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# What is Noise?

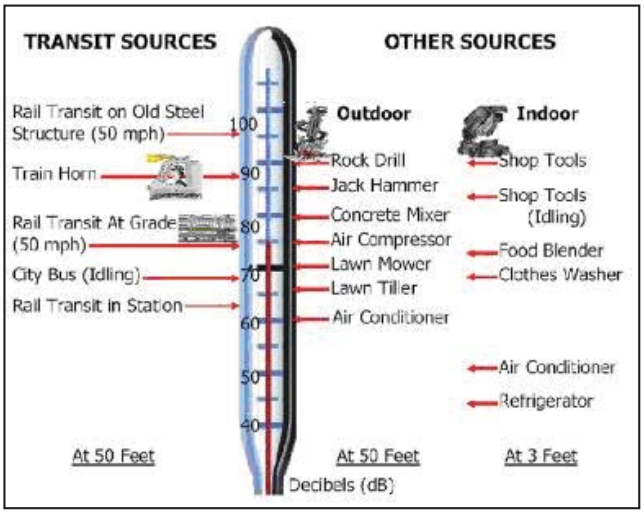
Noise is all around us and can be defined as unwanted sound. An alarm clock, a blender, a lawn mower, a tractor-trailer and a train all produce noise. The extent to which sound becomes annoying and then becomes noise is determined by the intensity of the noise, the frequency of the noise, and the background noise environment.

Noise is measured in decibels (dB). The human ear is sensitive. While a 2 to 3 dBA change is barely perceptible, a 5 dBA change is readily perceived. A 10-dBA change is perceived as a doubling or twice as loud.

As shown in the graphic, you can see some examples of the noise levels of various household items, as well as transit sources. The distance between the source (where the sound is produced) and the receiver (where the sound is heard) is also shown. It is important to note that sound reduces with distance. Three factors affect the sound between you and the source of the sound:  divergence, or sound going in a number of different directions; absorption/diffusion (trees, buildings, etc. absorb sound) and shielding (berms or noise walls deflect sound).

# Noise Sources

Commuter and light rail, by virtue of their names, operate on a wheel and track system. This system generates noise from several sources. Measured at a distance of 50 feet from the track, the noisiest pass-by levels from diesel multiple unit, electric multiple unit, and light rail transit vehicles operating at a speed of 50 mph are roughly the same, or about 80 dBA.




Engine noise from diesel-powered commuter rail vehicles is generated by the diesel engine. Light rail and EMU are powered by electricity.

Noise for all commuter and light rail vehicles also emanates from frictional contact between the wheels and the steel rails. This noise increases significantly with speed. Noise can become more pronounced when there are irregularities in the rail or wheel surface is rough. Noise also occurs when rail vehicles turn corners and the wheels "squeal" as the inside part of the wheel is forced against the track more tightly.

The loudest noise generated during transit operations is from horns, bells, and gongs that are used at stations, at-grade crossings, and at populated areas as a warning of the vehicle approach. These noise generators are located either on the train itself or at the crossing. This particular noise is addressed in the FasTracks Facts Sheet entitled Train Horns at Grade Crossings.

## How is a Noise Analysis Done?

Many elements go into a noise analysis, but first the existing noise levels or background noise is determined by specialists going out into the field and taking noise measurements. Let's use an example of the neighbor mowing the lawn. At that point in time, the sound is unwanted, but when the lawn mower stops, things get back to normal until another neighbor starts to pressure wash the deck. At the same time, a moving truck comes down the street with your new neighbors, a dog is barking somewhere, the birds are chirping, and neighbors are going to and from work. All of these factors are accounted for in background noise measurements.

### Step One: Determine Background Noise Levels

As directed by FTA, RTD must monitor the background noise for a period of 24 hours. In some areas, the noise is also monitored for 1 hour. This gives us a basis for the day-to-day noise levels in the community.

