritization done from 1996-1997.

The information, results, conclusions and next steps presented in this report are intended to provide a framework for working with municipalities, residents and transportation partners to make cost effective decisions for minimizing highway noise impacts in Minnesota.

APPENDIX

Appendix

MPCA LETTER OF SUPPORT FOR THE MINNESOTA HIGHWAY NOISE ABATEMENT STUDY

Appendix

HIGHWAY NOISE MITIGATION STRATEGIES

Traffic Control Strategies

Several traffic control strategies have been studied to determine their effects on reducing highway noise levels. These strategies have included the implementation of:

- Truck prohibitions
- Diversion of traffic to alternate routes
- Truck curfews
- Speed restrictions

The application of any single method, with the exception of truck prohibitions and possibly significant speed reductions, has not been found to yield significant reductions in traffic noise. In addition, an evaluation of these strategies indicates that they are generally not practicable on major urban thoroughfares where there is not easy access to alternative routes. These strategies may have more applicability on highways and streets under local jurisdictions.

Other traffic management strategies that control traffic flow or reduce the number of vehicle trips made on the system also have potential to minimize highway noise impacts. Mn/DOT is supporting efforts to promote transit, teleworking/telecommuting, bicycling and other travel alternatives. While these strategies may have some potential in the long term, traffic volumes are continuing to increase in Minnesota.

Mn/DOT will continue to consider and evaluate the feasibility of implementing new traffic management strategies for reducing highway noise impacts. In addition, the Department will continue to encourage local governments to consider the applicability of such measures for the mitigation of highway noise on street systems under their jurisdictions.

Pavement Material and/or Pavement Surface Treatment

Another strategy for mitigating highway noise that has been researched nationally and in Minnesota is the use of different pavement materials and/or surface treatments. These strategies have been found to have only limited value in mitigating highway noise for several key reasons.

The following summarizes research results into the effects of pavement materials and/or surface treatments on mitigating highway noise:

- Research shows that tire/pavement interaction is the dominant source of noise on adequately muffled automobiles when traveling at speeds higher than approximately 40 miles per hour. However, traffic noise is usually made up of noise from many different noise sources. For example, on most freeways, expressways and arterial highways the traffic mix includes trucks. Truck noise levels are typically greater than those for automobiles and result from the exhaust stack and engine, as well as tire/pavement interaction. Using particular pavement materials and/or treating pavement surfaces, does little to mitigate truck engine and exhaust noise.

- It has been suggested that where tire/pavement interaction is the dominant noise source, a pavement surface that can achieve reductions of 4-5 dBA or more would be useful. During the last two decades, there has been considerable research into different pavement materials and surface treatments. Surface treatments include the application of textures (tined groves, ground groves, etc.), which are used to decrease skidding during wet conditions.

  The FHWA conducted tests on the effects of pavement and surface treatment on tire noise. Results of these tests are shown in Table 1A. The FHWA concluded that with care in design and construction the greatest advantage that might be derived is a 4.5 to 5 dBA in automobile tire noise. The FHWA combined the results of all concrete pavement testing, regardless of surface treatment, which somewhat blurs the more dramatic differences found by states where concrete surface treatments were compared directly.

  Mn/DOT also carried out noise tests on bituminous pavements and concrete pavements (with and without tined surfaces) over a five-year period in the 1970's as part of a stipulation agreement with the MPCA. The results of these tests are also shown in Table 1A. Based on these tests, Mn/DOT changed its tine spacing from 1 inch to 1-1/2 inches.

  More recently, Wisconsin conducted research into the effects of surface treatments on highway noise levels. Their research indicated that a 3/4-inch tine spacing is optimal for reducing both interior and exterior noise levels. Based on this testing Mn/DOT updated its tine spacing guidelines from 1-1/2 inch to 3/4 inch.

Mn/DOT is continuing to monitor and support national research on the use of pavement materials and/or surface treatments for mitigating highway noise. The Department will incorporate any advances in the development of quiet and safe pavement surface materials and/or surface treatments into pavement design decisions.

Table 1A
Results from Automobile Tire/Pavement Noise Testing

FHWA	Information	Speed mph	50' Level dBA
OGAC		55	71.61
DGAC		55	73.16
PCCP	Inclds. tined and	55	76.17
	untined pavmts.		

MN/DOT	Information	Speed mph	50' Level dBA
OGAC		55	69.5
DGAC		55	71.5
3/4 " TINE SPACE		55	76.0
1" TINE SPACE (SITE 1)	Albert Lea Pad	55	74.5
1" TINE SPACE (SITE 2)	Willmar Pad	55	76.0
1-1/2" TINE SPACE		55	72.0

KEY:

OGAC	Open graded asphaltic concrete.
DGAC	Dense graded asphaltic concrete.
PCCP	Portland cement concrete pavement.
SMA	Stone matrix asphalt.
TINE	A PCCP with a tined surface texture at the given spacing.

