



# DOVE MOUNTAIN BOULEVARD

## Traffic Sound and Noise Assessment

Prepared For: Town of Marana

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## FORWARD

The Town of Marana (Town), in response to citizen concerns and complaints about traffic noise, has been evaluating street sound generated by vehicles along Dove Mountain Boulevard (DMB) within the Dove Mountain community. In fact, the Town has taken several actions to try and resolve some of these complaints. However, to several citizens, these traffic noise issues persist. In response to these continued concerns and complaints, the Town chose to conduct an assessment to review existing sound evaluation efforts and arrive at an actionable or non-actionable conclusion. This assessment included a public involvement and education meeting, a sound and noise survey, and review, collection, and evaluation of both qualitative and quantitative data and information. The goal is to develop and evaluate reasonable alternatives for potential mitigations that might be considered and pursued. This report provides the findings of this assessment.

## DESIGN OF THE REPORT

A different approach has been devised to make this report more readable, direct, and useful. The first chapter, *Introduction & Summary*, provides an overall view of the assessment. The intended audience of this portion of the report is those interested in what traffic sound and noise are all about but not necessarily interested in all the technical details. However, it does present many of the basic principles regarding traffic sound and noise abatement that are important to understand. It includes an in-depth discussion about the problem and possible solutions. The next chapter is titled *Conclusions* and presents a summary of those possible solutions that were considered and whether they would be brought forward into the *Recommendations*. The recommendations provide specific, actionable suggestions on how the DMB traffic noise issue might be addressed and some other items of consideration, including possible future actions. Behind the *Recommendations* is Chapter Three, *Supporting Information*, which provides supporting information about the assessment findings that support what is in the *Introduction & Summary* and the *Recommendations*. The Supporting Information Chapter contains sections with in-depth details and discussions. It is the technical chapter of this report. The appendices include more details and information developed for this report and help support the findings and recommendations.

## CHAPTER 1 – INTRODUCTION & SUMMARY

The Federal Highway Administration (FHWA) acknowledges that major highway and street noise significantly impacts millions of people in the United States, particularly in developing areas like Maricopa, Pinal, and Pima Counties. As these counties and regions experience increased urbanization and land use densification, traffic demand rises, increasing traffic sound to the point it reaches noise levels. Residents living adjacent to highways, freeways, and streets are particularly impacted by this sound that can be noise. It can have perceived adverse effects on residents’ quality of life. Residents may seek to mitigate traffic noise through construction of a noise barrier.

Noise barriers are typically long, solid walls ranging from 12 to 20 feet high. Figure 1 illustrates the basics of sound propagation and a typical noise wall. As shown in Figure 1, some sound is absorbed, but there are still reflections, diffraction, and even sound transmission through the barrier. No noise barrier blocks sound 100%. A noise barrier only reduces the amount of sound propagated to the receptors.