### Step Two: Evaluate Specifics of the Noise Environment

Once the background noise level is determined, the analysis will then look at several factors:

- Operational time-frame—Train operations during late night or early morning periods are penalized in the analysis because this is the time of day in which noise for the community is most annoying.

- Train speed—Train speed directly relates to the noise levels generated.
- Topography and distance—Evaluation of the relationship between the sound source (train) and the receiver (house, school, church, etc.).
- Sensitivity of the receiver—In the analysis, the type of activities that take place are considered. “Sensitive land uses” (like churches, and other places where quiet is essential) have higher criteria for the analysis.

## Step Three: Determine Level of the Noise Impact

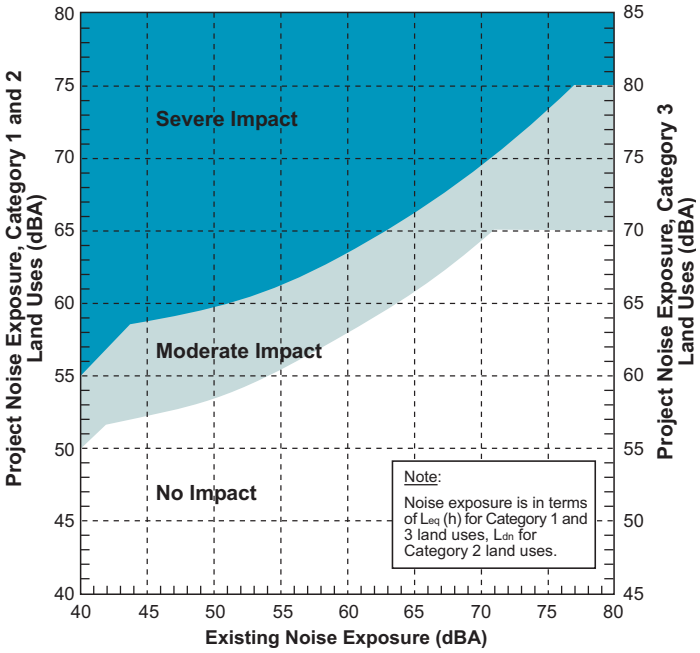
A noise impact is based on the comparison of the existing noise levels and the future projected noise levels from the project. The range of impacts has been determined using community surveys to help define what levels of sound increase are generally annoying to the public.

The FTA defines three levels of impact:

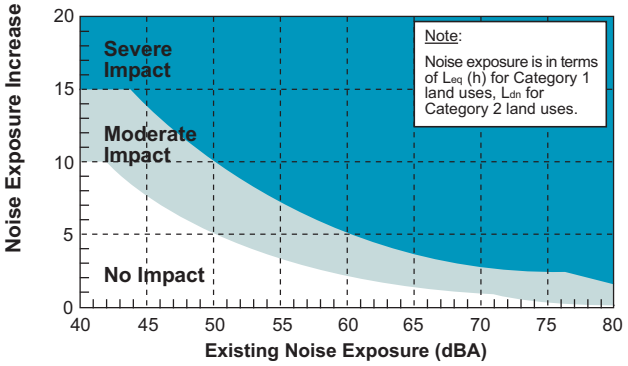
- No Impact
- Moderate Impact
- Severe Impact

***No Impact*** is when, on the average, the introduction of the project will result in increases in sound that are generally not perceived as annoying to the community.