Table 1A (cont'd)
Results from Automobile Tire/Pavement Noise Testing

WISCONSIN		Corrected Speed mph	50' Corrected Level dBA
DGAC	1993	55	66.0 TO 68.0
SMA (5/8")	1993	55	67.5 TO 69.5
3/4" TINE SPACE	1/8" DEPTH	55	68.5 TO 70.5
1" TINE SPACE	1/8" DEPTH	55	74.5 TO 76.5
1" TINE SPACE	1/16" DEPTH	55	69.5 TO 71.5
1-1/2" TINE SPACE	1/8" DEPTH	55	73.0 TO 75.0

KEY:

OGAC	Open graded asphaltic concrete.
DGAC	Dense graded asphaltic concrete.
PCCP	Portland cement concrete pavement.
SMA	Stone matrix asphalt.
TINE	A PCCP with a tined surface texture at the given spacing.

NOTE: The reason for the range of levels shown in the Wisconsin results is that the tests were done at 60 mph and 20 ft. from the passing test automobile. In order to change to a common speed of 55 mph and the usual emission testing distance of 50 ft from the passing automobile, allowing the comparison of results, approximate correction factors had to be used.

Acquisition of Buffer Zones

Another possible strategy for mitigating the effects of highway noise is through the acquisition of large tracks of land that can buffer or separate receivers from the highway.

Mn/DOT has not found this strategy to be cost effective because of the large tracts of land and possible rows of houses that would need to be purchased to assure that the nearest receivers are in compliance with Minnesota's noise standards.

Vegetation

When highway noise mitigation strategies were first being researched, there was some thought that dense plantings of vegetation might provide effective blocking of sounds from the highway. However, to be effective at blocking sound there must be complete blockage of the line of sight from the receiver to all noise sources and a great enough mass density to stop the transmission of sound. Vegetative plantings have not been found to meet these prerequisites.

The potential effects of vegetation in blocking highway noise were studied by the FHWA and summarized in *Highway Noise; FHWA Highway Traffic Noise Prediction Model, FHWA-RD-77-108*, which states:

> *"If the woods are very dense, i.e., there is no clear line of sight between the observer and the source, and if the height of the trees extends at least 5 metres (16-1/2 feet) above the line of sight, then 5 dBA attenuation is allowed if the woods have a depth of 30 metres (98-1/2 feet). An additional 5 dBA may be obtained if the depth of the woods extends for another 30 metres (98-1/2 feet). 10 dBA is the maximum attenuation dense woods can provide."*

In addition, research has shown that the growth of vegetation must have sufficient height and length to block a significant portion of the view to the highway to be fully effective in blocking noise.

The effects of vegetation in blocking highway noise are further summarized in a report entitled *Can Noise Radiation From Highways Be Reduced By Design?* written by John L. Beaton and Louis Borget in 1968. This study indicated that:

> *"Sooner or later the question of planting is brought up during any discussion of noise radiation from highways. This topic should be laid to rest. The simple truth is that plantings possess none of the physical properties required of a good sound shield. They are porous to air flow, vibrate easily and lack density. Their permeability to the flow of airborne sound is so great that virtually no acoustical benefit is obtained from planting within the right of way depth that is normally available. Their real merit is to improve appearances, and there is some "psychological shielding" that tends to favor public acceptance."*

In summary, measurable noise reductions require extensive and dense vegetative growth, which is beyond what can be accommodated within average highway rights of way.

Earth Berms

Earth berms (mounds) can be economical and effective for reducing highway noise if earth and space are readily available. Earth berms are slightly more effective than thin noise walls of comparable height. They can be blended into existing terrain or back slopes to achieve a natural appearance and facilitate landscaping.

The earth berms main limitation is the requirement of large areas for their effective construction. In retrofit noise mitigation projects, there is seldom enough right of way available for the construction of earth berms.

Land Use Planning and Development

Land use planning is an important strategy for mitigating highway noise impacts. Responsibility for mitigating or minimizing the impacts of highway noise on adjacent land falls both on highway authorities who establish roadway location, function and design and the city/county/regional governments which establish land use policies and have the legal authority for land development, control and zoning.

When new highway construction and major reconstruction projects are proposed, Mn/DOT is responsible for assessing noise impacts from the proposed projects on existing land uses. Noise analysis is conducted during the highway design process to assist in choosing new highway routes and design that minimize noise impacts to sensitive land uses. Consideration is given to the provision of abatement measures for receptors adjacent to new proposed highway construction. Decisions to mitigate adverse impacts must be made in the public interest, taking into account the need for safe and efficient transportation and the feasibility and practicality of mitigation.

To the extent that funding is available, consideration is also given to providing noise abatement measures adjacent to existing highways when such mitigation is shown to be reasonable and cost effective.

There are over 1000 miles of vacant/agricultural land adjacent to the interstate and trunk highway systems in the seven County Minneapolis-St. Paul metropolitan areas. If noise considerations are not incorporated into planning and design, subsequent residential and institutional development in these areas would likely be exposed to noise levels exceeding Minnesota's noise standards and/or Federal noise criteria.

Local units of government have the authority to incorporate noise considerations into land use planning. Exercising this authority includes:

- Assuring compatible land uses in areas where noise levels from existing or proposed highways exceed State and Federal noise standards.

- Ensuring that any development that does occur adjacent to highways is planned and/or designed to minimize the adverse effects of highway noise.