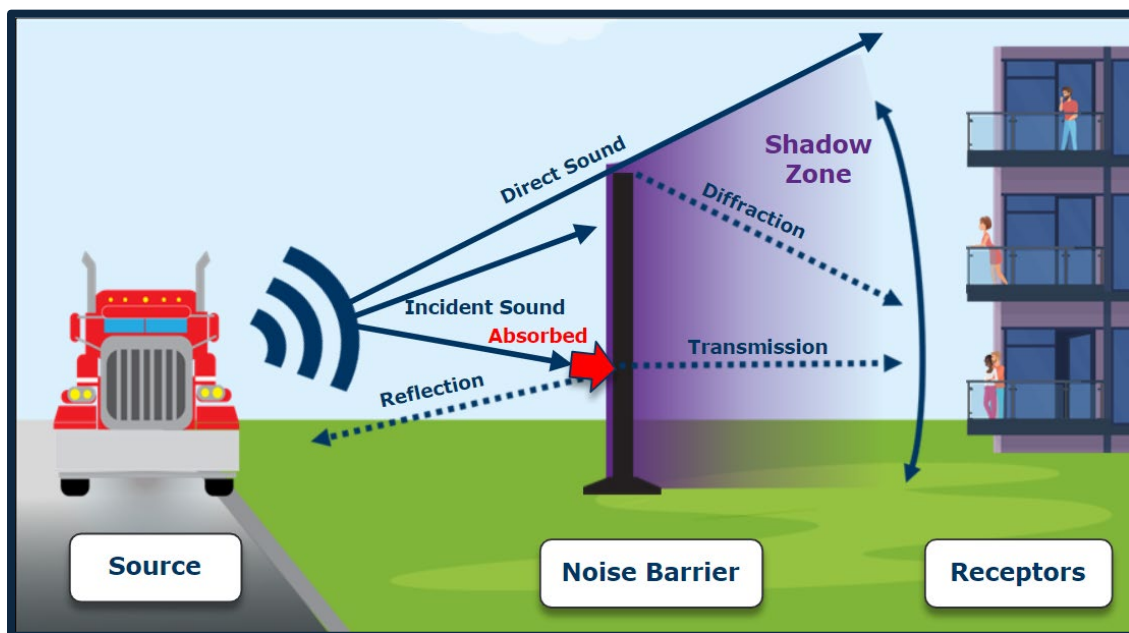


Figure 1 – Basics on Sound Propagations and Noise Barriers (source: National Highway Institute - NHI)

As illustrated in Figure 2, a street is a line source for traffic sound generation. Consequently, noise barriers are typically very long. That is to prevent sound from getting around them to the where the receptor is. The term used to describe this is “flanking.” Thus, to prevent flanking, noise barriers must be long and extended beyond the area of concern. Cross streets and driveways require openings in the wall. An opening in a noise wall significantly reduces the effectiveness of noise mitigation in the area of the opening.

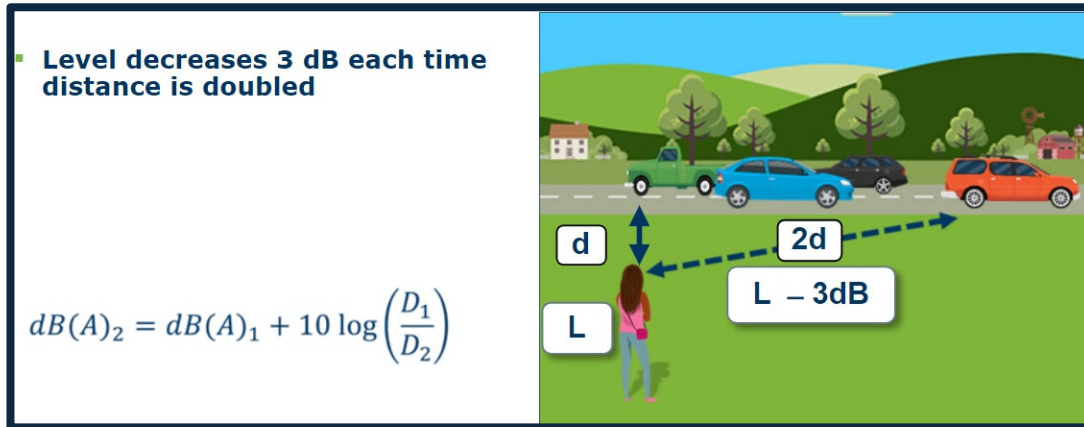


Figure 2 – Line Source (or Street Sound Generator) Divergence (source: NHI)

Achieving noise mitigation at the street source is often not feasible or desirable. In the case of an existing problem, the most effective and efficient approach is for individuals and/or groups of individuals to mitigate traffic noise inside and outside their residences on their own private property.

Noise barriers can be placed at the receiving end, or “receptor,” and potentially achieve a meaningful reduction in noise. As can be seen from Figure 3, placing a noise barrier at the receptor, which in this case would be at the private residence, can be effective, too. In the case of DMB, this seems to be the most pragmatic way to address this issue for those who perceive the sound to be noise.

