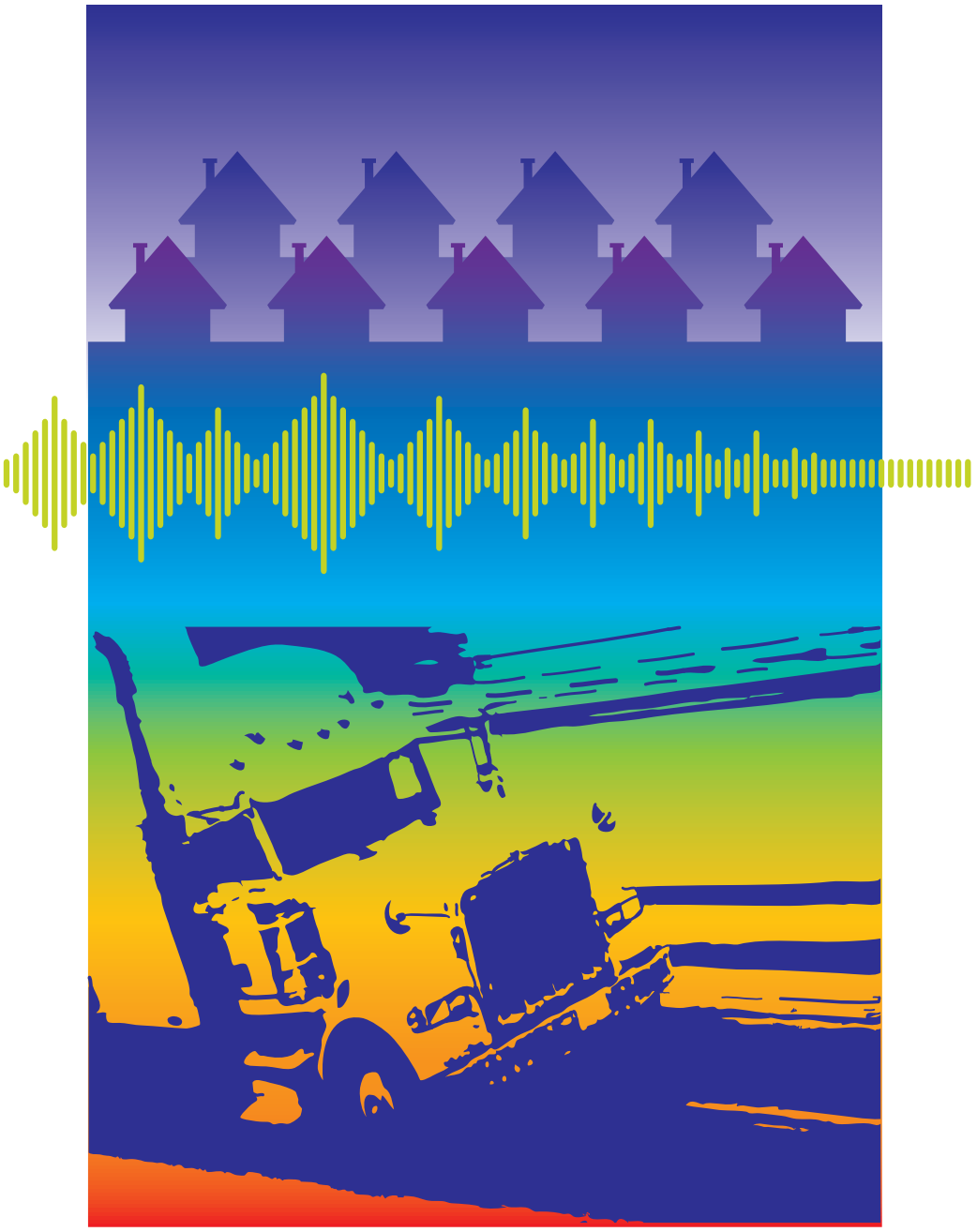

Growing Neighborhoods in Growing Corridors: Land Use Planning for Highway Noise

March 2008

RESEARCH PROGRAMS

Montana Department of Transportation

serving you with pride

Growing Neighborhoods in Growing Corridors: Land Use Planning for Highway Noise

Montana Department of Transportation

March 2008

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. FHWA/MT-08-002/8117-36	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Growing Neighborhoods in Growing Corridors: Land Use Planning for Highway Noise	5. Report Date March 2008	
	6. Performing Organization Code	
7. Author(s) Montana Department of Transportation and Headwaters Policy/Planning Partnership, LLP	8. Performing Organization Report No.	
9. Performing Organization Name and Address Montana Department of Transportation 2701 Prospect Avenue PO Box 201001 Helena MT 59620-1001 Headwaters Policy/Planning Partnership, LLP 737 5th Ave Helena, MT 59601	10. Work Unit No.	
	11. Contract or Grant No. 8117-36	
12. Sponsoring Agency Name and Address Research Section Montana Department of Transportation 2701 Prospect Avenue PO Box 201001 Helena MT 59620-1001	13. Type of Report and Period Covered Final March 2007-March 2008	
	14. Sponsoring Agency Code 5401	

15. Supplementary Notes Research performed in cooperation with the Montana Department of Transportation and the US Department of Transportation, Federal Highway Administration. This report can be found at www.mdt.mt.gov/research/docs/research_proj/noise_plan/final_report.pdf.

16. Abstract

This document aims to provide technical assistance to local authorities that wish to consider noise as an integral part of land use planning decisions. It provides tools to help local planning staffs and policy makers consider noise impacts as a routine part of their development regulations and review processes.

Montanans tend to want economic development, and many areas of the state are getting it. People move here, in part, to get away from the hectic pace of bigger cities. With development, the potential for conflicts between traffic noise and noise-sensitive land uses is almost certain to increase. Meeting the traffic noise challenge, while developing attractive communities and essential transportation corridors, will require sustained action at the state and local levels. Cooperative efforts and actions to avoid highway traffic noise problems are smart for residents, local governments, and the state. This toolkit was developed to help local governments address the challenges of highway noise.

The local basis for addressing noise may be found in local planning goals and objectives that are common elements of local policies that address public health, safety and welfare, and general quality of life. Integrating noise as a regulatory or programmatic consideration in local land use planning is likely to require modification of local policies and programs. This document provides model language that may be considered for integration into growth policies, subdivision regulations, zoning regulations, and land acquisition efforts.

The Montana Department of Transportation crafted this guide because highway noise issues are very likely to become more significant in many areas of the state, and because state and federal agencies cannot address them all. Local decision makers are likely to become increasingly responsible for noise impacts arising from land use decisions.

17. Key Words Noise-compatible, land use planning, noise mitigation, noise contours, traffic noise, noise barriers, noise control.		18. Distribution Statement Unrestricted. This document is available through the National Technical Information Service, Springfield, VA 21161.	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 51	22. Price

Table of Contents

List of Figures

List of Tables

Acknowledgements

This document was developed and authored by the Montana Department of Transportation and Headwaters Policy/Planning Partnership, LLP. Layout and Design completed by Geoffrey Wyatt, Wyatt Design.

The following committee was instrumental in the writing, production, development, review, and refinement of this document. We greatly appreciate the committee members' contribution of time and expertise.

Big Sky Acoustics
Sean Connolly, Owner

City of Kalispell
Tom Jentz, Director of Planning

City of Missoula
Mike Kress, Senior Transportation Planner, Office of Planning & Grants

Federal Highway Administration
Lloyd Rue, P.E., P.T.O.E., Traffic-Safety-Design Engineer

Montana Department of Transportation
Cora Helm, Environmental Science Specialist, Environmental Services
Hal Fossum, Economist and Planner; Rail, Transit and Planning Division
Susan Sillick, Research Manager

Headwaters Policy/Planning Partnership, LLP
Mary Vandenbosch
Jeff Erickson

Disclaimer Statement

This document is disseminated under the sponsorship of the Montana Department of Transportation and the United States Department of Transportation in the interest of information exchange. The State of Montana and the United States Government assume no liability of its contents or use thereof.

The contents of this report reflect the views of the authors, who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official policies of the Montana Department of Transportation or the United States Department of Transportation.

The State of Montana and the United States Government do not endorse products of manufacturers. Trademarks or manufacturers' names appear herein only because they are considered essential to the object of this document.

This report does not constitute a standard, specification, or regulation.

Alternative Format Statement

MDT attempts to provide accommodations for any known disability that may interfere with a person participating in any service, program, or activity of the Department. Alternative accessible formats of this information will be provided upon request. For further information, call (406) 444-7659, TTY (800) 335-7592, or Montana Relay at 711.

Acronyms Used in This Document

dB (dBA) – decibel (A-weighted decibel) – a logarithmic measure of noise

Leq – Loudest hour noise level

Ldn – Average daily noise level (commonly scaled to add a 10 dB "penalty" for noise during nighttime hours)

FHWA – Federal Highway Administration

NAC – Noise Abatement Criteria

MDT – Montana Department of Transportation

NLR – Noise Level Reduction

TNM – Traffic Noise Model

Executive Summary

This document aims to provide technical assistance to local authorities that wish to consider noise as an integral part of land use planning decisions. It provides tools to help local planning staffs and policy makers consider noise impacts as a routine part of their development regulations and review processes.

Montanans tend to want economic development, and many areas of the state are getting it. People move here, in part, to get away from the hectic pace of bigger cities. With development, the potential for conflicts between traffic noise and noise-sensitive land uses is almost certain to increase. Traffic noise may affect the usefulness of property developments near highways. It can be intrusive enough to devalue property, cause health problems, and diminish the quality of life for people who live in its wake. Meeting the traffic noise challenge, while developing attractive communities and essential transportation corridors, will require sustained action at the state and local levels. Cooperative efforts and actions to avoid highway traffic noise problems are smart for residents, local governments, and the state. This toolkit was developed to help local governments address the challenges of highway noise.

The Montana Department of Transportation considers noise in all its highway expansion projects and works to address anticipated issues. Land use decisions are, however, matters of local jurisdiction. Noise problems that arise from development and land use changes near transportation corridors are a local responsibility.

Noise is nothing more than unwanted sound. The volume of any sound decays with distance, but how it decreases and how disruptive it is depends on a number of factors including pitch, topography, motion, time, obstructions, and land use. Higher pitched sounds tend to be more annoying. Higher-up locations will receive more sound than flat or lower areas. Sounds from line sources, such as highways, seem louder than sounds from stationary sources. Sounds in the (otherwise) quiet hours of the evening and nighttime can be more disruptive than the same sounds during daytime (and therefore, the preferred measures of sound gauge decibels in ways that take time of day into account). Barriers such as buildings, vegetation, walls, or hills can deflect and dampen sound. This document provides an introduction to techniques, technologies, and resources needed to understand traffic noise from a land use planning perspective. Analytical tools such as noise contour maps can help identify the sound profile of areas.

Land use is a basic consideration in noise-sensitive land use planning. If a highway runs by a manufacturing plant or shopping center, few people will notice, but the same sound by a home or hospital could have significant health effects. Some land uses may be noise-sensitive enough to warrant civic action to protect them, including residences, hospitals and nursing homes, schools and day care centers, hotels, churches, auditoriums, libraries, and meeting rooms. Outdoor activities associated with noise-sensitive land uses are, of course, even more sensitive.

Noise-compatible land use planning may involve a variety of strategies to reduce the impacts of unwanted sound on sensitive uses. In planning practice, consideration of noise requires attention to basic elements of land use design, such as lot layout and setbacks, open spaces, and land use exclusions. It may be dealt with in building design (although addressing noise through building design restrictions may be outside the authority of local governments in Montana). Traffic noise may also be dealt with by landscaping interventions, such as berms, walls, or vegetative buffers.

The local basis for addressing noise may be found in local planning goals and objectives that are common elements of local policies that address public health, safety and welfare, and general quality of life. Integrating noise as a regulatory or programmatic consideration in local land use planning is likely to require modification of local policies and programs. This document provides model language that may be considered for

integration into growth policies, subdivision regulations, zoning regulations, and land acquisition efforts.

The Montana Department of Transportation crafted this guide because highway noise issues are very likely to become more significant in many areas of the state and because state and federal agencies cannot address them all. Local decision makers are likely to become increasingly responsible for noise impacts arising from land use decisions.

1. Introduction

This publication is presented as a toolkit for local planners and decision makers. It provides tools to address traffic noise before it becomes a problem, relying on planning first to prevent traffic noise impacts entirely, and mitigating existing problems second. It maintains that highway noise is an important consideration in land use planning and development design and attempts to provide local leaders with essential tools to:

- Understand and communicate the issue,
- Analyze potential noise impacts,
- Link local planners to more detailed resources, and
- Craft local policy to address this challenge at the pre-development stage.

This publication stresses cooperation from and between state and local jurisdictions.

The Montana Department of Transportation (MDT) will continue to address noise impacts of new transportation projects. MDT will also provide support (such as this publication) to local jurisdictions planning for noise.

State transportation resources cannot, however, be dedicated to noise problems created by local development decisions. Local jurisdictions that do not consider and act on noise as a factor in land use decisions are unlikely to get state support to correct neighborhood noise issues later. Noise-sensitive land uses that are located along an established MDT roadway are a local responsibility, as is the cost of noise mitigation, regardless of any increase in roadway noise that may arise from traffic growth.

The document begins with an overview of the basics of traffic noise (Chapter 2). This chapter provides enough information to allow the reader to understand basic sound propagation and the terminology used, and some specific information on noise in the highway environment and its adverse effects on the public.

Chapter 3 is a brief review of regulations that apply to traffic noise. Recommended noise levels for planning purposes are introduced in this chapter and the application of the recommended noise levels is expanded on in Chapter 4 with a discussion of noise compatible planning and the use of noise contours and overlay zones.

Chapters 5 through 8 expand on the existing tools Montana planners and decision makers have at hand and how these tools may be used or modified to incorporate noise compatible elements (through growth policy, subdivision regulations, zoning regulations, and acquisition of land).

Chapter 9 describes noise abatement – in the form of berms and barriers – which may be a necessary component of a development when other planning options are not feasible or fail to bring noise levels down to an acceptable level.

Chapter 10 presents some model ordinance language that could be incorporated into zoning and/or subdivision regulations for addressing noise compatible planning and/or noise mitigated developments.

Finally, the Resources chapter (11) provides lists of web-based resources where more information on particular traffic noise and planning subjects can be found.

***Proactive planning**, like anticipating noise impacts along highways is far more beneficial and cost-effective than mitigating noise impacts caused by encroaching development.*

2. Basic Highway Noise Primer

This chapter attempts to provide enough background information on the behavior of sound, the analysis of traffic noise, and the mitigation of traffic noise for the user to make informed decisions regarding the placement of noise-sensitive activities near busy highways.

2.1. Sound, Noise and Measures of Sound

Noise is unwanted sound.

Noise is unwanted sound. Sound travels in waves. Stationary objects make point-source sounds, and these sound waves radiate in a spherical pattern. Traffic noise is a line source of noise that propagates cylindrically (Figure 1).

Sound levels drop off the further you are from the source and this decrease in noise can be estimated. In general, a stationary point source of sound, such as a fan, idling truck, or a person's voice, decreases 6 decibels for every doubling of distance from the source over an acoustically hard surface (such as pavement, water). A line source, such as highway traffic, decreases about 3 decibels for every doubling of distance over an acoustically hard surface, and 4.5 decibels over acoustically soft ground (such as grass).