The mechanisms or techniques available to city, county and regional authorities for minimizing highway noise impacts can be divided into the following two types:

1. Administrative techniques:

    - The inclusion of noise mitigation in comprehensive plan preparation and zoning
    - Legal restrictions in subdivision laws or building or health codes
    - Municipal ownership or control of the land
    - Financial incentives for compatible land use
    - Educational and advisory municipal services

2. Physical techniques:

    - Acoustical site planning
    - Acoustical design of buildings
    - Local and/or developer construction of noise walls or berms

Land use planning can prevent or significantly reduce transportation noise impacts. In response to the need for mitigation of adverse noise impacts adjacent to transportation facilities through land use planning, Mn/DOT will continue to take the following actions:

- Inform local communities regarding potential adverse noise impacts.
- Issue copies of *The Audible Landscape* to all municipalities in the state.
- Participate in citizen group or local government sponsored presentations on land use planning and noise mitigation.
- Provide local units of government with proposed highway facility plans.
- Comment on potential transportation noise impacts to adjacent development as part of the Department's preliminary plat review authority and through Mn/DOT review of actions undergoing State Environmental Quality Board or Federal agency environmental impact statement review.
- Provide local planning and highway authorities with information on how to measure and predict noise levels at sites adjacent to transportation facilities.
- Support local governmental programs and policies, and State legislation that will result in land use measures to reduce adverse noise impacts adjacent to transportation systems in Minnesota.

In many cases noise impacts adjacent to highways could have been avoided or mitigated if land use compatibility had been a consideration early in local planning.

Often the means of achieving early consideration of noise impacts is in the comprehensive planning process. The most commonly used legal device available for implementing comprehensive plans is zoning.

Comprehensive plans represent a compilation of policy statements, goals and standards for guiding physical, social and economic growth within an area. Zoning ordinances generally specify the type of land use permitted within various areas of communities. Comprehensive plan provisions have been established through the *Municipal Planning and Development Act* cited in M.S. 462.351, the *Metropolitan Land Use Planning Act* cited in M.S. 473.851, county planning and zoning provisions outlined in M.S. Chapter 394, and the Regional Development Act of 1969 cited in M.S. 462.39. Enabling State legislation for zoning has been established for municipalities and counties in Minnesota.

In summary, Mn/DOT continues to recommend that the following actions be taken:

- Municipalities, Counties, Regional Development Commissions and the Metropolitan Council should incorporate a noise element into comprehensive planning efforts and into zoning ordinances adopted to implement comprehensive plans.

- Municipalities, Regional Development Commissions and Counties could identify vacant/agricultural land adjacent to existing or future interstate and trunk highways within their jurisdictions. Those areas, which exceed noise standards, could be identified on land use maps that are included with the comprehensive plan and policy guidelines could be established for the future development of these areas. Local zoning maps, plans and controls could also be changed to reflect more compatible commercial or industrial uses adjacent to the areas which will or are currently receiving noise impacts.

Acoustical Insulation of Buildings

Building noise insulation achieves interior noise attenuation only and does not address exterior receptor areas where Minnesota's noise standards apply. The costs for acoustical insulation of typical single residences are considered disproportionate for the amount of attenuation achieved and the number of receptors affected. There may be cases involving schools, hospitals, nursing or convalescent homes, or other public buildings where the number of receptors and the noise sensitivity of the receptors may justify the expense of insulating for noise mitigation.

Control of Acoustical Source Emissions

In Minnesota, motor vehicle noise emissions (source emissions) are regulated by Minnesota Rules Chapters 7030.1000 to 7030.1060. The rules establish various prohibitions for the operation, sale or modification of loud or noisy vehicles, in addition to setting maximum allowable noise limits for three general categories of vehicles:

- Vehicles over 10,000 pounds
- Motorcycles
- All other vehicles

The intent of the rules is to minimize vehicle noise at the source.

The enforcement of these rules is carried out by and at the discretion of Minnesota law enforcement agencies, i.e. police departments, county sheriffs and the State Patrol. The MPCA participates in the enforcement of these rules by loaning noise monitoring equipment and providing technical assistance to the staff of these agencies.

Minnesota rules for motor vehicle noise emissions are summarized in the Appendix.

Survey of Mitigation by use of Noise Walls:

Noise level measurements in many states, including Minnesota (see Highway Noise Abatement Volume I Executive Summary: A report for the Minnesota State Legislature as required by Chapter 791 Section 19, Laws for Minnesota for 1978.), have shown noise walls to be effective for the mitigation of noise. They generally require minimal right-of-way and the material and construction costs are usually not extreme. They do require care in design and placement in order to assure the planned reductions in noise levels for the receivers to be protected.

Appendix

NOISE ABATEMENT STUDY METHODOLOGY

Areas covered:

For the 1997 Noise Abatement Study, Mn/Dot conducted noise monitoring at over 800 residential areas adjacent to freeways and expressways in incorporated areas in accordance with state legislative statute. The noise monitoring was performed using procedures outlined in Minn. Rules ch.7030.0060, Measurements Methodology.

Methodology:

Monitoring methods in terms of where and how

Noise monitoring was done using certified Sound Level Meters (SLMs) to measure the L10 at a residence that represented all nearby residences that were similar in their proximity to the highway being measured, in intervening terrain and where traffic flow was the same.

