Q-1: How is noise measured?

A-1: Noise, usually defined as unwanted or unacceptable sound, is measured in terms of decibels. A decibel is a unit of measurement that quantifies the sound pressure differences in the air that we perceive as sound (or noise) on a scale ranging from zero decibels on up. Zero decibels is the threshold of human hearing, 40 to 50 decibels is normal for a peaceful neighborhood, 70 to 80 decibels is the level adjacent to a busy urban street or 50 feet from a major freeway, and 120 to 140 decibels is a typical level at which sound is painful. For highway traffic noise studies, noise levels are quantified in terms of the equivalent sound level, or Leq. The Leq is essentially the average noise level over period of time, usually one hour.

Q-2: How are noise level changes perceived?

A-2: Studies have shown that changes in noise levels of 3 decibels or less are not normally detectable by the average human ear. An increase of 5 decibels is generally readily noticeable by anyone, and a 10-decibel increase is usually felt to be "twice as loud" as before.

Q-3: How do changes in traffic or roadway geometry affect noise levels?

A-3: Due to the nature of the decibel scale, a doubling of traffic will result in a 3-decibel increase in noise levels, which in and of itself would not normally be a perceivable noise increase. Traffic would need to increase at least three times to result in a readily perceivable (5 decibel) increase in noise. Using the same reasoning, if a highway is moved half as close to existing homes as it is now (i.e., from 200 to 100 feet), the noise levels will increase by 3 decibels. Conversely, if a highway is moved double the distance from existing homes, the noise levels will decrease by 3 decibels. Noise level increases due to highway projects are usually due to a combination of increased traffic and changes in the roadway alignment.

Q-4: When is a noise analysis required?

A-4: A noise analysis is required for a proposed CDOT project if that project consists of:

- A new highway built on a new location, or
- An existing highway that is significantly altered by substantially changing the horizontal or vertical characteristics of the road, or
- The number of through traffic lanes being increased. Minor projects, such as normal roadway resurfacings (without adding new lanes), do not require a noise analysis.

Q-5: Is a noise analysis required when the speed limit of a highway is changed?

A-5: No. Under the current regulations, a speed limit increase does not qualify as a project in which a noise analysis is required. CDOT does not have legal enforcement authority on the highways and cannot enforce lower speeds; enforcement of the traffic laws are the responsibility of local law enforcement.

Q-6: Does CDOT analyze noise levels on existing highways?

A-6: In the absence of a major highway project as described above, CDOT does not perform noise studies or mitigate noise for existing highways.

Q-7: What constitutes a traffic noise impact?

A-7: A "noise sensitive receiver" (defined as homes, parks, schools, businesses, etc.) is considered impacted by noise if either future noise levels (generally a 20 year projection) approach or exceed the CDOT Noise Abatement Criteria, or if there is a substantial increase in future noise levels over existing noise levels from a proposed CDOT project as described above. These are the noise levels experienced at the commonly used exterior portions of a property on the lowest or ground level for each home or individual unit. For residences, schools, and parks, impact is defined when the Leq is 66 decibels or higher, and for businesses and other commercial properties the impact Leq value is 71 decibels. A substantial increase impact occurs when there is a projected 10-decibel increase over existing noise levels. Impacts such as these require mitigation consideration and analysis, which will result in the construction of noise barriers if they are determined to be feasible and reasonable.

Q-8: How was the selection of the noise levels in the Noise Abatement Criteria determined?

A-8: CDOT's selection of the noise abatement criteria levels were based on guidance from FHWA, and is consistent with the criteria used by all state DOT's. FHWA used numerous approaches in establishing the noise abatement criteria were considered, to include hearing impairment, annoyance, sleep interference, and speech communication interference. The main challenge in establishing the criteria was to balance noise levels which are desirable with those that are achievable. As a result, speech impairment was usefully applied as being the condition that best met that balance.

Q-9: Does EPA have standards which apply to highway noise?

A-9: Not at this time. EPA does have recommended noise levels which are considered goals, but did not recommend those levels as strict standards applicable to highway projects due to factors including but not limited to cost, engineering feasibility, and geographical characteristics.

Q-10: What does CDOT consider "feasible and reasonable"?

A-10: A noise barrier must be both feasible and reasonable if it is to be constructed with a highway project. Feasibility and reasonableness are determined by criteria that are quantifiable but flexible, and judgments for special and/or unusual circumstances are made on a case-by-case basis. As a result, noise mitigation is not automatically provided where noise impacts have been identified. A barrier is feasible if it can be constructed without major engineering or safety issues and provide a substantial noise reduction to the adjacent receivers. Reasonableness deals with whether or not the barrier can be constructed in a cost-effective manner, the percentage of residential-type development, overall noise levels and noise level increases, and the desires of the community.

Q-11: What is a "substantial noise reduction"?