2.1.1. Measurement of Sound

The volume or intensity of sound is measured in decibels (dB). The decibel scale is designed to match the upper and lower limits of human hearing. The decibel scale is logarithmic, meaning that units on the scale reflect multipliers, rather than additive qualities typical of linear scales; X decibels is ten times Y decibel, and so on. Sound also has pitch, or frequency, which is measured in Hertz (Hz) or cycles per second, and in time. Higher pitched sounds are often considered more annoying than lower frequencies; even at the same volume; the bark of a small dog is typically more annoying than a large one (Table 1 and Figure 2).

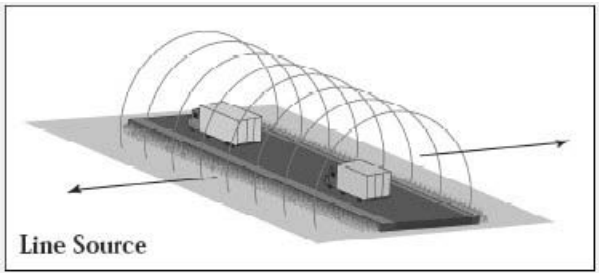

Figure 1 Line Source of Noise
(Source: PENNDOT 2003)

Sound is perceived differently by different people, but generally an increase or decrease in sound of 10 decibels is perceived as a doubling or halving of the loudness. A one decibel change in sound is imperceptible, and a 3 decibel difference is not likely to be noticed by most people.

Table 1 Perceived Sound Level Changes

Sound level change	Perception of change
+/-20 dB	Four times or one-quarter as loud
+/-10 dB	Twice or one-half as loud
+/- 5 dB	Readily perceptible change
+/- 3 dB	Barely perceptible change
+/- 1 dB	Imperceptible change

Most noise levels in this document are discussed in terms of dBA, or A-weighted decibels. "A-weighting" is a term used to describe a measure of sound that reflects the sensitivity of the human ear.

Combining two noise levels at the same decibel level will add 3 dB to the resulting noise (e.g., 60 dB + 60 dB = 63 dB, not 120 dB). When combining two noise sources of different decibel levels, add less than 3 dB to the loudest noise source. The louder noise source dominates the noise environment.

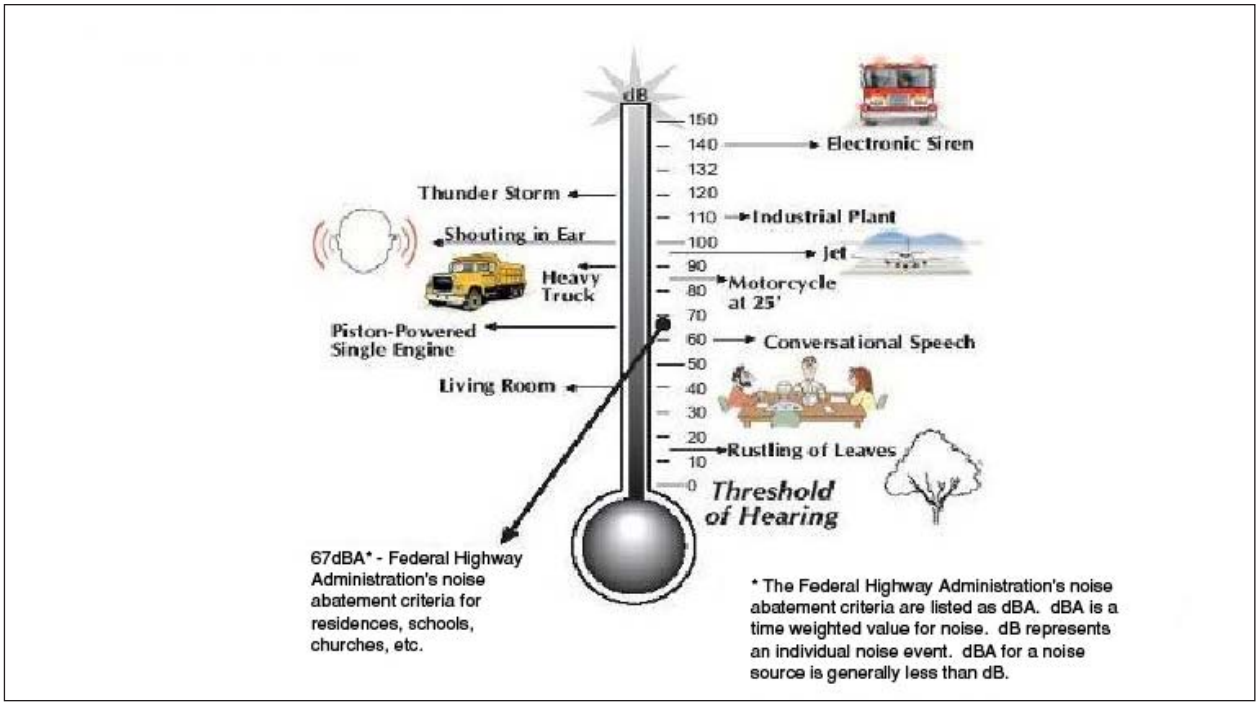

Figure 2 Sound Level Comparisons
(Source: Wyckoff et al. 2005)

2.1.2. Sound Metrics – Ldn and Leq

Highway traffic noise is reported as an equivalent sound level, or Leq. This is a single value of sound for a specified duration of time which has the same acoustical energy as the time-varying sound energy, including the peaks and valleys measured in the same time period (Figure 3).

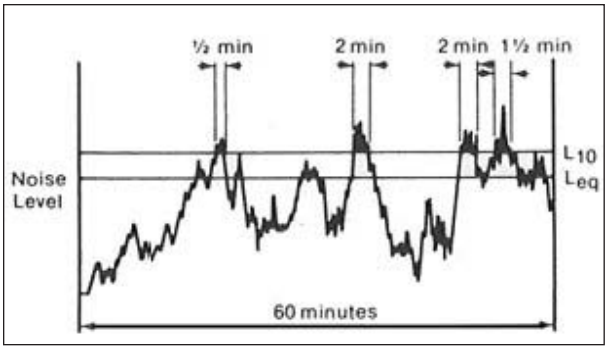

Figure 3 Equivalent Sound Level, Leq
(Source: FHWA 1992)

Another commonly used sound metric is the day-night noise level, or Ldn. The Ldn is a single number value that represents the constantly varying sound level during a continuous 24-hour period. The Ldn is typically calculated using 24 consecutive one-hour A-weighted Leq noise levels, with a 10 dBA penalty applied to nighttime levels (10:00 pm to 7:00 am) to compensate for the increased sensitivity to noise during the quieter nighttime hours. The Ldn is used by the U.S. Department of Housing and Urban Development (HUD), Federal Energy Regulatory Commission, Federal Aviation Administration, and by many communities as the descriptor for complying with noise ordinances.

2.2. Topography and Traffic Noise

Topography affects the way sound travels, and this is a very important point when planning for noise along heavily traveled and/or high-speed roadways. Properties sitting on hillsides overlooking a highway will be more exposed to noise than areas that are flat or below the elevation of the roadway. Figure 4 illustrates that the house much closer to the highway is shielded in the shadow zone behind a berm. The house on the hillside, while further away from the highway, is unshielded from the path of traffic noise.

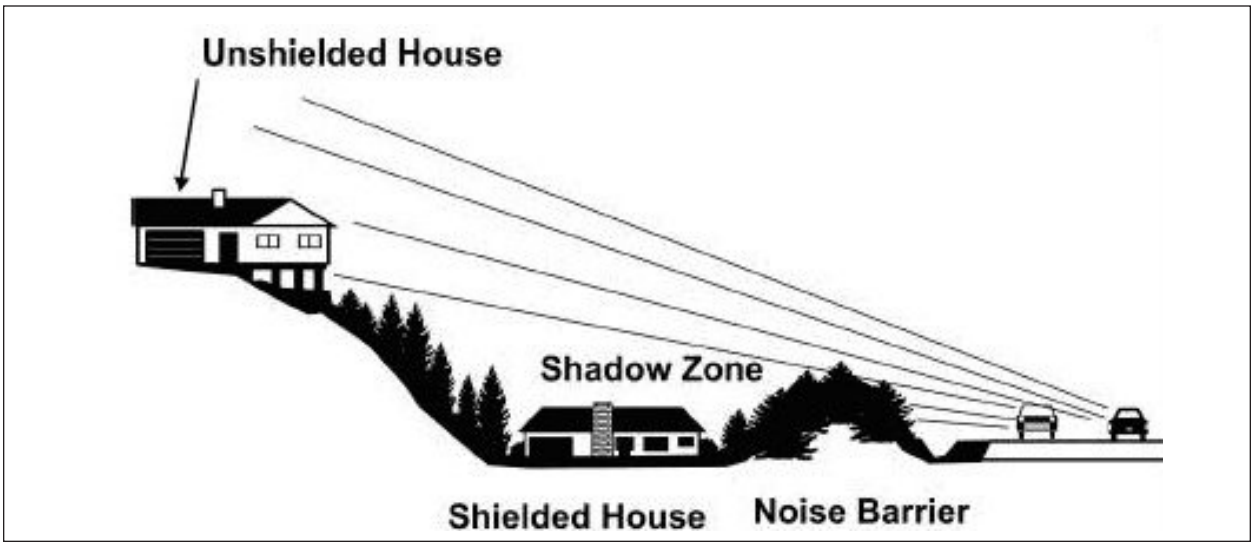

Figure 4 Unshielded and Shielded Houses
(Source: FHWA 2001)

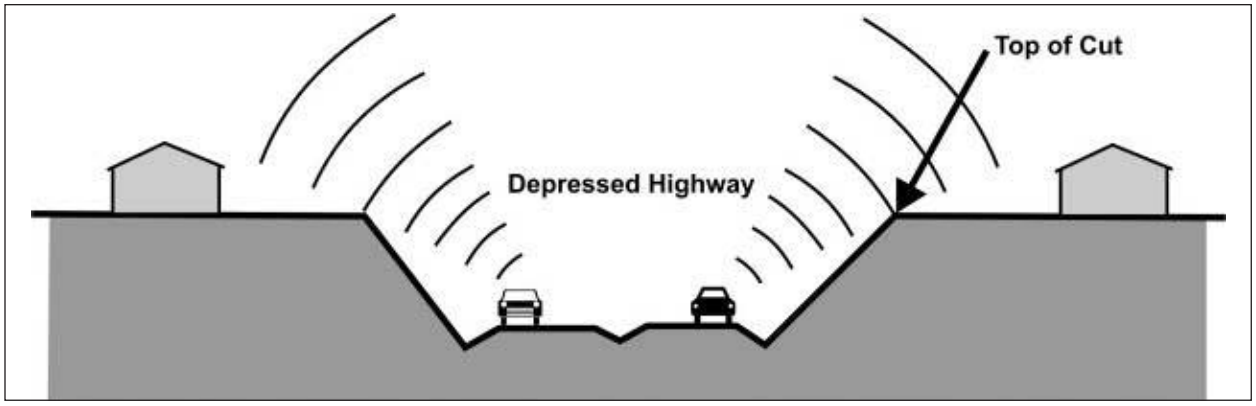

Figure 5 Topography Effects of a Depressed Highway
(Source: Wyckoff et al. 2005)

Depressing a roadway can provide some shielding from noise. In Figure 5, houses that are set back from the top of a cut of a depressed roadway are somewhat shielded from the traffic noise — the path of noise travels up to and over the roofline of the house.

2.3. Highway Noise Sources

The principal noise sources from highways are the tire/pavement, engine, and exhaust systems. At speeds greater than 30 mph, the tire/pavement noise is dominant, and noise increases as speed increases. Figure 6 illustrates how increasing the speed significantly increases noise from vehicles.

Vehicle mix is another important factor in traffic noise; a higher percentage of trucks results in a noisier roadway. Figure 7 compares the noise level of one traveling truck to numerous cars.

Traffic volume is a major contributor to noise levels. Combining high traffic volume with high speeds

***Highways that carry** a lot of truck traffic will be much noisier, and in many urban areas, truck traffic dominates the nighttime noise environment causing sleep disturbance.*

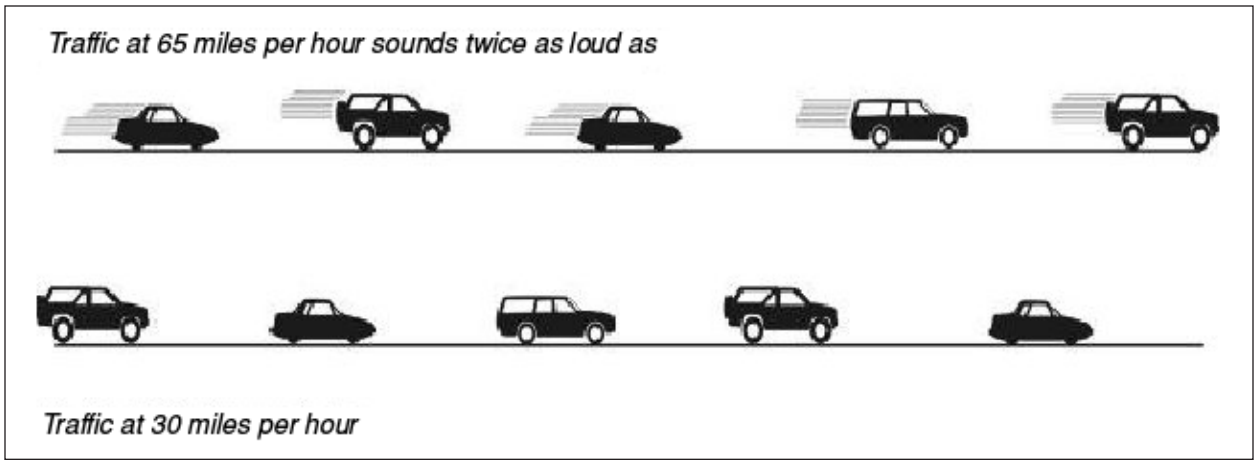

Figure 6 How Automobile Speed Affects Noise
(Source: FHWA 1992)

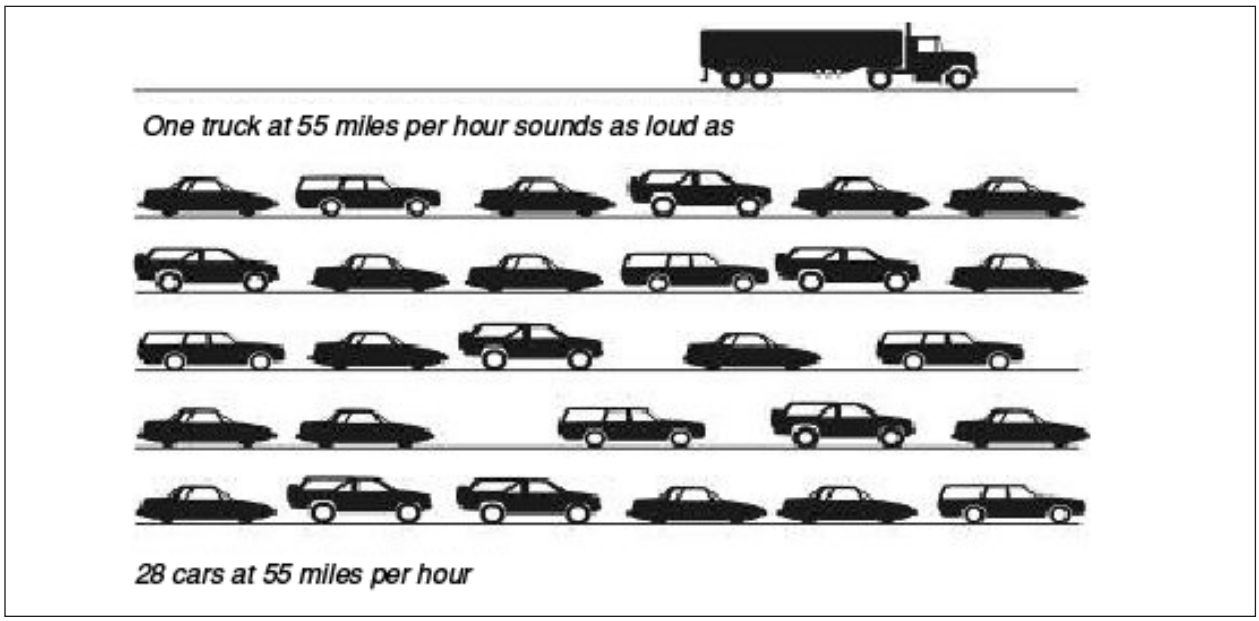

Figure 7 How Trucks Affect Noise
(Source: FHWA 1992)

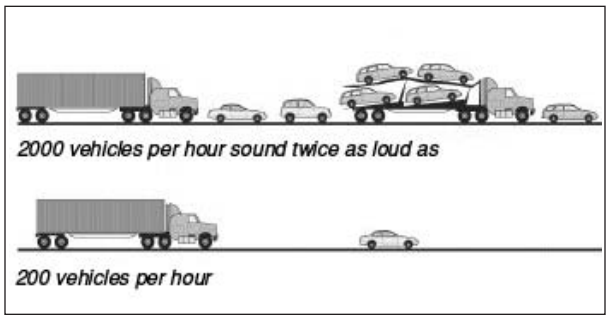

Figure 8 How Traffic Volume Affects Noise
(Source: FHWA 1992)

and a high percentage of trucks will result in the noisiest roadway. Figure 8 illustrates how volume affects noise.