The SLM was located on the highway side of the residence at a location where outdoor activity on that side of the residence would have a high probability of occurring. At the same time, the SLM could not be too close to large reflecting surfaces, usually no less than 20 ft. away. Two measurements were done. A measurement was done during the hours of 7 am to 11 am and another between the hours of 1 pm to 5 pm. If the forenoon and afternoon measurements were within 2 dBA of one another, they were averaged and the average was used as the representative L10 level. If the measurements were not within 2 dBA, several more measurements were made until closure was achieved or it became clear that traffic was too light and variable to allow closure in a reasonable amount of time. At sites where closure was not possible, an overall average of available measurements was used. Invariably, the few areas where closure wasn't achieved had low noise levels and traffic flows, leading to low noise impacts.

After an average representative L10 measurement was acquired, the length along the highway of the represented residential area was determined. This residential length, along with a count of the number of represented residences was used to calculate the residential density (residences per length) of the area. The residential densities of all areas were then normalized to the number of residences in a half-mile.

Ranking methods and procedures to determine priorities

The priority ranking for residential areas was done using a procedure developed by Mn/DOT and the MPCA (see form EXISTING ROAD (RETROFIT) NOISE BARRIER STUDY at the end of this appendix). This scoring procedure was used to rank the different areas on the basis of noise level and residential density. An initial ranking based on an area's overall reasonableness scoring, using noise level and residential density, was done. The residential areas would be scored as high, medium or low on the basis of their reasonableness scoring. Then, all those areas where a noise wall would not be cost effective, based on Mn/DOT's maximum cost effectiveness limit of $3250 of wall cost per residence per dBA of reduction, were dropped from consideration. Then a second ranking based on the reasonability ranking, weighted by cost effectiveness, of the remaining areas was done. In this way, those areas that didn't meet the cost effectiveness criteria were eliminated and a final ranking, based on overall reasonableness scoring weighted by cost effectiveness, was determined.

Benefit/cost methods to determine optimal opportunities for mitigation

Cost effectiveness is considered to be an important factor in determining the reasonableness of noise wall construction. The limiting cost effectiveness amount of $3250/residence/dBA of reduction is based on FHWA cost effectiveness values that have been corrected from time to time to account for price and construction cost changes over the years. Mn/DOT's cost effectiveness value falls within the range of the latest cost effectiveness values quoted by the FHWA. Mn/DOT prefers to continue the use of a cost per decibel of reduction per residence as the unit of measure for cost effectiveness, rather than the FHWA's latest suggestion of cost per residence. It should be remembered that the cost effectiveness limit is a guideline value, not a statutory or regulatory limit.

In the noise abatement study, a noise wall's cost effectiveness was estimated using an assumed, typical terrain between the roadway and receiver. While an assumed terrain won't accurately represent all residential areas, the values are expected to be close enough to actual values so as to allow for a first ranking. A noise wall height of 20 feet was assumed for the entire anticipated length of a noise wall. The 20 foot height and the estimated wall length allow for the calculation of a noise wall's area. The application of a cost of $15 per square foot was then applied and in this way, an estimated wall cost for each area was determined. Mn/DOT uses this cost when factors such as noise wall material, noise wall type, soil characteristics, engineering costs, mobilization costs, etc. are unknown. Using this estimated wall cost along with noise level reductions, residential density, noise wall geometry and end effects, a cost effectiveness value was determined for the noise wall under consideration. When listed areas

are looked at in greater detail as they come up for possible construction, the cost effectiveness values could be refined and be different than those used in the study. For example, the estimated length of a noise wall could differ from a final actual length used. The diffraction effects used are approximate. Any cost effectiveness changes due to later, more detailed analysis would be taken in to account at the time of final detailed analysis.

EXISTING ROAD (RETROFIT) NOISE BARRIER STUDY

LOCATION OF PROPOSED BARRIER

City:	County:	Highway:
From:	To:	Length:

REASONABLENESS CRITERIA

	Points	Point Values	
1) Daytime existing ambient noise levels (L_{10}) *	_____	30	> 70 dBA
		20	>67 dBA to 70 dBA
		10	>65 dBA to 67 dBA
		0	<= 65 dBA
2) Housing Density (homes per half mile)	_____	30	> 31
		20	>21 to 31
		10	10 to 21
		0	< 10
Reasonableness Total:			

REASONABLENESS SCORING:

0-20	Low Priority
21-40	Med. Priority
41-60	High Priority

3) Is barrier feasible?	Yes / No	If, *No*, end study.
4) Barrier Right of Way available	Yes / No	If, *No*, end study.
5) Barrier Cost Effectiveness (Cost/dBA/Residence)		- Select cost-effective design. - Minimum 5 dBA reduction - Maximum 20' height ** - Must be less than $3,250/dBA/Residence
70 dBA barrier design		
65 dBA barrier design		
60 dBA barrier design		
6) Municipality supports barrier	Yes / No	If, *No*, end study.

* Use attached worksheet if necessary.

** 20' maximum as normally used by Mn/DOT

exist.wk1

Appendix

CHAPTER 7030: MINNESOTA POLLUTION CONTROL AGENCY'S NOISE STANDARDS, RULES, DEFINITIONS AND MEASUREMENT METHODOLOGY

7030.0010 INCORPORATION BY REFERENCE.

For the purpose of chapter 7030, American National Standards Institute, Specification for Sound Level Meters, S1.4-1983 is incorporated by reference. This publication is available from the American National Standards Institute, 1430 Broadway, New York, N.Y. 10018 and can be found at: the offices of the Minnesota Pollution Control Agency, 1935 West County Road B-2, Roseville, Minnesota 55113; the Government Documents Section, Room 409, Wilson Library, University of Minnesota, 309 19th Avenue South, Minneapolis, Minnesota 55454; and the State of Minnesota Law Library, 25 Constitution Avenue, Saint Paul, Minnesota 55155. This document is not subject to frequent change.