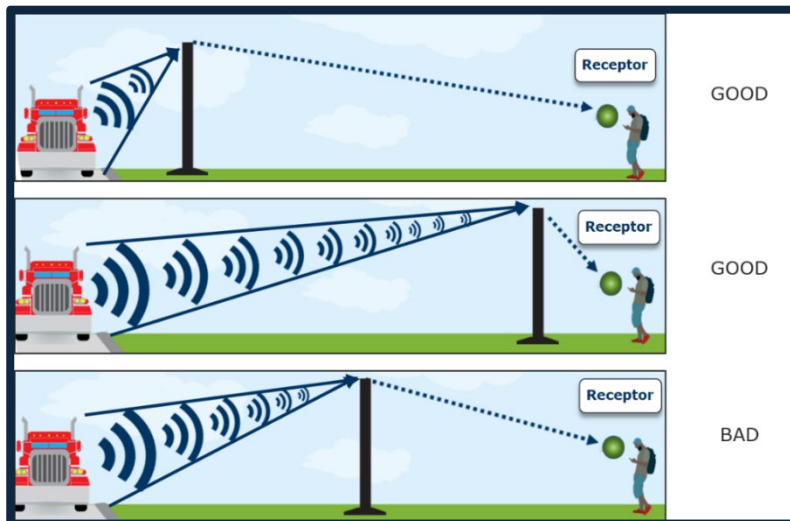


Figure 3 – Effectiveness of Noise Barrier Wall Locations

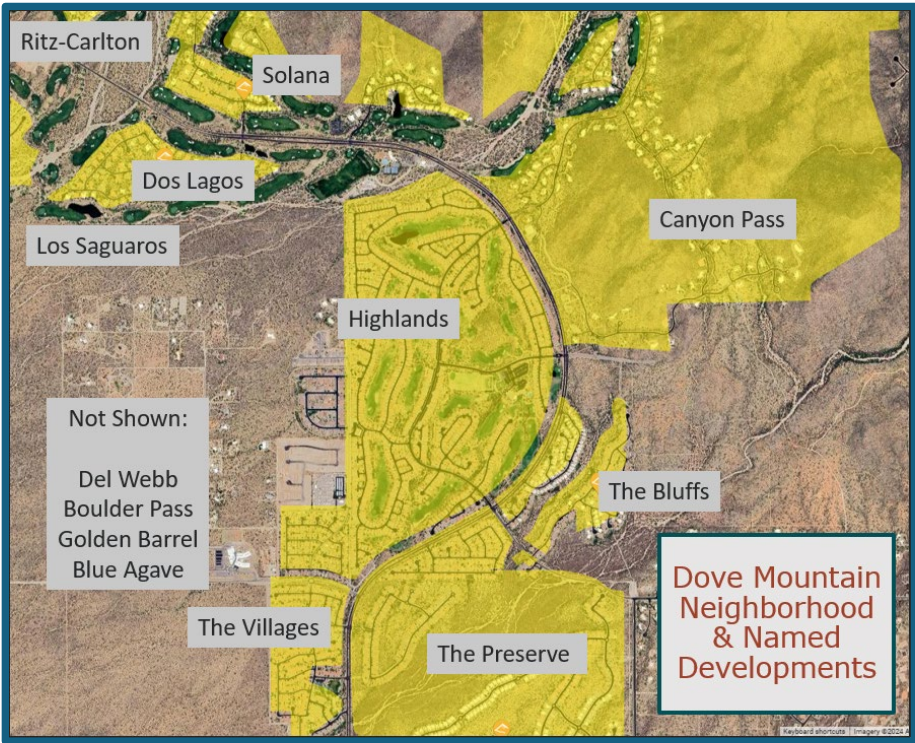
Insertion loss is a term used to describe the reduction in sound level achieved by a noise barrier or other sound mitigation measures or attenuators. A 5 dB insertion loss is readily perceptible to the human ear. Vegetation and the condition of the soil (if it is soft or has lots of vegetation, like grass) also contribute to sound attenuation.

The rule of thumb on traffic noise is if you can see the street and the traffic on it, you will hear it. Distance from a sound source is one of the best attenuators. The sound level decreases by 3 dB each time the distance is doubled from a line source sound generator like a street. This is called “divergence.”

**Existing Condition and Challenges**

In response to traffic noise complaints along DMB, the Town conducted noise measurements along DMB and comparable streets. The sound levels measured on other streets were similar or even higher than those experienced on DMB. However, Dove Mountain is primarily residential, and ongoing construction in the Dove Mountain area introduces heavy truck traffic all hours of the day. Truck traffic, unfortunately, can be very noisy. Vehicle classification data taken by the Town in July 2020 showed that heavy truck traffic makes up around 7% of all traffic on average, which is high. Typical heavy truck percentages are 5% or lower. Construction activity in the Dove Mountain area is expected to continue for at least another six years.