2.4. Health Effects of Highway Noise

The effects of noise on humans have been widely studied. Although the effects of noise are rarely catastrophic, adverse effects are cumulative with prolonged and repeated exposure. Noise exposure can cause health problems including elevated blood pressure and the secondary effects due to sleep interference (Suter 1992).

The most significant effects of highway traffic noise on humans are in the areas of conversation, sleep, and annoyance. Interference with sleep is the most potentially damaging consequence of persistent noise. The primary effects of sleep disturbance are difficulty in falling asleep, awakenings, and alterations of sleep stage or depth, increased blood pressure, changes in respiration, and cardiac arrhythmia (Berglund et al. 1999).

Other effects may include noise-induced hearing loss, interference with communication, effects on performance or behavior, and annoyance (Suter 1992). The FHWA Noise Abatement Criteria (described in Chapter 3) for residential land uses was established with the goal of preserving conversational speech during the loudest traffic hour of the day. Normal conversational speech at 3 feet is typically 50 to 65 dBA, provided that the background noise level is 50 dBA or lower. In an outdoor environment, people can communicate clearly using normal voice levels at up to 13 feet if the background noise does not exceed 60 dBA. If the background noise exceeds 65 dBA, raised and/or loud voices would be needed to be understood beyond approximately 7 feet (Harris 1998).

3. Role of Federal Government and MDT

Federal regulation 23 CFR 772 (CFR 2007) provides the state highway agencies (like MDT) guidance and requirements for evaluating and mitigating noise impacts along federally funded road projects. The regulations define for what type of project a noise analysis is needed, supply noise abatement criteria, and establish requirements for information to be disseminated to local officials.

MDT must conduct noise analyses on all Type I and Type II projects, as defined in the regulation. Type I projects involve any improvement that adds through travel-lanes, significantly changes the horizontal or vertical alignment, or builds a new highway on a new alignment. For Type I projects, the consideration of noise abatement is mandatory if traffic noise impacts are identified. Mitigation of those impacts must be shown to be reasonable and feasible before federal funds can be used to finance such mitigation.

Type II projects are considered stand-alone noise abatement projects, often referred to as retrofit noise abatement. Before a retrofit noise abatement project can be built, the state must have a federally-approved Type II program in place. These programs are completely voluntary and MDT does not have a Type II program, and is unlikely to develop one, which is one reason this guide is so important for growing communities to adhere to.

3.1. Noise Levels for Land Use Activities

The FHWA has established absolute noise level thresholds for all land use activities as part of its Type I and Type II programs. These thresholds are referred to as the Noise Abatement Criteria or NAC. Noise abatement (usually in the form of noise barriers or berms) must then be considered whenever the NAC is approached, exceeded, or when noise levels increase substantially over existing noise levels. Individual states must add to these criteria their determination of what constitutes "approach" and "substantial increase." Table 2 lists those federal and MDT criteria.

The FHWA and MDT noise abatement criteria for highway projects are a high threshold and do not make the distinction between activities that involve sleep and those that do not. The higher noise levels are quite loud when it comes to trying to engage in outdoor conversation in a backyard near the highway at peak periods or sleeping with open windows.

Table 2 FHWA/MDT Noise Abatement Criteria (NAC)
(Source: CFR 2007 (40 CFR 772) and MDT 2001)

Activity Category	FHWA dBA Leq	MDT dBA Leq	Description of Activity Category
A	57 (Exterior)	56 (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. Examples: university commons, outdoor sanctuary, or a public garden.
B	67 (Exterior)	66 (Exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	72 (Exterior)	71 (Exterior)	Developed lands, properties, or activities not included in Categories A or B above.
D	--	--	Undeveloped lands.
E	52 (Interior)	51 (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums. These uses would not have primary outdoor activities.
Leq is a measure of the loudest hour noise level of traffic. ***MDT definition of "substantial increase" is 13 dBA over existing.***			

3.2. MDT Recommended Noise Levels for Planning

With this document, MDT is recommending noise planning thresholds for different land use activities. These recommended noise levels, explained in more detail in Chapter 4, should be used by local agencies to plan noise sensitive developments near MDT Highways. If followed, the noise levels planning thresholds will preserve the quality of life one expects in Montana while still allowing for increases in traffic volumes as growth increases.

The recommended noise planning thresholds are computed using projected traffic volumes for 20 years or more into the future. For those reasons, noise levels lower than those in Table 2 are recommended for planning purposes in order to protect speech outdoors in noise sensitive land uses like backyards and parks, and to protect sleep.

The rest of this document illustrates how to reduce or eliminate noise impacts in new developments by either (1) using noise compatible land use planning to restrict noise sensitive land uses from being too close to busy highways; (2) setting those land uses back a safe distance from the highway so that noise impacts will not occur; or (3) mitigating noise impacts by development layout, use of building materials, and other construction-related methods of noise reduction. When those methods fall short of planning goals or when noise impacts already exist, mitigation in the form of barriers may be necessary. A description of noise walls and berms, and how they work is provided in Chapter 9.

Recommended Noise Planning Thresholds

***60** dBA for indoor and outdoor noise sensitive areas (activities included in land use category B of Table 2).*

***60** dBA for indoor activities only that involve places where people sleep (also category B in Table 2).*

***70** dBA for indoor-only activities that do not involve places where people sleep (activities in land use category C in Table 2).*

4. Noise Compatible Land Use Planning

While highway noise has not received much attention in the arena of land use planning and regulation, it is important to note that the level of noise is, to a significant degree, a function of any growth that generates more vehicle traffic. As more development occurs and land use patterns change, concerns about highway noise are likely to increase.

There are many ways a community can take traffic noise under consideration when planning developments. One way is through noise compatible land use planning, where land use activities that are NOT sensitive to noise, such as those depicted in Figure 9 are sited near the highways.

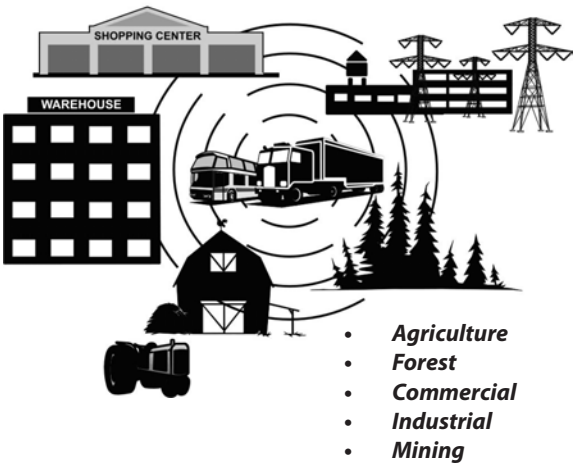

Figure 9 Noise Compatible Land Uses
(Source: Wyckoff et al. 2005)

In contrast, land use activities which are noise-sensitive are sited farther away from highways, outside the area of traffic noise impacts. Examples of land uses that are noise sensitive are illustrated in Figure 10.

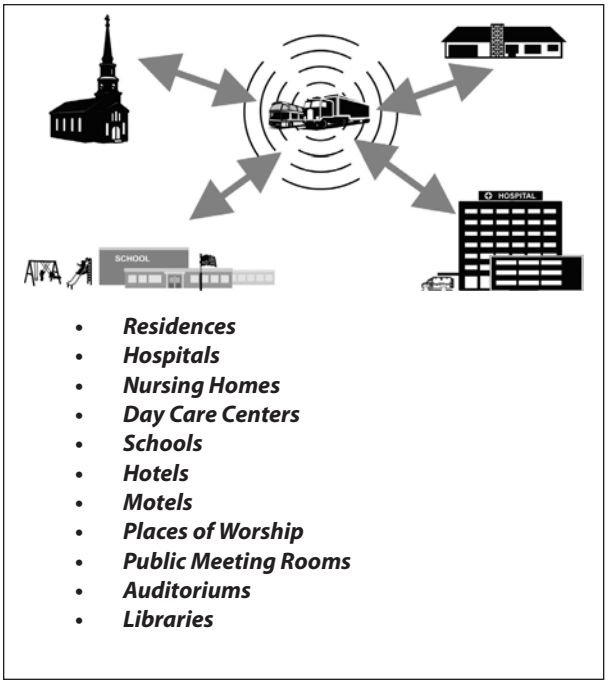

Figure 10 Noise Sensitive Land Uses
(Source: Wyckoff et al. 2005)

4.1. Noise Compatible Land Use Measures

Buffer zones of open space and storm water detention areas can provide separation between noise sensitive land uses and the highway. Other techniques as well can be employed to ensure a better quality of life for people who live in developments near highways. A summary of noise compatible land use measures is provided in Table 3. The table describes each measure, identifies locations where it may be implemented, notes which land use tools are appropriate for implementing the measure, and summarizes its advantages and disadvantages. Further illustration of these measures is presented in Chapter 6.

Table 3 Noise Compatible Land Use Measures

Technique	Description	Implementation	Pros and Cons
Landscaping Buffer	A noise barrier in the form of dense vegetation located between the roadway and the affected land use. Must break the line-of-sight between the affected land use and roadway noise sources.	Most practical where extensive vegetation already exists Tools: Capital Improvements Zoning Subdivision	+ Aesthetic benefits - Significant vegetation required (e.g., 200 foot width of dense vegetation is needed to achieve 10 dB reduction)
Setback	Requirement that structures or noise sensitive land uses be set back from a property line, right-of-way, or center line. Can be used to ensure adequate space for noise barriers or to exclude noise sensitive land uses from the area affected by highway noise.	Best for undeveloped areas or developed areas where lot sizes permit Tools: Zoning Subdivision	+ Noise compatible uses may be located within the setback. These may include otherwise required uses, such as right-of-way and utilities - Depending on setback distance required, lot sizes may not be sufficient to accommodate setback and allow for use of the land
Open Space Buffer Zone	Land between highway and noise contour for acceptable noise level is dedicated to open space through acquisition by local government, land trust, MDT (for active projects), or dedication by subdivider.	Best for undeveloped areas where land values and lot sizes permit Tools: Zoning Subdivision Land Acquisition	+ Can be used for greenways, recreation paths, or other beneficial uses of open space and provide multiple benefits - May be cost prohibitive - Not feasible if land is already developed
Prohibit Noise Sensitive Uses	Establish a noise overlay zone or zoning district and prohibit noise sensitive uses or allow as conditional use if noise impacts are mitigated.	Best for areas where noise compatible land uses are existing or desired Tools: Zoning	+ Eliminates traffic noise impacts on noise-sensitive land uses +Avoids need for mitigation measures + Very effective if noise compatible land uses are existing or desired - May promote strips of commercial/industrial use in areas where not desirable

Table 3 continued

Technique	Description	Implementation	Pros and Cons
Lot Layout	Require that lot size, width, and depth be adequate to provide for setbacks and/or noise barriers.	Best for undeveloped areas where density goals permit Tools: Subdivision Zoning	+ Allows for a wider range of options for noise abatement - May not be compatible with desired density for area
Site Design	Require or encourage that developments be designed so that noise compatible uses are next to the highway and noise sensitive uses are farther from or facing away from the highway.	Best for undeveloped areas where major subdivisions are proposed Tools: Subdivision Zoning	+ Eliminates or reduces traffic noise impacts on noise-sensitive land uses - May limit number or size of salable lots
Acoustical Building	Includes: *Installing windows, doors, and wall systems with higher sound transmission class (e.g., brick exterior wall) * Limiting openings (doors & windows) on highway side * Central heating, ventilation, air conditioning * Acoustic design to absorb sound	Best for new construction of buildings intended for noise-sensitive uses, such as hospitals, schools, churches, motels, hotels, or residences on undeveloped lands Tools: Subdivision Zoning	+ May be sufficient mitigation for noise sensitive uses without outdoor activities + May be only option for high-rise buildings close to highway - Occupants/owners must pay ongoing cost for air conditioning - Only protects indoor uses; any outdoor activities will still be affected by noise

Table 3 continued

Technique	Description	Implementation	Pros and Cons
Noise Barrier	A solid wall or earth berm, or combination of berm and wall, located between the roadway and the affected land use. To be effective, these must break the line-of sight between the affected land use and roadway noise sources.	Most practical where there are high-density noise sensitive land uses next to the highway and the need for openings to allow access is limited Tools: Capital Improvements Zoning Subdivision	+ Reduce noise levels by 6-15 dB + Increase privacy + Block view of highway + Reduce noise impacts on both outdoor and indoor uses - May block desirable views/light for residents and/or motorists - Effectiveness of barrier reduced if breaks are required to provide for driveway and street access - Expensive to build barriers long enough to protect homes on large lots or in low-density neighborhoods - Maintenance required (varies depending on type of barrier) - Expensive ($1M-$4M per mile on each side of the highway) - Not effective for buildings or rooms above barrier (e.g., homes on hillside) - Limited in height due to structural and aesthetic considerations; therefore, generally not feasible for multi-story development - May not be feasible due to site-specific impacts including sight distance restriction, drainage problems, shadow causing icing of driving lanes or other hazards
Berm	A noise barrier in the form of an earth mound that is generally parallel to the highway.	Discussed under "Noise Barrier"	+ Natural appearance; usually attractive + Reduce noise ~3dB more than same height wall + Cost of materials less than noise walls + Can incorporate bike/pedestrian paths - Take a lot of space
Noise wall	A noise barrier in the form of a high vertical wall parallel to the highway.	Discussed under "Noise Barrier"	+ May provide security and/or privacy + Take less space than berms - More expensive than berms - May be unattractive (possibly mitigated with landscaping or surface treatments)

***Communities that proactively consider** highway noise issues in their growth policy and land use regulations are likely to benefit from the ability to choose from a wider range of options for addressing highway noise. Once lots are divided and noise sensitive land uses are located next to a highway, many options are no longer feasible.*

Many of the measures included in Table 3 are already used by local governments to accomplish goals not related to highway noise. In some cases, these measures may be adapted to achieve multiple goals.