The Federal Highway Administration publication, Sound Procedures for Measuring Highway Noise: Final Report, FHWA-DP-45-1R (August 1981) is incorporated by reference. This publication is available from the United States Department of Transportation, Federal Highway Administration, 1000 North Globe Road, Arlington, Virginia 22201 and can be found at: the offices of the Minnesota Pollution Control Agency, 1935 West County Road B-2, Roseville, Minnesota 55113; the Government Documents Section, Room 409, Wilson Library, University of Minnesota, 309 19th Avenue South, Minneapolis, Minnesota 55454; and the State of Minnesota Law Library, 25 Constitution Avenue, Saint Paul, Minnesota 55155. This document is not subject to frequent change.

STAT AUTH: MS s 116.07 subds 2,4

HIST: 11 SR 43; 18 SR 614
Current as of 11/03/98

7030.0020 DEFINITIONS.

Subpart 1. Application. The terms used in chapter 7030 have the meanings given them in this part.

Subp. 2. A-weighted. "A-weighted" means a specific weighting of the sound pressure level for the purpose of determining the human response to sound. The specific weighting characteristics and tolerances are those given in American National Standards Institute S1.4-1983, section 5.1.

Subp. 3. Daytime. "Daytime" means those hours from 7:00 a.m. to 10:00 p.m.

Subp. 4. dB(A). "dB(A)" means a unit of sound level expressed in decibels (dB) and A-weighted.

Subp. 5. Decibel. "Decibel" means a unit of sound pressure level, abbreviated as dB.

Subp. 6. Impulsive noise. "Impulsive noise" means either a single sound pressure peak (with either a rise time less than 200 milliseconds or total duration less than 200 milliseconds) or multiple sound pressure peaks (with either rise times less than 200 milliseconds or total duration less than 200 milliseconds) spaced at least by 200 millisecond pauses.

Subp. 7. L10. "L10" means the sound level, expressed in dB(A), which is exceeded ten percent of the time for a one hour survey, as measured by test procedures approved by the Commissioner.

Subp. 8. L50. "L50" means the sound level, expressed in dB(A), which is exceeded 50 percent of the time for a one hour survey, as measured by test procedures approved by the Commissioner.

Subp. 9. Municipality. "Municipality" means a county; a city; a town; a regional planning and development commission established under Minnesota Statutes, chapter 473; the metropolitan council; or other governmental subdivision of the state responsible by law for controlling or restricting land use within its jurisdiction.

Subp. 10. Nighttime. "Nighttime" means those hours from 10:00 p.m. to 7:00 a.m.

Subp. 11. Person. "Person" means any human being, any municipality or other governmental or political subdivision or other public department or agency, any public or private corporation, any partnership, firm, association, or other organization, any receiver, trustee, assignee, agency, legal entity, other than a court of law, or any legal representative of any of the foregoing, but does not include the agency.

Subp. 12. Sound pressure level. "Sound pressure level", in decibels, means 20 times the logarithm to the base 10 of the ratio of the pressure to the reference pressure. The reference pressure shall be 20 micronewtons per square meter.

STAT AUTH: MS s 116.07 subds 2,4

HIST: 11 SR 43; L 1987 c 186 s 15; 18 SR 614
Current as of 11/03/98

7030.0030 NOISE CONTROL REQUIREMENT.

No person may violate the standards established in part 7030.0040, unless exempted by Minnesota Statutes, section 116.07, subdivision 2a. Any municipality having authority to regulate land use shall take all reasonable measures within its jurisdiction to prevent the establishment of land use activities listed in noise area classification (NAC) 1, 2, or 3 in any location where the standards established in part 7030.0040 will be violated immediately upon establishment of the land use.

STAT AUTH: MS s 116.07 subds 2,4

HIST: 11 SR 43; 18 SR 614
Current as of 11/03/98

7030.0040 NOISE STANDARDS.

Subpart 1. Scope. These standards describe the limiting levels of sound established on the basis of present knowledge for the preservation of public health and welfare. These standards are consistent with speech, sleep, annoyance, and hearing conservation requirements for receivers within areas grouped according to land activities by the noise area classification (NAC) system established in part 7030.0050. However, these standards do not, by themselves, identify the limiting levels of impulsive noise needed for the preservation of public health and welfare. Noise standards in subpart 2 apply to all sources.

Subp. 2. Noise standards.

Noise Area Classification	Daytime		Nighttime	
	L50	L10	L50	L10
1	60	65	50	55
2	65	70	65	70
3	75	80	75	80

STAT AUTH: MS s 116.07 subds 2,4

HIST: 11 SR 43; 18 SR 614
Current as of 11/03/98

7030.0050 NOISE AREA CLASSIFICATION.

Subpart 1. Applicability. The noise area classification is based on the land use activity at the location of the receiver and determines the noise standards applicable to that land use activity unless an exception is applied under subpart 3.