### FTA NOISE IMPACT CRITERIA



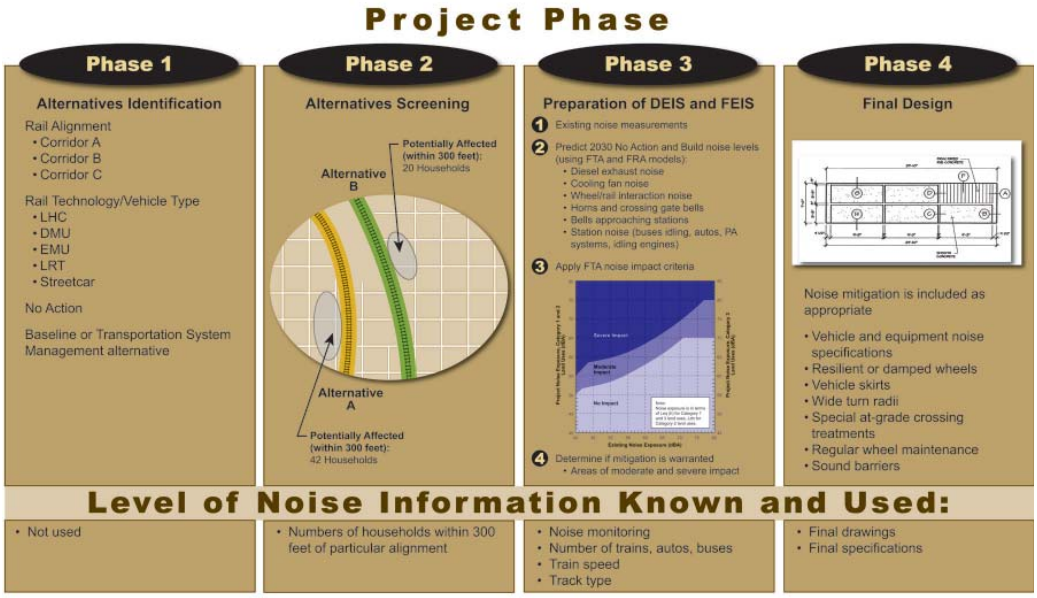

### INCREASE IN CUMULATIVE NOISE LEVELS ALLOWED BY FTA CRITERIA




*Source: Transit Noise and Vibration Impact Assessment, FTA 2006.*

***Moderate Impacts*** are a change in the cumulative noise level that is noticeable to most people, but may not be sufficient to cause adverse reactions from the community. RTD is committed to evaluating reasonable noise mitigation for areas predicted to experience Moderate Impacts (see RTD moderate noise impact mitigation policy).

***Severe Impacts*** are considered when a significant percentage of people would be annoyed by the new noise. FTA and RTD are committed to providing some type of noise mitigation to all noise locations predicted to experience a "Severe" noise impact unless there are circumstances that prevent it or the community does not want the mitigation (see RTD noise wall policy described on page 7).




As you can see from the graphic above, the noise analysis is completed during Phase 3, or detailed analysis, in preparation of the Draft Environmental Impact Statement (DEIS). The DEIS will include the results of the noise analysis, determine areas with Moderate and Severe noise impacts, and propose mitigation measures for each of the impacted areas. Moving into Phase 4 or Final Design, the mitigation measures that have been accepted will be included in drawings and specifications for construction.

## Noise Mitigation

- FTA requires that all severe impacts be mitigated.
- FTA recommends that each transit agency (RTD) devise a policy to mitigate moderate impacts that is fair, reasonable and effective.
- RTD developed and adopted their Moderate Impacts Policy for all FasTracks corridors. FTA has determined that this policy is fair, reasonable and effective.

## What are Some Mitigation Measures?

Typically, everyone thinks of noise walls as the solution for mitigating noise impacts. This is true in many cases, but there are other measures that can be implemented to reduce noise impacts, including:

- Operational changes (running the trains less frequently, slower, or less during late evening hours)
- Modifications or design of the vehicle and trackwork.
- Specifications and design of the transit vehicle.

It is important to remember that these mitigation measures will not eliminate the noise but will reduce excessive noise at a specific site.