The chapters that follow explain how noise contours can be an effective tool for planning adjacent to highways and how local governments can use four major land use tools to implement these measures:

- Growth Policy (including Capital Improvements Strategy),
- Subdivision Regulations/Review,
- Zoning Regulations, and
- Land Acquisition.

Many Montana communities are implementing these concepts.

4.2. Noise Contours and Overlay Zones

In order to determine where noise impacts are expected to occur, noise contours are developed using existing and projected traffic data, vehicle mix, and speed. Noise contours, similar to terrain contour lines on a topographic map, can be used to map noise sensitive areas adjacent to highways.

This document establishes recommended noise contours for different types of land uses and the sensitivity of those land uses to traffic noise.

Like topographic contours or 100-year flood plain lines on a map, noise contours can be used effectively for future planning along highways and other high-volume, high-speed roadways. Noise contours are generated using a computer modeling tool that calculates a loudest-hour noise level (Leq) for a specified volume and mix of traffic, the speeds at which that traffic is traveling, and at various distances from the roadway that sensitive receivers may be located.

Noise contours can be used to create Noise Overlay Zones – areas within which noise sensitive development should not occur or mitigation of traffic noise will be required for noise sensitive development.

A noise overlay zone depicts the areas along a highway where noise impacts are predicted to occur for noise sensitive land uses, such as residential developments (Figure 11). In Figure 11, noise sensitive activities would experience noise impacts from the Montana highway if allowed to develop in the shaded areas. Commercial land uses and land uses that do not involve sleep could

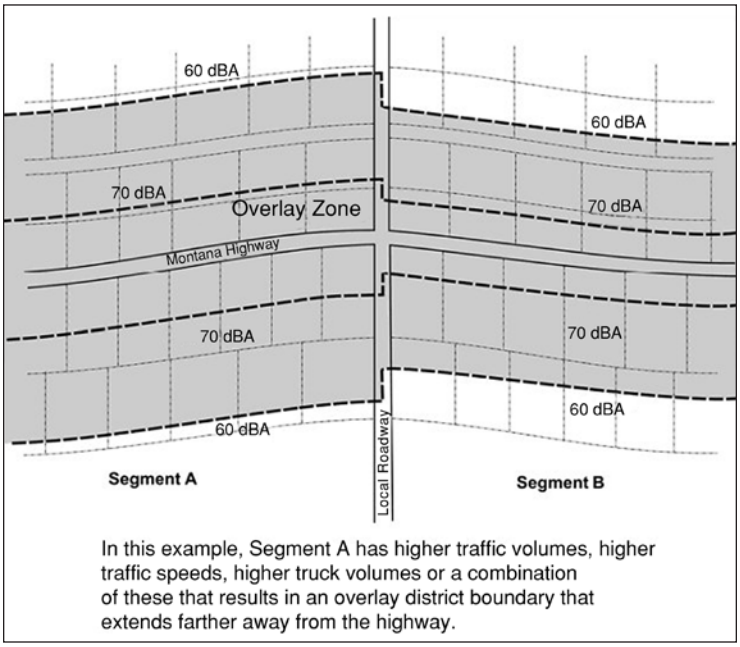

Figure 11 Noise Contours and Overlay Zones
(Source: Adapted from SDDOT 2006)

be developed between the 70 and 60 dBA contours without the need for any kind of noise mitigation. In this example, the noise contours are different for Segments A and B due to traffic volume differences, speeds, and/or percentage of trucks.

60 dBA protects speech outdoors, ensures a healthy sleeping environment, and allows for area growth.

Noise compatible land uses are those land uses where highway traffic noise should not be a problem and, therefore, are not protected for indoor or outdoor conversation. These typically include commercial, industrial, agricultural, and mining land uses. Noise compatible land uses that have no noise sensitive elements may be sited without consideration of the highway noise contours or overlay zones.

4.2.1. Developing Noise Contours and Overlay Zones

For very simple roadway alignments, the program "TNM 2.5 Look-up Tables" can be used. This program is explained in more detail and available free at the FHWA website (listed in Chapter 11, Resources). The program assumes flat terrain, an infinitely straight stretch of roadway, and no obstacles between the path of the noise source and receiver. While in reality, that is never the case; the program is useful for obtaining an estimate of noise levels based on certain traffic conditions.

Local governments may opt to choose a lower threshold value (58-59 decibels for residential land uses) that would trigger the need for a more detailed noise study or more precisely modeled noise contours for the area in question.

4.2.2. Other Resources for Noise Contours

MDT prepares noise analysis reports, often including noise contours, for many highway projects. These noise reports, including contours and/or recommended setback distances, are forwarded to the local city/county government offices and may be helpful in developing noise contours for some areas. As resources allow, MDT will calculate noise contours using the full TNM 2.5 noise program (not just the Look-up Tables), resulting in noise contours that take topography into account.

Data you need to use the TNM Look-up Program for present year noise levels:

- ***Highest hourly volume or design hourly volumes (30th percentile) auto, heavy trucks, medium trucks. Note: if highest hourly volume results in slower speeds, use the design hourly volume.***
- ***Traveling speeds for each vehicle class used in the model.***
- ***Select if ground type between the roadway and receiver is hard (pavement) or soft (grass, dirt).***
- ***Distance from centerline of roadway to sensitive receiver.***
- ***Often 3 or more distances are calculated to get an idea of where the 60 and 70 dBA contour lines are located.***

Once the data is entered, an hourly equivalent noise level (Leq) is calculated.

Limitations of the TNM Look-up Tables:

- ***The Look-up Tables program assumes a receiver height of 5 feet from the ground surface. If the goal is to predict noise at a second floor window or balcony, the TNM Look-up Tables will not be reliable.***
- ***The Look-up Tables program cannot be used to accurately describe noise contours on hilly terrain. When predicting noise contours for areas that are above the elevation of the highway, consider that the noise level at the receiver is higher than predicted. For areas that are below the elevation of the highway, noise levels will be lower than predicted.***
- ***For situations where terrain is not flat, consider having noise contours developed by a noise specialist.***

Check with MDT to see if noise contours have already been developed for your area of interest.

4.2.3. Using TNM Look-up Tables

To create noise contours on level terrain, the FHWA computer program called TNM Look-up can be used. This simple computer program includes input fields for hourly volumes of automobiles, medium trucks (2 axles, 6 tires); and heavy trucks (more than 2 axles, including trucks with trailers). There are also fields for motorcycles and school buses.

Once the distance from centerline to the 60 and 70 dBA contour lines is established, then the area between those contour lines on each side of the highway can be shaded and designated a noise overlay zone (as in Figure 11).

4.2.4. Examples of TNM Look-up Tables

Table 4 A through F illustrate the input and output information obtained using the TNM Look-up Tables.

Note: Although noise models estimate noise levels to a tenth of a decibel, all decibel levels should be rounded to the nearest decibel for reporting purposes.

Table 4 A: Vehicle Mix: 500 Autos, 13 Heavy Trucks, and 13 Medium Trucks. Speed: all vehicles 45 mph. Distances are from centerline in feet.

Receiver	Distance	Output Leq(hr)dBA
1	33	67.3
2	50	64.8
3	100	58.5
note: %Trucks = 6		

Table 4 B: Vehicle Mix: 500 Autos, 13 Heavy Trucks, 13 Medium Trucks. Speed: all vehicles 55 mph. Distances are from centerline in feet.

Receiver	Distance	Output Leq(hr)dBA
1	50	67.2
2	75	63.8
3	100	60.9
note: %Trucks = 6		

Table 4 C: Vehicle Mix: 300 Autos, 15 Heavy Trucks, 15 Medium Trucks. Speed: all vehicles 45 mph. Distances are from centerline in feet.

Receiver	Distance	Output Leq(hr)dBA
1	50	63.6
2	75	60.3
3	100	57.5
note: %Trucks = 10		

Table 4 D: Vehicle Mix: 300 Autos, 15 Heavy Trucks, 15 Medium Trucks. Speed: all vehicles 55 mph. Distances are from centerline in feet.

Receiver	Distance	Output Leq(hr)dBA
1	50	65.9
2	75	62.5
3	100	59.7
note: %Trucks = 10		

Table 4 E: Vehicle Mix: 140 Autos, 2 Heavy Trucks, 3 Medium Trucks. Speed: all vehicles 60 mph. Distances are from centerline in feet.

Receiver	Distance	Output Leq(hr)dBA
1	50	62.5
2	75	59.0
3	100	56.0
note: %Trucks = 1.1		

Table 4 F: Vehicle Mix: 2600 Autos, 40 Heavy Trucks, 39 Medium Trucks. Speed: all vehicles 35 mph. Distances are from centerline in feet.

Receiver	Distance	Output Leq(hr)dBA
1	50	68.2
2	75	64.9
3	100	62.2
note: %Trucks = 3		

The Look-up Tables program provides sound levels in decibels based on traffic data and distance to various receivers. Typically, the program is used to estimate noise at existing sensitive receptors. In order to use this program to create noise contours for an undeveloped area, numerous adjustments to distance may be necessary before the "precise" distance to the desired noise contour is obtained.

4.3. Planning with Noise Contours & Overlay Zones

The FHWA and MDT noise abatement criteria (Table 2) are a high threshold. The higher noise levels are quite loud when it comes to trying to engage in outdoor conversation in a backyard near the highway at peak periods or sleeping with open windows. For that reason, this document establishes noise standards for certain land uses with regard to noise sensitive activities and building construction (Table 5). For example, in areas where people sleep and the building construction includes a central HVAC system and double paned windows, the recommended noise contour is 60 decibels at the edge of the building. Examples of this type of land use and building construction would be motels, hotels, hospitals, and nursing homes. For residential structures, where there may or may not be central air conditioning systems and windows would often be open, the 60 decibel contour line falls at the edge of the outdoor active use area, such as a backyard or patio.

***For planning purposes,** it is recommended to evaluate what noise levels may approach in 20 or 30 years, given an area's estimated growth. For those reasons, lower noise levels are recommended for implementation by local governments in order to protect speech outdoors in noise sensitive land uses like backyards and parks, and to protect sleep indoors.*

To avoid future noise impacts in areas with sensitive land uses, Figure 12, Figure 13, and Figure 14 illustrate where the recommended noise level contours fall (either 60 dBA for places where people sleep or 70 dBA for commercial uses). Adhering to these guidelines will avoid the need for additional mitigation, such as noise walls or berms. It is MDT's position that statewide all planning jurisdictions apply the same methods and noise contours in planning developments without noise mitigation.

Table 5 Noise Standards for Noise Sensitive Land Uses

Land Use	Location of Human Activity	Building Construction	Exterior Noise Standard (Loudest Hour Leq)	Interior Noise Standard (Loudest Hour Leq)
Picnic areas, recreation areas, playgrounds, active sports areas, parks	Outdoor	N/A	60 dBA at edge of active use area	N/A
Residences, motels, hotels	Indoor	Opening windows with or without central HVAC	60 dBA at edge of active use area	40 dBA
Residences, motels, hotels, nursing homes, and hospitals	Indoor	Central HVAC and non-opening, double-pane windows	60 dBA at edge of principal building	40 dBA
Public meeting rooms, schools, day care centers, places of worship, libraries, and auditoriums	Indoor	Central HVAC and non-opening, double- pane windows	70 dBA at edge of principal building	50 dBA

4.3.1. Indoor and Outdoor Noise Sensitive Activities

The loudest hour Leq of 60 dBA preserves the yard area for conversational speech for NAC B (noise sensitive) land uses (Figure 12). It is located some distance away from the highway (depending on that highway's volume, mix, and speed of traffic), and represents an outdoor area of frequent human use, such as a backyard or patio. The 60 dBA contour line is protective of outdoor speech and keeps interior noise levels low enough to protect sleep.

4.3.2. Indoor Only Activities - Protecting Sleep

For areas where there is not an outdoor area of frequent human use, but sleep must be protected, MDT's recommended indoor noise criterion is 40 dBA Leq. This is derived from the HUD (1974) requirement that day-night interior noise levels do not exceed 45 dBA (HUD 1974) and the World Health Organization's (Berglund et al. 1999) recommendation that the effects of noise on sleep begin at about 30 dBA Leq (24 hr). Generally, closed windows provide between a 20 and 35 dBA reduction in noise, so the 60 dBA noise contour at the edge of buildings where people sleep is protective (Figure 13).

***It is MDT's position** that statewide all planning jurisdictions apply the same methods and noise contours in planning developments.*

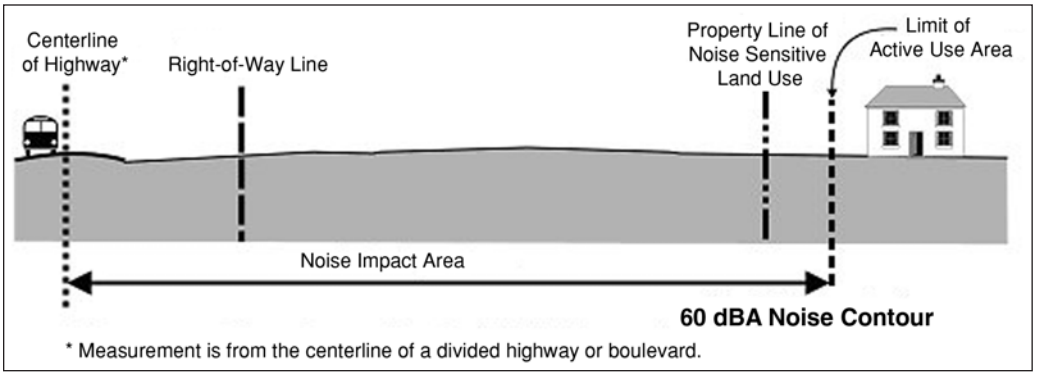

Figure 12 Highway Noise Impact Area - Outdoor and Indoor Activities Including Sleep
(Source: Adapted from Wyckoff et al. 2005)

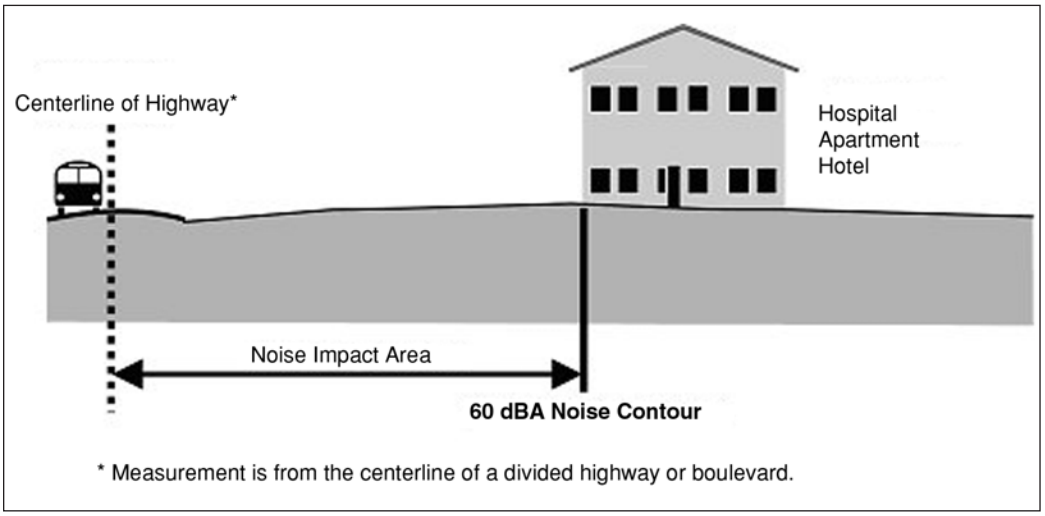

Figure 13 Highway Noise Impact Area - Indoor Only Activities Including Sleep
(Source: Adapted from Wyckoff et al. 2005)

4.3.3. Indoor Only Activities - Excluding Sleep

For structures where people do not regularly sleep, but which are considered noise sensitive in their interiors (such as schools and churches), local governments are encouraged to use the loudest hour Leq of 50 dBA, which corresponds to an outdoor loudest hour Leq of 70 dBA (Figure 14). This is the same criterion used for Land Use Category C (Table 2), which includes commercial areas and takes into consideration that closed windows will reduce interior noise levels to 50 decibels or lower and need not be protective of sleep.