A-11: A noise barrier must provide at least a readily perceptible decrease in noise levels to adjacent receivers to be effective. This is defined as a noise decrease of at least 5 decibels. As noise level changes of 3 decibels or less are not generally perceivable, it is not prudent to construct a noise barrier that gives only a 1 or 2 decibel benefit to adjacent properties.

Q-12: What types of noise barriers are constructed?

A-12: Noise barriers are commonly constructed as walls, earthen berms, or a combination of the two. Walls are most common, and are usually constructed out of dense materials such as concrete or masonry block. Earth berms are a natural alternative to walls, but require much more land to construct. Walls can be constructed on top of berms in order to raise the overall height of the barrier.

Q-13: How do noise barriers work?

A-13: Noise barriers reduce noise by blocking the direct travel of sound waves from a source (such as a highway) to adjacent homes or businesses, forcing the waves over the top or around the barrier. The barrier must be high enough and long enough to block the view (line of sight) of the highway. This is the phenomenon that allows a noise barrier to provide a perceivable noise reduction. Noise barriers do very little good for homes on a hillside overlooking a road or for buildings which rise above a barrier. Openings or gaps in barriers for driveway connections or street intersections reduce barrier effectiveness. Noise barriers are most effective for the first one or two rows of homes at distances up to 200 to 300 feet from the barrier. As noise levels decrease with distance, there is a point away from the highway at which noise barriers are no longer effective. It is important to note that barriers are not designed to eliminate or block all noise.

Q-14: Are noise barriers built to protect locations on the upper floors of homes?

A-14: Noise barriers may, under certain geographic conditions, be able to be designed to protect upper levels of multi-family structures, where each unit is a separate residence. For single-family homes, the primary consideration is the outdoor, ground-floor areas of human activity. Barriers built for the second floor would have to be tall enough to provide a substantial noise reduction for those areas, which in most cases would require very high walls that would not be feasible or reasonable.

Q-15: How are noise reflections from buildings and barrier walls considered?

A-15: Highway traffic noise levels are not substantially increased by construction of a noise barrier or the presence of a building on the opposite side of a highway from sensitive properties. This is because the theoretical maximum noise increase from a source is limited to 3 decibels, which corresponds to a doubling of the source. In practice, not all of the sound energy is reflected back to the receiver. Some of the sound is diffracted over the barrier, some is reflected to points other than the affected property, some is scattered and/or absorbed by ground coverings and other terrain, and some is blocked by the presence of other vehicles on the highway. The overall noise increase is normally limited to 1-2 decibels at the most. In general, this is not a perceptible increase, but the character of the noise may seem to change, which is what is usually noticed.

In the case of parallel barriers, however, studies have shown that if two walls are constructed very close together, there is a potential for multiple reflections that may perceptibly increase noise levels. Generally, this is not normally a problem for barriers greater than 200 feet apart or where the width-to-height ratio is more than 10:1 (barriers 10 feet high should be at least 100 feet apart).

Q-16: Will planting vegetation help reduce noise levels?

A-16: Vegetation is only effective for reducing noise levels if it is at least 100-200 feet deep, high enough that it cannot be seen over, and dense enough that it cannot be seen through. It is not feasible to plant enough vegetation along a highway to achieve this type of reduction, although planting trees or shrubs can provide aesthetic benefit and visual screening.

Q-17: Can anything be done about "Jake Brake" use?

A-17: Colorado state law now requires that any vehicle equipped with engine compression brake devices (commonly referred to as "Jake Brakes") be equipped with proper mufflers. Failure to do so will result in a $500 fine. The enforcement of this law is the responsibility of the local authorities.

CDOT has not restricted the use of these devices for safety reasons. However, CDOT has assisted local entities with this issue by installing "Engine Brake Mufflers Required" signs along selected highways.

Q-18: What is the effect of pavement type on noise levels?

A-18: Research regarding pavement influence on noise levels has been an ongoing process. In general, the use of certain types of asphalt pavements or texturing of concrete pavements can give an initial noise reduction benefit to properties 200 to 300 feet from the highway. Over a long period of time, however, it is not known if these benefits continue to be realized. As a result, pavement type, in and of itself, cannot be considered as an alternative to conventional noise mitigation measures at this time. CDOT's present policy for pavement type selection is made based on a life-cycle cost analysis, which at this time does not consider noise as a primary factor.

Typical Noise Levels

Noise Source	Noise Level (DBA)
Commercial Jet	110-120
Shouting at 5 feet	95-105
Heavy Truck/Motorcycle at 25 feet	85-95
Freeway Traffic at 50 feet	70-80
Conversational Speech at 5 feet	55-65
Quiet Neighborhood	45-55
Living Room	35-45
Remote Outdoor Location (no wind)	20-30
Threshold of Hearing	0