There are three factors that influence noise:  the source (vehicle and trackwork), path (what's between the vehicle and the receiver); and the receiver (house, church, etc.). With each of these factors, mitigation measures are possible. The table below lists some of the mitigation measures that are possible to mitigate for the cause of the noise. Some of these are technical engineering measures and vehicle specifications that will be analyzed during design and vehicle procurement.

| Application | Mitigation Measure |
|---|---|
| Source | Stringent vehicle and equipment noise specifications |
| | Operational restrictions |
| | Resilient or damped wheels |
| | Vehicle skirts |
| | Undercar absorption |
| | Spin-slide control (prevents flats) |
| | Wheel truing (eliminates wheel flats) |
| | Turn radii greater than 1,000 feet |
| | Rail lubrication on sharp curves |
| | Movable-point frogs |
| Path | Sound barriers close to vehicles |
| | Sound barriers at right-of-way line |
| | Alteration of horizontal and vertical alignments |
| | Acquisition of buffer zones |
| | Ballast on at-grade guideway |
| | Ballast on aerial guideway |
| | Resilient track support on aerial guideway |
| Receiver | Acquisition of property rights for construction of sound barriers |
| | Building noise insulation |

Noise mitigation will likely be a combination of the above measures identified in the list. Sound barriers or noise walls are one piece of the puzzle and are generally used in combination with other factors. Mitigation measures will be closely coordinated with the communities because not all residents will agree with the proposed measures. Noise barriers may impact views and may not be the answer everywhere.

Another measure that may be implemented is Quiet Zones. On April 27, 2005, the Federal Railroad Administration published the Final Rule on the use of locomotive horns at highway-rail grade crossings. Effective June 24, 2005, the rule requires that locomotive horns be sounded at all public grade crossings.

The Final Rule also provides public authorities the option to maintain and/or establish Quiet Zones provided certain supplemental or alternative safety measures are in place and the crossing accident rate meets FRA standards.

RTD cannot apply for a Quiet Zone for a community; only the local jurisdiction in which the potential quiet zone exists can make this application to the FRA. RTD

can assist the communities with understanding the application process and provide resources for the implementation of Supplemental Safety Measures (SSMs) that will assist communities in qualifying for Quiet Zones. Examples of SSMs include four-quadrant gate systems, dual gate systems in the appropriate situations, and median or channelization devices.

## RTD Moderate Impacts Policy

The Moderate Impacts Policy is used to identify properties within the corridor with moderate impacts and help to define which of these should be considered for mitigation. The properties are evaluated as follows:

1. Is the impact on the property in the upper 50 percent of the moderate impact range?
   - » If not, then a noise is often not perceivable and the noise wall is not very effective (will not receive a perceptible benefit), and the property will not receive a noise wall.
   - » If so, then the next criterion is applied.
2. Is a noise wall cost effective for this property? No more than $35,000 per property can be spent.
   - » If not, then a noise wall is not cost-effective and the property will not receive a noise wall.
   - » If so, then the next criterion is applied.
3. Are there at least 10 properties and/or 800 feet of properties affected? Short noise walls are not effective. This can be a combination of severe and moderate impacts.
   - » If not, then a noise wall is not reasonable or effective and the property will not receive a noise wall.
   - » If so, then a noise wall is planned.

## RTD Noise Wall Policy

RTD uses the following policy to address who receives a noise wall:

- All severe impacts receive a noise wall and/or other reasonable and effective mitigations

- All walls in front of severe properties will be extended a minimum of 100 feet on either side of the affected structure or to the nearest cross street.
- When that 100 feet extends in front of a residential property adjacent to the severe property, the wall will be continued to the property line of that adjacent property.
- Moderate Impact Policy steps 2 and 3 are applied.

## RTD Noise Wall Opt Out Policy

RTD has also developed a noise wall opt out policy. This is because on previous projects, some communities expressed the preference for preserving their view over reducing the noise from the project. Please refer to the FasTracks Noise Barrier Change Policy adopted by the RTD Board of Directors on March 27, 2007.

## Bibliography

http://www.nonoise.org

FTA-VA-90-1003-06, Federal Transit Administration's "Transit Noise and Vibration Impact Assessment, May 2006.