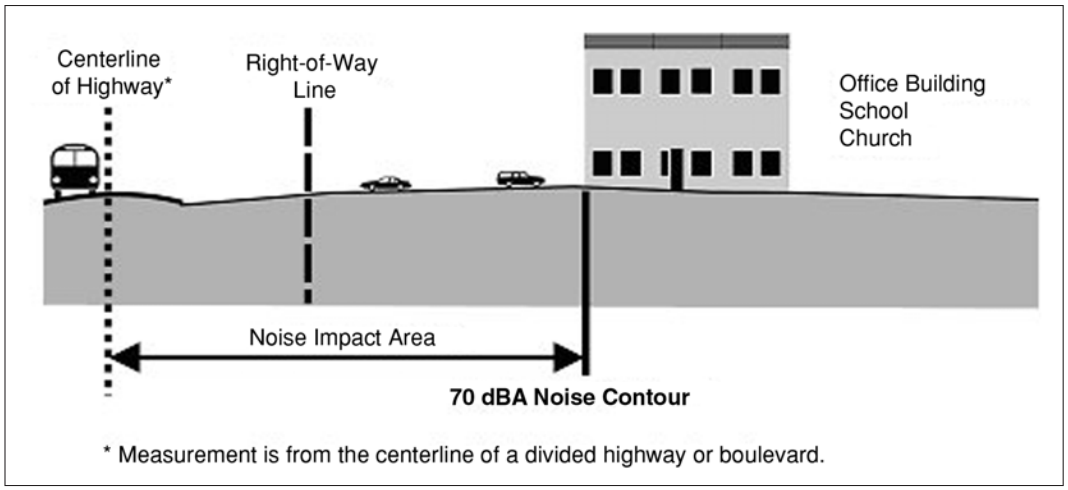

Figure 14 Highway Noise Impact Area - Indoor Only Activities Excluding Sleep
(Source: Adapted from Wyckoff et al. 2005)

5. Growth Policy

The growth policy establishes a vision for community development and serves as the foundation of all land use planning and regulation at the local level. The growth policy provides a vehicle for a community to:

- Identify areas affected by highway noise,
- Establish goals related to noise and/or transportation corridors, and
- Consider the best way to accomplish each goal.

Noise compatible land use planning may be incorporated into the following key elements of a growth policy:

- Maps and text describing an inventory of the existing characteristics and features of the jurisdictional area;
- Projected trends for the life of the growth policy;
- Community goals and objectives;
- A description of policies, regulations, and other measures to be implemented in order to achieve the goals and objectives;
- A strategy for development, maintenance, and replacement of public infrastructure, including roads; and
- A statement of how the governing body will coordinate and cooperate with other jurisdictions.

The growth policy laws were amended in 2007 to clarify that local governments may collect planning fees to pay for growth policies. The fees may be collected with subdivision applications or zoning permits.

5.1.1. Legal Authority

Growth policies are governed by Title 76, Chapter 1, Montana Code Annotated (MCA 2007) and may include any elements that fulfill the purpose of the chapter (76-1-601, 76-1-102, MCA).

A growth policy may include a neighborhood plan, which must be consistent with the growth policy (MCA 2007, 76-1-601). A neighborhood plan dealing with a specific geographic area may address one or more elements of a growth policy in more detail; a corridor plan focusing on a particular section of highway is a type of neighborhood plan that has been used in some communities to deal with a diverse range of issues associated with highway corridors.

Many communities also adopt special plans that address particular elements of the growth policy in more detail. In most cases these plans are technically amendments to the growth policy that must be consistent with the overall document. Examples of topics commonly dealt with in more detailed plans relevant to noise compatible land use planning include:

- Transportation,
- Specific Highway Corridors,
- Parks and Recreation,
- Open Space, and
- Capital Improvements.

The growth policy law was amended in 2007 to specifically authorize the development of an infrastructure plan for infrastructure planning areas adjacent to cities. Among the facilities to be addressed in the infrastructure plan are highways, streets, roads, trail systems, parks, and open space.

***Protecting residents** from the impacts of highway noise is consistent with the purpose of the laws governing growth policies, which include "to improve the present health, safety, convenience, and welfare of their citizens" and "that residential areas provide healthy surroundings for family life."*

Subdivisions within infrastructure planning areas may be exempted from certain subdivision review requirements (MCA 2007, 76-3-616).

5.2. Key Data and Provisions

5.2.1. Inventory and Project Trends for Areas with Noise Impacts

It is essential that the growth policy identify highways with existing and potential noise impacts and delineate noise contours for each of these roads. Noise contours are very useful for growth policy development because they can be displayed on maps overlaying other data. Citizens and decision makers can then evaluate the various measures identified in Table 3 to determine which measures will work best within the areas affected by highway noise.

Because traffic through the highway corridor (and associated noise levels) may increase and a subdivision approved today may not be built for many years, noise contours should be developed for the level of noise projected to occur in 20 years (or later, if the governing body determines that using a longer time frame is prudent). Roads at or near capacity may already have reached the maximum noise level; other roads may reach the maximum noise level in 20 years.

Key data and information necessary to show current conditions and projected trends related to noise compatible land use planning include:

- Location of highways and other busy roads,
- Noise contours for 60 and 70 dBA levels based on 20-year projections or the operational capacity if the highway is approaching its operational capacity,
- Traffic data,
- Description of any existing noise problems,
- Classification of existing land uses adjacent to highways,
- Land uses allowed or prohibited under existing zoning regulations,
- Existing parcel lines for parcels within noise contours,
- Right-of-way lines,
- Projected roads and highways,
- Projected land use trends, and
- Input from citizens regarding current and anticipated problems associated with highway noise.

5.2.2. Community Goals and Objectives

The purpose of preventing adverse impacts from highway noise may be congruent with various growth policy goals. Examples include goals that aim to:

- Promote consideration of public health, safety, and welfare in land use decisions;
- Protect people living and working in the jurisdiction from the effects of excessive noise; or
- Improve the quality of life for community residents.

Communities throughout Montana use a wide variety of approaches to developing objectives. Some objectives identify specific, measurable steps that will be taken to reach goals. Other objectives articulate aims consistent with the general goals. Examples of various types of objectives related to the purpose of preventing adverse effects from highway noise include the following:

- Strive to provide an environment reasonably protected from highway noise by preventing unwanted highway noise impacts and mitigating existing highway noise in areas already subject to such impacts.
- Work cooperatively with adjacent jurisdictions to identify and implement noise compatible land use controls.
- Amend the subdivision regulations to provide for prevention or mitigation of highway noise impacts by a specified date.
- Adopt or amend zoning regulations to provide for prevention or mitigation of highway noise impacts by a specified date.
- Carry out a program to educate citizens, local officials, developers, and realtors about highway noise impacts, and options for preventing and mitigating these impacts.
- Adopt one or more corridor plans for specific roads to address various goals, including those related to highway noise.
- Adopt a transportation, open space, or parks and recreation plan that includes pedestrian and bike pathways and/or open space along highways.

- Conduct additional noise studies to identify areas impacted by highway noise.
- Develop a capital improvements plan that provides for development of noise barriers.

Examples of goals and objectives adopted by communities in Montana are presented in the section entitled "Montana Examples," 5.3.

The growth policy provides an opportunity to consider how actions related to highway noise may be integrated with measures used to accomplish other aims. For example, a highway corridor plan may be used to promote transportation, aesthetic, recreation, economic development, and noise abatement goals.

5.2.3. Implementation Tools

A growth policy must include a description of policies, regulations, and other measures to be implemented in order to achieve the goals and objectives. By identifying and evaluating alternative options in light of the full range of growth policy goals, a community can consider its future holistically.

An analysis of alternatives for preventing highway noise impacts might include the following steps:

- Review the noise contour maps.
- Divide the highway corridor into segments according to current or projected land uses or other characteristics.

Options in Alternatives Analysis
One segment of the highway corridor is surrounded by agricultural lands. The growth policy articulates the community's desire to "Preserve the rural character of the County by promoting farming and ranching operations." Prohibiting noise sensitive land uses or requiring setbacks for residential structures might be effective tools in this area.

Another segment of the highway corridor is already developed at high density. Noise barriers and acoustical building design might be the best options for this segment.

- Evaluate the Noise Compatible Land Use Measures described in Table 3 to determine which measures are best suited for each segment, taking into consideration all relevant growth policy goals and objectives.
- Describe the policies and regulations that will be used to implement these measures.

A simplistic example illustrating this analysis process is presented below.

5.2.4. Coordination and Cooperation with Other Jurisdictions

Highway noise is not constrained by jurisdictional boundaries. Fast-growing areas adjacent to, but outside of, city boundaries may be targeted for noise compatible land use measures. Consequently, local governments may want to specifically address noise compatible land use planning in the required statement explaining how the governing body will coordinate and cooperate with other jurisdictions.

5.3. Montana Examples

5.3.1. Kalispell

The city of Kalispell provides an example of a Montana community that chose to plan for entrance corridors. The Growth Policy includes the following goal:

Gateway entrances to Kalispell that enhance the community through improved design (Kalispell City Planning Board 2003).

It is important to note that improved design is sought to enhance the community in a number of ways, not just by preventing adverse effects from highway noise. For example, the Growth Policy seeks to maintain the scenic value of the entrance corridor and to maintain traffic flow.

Kalispell's Growth Policy identifies specific gateway entrance corridors (including Highway 93 North) and describes design standards for landscape buffers along these roads. Street trees, pedestrian trails or sidewalks, and/or berms must be incorporated into the buffers, which must be 20 to 150 feet wide. Requirements for buffer width and other features vary depending on the adjacent road speed.

Other design standards in the Growth Policy address access control, signage, architecture, and parking lot location and design.

5.3.2. Missoula County

The Missoula County Growth Policy includes the following goals and objectives:

- Encourage a land use pattern that facilitates use of all modes of transportation and provides for safe, healthy, affordable, efficient, and convenient access to transportation connections for residential, commercial, industrial, and emergency traffic (Missoula County 2006, General Local Services and Facilities Goal #4).
- Address noise, air quality, and safety impacts of major transportation facilities on adjacent land uses (Missoula County 2006, Transportation Objective #4).

Selected objectives from the 2004 Missoula Urban Transportation Plan Update that are not specifically noise-related, yet may be beneficial for noise compatible land use planning are highlighted below in order to illustrate how various goals and objectives of the growth policy may be interrelated.

- Develop ordinance provisions, standards, and/or other regulatory provisions that require property owners/developers to make right-of-way dedications and/or roadway improvements in conjunction with new development adjacent to a road that does not meet standards that the transportation plan establishes for that road.
- Develop ordinance provisions, standards, and/or other regulatory provisions that require property owners/developers to construct trails or other facilities designated on or adjacent to their property.
- Consider and adopt impact fees, mitigation fees, or other mechanisms that require the cost of transportation improvements needed as a result of new development to be included as a cost of the development.
- Concentrate employment and other activity centers along existing and planned transit corridors (fully considering the relationship of transit and parking availability as associated with such activity centers).
- Incorporate aesthetic design treatments in all road, trail, and transit facilities (URS 2004).

5.3.3. Bozeman

The city of Bozeman's planning documents do not have goals, objectives, or actions related to highway noise, but the following goal from the *Bozeman 2020 Community Plan* (City of Bozeman 2001) provides an excellent example of a strategy that could be modified to incorporate highway noise issues.

Establish an integrated system of transportation and recreational pathways, including bicycle and pedestrian trails, neighborhood parks, green belts, and open space.

When located along the highway, recreational paths, green belts, and open space effectively separate noise sensitive land uses from traffic noise.

6. Subdivision Regulations/Review

6.1. Description

Subdivision regulations govern the division of land into smaller parcels and provide an opportunity to ensure that lots and subdivisions are designed to allow for provision of needed infrastructure and abatement of conditions that could harm property values.

***Subdivisions can be designed** to provide for separation of noise sensitive uses from the highway or mitigation with noise barriers.*

Subdivision review is an important tool for noise compatible land use planning for the following reasons:

- Subdivision is the first step in land development.
- Division of land into lots sets the pattern of development.
- Subdivision regulations are the only general land use regulations that local governments are required to adopt under state law.

The process of developing and reviewing subdivision applications typically involves a great deal of informative discussion between local planners and developers. Many communities have used pre-application meetings to discuss requirements and potential concerns. Some communities have found that developers are willing to mitigate potential noise impacts when these impacts and potential solutions are identified early in the subdivision review process.

6.2. Legal Authority

Local governments (counties, cities, and towns) are required to adopt subdivision regulations and to review and approve divisions of land that create parcels of 160 acres or less. Local subdivision regulations must prescribe standards for the design and arrangement of lots. Furthermore, local subdivision regulations must provide for:

- The avoidance of subdivisions that would involve unnecessary environmental degradation and danger of injury to health, safety, or welfare by reason of natural hazard or the lack of water, drainage, access, transportation, or other public services or that would necessitate an excessive expenditure of public funds for the supply of the services (MCA 2007, 76-3-501).
- The identification of areas that, because of natural or human-caused hazards, are unsuitable for subdivision development and prohibit subdivisions in these areas unless the hazards can be eliminated or overcome by approved construction techniques (MCA 2007, 76-3-504).

Clearly, it is within the scope of local subdivision regulations to identify any areas that may be unsuitable for subdivision development due to noise from highways and to prohibit noise sensitive development in those areas unless the hazards can be mitigated. Subdivision regulations must be in accordance with the growth policy, if a growth policy has been adopted (MCA 2007, 76-1-606).

The governing body is required to review a subdivision to determine its impact on public health and safety and may require the subdivider to design the proposed subdivision to "reasonably" minimize potentially significant adverse impacts identified through this review (MCA 2007, 76-3-608).

6.3. Options

Noise compatible land use planning measures that can be implemented through subdivision regulations are summarized below. Model Subdivision Regulations (MACO 2006) developed collaboratively by several organizations to comply with the Montana Subdivision and Platting Act are referenced where appropriate (see "Resources" Chapter for a link to the model regulations). In addition, model language that can be used to implement some of these options is provided in the Chapter 10.

6.3.1. Noise Analysis and Mitigation

The governing body may require that a noise analysis be submitted with the subdivision

application and preliminary plat if the proposed subdivision will include noise sensitive land uses located inside the 60 dBA noise contour established in the growth policy. The noise analysis, prepared by a qualified person and following MDT guidelines for traffic noise analysis, must account for site-specific conditions, including topographic factors, and existing and projected traffic volumes. The noise analysis must show whether or not noise sensitive land uses within the subdivision would be impacted by highway noise. If the noise analysis identifies an impact, then the noise analysis must also include an evaluation of proposed mitigation measures. The governing body may require mitigation as a condition of subdivision approval.

6.3.2. Site Design

Table 6, Figure 15, and Figure 16 identify noise compatible site elements as well as those that should be set back from the highway. Some of these site elements (e.g., dedicated right-of-way) may already be required by local governments. Designing a site so that noise compatible elements are located next to the highway can prevent noise impacts, while at the same time making the most appropriate use of the available space. When accessory structures designated for noise compatible uses are strategically located, noise sensitive land uses can be shielded by these buildings.