Subp. 2. Noise area classifications. The noise area classifications and the activities included in each classification are listed below:

Noise Area Classification	Land Use Activities
1	Household Units (includes farm houses) Group quarters

Residential hotels
Mobile home parks or courts
Transient lodging
Other residential
Motion picture production
Medical and other health services
Correctional institutions
Educational services
Religious activities
Cultural activities and nature exhibitions
Entertainment assembly
Camping and picnicking areas (designated)
Resorts and group camps
Other cultural, entertainment, and recreational activities.

2 Railroad terminals (passenger)
Railroad terminals (passenger and freight)
Rapid rail transit and street railway passenger terminals
Bus passenger terminals (intercity)
Bus passenger terminals (local)
Bus passenger terminals (intercity and local)
Other motor vehicle transportation
Airport and flying field terminals (passenger)
Airport and flying field terminals (passenger and freight)
Marine terminals (passenger)
Marine terminals (passenger and freight)
Automobile parking
Telegraph message centers
Transportation services and arrangements
Wholesale trade
Retail trade -- building materials, hardware, and farm equipment
Retail trade -- general merchandise
Retail trade -- food
Retail trade -- automotive, marine craft, aircraft, and accessories

Retail trade -- apparel and accessories
Retail trade -- furniture, home furnishings, and equipment
Retail trade -- eating and drinking
Other retail trade
Finance, insurance, and real estate services
Personal services
Business services
Repair services
Legal services
Other professional services
Contract construction services
Governmental services (except correctional institutions)
Miscellaneous services (except religious activities
Public assembly (except entertainment assembly and race tracks)
Amusements (except fairgrounds and amusement parks)
Recreational activities (except designated camping and picnicking areas)
Parks.

3 Food and kindred products -- manufacturing
Textile mill products -- manufacturing
Apparel and other finished products made from fabrics, leather, and similar materials -- manufacturing
Lumber and wood products (except furniture) -- manufacturing
Furniture and fixtures -- manufacturing
Paper and allied products -- manufacturing
Printing, publishing, and allied industries
Chemicals and allied products -- manufacturing
Petroleum refining and related industries
Rubber and miscellaneous plastic products -- manufacturing
Stone, clay, and glass products -- manufacturing

Primary metal industries
Fabricated metal products -- manufacturing
Professional, scientific, and controlling instruments; photographic and optical goods; watches and clocks -- manufacturing
Miscellaneous manufacturing (except motion picture production)
Railroad, rapid transit, and street railway transportation (except passenger terminals)
Motor vehicle transportation (except passenger terminals)
Aircraft transportation (except passenger terminals)
Marine craft transportation (except passenger and freight terminals)
Highway and street right-of-way
Communication (except telegraph message centers)
Utilities
Other transportation, communication, and utilities (except transportation services and arrangements)
Race tracks
Fairgrounds and amusement parks
Agricultural
Agricultural and related activities
Forestry activities and related services (including commercial forest land, timber production, and other related activities)
Fishing activities and related services
Mining activities and related services
Other resource production and extraction
All other activities not otherwise listed.

4 Undeveloped and unused land area (excluding noncommercial forest development)
Noncommercial forest development
Water areas
Vacant floor area
Under construction

	Other undeveloped land and water areas.

Subp. 3. Exceptions. The noise area classification for a land use may be changed in the following ways if the applicable conditions are met.

A. The daytime standards for noise area classification 1 shall be applied to noise area classification 1 during the nighttime if the land use activity does not include overnight lodging.

B. The standards for a building in a noise area classification 2 shall be applied to a building in a noise area classification 1 if the following conditions are met:

(1) the building is constructed in such a way that the exterior to interior sound level attenuation is at least 30 dB(A);

(2) the building has year-round climate control; and

(3) the building has no areas or accommodations that are intended for outdoor activities.

C. The standards for a building in a noise area classification 3 shall be applied to a building in a noise area classification 1 if the following conditions are met:

(1) the building is constructed in such a way that the exterior to interior sound level attenuation is at least 40 dB(A);

(2) the building has year-round climate control; and

(3) the building has no areas or accommodations that are intended for outdoor activities.

D. The standards for a building in a noise area classification 3 shall be applied to a building in a noise area classification 2 if the following conditions are met:

(1) the building is constructed in such a way that the exterior to interior sound level attenuation is at least 30 dB(A);

(2) the building has year-round climate control; and

(3) the building has no areas or accommodations that are intended for outdoor activities.

STAT AUTH: MS s 116.07 subds 2,4

HIST: 11 SR 43; 18 SR 614
Current as of 11/03/98

7030.0060 MEASUREMENT METHODOLOGY.

Subpart 1. Measurement location. Measurement of sound must be made at or within the applicable NAC at the point of human activity which is nearest to the noise source. All measurements shall be made outdoors.

Subp. 2. Equipment specifications. All sound level measuring devices must meet Type O, I, II, or S specifications under American National Standards Institute S1.4-1983.

Subp. 3. Calibration. All sound level measuring devices must, at a minimum, be externally field calibrated before and after monitoring using a calibration device of known frequency and sound pressure level.

Subp. 4. Measurement procedures. The following procedures must be used to obtain representative sound level measurements:

A. Measurements must be made at least three feet off the ground or surface and away from natural or artificial structures which would prevent an accurate measurement.