DMB’s semicircular horizontal alignment, and the fact that the street is at grade or above many of the adjacent residential developments, contribute to the noise exposure experienced by Dove Mountain residents. Figure 4 shows the horizontal alignment of the street and the named residential developments within the Dove Mountain area.



**Figure 4 – Map of DMB & Dove Mountain Neighborhood**

In addition to the semicircular alignment, many of the first rows of houses in these developments are offset only 65 feet from DMB. Some homes have solid masonry walls around them, while others do not. Most of the masonry walls are only 5 feet to 6 feet high and provide little, if any, attenuation of the street noise that is perceptible and, in many instances, does not interrupt the line of sight to DMB. This is especially true where DMB is above these houses. Typically, a wall must project 10 to 12 feet above the offending street to reduce traffic noise. Recall that a barrier must reduce the noise level by at least 5 dB to be perceptible. To support noise attenuation, barriers need to break the line of sight from the residence to the street. Once the line of sight is broken, barrier height becomes the key factor in providing attenuation. A rule of thumb is that one can expect a 1 dB reduction in noise levels for every two-foot increase in wall height. There is a point of diminishing return once a barrier reaches a certain height, typically around 20 feet.

Existing solid masonry walls on private property could be raised to break the line of sight to DMB traffic. How much will need to be evaluated on a case-by-case basis. However, even if increased wall height just barely breaks the line of sight, the increased height combined with other on-site noise mitigation treatments, might achieve meaningful attenuation.

The issue with extending the masonry walls on private property is that the existing footing might not support the added height. Strengthening the wall and footing may be necessary to accommodate the extension and addition of live load potential from wind. Various prefabricated modular noise wall systems are available that can do this. Conventional construction can also accomplish this. It is reported that at least one Dove Mountain resident has installed tall, continuous clear acrylic noise-attenuating panels around their backyard wall with reported success.

The pictures in Figure 5, provided by a resident of the Los Saguaros development in response to the survey conducted as a part of this assessment, illustrate the typical conditions between DMB and the houses. In this case, the resident is asking for more landscaping to block the view or the line of sight between their home and DMB.

Also, some people think seeing traffic from one's backyard is not desirable either. In many instances, houses are much closer than what is shown in Figure 5. There are opportunities to introduce additional vegetation or landscaping to provide shielding from DMB. However, it is important to realize that traffic sound and noise occur on all major roadways and streets, and DMB is a major street that provides access in and out of the Dove Mountain area.

Preserving the natural beauty of this area poses a significant challenge when addressing traffic noise directly adjacent to the street. An area like Dove Mountain presents environmental challenges caused by the goal of preserving as much of the natural surroundings and views of the desert valley and mountains as possible, not only from individual residences and recreational facilities but also from the street itself. Given that DMB has residences on both sides of DMB. The noise barrier would have to be miles long and almost totally continuous, so all potential receptors would be covered, and flanking would be prevented. DMB would essentially become a "street in a tube." Most people would likely object to this application, as it would disrupt views of the desert and mountains.



Figure 5 – View To/From DMB to Adjacent Residence (source: citizen via survey)

### Traffic Noise Compatible Land-Use Planning

FHWA emphasizes that preventing traffic noise issues before they happen is the best approach. Once a noise problem happens, it can be challenging and expensive to address. FHWA encourages collaboration among developers, governmental officials, planners, and private citizens to establish proactive traffic noise policies and standards. One key strategy is incorporating traffic noise-compatible land-use planning and building code requirements that mitigate traffic sound, minimizing its perception as noise.

Traffic noise-compatible land use planning provides maximum physical separation between noise-sensitive land uses, like family homes. As already stated, distance is an effective and efficient attenuator of sound. Other potential measures include selecting a street alignment that keeps the street at or below grade and



offers the opportunity to depress the street without an adverse impact on. A street alignment like this can be combined with walls, berming, landscaping, and separation to make the street less noisy.