The Montana Subdivision and Platting Act includes some specific provisions which may prove useful in developing regulations that provide for site design to eliminate or minimize highway noise impacts.

Cluster Development. A local government that has a growth policy may adopt subdivision regulations that promote cluster development and preserve open space. Cluster development is defined in the law and refers to a subdivision with lots clustered in a group of five or more that is designed to reduce costs for infrastructure through the use of concentrated public services and utilities, while allowing other lands to remain undeveloped (MCA 2007, 76-3-103). Communities may choose to adopt cluster development regulations that provide for expedited subdivision review, provided that they meet certain requirements (MCA 2007, 76-3-509) (see Section X of the Model Subdivision Regulations for sample language).

Planned Unit Development. A planned unit development is a land development project consisting of residential clusters, industrial parks, shopping centers, or office building parks that compose a planned mixture of land uses built in a prearranged relationship to each other and having open space and community facilities in common ownership or use (MCA 2007, 76-3-103). Many communities have regulations that provide for flexibility in the application of subdivision design standards to planned unit developments (see Section VIII, Model Subdivision Regulations).

Table 6 Noise Compatibility of Selected Site Elements

Noise Compatible	Streets and frontage roads Parking facilities: garages and parking lots Open space Recreation facilities, including parks, bike paths, clubhouses, pools, tennis courts Required common facilities for drainage, sewage treatment, solid waste, or water supply Storage structures Hills and other natural features Utilities Rooms within residential buildings: kitchen, bathroom, laundry room
Noise Sensitive	Patios, decks, balconies, bedrooms Buildings with noise sensitive uses facing the highway, including residences, day-care centers, schools, hospitals, libraries, churches, lodging, public meeting rooms, and auditoriums

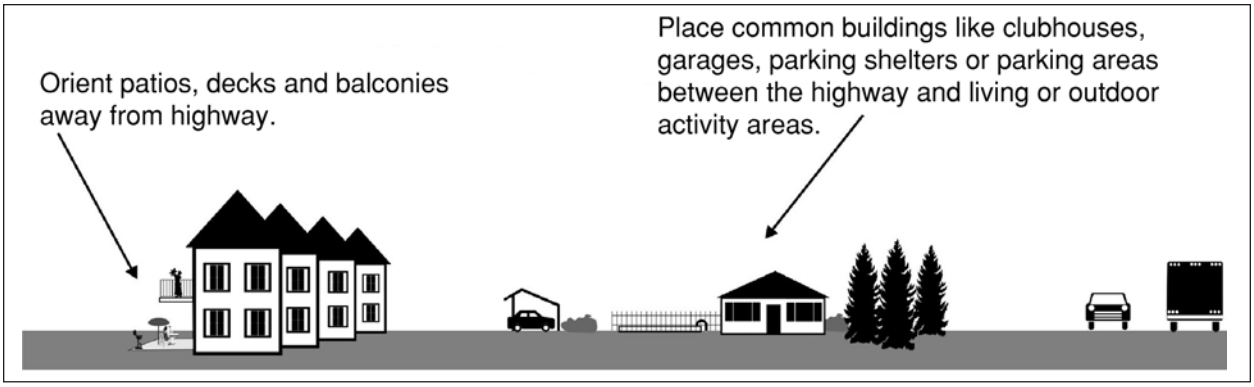

Figure 15 Site Design
(Source: Wyckoff et al. 2005)

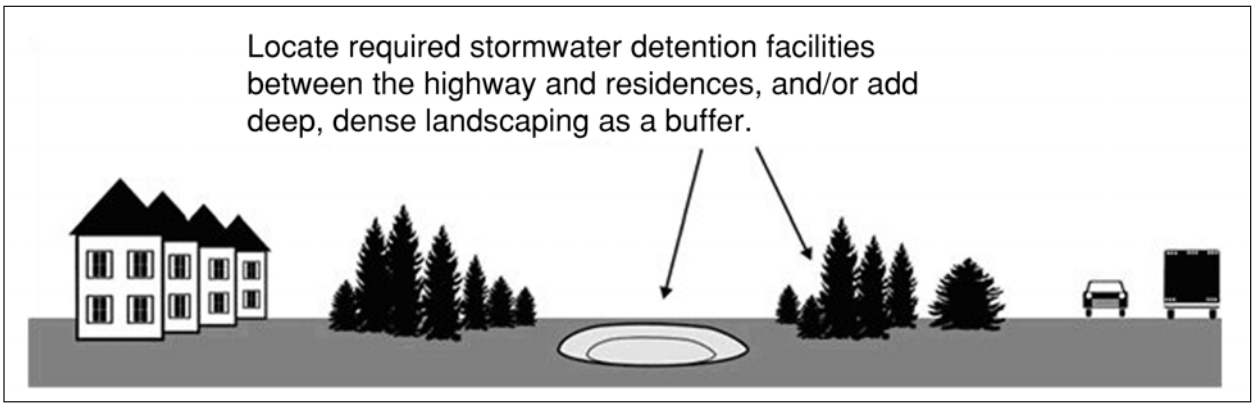

Figure 16 Site Design - Stormwater
(Source: Wyckoff et al. 2005)

Park Land Dedication. Subdividers are required to dedicate parkland for major subdivisions. Effective October 1, 2007, local governments have the authority to require that parkland be dedicated for minor subdivisions (MCA 2007, 76-3-621(8)). While there are many factors which affect the usefulness and location of dedicated parkland, communities may consider whether or not it is desirable to locate dedicated parkland next to the highway.

***Planned unit developments** are comprised of mixed uses, providing an excellent vehicle for designing subdivisions so that noise compatible uses are located close to the highway and noise sensitive uses are situated away from the highway.*

6.3.3. Lot Layout

Lot layout may be adjusted to either allow for noise walls or berms, or to provide adequate setback distances between the residence and the highway.

The governing body may require or allow for lots that are sufficiently deep to provide for noise barriers or setbacks for noise sensitive land uses. The distance required depends on the noise contours for the adjacent highway.

If lots back up to the highway noise source, deep and wide lots provide the most flexibility (Figure 17), allowing for the use of setbacks – usually a less expensive alternative – to separate noise sensitive uses from highway noise.

It is not possible to install an effective noise barrier next to lots with separate driveways. The Model

Subdivision regulations and many local regulations include a provision that limits the average depth of a lot to a distance that is three times its average width (see Section VI-F, Model Subdivision Regulations). Local governments could evaluate the feasibility (in light of the distances required to accomplish noise abatement) of creating lots that are deep enough to allow for noise barriers or setbacks in addition to noise-sensitive land uses. If this is a viable option, the governing body could amend its regulations to allow alternative narrow and deep lot configurations in order to maximize the useable space in areas affected by highway noise.

Narrow and deep lots are nearly impossible to mitigate for traffic noise impacts because there is no room for a berm and the homes are closer to the highway.

Prohibit through lots except when they are essential to provide separation of residential development from traffic arteries or to overcome specific disadvantages of topography or orientation. A "through" or "double-frontage" lot is a lot for which front and rear lines both abut streets) (see VI-F, Model Subdivision Regulations).

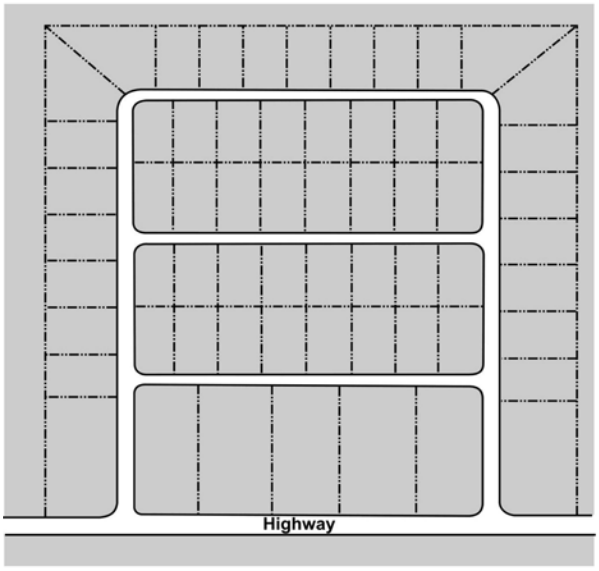

Figure 17 Deep & Wide Lots and Plats are most flexible for controlling noise next to highways
(Source: Wyckoff et al. 2005)

7. Zoning Regulations

7.1. Description

Zoning regulations divide jurisdictions into zones and restrict uses to certain zones or establish standards for the form of new development. Examples of commonly applied types of development standards that can be used to avoid highway noise impacts are building setbacks, height restrictions, and buffers between adjacent uses.

Zoning regulations are the primary tool available to local governments to guide future land use. Once land has been subdivided, zoning regulations are the only tool remaining to regulate the development of land.

Airport noise is an example of a noise source that has been addressed through local zoning regulations. Local governments have the authority to adopt airport affected area regulations that show noise contours for specified decibel levels, specify permitted and conditional uses, and address land uses that are not compatible with certain noise levels (MCA 2007, 67-7-203).

7.2. Legal Authority

Cities, towns, and counties have the authority to adopt zoning regulations for the purpose of promoting public health, safety, and welfare under Title 76, Chapter 2, Parts 1-3, MCA (MCA 2007). Zoning regulations can prescribe permitted and prohibited uses of the land, height and size of buildings, setbacks, and areas to be occupied by buildings versus open space.

Zoning regulations must be made in accordance with the growth policy (MCA 2007, 76-1-605, 76-2-203, 76-2-304).

7.3. Options

Options and key provisions for preventing or mitigating highway noise impacts through zoning regulations are identified below. Model language illustrating how some of these options might be implemented is included in Chapter 10. Options should be evaluated based on consistency with the desired land use pattern identified in the growth policy.

7.3.1. Purpose

Zoning regulations should include a finding stating the purpose of the provisions as it relates to promoting public health, safety, and welfare.

7.3.2. Zoning District

If the area within the 60 dBA noise contour is already zoned, adopt a noise overlay district with boundaries that coincide with the noise contour. A noise overlay district provides additional regulations that apply to the parcels within the designated overlay zone.

If the area within the 60 dBA noise contour is not zoned, establish a zoning district for the area affected by highway noise.

7.3.3. Permitted and Prohibited Uses

Allow only noise compatible land uses and prohibit noise sensitive uses. This option would work for areas where existing and desired land uses are noise compatible and the demand for such uses corresponds with the area of land in the zoning district. For example, agricultural zoning districts have been created in Park and Jefferson Counties.

Allow noise sensitive land uses only with a conditional use permit. Authorize a conditional use permit only if the applicant demonstrates with a noise analysis that the proposed use will not be affected by highway noise or that noise impacts will be mitigated with noise barriers, superinsulation, or setbacks. This is a good option for a community that does not want to limit land use within the district to only noise compatible uses. For example, some communities seek to avoid strips of commercial development which might be a consequence of the previous option. Check the "Resources" chapter (11) for more information about noise barriers and superinsulation.

Establish performance standards for any noise sensitive land uses within the zoning district. This option provides predictability for developers, mak-

***Zoning regulations can be used** to exclude noise sensitive land uses from areas impacted by highway noise unless noise impacts are mitigated.*

ing it attractive to communities that want to allow noise sensitive land uses in areas with noise issues. However, to the extent it differs from a conditional use process, it shifts the burden for determining appropriate noise mitigation from the developer to the governing body. This may be problematic because a "cookbook approach" may not ensure that noise impacts are mitigated. Site-specific factors affect noise impacts and the effectiveness of noise mitigation measures. Furthermore, Montana's Building Code, the International Building Code, and the International Residential Code only deal with sound transmission in the interior of the building. These codes do not apply to transmission of sound from the exterior of the building to the interior.

7.3.4. Mitigation

Require that mitigation measures achieve the following noise levels:

- A maximum loudest hour interior noise level of 40 dBA for structures where people regularly sleep,
- A maximum loudest hour interior noise level of 50 dBA for structures where people do not regularly sleep,
- A maximum loudest hour exterior noise level of 60 dBA for uses with outdoor activities (measured at the edge of the active use area), and
- If lot sizes are sufficient to allow for both adequate setbacks and noise sensitive land uses, require setbacks for noise sensitive structures.

7.3.5. Incentives

Provide an incentive to install berms or to set back noise sensitive land uses by waiving other requirements when these abatement measures are agreed to. For example, lot coverage or setback requirements could be waived on the opposite side of the lot to allow a residential structure to be set back to a location where residents are not harmed by noise.

Adopt regulations that provide an incentive for planned unit developments and cluster developments that mitigate highway noise impacts by placing noise compatible uses (including open space) next to the highway and setting back noise sensitive uses.

Adopt regulations that allow for a transfer of development rights. Rights to develop noise sensitive land uses could be transferred from designated "sending areas" to designated "receiving areas" where such development is desired.

7.3.6. Montana Example: City of Missoula

The city of Missoula created a special district for the Reserve Street Planning Area. The ordinance governing this district is performance-based and includes both absolute and relative standards. (Absolute standards must be met. Relative standards provide for points to be awarded for specified measures; a certain number of points must be earned before the development may be approved.) Key provisions of the ordinance are identified below.

- Purpose of ordinance includes abating noise generated by vehicular traffic.
- Requires setback of 100 feet between any residential structure and Reserve Street.
- Requires setback of 45 feet between any non-residential structure and Reserve Street.
- Requires that multi-family residential structures erect walls and/or berms or incorporate non-residential structures to reduce the noise level to the acceptable rate of 45 decibels within dwellings. (Also specifies sound transmission class and minimum height requirements for noise barriers).
- Awards points for limited access.
- Awards points for internal pedestrian walkway system.

7.3.7. Idaho Example – City of Meridian

The city of Meridian, Idaho, has included an article in their city code specifically addressing development along federal and state highways. The code includes a provision for noise abatement for residential uses along state highways (Chapter 3, Article H, 11-3H-4, Section D). In this section the requirement for noise abatement is detailed, including wall/berm height, materials, color/texture, and restrictions (Sterling 2007).

8. Acquisition of Land

8.1. Description

Local governments may avoid future highway noise impacts by acquiring land or the right to develop undeveloped land that is located within the 60 dBA noise contour and using the land for open space, biking and walking paths, and similar noise compatible land uses. This may be a good option for communities that are working to preserve values such as rural character, viewsheds, or recreational uses along undeveloped highway corridors.

8.2. Legal Authority

The Open-Space Land and Voluntary Conservation Easement Act (MCA 2007, Title 76, Chapter 6) authorizes cities, towns, and counties (as well as other public bodies and qualified private organizations) to purchase land, water, or development rights to preserve open space or certain conservation and aesthetic characteristics (MCA 2007, 76-6-106). "Open space" land is defined and refers to land that is provided or preserved for the following purposes:

- Parks or recreation;
- Conservation of land or other natural resources;
- Historic or scenic purposes; or
- Assisting in the shaping of the character, direction, and timing of community development.

Importantly, this law also authorizes local governments to appropriate funds, levy taxes and assessments, and issue and sell general obligation bonds for these purposes subject to certain requirements (MCA 2007, 76-6-109).

Local governments also have authority to acquire real property under other laws.

8.3. Options

8.3.1. Planning/Growth Policy

Adopting an open space or parks and recreation plan that is consistent with and an amendment to the growth policy is a good starting point. In addition to serving as a blueprint for any future acquisitions of public land, it may help to guide acquisitions by private organizations or dedications by developers.