B. Measurements must be made using the A-weighting and fast response characteristics of the sound measuring device as specified in American National Standards Institute S1.4-1983.

C. Measurements must not be made in sustained winds or in precipitation which results in a difference of less than ten decibels between the background noise level and the noise source being measured.

D. Measurements must be made using a microphone which is protected from ambient conditions which would prevent an accurate measurement.

Subp. 5. Data documentation. A summary sheet for all sound level measurements shall be completed and signed by the person making the measurements. At a minimum, the summary sheet shall include:

A. date;

B. time;

C. location;

D. noise source;

E. wind speed and direction;

F. temperature;

G. humidity;

H. make, model, and serial number of measuring equipment;

I. field calibration results;

J. monitored levels; and

K. site sketch indicating noise source, measurement location, directions, distances, and obstructions.

STAT AUTH: MS s 116.07 subds 2,4

HIST: 11 SR 43; 17 SR 1279; 18 SR 614
Current as of 11/03/98

7030.0070 SOUND ATTENUATION MEASUREMENT METHODOLOGY.

Subpart 1. Purpose. Sound level measurements made for assessing sound attenuation as specified in part 7030.0050, subpart 3, item B, C, or D, shall be made according to the requirements of this part.

Subp. 2. Equipment. The equipment shall meet the requirements specified in part 7030.0060, subpart 2.

Subp. 3. Calibration. The equipment must meet the calibration requirements specified in part 7030.0060, subpart 3.

Subp. 4. Measurement procedure. The measurement procedure described in FHWA-DP-45-1R, section 8 must be used for determination of the sound attenuation.

Subp. 5. Equivalent methods. Methods equivalent to those described in subpart 4 may be used provided they are approved by the commissioner of the Minnesota Pollution Control Agency. The commissioner shall approve an alternative method if the commissioner finds that the method will produce representative data and results which are as reliable as the methods specified in subpart 4.

STAT AUTH: MS s 116.07 subds 2,4

HIST: 11 SR 43; L 1987 c 186 s 15; 18 SR 614
Current as of 11/03/98

7030.0080 VARIANCE.

If, upon written application of the responsible person, the agency finds that by reason of exceptional circumstances strict conformity with any provisions of any noise rule would cause

undue hardship, would be unreasonable, impractical, or not feasible under the circumstances, the agency may permit a variance upon the conditions and within the time limitations as it may prescribe for the prevention, control, or abatement of noise pollution in harmony with the intent of the state and any applicable federal laws.

STAT AUTH: MS s 116.07 subds 2,4

HIST: 11 SR 43; 18 SR 614
Current as of 11/03/98

7030.1000 DEFINITION.

"Motor vehicle" means any self-propelled vehicle not operated exclusively upon railroad tracks and any vehicle propelled or drawn by a self-propelled vehicle and includes vehicles known as trackless trolleys which are propelled by electric power obtained from overhead trolley wires but not operated upon rails, except snowmobiles.

STAT AUTH: MS s 116.07 subd 4

HIST: 18 SR 614
Current as of 11/03/98

7030.1010 PROHIBITIONS.

Subpart 1. Operation of vehicle. No person shall operate either a motor vehicle or combination of vehicles of a type subject to registration pursuant to Minnesota Statutes, chapter 168 at any time or under any condition of grade, load, acceleration, or deceleration in such a manner as to exceed the noise limits contained herein for the category of motor vehicle and speed limits specified, when tested with a measurement procedure approved by the commissioner.

Subp. 2. Sale of vehicle. No person shall sell or offer for sale a new motor vehicle or combination of vehicles of a type subject to registration pursuant to Minnesota Statutes, chapter 168 which when maintained according to the manufacturer's specifications would exceed the noise limits contained herein for the category of motor vehicle and speed limits specified, when tested with a measurement procedure approved by the commissioner.

Subp. 3. Modification of vehicle. No person shall modify a motor vehicle or combination of vehicles of a type subject to registration pursuant to Minnesota Statutes, chapter 168 in a manner which will amplify or increase the noise emitted by the vehicle, above the noise limits contained herein for the category of motor vehicle and speed limits specified, when tested with a measurement procedure approved by the commissioner. No person shall operate a motor vehicle so modified.

Subp. 4. Sale of parts. No person shall sell or offer for sale replacement or additional parts for a motor vehicle or combination of vehicles of a type subject to registration pursuant to Minnesota Statutes, chapter 168 which when installed in the vehicle will amplify or increase the noise emitted by the vehicle, above the noise limits contained herein for the category of motor vehicle and speed limits specified, when tested with a measurement procedure approved by the commissioner. No person shall operate a motor vehicle incorporating such parts.

STAT AUTH: MS s 116.07 subd 4

HIST: L 1987 c 186 s 15; 18 SR 614
Current as of 11/03/98

7030.1020 SCOPE.

This chapter applies to the total noise from a vehicle or combination of vehicles of a type subject to registration pursuant to Minnesota Statutes, chapter 168 and shall not be construed as limiting or precluding the enforcement of any other provision of law relating to motor vehicle exhaust noise.