Noise levels in Dove Mountain will be greatly reduced once construction is completed. But the need for traffic noise land-use planning aspect is one to consider. The main goal of traffic noise-compatible land-use planning is to provide alternatives for reducing traffic noise without the use of physically intrusive barriers, such as the wall along Interstate-10 near the Marana Unified School District (MUSD) District Offices and Marana Middle School. Mitigation like this is not compatible in most City or Town settings, especially Dove Mountain, and is not typically possible except adjacent to freeways per ADOT's Noise Abatement process and program.

But even then, ADOT has engineering and acoustic feasibility limitations and reasonableness criteria that are placed on whether a sound barrier is provided or not. The "reasonableness criteria" include consideration of meeting the noise reduction goal, being cost-effective, and being acceptable to impacted property owners. If neither of these criteria are met, then the noise barrier is not provided.

Some areas along DMB do have aspects of noise-compatible planning, but in most places, traffic noise could be an issue. This assessment focuses on reviewing and trying to find potential reasonable solutions that might work within existing constraints for individual or groups of properties.

## CHAPTER 2 - CONCLUSIONS

### Noise Barriers

Street traffic noise barriers are typically walls. To be effective, walls at the noise source need to be tall, close to the roadway, and very long to prevent flanking. If there are residence (or receptors) on both sides of a street, then noise walls should typically be used on both sides of the road to avoid reflecting noise onto other properties. Because of the desire to preserve views of the natural beauty of the Dove Mountain area, walls would not be a good fit for the DMB public right-of-way.

There is a greater potential for walls to be effective when installed close to the receptors, i.e., around individual residences. Products are available that can extend existing walls around properties and are effective as noise barriers. Clear, plexiglass products are available that allow residents to block noise and maintain views of the desert environment. On a case-by-case basis, new walls or extended walls within common property may be evaluated to determine whether the walls can be effective in mitigating traffic noise.

Wall treatments that extend existing walls or attach to existing walls should be evaluated to ensure that the structural integrity of the existing wall is not compromised.

While not considered a noise barrier, vegetation can help attenuate noise. Vegetation can also shield homes from views of the road, which is desirable. There may be opportunities to enhance vegetation and/or landscaping to improve shielding from DMB. Addition of vegetation or landscaping would be the responsibility of the Dove Mountain Community Association whether it occurs within or outside of the public right-of-way.

### Traffic Restrictions

Higher traffic speeds produce higher overall sound levels, especially those who exceed the speed limit by more than 10 mph. The posted speed limit of 40 mph for DMB is not an unreasonable speed limit for this class of street. Not all drivers choose to maintain the posted speed limit. In fact, it is typical for most drivers

to go from 6 to 8 mph over the speed limit. As is the case with all streets, continued police enforcement may be necessary to maintain travel speeds within a reasonable range of the posted speed limit. The typical enforcement threshold is 10 mph. Adherence to reasonable speeds can also decrease crash severity risk, as well. Reasonable, continued police enforcement can help curtail excessive sound and help maintain the safety of the road.

Construction within the Dove Mountain Specific Plan area is largely complete, however, there may be as many as six more years of construction activity. The ongoing home-building activity draws construction traffic onto Dove Mountain Blvd, since Dove Mountain Blvd is the main thoroughfare through the community. Large construction vehicles produce more noise than passenger vehicles. A 2020 study conducted by the Town indicated that truck traffic comprises 7% of all traffic on DMB.

The Town determined that truck traffic operates at or below the posted speed limit and concluded that reducing the speed limit for trucks will have little impact on the overall traffic noise.

Currently, time-of-day truck restrictions are not supported by the Town Code. Time-of-day truck restrictions also require consistent and conspicuous police enforcement, which places a burden on Town law enforcement personnel. During summer months, construction activities often begin in the very early hours of the morning so that workers can avoid exposure to the highest daytime temperatures. There can be human health risks with time-of-day truck restrictions, and the construction industry is unlikely to support such restrictions. For these reasons, time-of-day truck restrictions will be difficult to implement.