8.3.2. Partnerships with Private, Nonprofit Land Trusts

Private, nonprofit land trusts have their own goals and values. However, to the extent that they overlap with those of the local government, such organizations can play an important role in the preservation or acquisition of open space. Often these organizations have the flexibility to acquire the land or development rights when they are available, while the local government does not. The property may be transferred to the local government at a later date.

8.3.3. Open Space Bonds

Several Montana communities, including Gallatin, Ravalli, and Missoula Counties and the city of Helena have issued bonds to pay for open space.

8.3.4. Community Transportation Enhancement Program

The Community Transportation Enhancement Program (CTEP) funds transportation related projects designed to strengthen the cultural, aesthetic, and environmental aspects of Montana's intermodal transportation system. Examples of projects include paths for pedestrian and bicycle transportation, landscaping, and acquisition of scenic easements. It is important to note that CTEP funds may be used to pay for bicycle or pedestrian paths that are principally used for transportation and not recreation.

9. Noise Abatement

If, in following recommendations for noise compatible planning, noise impacts are unavoidable, then noise barriers can be built to mitigate noise for a planned or existing development. This chapter discusses noise abatement options, such as barriers and berms. A local government may opt to require the developer build noise abatement when noise impacts are likely (such as when residential developments are planned outside the 60 dBA contour line).

When MDT conducts a noise analysis on a new or expanded road building project and finds that noise impacts exist or will exist in the design year of the project, then noise abatement is considered to mitigate those impacts. Depending on the scope of the project, noise abatement may come in the form of a design change to shift the vertical or horizontal alignment of the project if possible to avoid or lessen the noise impacts. If this is successful, then noise abatement in the form of noise barriers may never be necessary. But when that fails, often the only solution to an existing or potential noise problem may be to construct noise barriers, either walls or berms, or a combination of these (Figure 18).

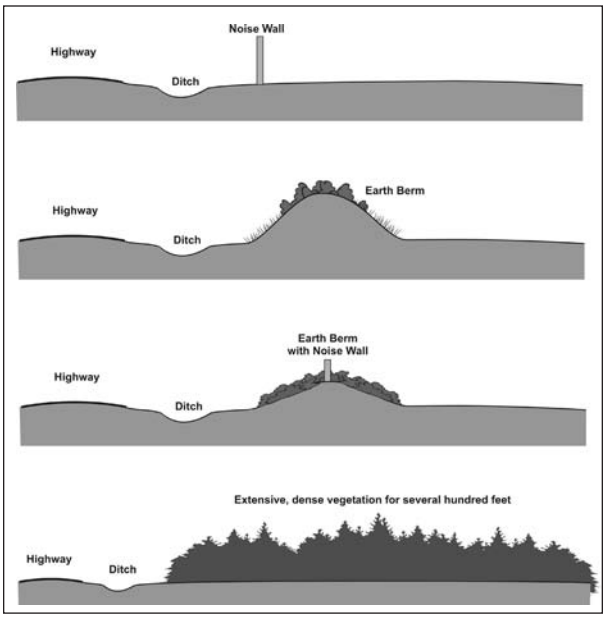

Figure 18 Common Noise Barriers
(Source: SDDOT 2006)

Noise barriers are an effective tool to protect or restore quality of life for people who must live along busy highway corridors. Table 7 summarizes noise barrier characteristics.

Noise barriers

Can reduce the loudness of traffic noise by as much as half;

Do not completely block all traffic noise;

Can be effective, regardless of the material used;

Must be tall and long with no openings;

Are most effective within 61 meters (200 feet) of a highway (usually the first row of buildings);

Do not increase noise levels perceptibly on the opposite side of a highway; and

Substantially reduce noise levels for people living next to highways.

(FHWA 2001)

9.1. Line of Sight

To be effective, noise barriers (either berms or walls) must break the line of sight between the noise source and the receiver (Figure 19). The line of sight refers to the direct path from the source to receiver without any intervening objects or topography and is often depicted as a ray of sound (drawn as a line). A noise barrier built to block this line of sight will interfere with the direct path the sound waves take from source to receiver. By just blocking the entire view of the noise source (such as trucks on a highway), the noise is reduced by 5 dBA.

Anytime you can increase the path length (distance and angle), forcing the sound to travel farther, you reduce the noise.

Table 7 Typical Noise Barrier Characteristics
(Source: Adapted from Wyckoff et al. 2005)

Noise Barrier Type	Width/Depth	Height	Materials	Cost	Noise Reduction (dBA Insertion Loss)
Noise Walls	Post width varies based on structural loadings and post spacing. Drilled concrete foundations are typically 3 to 4 ft. in diameter.	6-14 feet based on noise study	Precast concrete post & panel and others	Approx $30-35/ sq ft for precast or cast-in-place concrete post and panel; slightly more for concrete block	5 dBA for a wall that breaks line of sight. Much higher reductions attainable in many instances. Approx. upper limit: 15 dBA
Earth Berms	3:1 slopes minimum for maintenance	6-14 feet based on noise study	Earth covered with sod and/or other approved vegetation	$0-15/sq ft	Slightly greater than noise walls of equal height
Vegetative Buffer	100-600 feet	High enough to completely block the line of sight	Dense vegetation that cannot be seen through, even in winter	unknown	Maximum of 10 dBA at +/- 200 ft

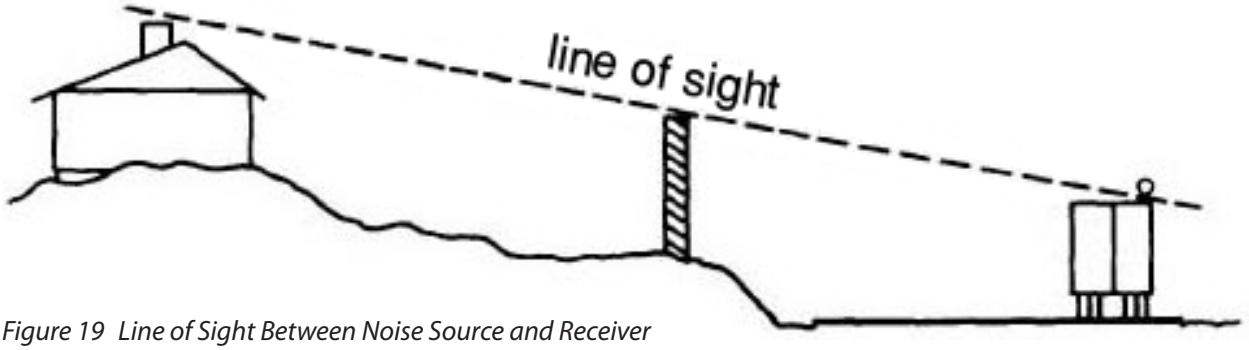

Figure 19 Line of Sight Between Noise Source and Receiver
(Source: Urban Systems Research & Engineering 1974)

9.2. Insertion Loss

Some amount of noise is reflected off the barrier, transmitted through the barrier, diffracted over the barrier, and some is absorbed (Figure 20). The term "insertion loss" is used to describe the effectiveness of a noise barrier and is dependent upon many factors. Insertion loss is the sound level at a receiver before construction of a barrier minus the sound level at the same receiver after the construction of the barrier.

9.3. Barrier Height

Once the line of sight is broken, each additional meter of height provides another 1.5 dB reduction in noise (Figure 21). The resulting taller wall will provide more noise reduction to more receivers, even those in the second row of houses.

Montana's policy requires that noise barriers built by MDT provide a minimum 6 dBA reduction in noise. Noise barriers must maximize the noise

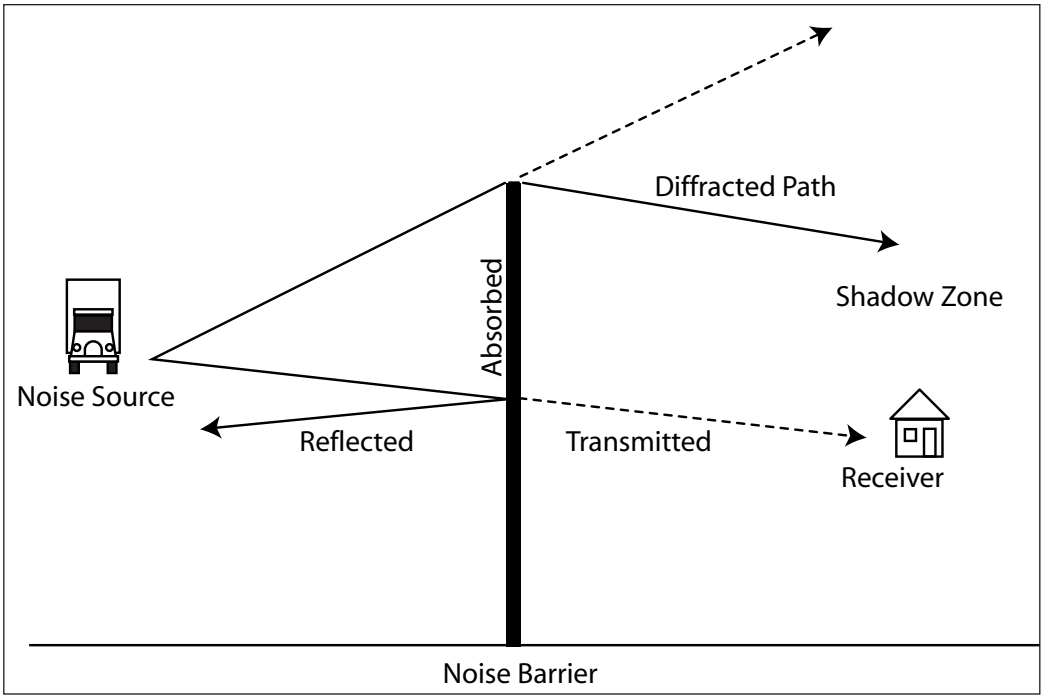

Figure 20 Noise Paths
(Source: Adapted from Fleming et al. 2000)

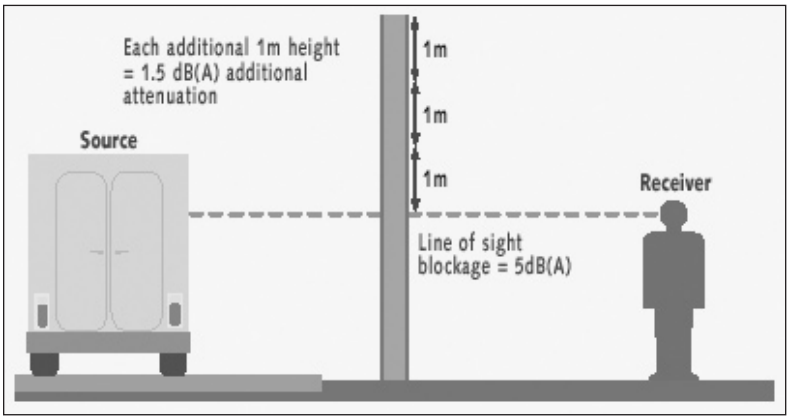

Figure 21 Noise Barrier Reduction with Height
(Source: FHWA 2001)

benefit, which means the noise barrier should achieve a higher decibel reduction and benefit the most residences as is economically reasonable.

9.4. Barrier Length

To be effective, a noise barrier that breaks the line of sight must extend beyond the affected receivers by a distance of four times in length as the distance between the source and the receiver. Figure 22 illustrates this. If the additional length needed is not obtainable, the receivers near the ends of the barrier will receive noise that wraps around the barrier ends. An option to combat this phenomenon is to wrap the barrier around the end receivers, as seen in the photo (Figure 23).

***MDT-built noise barriers** must reduce noise at first row homes by at least 6 decibels.*

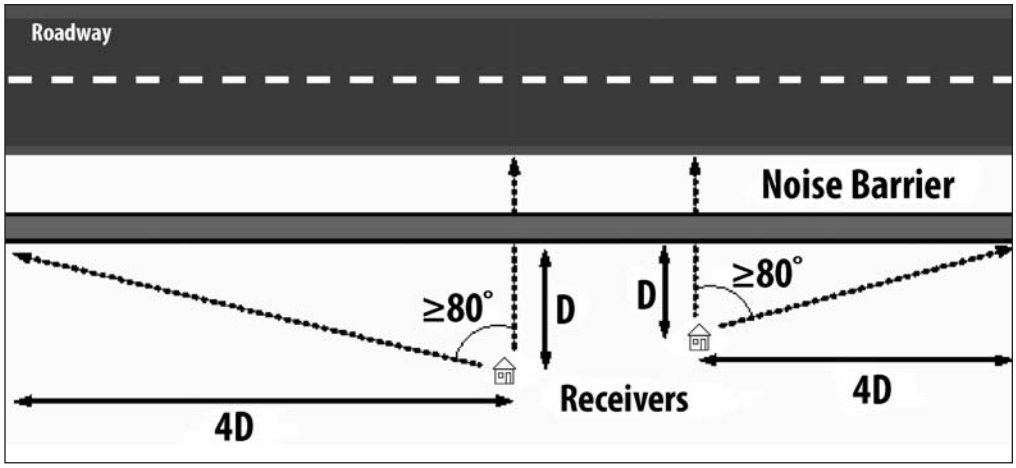

Figure 22 Length of Barrier Needed
(Source: FHWA 2001)

Figure 23 Wrap-Around Noise Barrier
(Source: Fleming et al. 2000)

9.5. Placement of a Barrier

A barrier's effectiveness has much to do with where it is placed in relation to the noise source and receiver. Generally, a noise barrier is most effective when it is close to either the noise source or the receiver (within 200 ft), causing the transmitted sound to travel the maximum distance to the receiver. The least effective position for barriers is midway between receiver and noise source.

10. Model Ordinance Language

This chapter includes model language that could be adapted for use in local zoning ordinances and subdivision ordinances.

10.1. General Provisions

These provisions are applicable to both zoning and subdivision ordinances.

Section 1 - Definitions
As used in this section, the following definitions apply:

"Active use area" means the land area within 35 feet of a dwelling unit on the sides closest to the highway where patios, children's play areas, and outdoor activities are common.

"dBA" means a number representing the sound pressure level in decibels that is frequency weighted to the A-scale according to a frequency response established by the American National Standards Institute (ANSI S1.4-1971) and that approximates the frequency response of the human ear.

"HVAC" means heating, ventilation, and air conditioning systems.

"Leq" means the equivalent, steady-state A-weighted sound level that in a stated period of time (usually one hour) contains the same acoustic energy as the time-varying sound level during the same period.

"Leq(h)" means the hourly value of Leq.

"Loudest hour Leq" means the Leq(h) associated with the loudest highway traffic hour.

"Noise barrier" means a noise wall, an earth berm, or a noise wall in combination with an earth berm, that obstructs the path of sound from the sound source to the sound receiver.

"Noise mitigation" means reduction of the noise that is transmitted from a noise source to a receiver as a result of distance, natural features, noise barriers, or other structures.

"Noise sensitive land uses" means residential uses, hospitals, nursing homes, hotels, motels, places of worship, libraries, schools, public meeting rooms, auditoriums, and day care centers.

"Superinsulated" means a building is designed and constructed to achieve a noise level reduction of more than 20 dBA between outdoor and indoor noise levels.

Section 2 - Purpose
The purpose of these regulations is to protect public health, safety, and welfare by protecting persons from excessive exposure to highway noise through requirements that prevent or mitigate the effects of highway noise on persons within the area affected by highway noise.

Section 3 - Standards
The noise standards set forth in Chapter 4 should be referenced in this section. In summary, 60 decibels at the edge of the active use area for outdoor activities and for land uses involving sleep where windows can be opened; 60 decibels at the edge of a principal building for indoor activities involving sleep where windows do not open and are double-paned; and 70 decibels at the edge of a principal building where activities do not include sleep.