STAT AUTH: MS s 116.07 subd 4

HIST: 18 SR 614
Current as of 11/03/98

7030.1030 EXCEPTIONS.

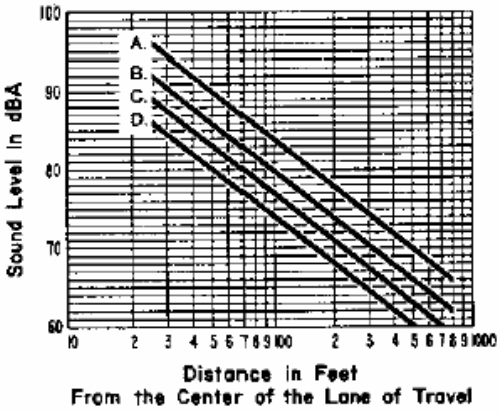
Vehicles under parts 7030.1050 and 7030.1060 are allowed to exceed the noise limits contained herein when performing acceleration maneuvers for safety purposes.

STAT AUTH: MS s 116.07 subd 4

HIST: 18 SR 614
Current as of 11/03/98

7030.1040 NOISE LIMIT FOR VEHICLES OVER 10,000 POUNDS.

Motor vehicle noise limits for vehicles with a manufacturer's gross vehicle weight rating of more than 10,000 pounds and any combination of vehicles towed by such motor vehicle.



A. Speed limits greater than 35 mph.

B. Speed limits equal to or less than 35 mph and stationary run-up tests (for vehicles with governed engines). For stationary run-up tests on all-paved surfaces, add 2 dBA.

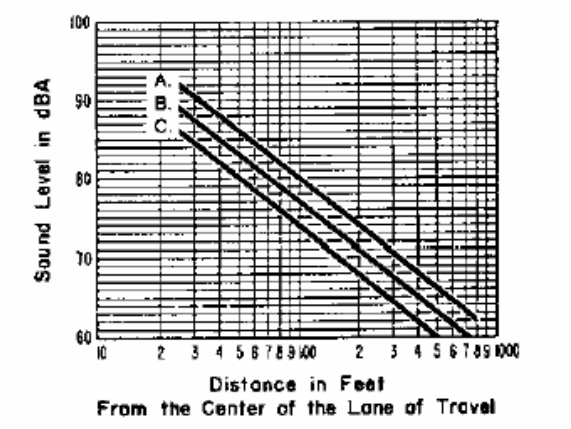
C. Speed limits equal to or less than 35 mph and stationary run-up tests (for vehicles with governed engines), for vehicles manufactured on or after January 1, 1978. For stationary run-up tests on all-paved surfaces, add 2 dBA.

D. Speed limits equal to or less than 35 mph and stationary run-up tests (for vehicles with governed engines), for vehicles manufactured on or after January 1, 1982. For stationary run-up tests on all-paved surfaces, add 2 dBA.

STAT AUTH: MS s 116.07 subd 4

HIST: 18 SR 614
Current as of 11/03/98

7030.1050 MOTOR VEHICLE NOISE LIMITS FOR MOTORCYCLES.



A. For vehicles manufactured before January 1, 1975.

B. Speed limits greater than 35 mph for vehicles manufactured on or after January 1, 1975.

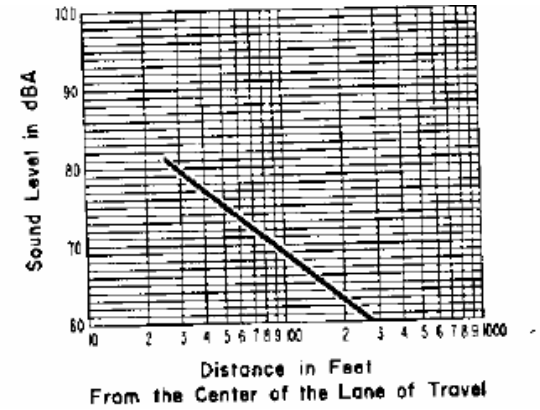
C. Speed limits equal to or less than 35 mph for vehicles manufactured on or after January 1, 1975.

STAT AUTH: MS s 116.07 subd 4

HIST: 18 SR 614
Current as of 11/03/98

7030.1060 NOISE LIMITS FOR OTHER VEHICLES.

Motor vehicle noise limits for any other motor vehicle not included under parts 7030.1040 and 7030.1050 and any combination of vehicles towed by such motor vehicle.



STAT AUTH: MS s 116.07 subd 4

HIST: 18 SR 614
Current as of 11/03/98

Appendix

COMPLETE TABULATION OF ALL METRO AREAS STUDIED IN THE NOISE ABATEMENT STUDY

Appendix

LIST OF REPORT PREPARERS

PREPARERS	OFFICE/DIVISION	CONTRIBUTION
Jordahl-Larson, Marilyn	Office of Environmental Service	Document Review
Hansen, Jim	Metro Division	Data Collection Data Analysis Report Writing
Timerson, Brian	Minnesota Pollution Control Agency	Data Analysis Document Review
Wasko, Peter	Metro Division	Data Collection Data Analysis Report Writing
Roseen, Mel	Office of Environmental Services	Data Collection Data Analysis Report Writing
Tiemann, Lyle	Office of Environmental Services	Data Collection Data Analysis
Turk, John	Metro Division	Data Collection
Lunceford, Ryan	Metro Division	Data Collection