### **Roadway Surface Changes**

The Town resurfaced DMB with rubberized chip seal in 2021. Before and After noise readings taken in early 2022 indicated that the rubberized asphalt surface produced less noise, although the difference may not have been perceptible to the human ear. Because of concerns expressed by Dove Mountain residents, DMB was resurfaced again in 2023. Noise readings were not taken following the second resurfacing; however, residents reported an improvement. But it is important to note that FHWA does not recognize pavement resurfacing as a noise mitigation treatment. Plus, there is an indication that sometimes as pavement ages it becomes rougher and consequently noisier.

One surface change that could prove to help reduce noise, in some areas, would be to remove the existing decorative concrete crosswalks at DMB intersections. There appears to be seven of these types of crosswalks. The decorative crosswalks are not maintained by the Town of Marana, but are aesthetic treatments governed by the Right-Of-Way License Agreement between the Town of Marana and the Dove Mountain Community Association. The Right-Of-Way License Agreement allows landscaping and hardscaping treatments that are beyond that which the Town maintains, provided these treatments are maintained by the Dove Mountain Community Association.

Residents report that traffic traversing the change in surface at these decorative treatments generates an increase in overall noise. Removing the decorative concrete crosswalks and header walls and replacing them with standard asphalt will produce a small reduction in overall noise levels that would be appreciated by residents, most especially those who live close to the decorative treatments' locations.

### **Other**

Treatments can be applied on private property that can address noise concerns. These include updates to the home to reduce noise intrusion and noise masking, like fountains or white-noise-generating machines, which may be applied indoors and outdoors. It is interesting to note that the Federal Aviation Administration (FAA) has some very specific guidelines for providing sound insulation of structures exposed to aircraft noise (e.g. windows, doors, insulation, etc). In fact, these guidelines were recently updated in June of 2022, and the guide is called "Guidelines for Sound Insulation of Structures Exposed to

Aircraft Noise.” Chapter 7 is entitled Sound Insulation Treatment Strategies. It gives a lot of detailed information on what can be done to reduce noise inside buildings caused by outside sources.

Table 1 summarizes the noise treatments discussed and considered.

**Table 1 Summary of Possible Dove Mountain Area Noise Mitigations**

| Treatment               |  | Consider (Y/N) |
|-------------------------|--|----------------|
| Noise Barriers          | Walls along Dove Mountain Blvd                     | No             |
|                         | Walls around individual properties                 | Yes            |
|                         | Walls around common property                       | Yes            |
|                         | Vegetative screening                               | Yes            |
| Traffic Restrictions    | Continued speed enforcement                        | Yes            |
|                         | Truck speed limit                                  | No             |
|                         | Time-of-day truck restrictions                     | No             |
| Roadway Surface Changes | Decorate concrete crosswalk removal                | Yes            |
| Other                   | Updates to minimize noise intrusion inside a house | Yes            |
|                         | Noise masking treatments (e.g., fountains)         | Yes            |

## CHAPTER 3 - RECOMMENDATIONS

Based on the findings documented in this report, the following recommendations are offered. The recommendations are divided by what party or parties might be responsible for action on that recommendation. None of these recommendations are binding on any party, including the Town.

### A. Recommendations to Be Considered by The Dove Mountain Community Association

1. The paved or decorative stamped concrete crosswalks should be replaced with standard pavement and marked with conventional high-visibility crosswalks using white pavement markings such as 90 mil extruded thermoplastic or high-quality preformed pavement marking tape. According to the citizen survey, these decorative crosswalks generate a lot of noise, particularly when large trucks drive over them.
2. In areas with a clear line of sight between backyards and DMB, consider adding additional landscaping or landscaping features that break that line of sight.
3. Coordinate with Homeowners Associations (HOA) to determine if their members favor evaluating additional traffic noise mitigation measures. Then work with these HOAs to determine the best configuration and location for those mitigations. Mitigations that might apply would be denser vegetation and some berming between DMB and adjacent residences. On private property mitigation could be existing wall extensions, new walls, new walls to fill gaps, berms, or some combination thereof.