Section 4 - Noise Analysis
A noise analysis must be prepared by a registered engineer or qualified professional transportation noise analyst who has been trained in the use of the Federal Highway Administration (FHWA) Transportation Noise Model or a replacement model that has been approved by the FHWA. A noise analysis must include the following:

- A description of the proposed development.
- A narrative description of the proposed site configuration and any proposed noise mitigation measures.
- A diagram showing the proposed site configuration including the location of noise sensitive land uses and any proposed noise mitigation measures.

- Unadjusted 60 and 70 dBA noise contours shown as an overlay on the site diagram. Noise contours must be developed using the FHWA Transportation Noise Model (or a replacement model that has been approved by the FHWA).
- If the noise analysis shows that projected noise levels will exceed the planning noise threshold for the applicable activity at the location specified, the noise analysis must include:
    - Any adjusted noise contours and site specific analyses used to adjust the noise contours based on improved topography;
    - Calculations to support the noise level reduction of any proposed noise mitigation measure;
    - A description of the width, depth, height, length, and materials used in any proposed noise barrier; and
    - A description of construction methods and materials used in any proposed superinsulated building design. The sound transmission class must be provided for materials used.

10.2. Subdivision Regulations

Section 5 - Special Requirements for Subdivisions Proposed in Highway Noise Overlay District

The requirements of this section apply to divisions of land that include land within the Highway Noise Overlay District identified on [*insert name of map that shows noise contour here*]. The Highway Noise Overlay District includes land inside the projected, unadjusted 60 dBA loudest hour noise contour for [*fill in the year for which the projection was done or "the operational capacity of" insert name of highway*].

A noise analysis prepared in compliance with Section 4 must be submitted with any application for preliminary plat approval.

A subdivision in the Highway Noise Overlay District can be approved only if:

- Noise sensitive land uses within the subdivision are prohibited by a zoning regulation, deed restriction, or covenant or
- A noise analysis prepared in compliance with Section 4 demonstrates that any applicable exterior noise standards established in Section 3 will be met through one or more of the following measures:
    - Site design to ensure that noise sensitive land uses are placed outside of the applicable noise contour,
    - Site design that achieves noise mitigation through placement of accessory structures between the noise source and the noise receiver, or
    - Installation of a noise barrier.

Note: Recommended additional revisions to the existing subdivision regulations include the following:

- Add noise analysis to the list of required materials to be submitted with a subdivision application (Section II-A-5, Model Subdivision Regulations).
- Add noise barriers to the definition of "public improvement" (Definitions, Model Subdivision Regulations).

10.3. Zoning Regulations

Section 6 - Zoning Overlay District

The requirements of this section apply to development of land that is within the Highway Noise Overlay District identified on [*insert name of map that shows noise contour here*]. The Highway Noise Overlay District includes land inside the projected, unadjusted 60 dBA loudest hour noise contour for [*fill in the year for which the projection was done or "the operational capacity of" insert name of highway*].

Within the Highway Noise Overlay District, noise sensitive land uses permitted in the underlying zoning district are conditional land uses.

A noise analysis prepared in compliance with Section 4 must be submitted with any application for a conditional use permit under this section.

An application for a conditional noise sensitive use in the Highway Noise Overlay District may

be approved only if a noise analysis prepared in compliance with Section 4 demonstrates that any applicable exterior and interior noise standards established in Section 3, will be met through one or more of the following measures:

- site design to ensure that noise sensitive land uses are placed outside of the applicable noise contour;
- site design that achieves noise mitigation through placement of accessory structures between the noise source and the noise receiver;
- installation of a noise barrier; or
- superinsulated building design and construction.

11. Published Resources for Noise Management

A number of helpful publications and resources are available on the Federal Highway Administration's website, Environment Section, Highway Traffic Noise. All of these links were valid as of the published date of this document. If any of these links do not work, try pasting them into your web browser. The following is a list of the different types of documents you can find at this general address: www.fhwa.dot.gov/environment/ab_noise.htm#general.

Highway Traffic Noise (1992). This pamphlet describes some of the fundamentals of highway traffic noise and the noise requirements in the highway program.

Synthesis of Noise Effects on Wildlife Populations (2004). This report contains a summary of ongoing work on the effects of noise on wildlife populations.

Summary of Noise Barriers Constructed by December 31, 2004. This paper contains a listing of all noise barriers constructed with highway program monies since 1973, as reported by State highway agencies. The listing is updated every three years and contains information on length, height, cost, material, location, and year constructed for each State. It is intended for all audiences.

Highway Traffic Noise Barrier Construction Trends. Through the end of 2004, forty-four State DOTs and the Commonwealth of Puerto Rico have constructed over 2,205 linear miles of barriers at a cost of over $2.6 billion ($3.4 billion in 2004 dollars) This paper presents a brief analysis of the data on these barriers. (For the data, please consult the detailed barrier listing, Summary of Noise Barriers Constructed by December 31, 2004).

Highway Traffic Noise Barrier Materials and Cost by State. State DOTs have constructed noise barriers from earth, masonry block, brick, concrete, metal, wood, other materials (e.g., polyurethane), and combinations of materials. This paper contains an analysis of data on noise barrier materials, listed by each state that has utilized a specific material type. (For the data, please consult the detailed barrier listing, Summary of Noise Barriers Constructed by December 31, 2004).

Keeping the Noise Down, Highway Traffic Noise Barriers (2001). This brochure presents very basic information on noise barriers, i.e., it discusses the questions a person might normally ask about noise barriers.

Highway Noise Barrier Design Package (2000). This package includes a noise barrier design manual entitled "FHWA Highway Noise Barrier Design Handbook"; an accompanying 40-minute videotape, which highlights all the facets of barrier design included in the manual; and a CD-Rom, which contains an extensive noise barrier design photographic library and an electronic copy of the noise barrier design manual.

11.1. Building Design and Construction

The Noise Guidebook (undated). www.hud.gov/offices/cpd/energyenviron/environment/resources/guidebooks/noise/. Contact the Environmental Planning Division, Office of Environment and Energy, U.S. Department of Housing and Urban Development (HUD). This guidebook was prepared as the basic reference document for HUD field staff responsible for implementing the HUD Department's noise policy. It brings together in one place all the various reports, informational papers, and other HUD-sponsored items. More publications about acoustics can be found at www.hudnoise.com/.

Insulation of Buildings Against Highway Noise. (1977). www.fhwa.dot.gov/environment/high/index.htm. This technical report covers basic concepts of noise insulation, calculation of noise reduction using the Exterior Wall Noise Rating and a room absorption factor, noise measurement, ventilation design, and cost estimation.

11.2. Local Plans and Regulations

Model Subdivision Regulations (September 2006). www.montanaplanners.org/news.htm. Presents model regulations developed in collaboration with several organizations to comply with the Montana Subdivision and Platting Act. The model regulations do not specifically address highway noise concerns; however, this guide references several provisions that could be modified for the purpose.

Bozeman Unified Development Ordinance. revize.bozeman.net/revize/bozeman/planning/unified_development_ordinance.aspx. Section 18.30 of the document contains the provisions of the *Bozeman Entryway Corridor Overlay District*. While noise impacts are not specifically addressed, these regulations provide a good example of an overlay district for road corridors. Provisions address setbacks and landscaping of setbacks.

Greater Bozeman Area Transportation Plan Year 2001 Update (June 2001). www.bozeman.net/planning/_image.aspx.

Kalispell Growth Policy 2020 (February 2003). www.kalispell.com/planning/growth_policy.cfm. Growth Policy amendments for Highway 93 South and Highway 93 North include goals for highway corridors that address highway noise and other issues.

Missoula County Growth Policy, 2005 Update (June 2006). www.co.missoula.mt.us/opgweb/LongRange/GrowthPolicy.htm.

2004 Missoula Urban Transportation Plan Update (May 2004). www.co.missoula.mt.us/transportation/documents.htm. See especially the "Growth Policy" section.

City Special District #2, Ordinance #2924, Reserve Street Planning Area (January 1995). ftp://www.co.missoula.mt.us/opg2/Documents/CurrentRegulations/Misc/SD2City.pdf. Zoning regulations designed to abate noise generated by vehicular traffic. Described in "Zoning Regulations" section.

11.3. Noise Compatible Land Use Planning

The Federal Highway Administration's website has a number of helpful and informative documents on this topic as well, located at the general link of: www.fhwa.dot.gov/environment/noise/ncp/index.htm. Some of the documents currently available at their website include:

The Audible Landscape: A Manual for Highway Noise and Land Use (1976). This manual covers a full range of techniques to address highway noise through land use planning, including a wide variety of regulatory measures as well as physical techniques.

Entering the Quiet Zone: Noise Compatible Land Use Planning (2002). This brochure summarizes the general nature of highway traffic noise; provides examples of Noise Compatible Land Use strategies, either constructed or planned; and encourages a proactive posture by local decision makers, developers and citizens to share in and actively influence land use next to highways.

Noise Compatible Planning (2006 – Updated Periodically). This fact sheet includes synopses of several local plans and regulations. In most cases, links to online documents are provided.

The rest of this list includes documents found at other websites:

Traffic Noise in Montana: Community Awareness and Recommendations for a Rural State (2004). www.mdt.mt.gov/research/docs/research_proj/noise/final_report.pdf. This research report presents a detailed examination of land use planning and development processes and procedures within the state of Montana and includes the results of discussions with a number of local planners in Montana and other states. The document synthesizes noise compatible planning activities in cities and counties in other states. Additionally, two surveys were developed and administered: one for citizens living near busy roads in four Montana urban areas and one for

local Montana planners. The surveys deal with people's perceptions of noise and noise mitigation, and interest in noise compatible planning and development. The analysis of the survey data, the literature, and the practice has resulted in a number of recommendations to MDT regarding implementation of noise compatible planning and development in Montana.

Proactive Noise Avoidance and Mitigation Measures (2006). www.state.sd.us/Applications/HR19ResearchProjects/Projects%5CSD2005_06_F.pdf. South Dakota Department of Transportation (SDDOT) focuses this research project on mitigation and avoidance of highway noise through a program of shared responsibility between the SDDOT and local governments.

11.4. Other Noise Resources

MDT Noise Policy and Manual, Environmental Services Division (Periodically Updated). www.mdt.mt.gov/business/contracting/air_noise.shtml.

Code of Federal Regulations (23 CFR 772). 23 CFR 772. FHWA noise regulations.

Traffic Noise Model Version 2.5 TNM Lookup Tables. www.fhwa.dot.gov/environment/noise/tnm/index.htm. The FHWA TNM Version 2.5 Look-up Tables provide a reference of pre-calculated FHWA TNM results for simple highway geometries (i.e., long, straight roadways over flat ground). The calculations assume a receiver set at a height of 1.5 m above the ground. If desired, a parallel barrier may also be included in the calculations. The simple computer program can be used to calculate noise levels for a given set of traffic volumes and mix, speeds, and distances.

Other States

The FHWA website for noise-compatible planning (November 2006 – Updated Periodically). www.fhwa.dot.gov/environment/comgrwth.htm. Provides reports and examples of what other states and local jurisdictions are doing with regard to noise compatible planning.

Proactive Noise Avoidance and Mitigation Measures (November 2006). www.state.sd.us/Applications/HR19ResearchProjects/Projects/SD2005_06_X.pdf. This technical report was prepared for the South Dakota Department of Transportation (SDDOT). Its objectives are to equip the SDDOT and local communities with tools for noise compatible land use planning. It provides a good summary of options for addressing highway noise.

11.5. Some Traffic Noise Consultants in the Region

Axiom-Points, LLC. PO Box 595, Star, ID 83669. Phone: (208) 869-4155 Fax: (208) 585-9015

Big Sky Acoustics, Helena, MT (406) 457-0407. Online: www.bigskyacoustics.com/

Bionomics Environmental, Boise, ID (208) 939.1022. Online: bionom.com/

Carter & Burgess, Inc., Denver, CO (303)223-5852. Online: www.c-b.com

11.6. Traffic Data

MDT Traffic Data Collection Section. mdt.mt.gov/publications/datastats.shtml or (406) 444-7217. Vehicle volume data from 58 Automatic Traffic Recorders are available online. Vehicle volume data from other sites and speed data may be purchased.

12. References

Berglund, B., Lindvall, T., and Schwela, D.A., eds., "Guidelines for Community Noise." World Health Organization, Geneva. (1999).

City of Bozeman, "Bozeman 2020 Community Plan." (October 2001) p. 10-22.

Code of Federal Regulations (CFR), Title 23 Highways, Part 772 Procedures for Abatement of Highway Traffic Noise and Construction Noise. 23CFR772. Date last accessed October 28, 2007.

Federal Highway Administration (FHWA), "Keeping the Noise Down: Highway Traffic Noise Barriers." Publication No. FHWA-EP-01-004, Washington, D.C. (February 2001) 22 pp.

FHWA, "Highway Traffic Noise." www.fhwa.dot.gov/environment/htnoise.htm. (1992). Date last accessed October 26, 2007.

Fleming, G.G., Knauer, H.S., Lee, C.S.Y., and Pedersen, S., "FHWA Highway Noise Barrier Design Handbook". www.fhwa.dot.gov/environment/noise/design/index.htm. (2000). Date last accessed December 19, 2007.

Harris, C. M., "Handbook of Acoustical Measurements and Noise Control." Acoustical Society of America, Woodbury, New York. (1998) p 16.2, 16.11.

Housing and Urban Development (HUD), "The Noise Guidebook." HUD Environmental Planning Division Office of Environment and Energy, Washington, D.C. (1974).

Kalispell City Planning Board, "Kalispell Growth Policy 2020." (February 2003) pp. 74-80.

Missoula County, "Missoula County Growth Policy 2005 Update." (June 2006) pp. 3-6.

Montana Association of Counties (MACO), "Model Subdivision Regulations." (September 2006) 224 pp.

Montana Code Annotated (MCA), data.opi.state.mt.us/bills/mca_toc/index.htm. (2007). Date last accessed December 19, 2007.

Montana Department of Transportation (MDT), "Traffic Noise Analysis & Abatement: Policy and Procedure Manual" (June 2001) 31 pp.

Pennsylvania Department of Transportation (PENNDOT) and Federal Highway Administration, "Making Sound Decisions about Noise Abatement." ftp://ftp.dot.state.pa.us/public/PubsForms/Publications/PUB%2021.pdf. PENNDOT publication #21. (July 2003) 20 pp. Date last accessed December 19, 2007.

South Dakota Department of Transportation (SDDOT), "Tools for Preventing Adverse Effects From Highway Noise: A State/Local Partnership Approach." Pierre, South Dakota (August 2006) 40 pp.

Sterling Codifiers, Inc., "Meridian, Idaho: City Code." www.sterlingcodifiers.com/ID/Meridian/index.htm. (July 2007). Date last accessed December 19, 2007.

Suter, A. H., "Noise Sources and Effects – A New Look." *Sound and Vibration,* (January 1992) 14 pp.

Urban Systems Research and Engineering, Inc., "The Audible Landscape: A Manual for Highway Noise and Land Use." www.fhwa.dot.gov/environment/audible/index.htm. U.S. Department of Transportation, Federal Highway Administration, Washington D.C. (1976, 1974), 95 pp. Date last accessed December 19, 2007.

URS, "2004 Missoula Urban Transportation Plan Update." Missoula Office of Planning and Grants, Missoula, MT. (May 2004) pp. 11-15, 127-131.

Wyckoff, M.A., Manning, M., Avery, K. and Joseph VanKerkhove, "Michigan Local Highway Noise Guidebook: Tools to Prevent and Mitigate Highway Noise." Michigan Department of Transportation (September 2005, unpublished).