## **B. RECOMMENDATIONS TO BE CONSIDERED BY INDIVIDUALS, GROUPS OF INDIVIDUALS, AND INVOLVED HOMEOWNER'S ASSOCIATIONS**

1. Homeowner Association (HOA) members and their professional property managers should review their Covenants, Conditions, and Restrictions (CCRs) or architectural guidelines to determine if any restrictions might prevent potential noise mitigation measures, such as wall extension or closing off an open wall. If there are restrictions, the HOAs should start the process to determine if the membership is agreeable to modify CCRs to allow sound mitigation treatments, such as 6 to 8 feet wall extensions along with needed structural reinforcements and new solid walls that are 10 to 12 feet high on those member units that face DMB.
2. HOA members should inform their property manager about noise issues from DMB and construction traffic. The property managers can then take steps to try and address these problems with developers and contractors. All HOA property managers have been contacted, and none have received complaints about DMB traffic noise, even that concerning early morning heavy construction truck activity. It seems reasonable that those individuals and those impacted HOAs should be contacting those development companies and their involved construction contractors, subcontractors, and suppliers about these noise issues.
3. Converting existing walls or adding new walls should be carefully evaluated for both estimated insertion loss and aesthetics. This evaluation should involve assessing different wall material types or combinations of materials. Typically, to achieve meaningful noise attenuation the noise barrier needs to project about the line of sight to DMB. Once the line of sight is obstructed, a general rule is that every additional 2 feet of wall provides 1 dB of sound reduction. Sound attenuation of 5 dB is readily perceptible by the human ear. Before deciding to extend a wall, it's advisable to conduct an FHWA Traffic Noise Model (TNM) analysis to determine if the expected noise reduction justifies the cost. Solid, tall walls may obstruct views, so it might be worth considering clear acrylic panel walls offering transparency while reducing noise. Several companies sell prefabricated noise barrier systems (e.g., Durisol, etc.).
4. If it is found that that individual, group of individuals, and/or HOA wish to pursue walls and it is determined they will reduce noise enough to make them worthwhile, then a qualified engineer or contractor should be contacted to determine what the best approach might be to building them. The major issue to be addressed is the structural capacity of the existing wall to withstand the additional wind load needed for the wall extension. The same goes for a new wall. Once a design is arrived at, a building permit needs to be applied for and obtained from the Town before the wall is built. An HOA architectural application will also need to be filled out and submitted, and approval will be gained from the applicable HOA.
5. Consider procuring white noise generators indoors and outdoors to help mask traffic noise. As reported in response to the citizen survey conducted as a part of this assessment, some residents have installed outdoor speakers and play music to help mask traffic noise. Evaluate the feasibility and desirability of designing and building a water feature with enough water fountain capacity to produce enough sound to mask traffic noise. The amount of sound is anticipated to be 60 to 64 dB. Small garden shop-style water features do not move enough water to create enough masking sound to be effective. Typically, the water feature needs a one to two horsepower pump with a significant splash and bubble pond to create this much masking sound.
6. Evaluate the effectiveness of all door seals and make sure there are no gaps. Additionally, all gaps between interior electrical boxes, windows, doors, wall-to-roof, and wall-to-foundation lines should be sealed with caulk. The idea is to block any chances of direct sound transmission or at least interrupt it twice before it enters the house.

7. Noise-impacted individuals should evaluate the feasibility and desirability of installing noise-reducing or acoustic-grade window inserts and/or upgrading their windows and doors to those with a higher noise-reduction rating. Windows that have the highest possible Sound Transmission Class (STC) are desirable, especially those that face DMB.
8. Consult with a professional architect on additional sound mitigation measures in and outside the house. It might be possible to retrofit some interior walls to provide additional sound attenuation. See a list of those possible treatments under “D. Possible Future Actions by the Town of Marana and Southern Arizona Home Builders Association” at the end of this chapter.

### **C. TOWN OF MARANA RECOMMENDATIONS TO BE CONSIDERED.**

1. The Town of Marana and the Marana Police Department should continue to conduct scheduled speed enforcement at the four speed feedback signs that the Town has installed on DMB to help reinforce better speed limit compliance. Consider establishing other enforcement locations to help promote and reinforce good speed behaviors on DMB.
2. Per provision #9 in the License Agreement with DMCA, consideration should be given to remove decorative stamped concrete from this agreement as listed under provision #5 and have DMCA remove the decorative crosswalks from DMB and replace them with asphaltic concrete pavement and standard marked high-visibility crosswalks. The current decorative pavement crosswalks create excessive noise.
3. Consideration should be given to requiring a noise analysis to be conducted for proposed residential developments near major roadways. It’s worth noting that cities such as Scottsdale, Buckeye, Mesa, Goodyear, already have this requirement in place.
4. Consider requiring all solid screening walls facing arterial or major collector streets to have a foundation that can support a higher wall (say 10 to 12 feet). This would apply to both common areas screen walls and individual property residents’ walls. The minimum height can still be 6 feet, but this would allow the HOA or the homeowners to extend their walls to improve noise attenuation and/or security if need be.
5. Consideration should be given to developing time-of-day heavy truck restrictions in residential areas, perhaps specifically for DMB. Heavy trucks generate a significant amount of traffic noise, which may necessitate the establishment of a special heavy truck speed limit.

### **D. POSSIBLE FUTURE ACTIONS BY THE TOWN OF MARANA AND SOUTHERN ARIZONA HOME BUILDERS ASSOCIATION**

1. In the future, the Town of Marana, and the Southern Arizona Home Builders Association (SAHBA) should consider collaborating to develop acoustical architectural requirements and measures to reduce sound from vehicle traffic on streets. These requirements would apply to those houses that are known to be in areas where traffic noise could be an issue. Such measures and requirements might be as follows:
  - a. Placing rooms that are less sensitive to noise on that side of the house (kitchen, garage, bathroom, laundry rooms) that faces the street.
  - b. Positioning the living room and bedrooms as far away as possible from the street side of the house.
  - c. Minimizing the number of windows and doors that face a street.
  - d. Requiring double or triple-paned glass windows with a rated noise attenuation level (e.g., a reduction rating of 41 dB to 45dB).

- e. Increasing the depth of the wall with air gaps and additional insulation, using double wall board and/or 5/8 thick wallboard for interior walls facing major streets.
  - f. Adding a layer of mass-loaded vinyl (1 to 2 pounds per square foot) in between the two layers of wallboard.
  - g. Require additional insulation in ceiling and/or double wall boarding.
  - h. Provide additional air space between the ceiling and the roof (an attic or crawl space).
  - i. Promoting the use of solid materials (brick, masonry, concrete) for exterior walls instead of wood frames with stucco.
  - j. Use solid core doors and insulate interior walls.
  - k. Providing noise dampers on air intakes and vents.
  - l. Consideration of the FAA Guidelines found in “Guidelines for Sound Insulation of Structures Exposed to Aircraft Noise” that might also apply to reducing vehicle generated noise.
2. Avoid placing houses that have double exposures to streets at intersections.

## CHAPTER 4 - SUPPORTING INFORMATION

The next sections provide additional information on the summary, introduction, and recommendations. Behind these sections are the Appendices that are referred to as applicable to that section.

### 1. ASSESSMENT SCOPE

The Town of Marana has hired Dibble to conduct this DMB traffic sound assessment. The objective of the assessment was to review existing sound evaluation efforts and arrive at actionable or non-actionable recommendations. This included an effort to help educate interested parties on the principles and processes involved. Additionally, this assessment collected additional data and information. The data and information were evaluated to determine if the sound qualifies as noise and what could or could not be done about it. This additional data and information included conducting one public meeting, conducting a community outreach survey, and engaging various interested parties on the issues of traffic sound and noise on DMB.

### 2. BACKGROUND

The Dove Mountain neighborhood is characterized by mountainous and rolling terrain and abundant desert vegetation. The Dove Mountain Specific Plan has governed the development of this area and will continue to shape its future. The Dove Mountain Community Association (DMCA) holds a formal License Agreement with the Town to maintain various features in the public right-of-way streets, including landscaping and paths. The current agreement was put in place on November 11, 2013. See Appendix A for a copy of this agreement.

DMB is a four-lane divided roadway extending from Paseo Vista Solana east and south to Tangerine Road, covering approximately 3.6 miles. West of Paseo Vista Solana, DMB transitions into a two-lane road spanning just over 2.5 miles. The total length of the road, from Tangerine Road to the roundabout at DMB and Buckeye Place, measures slightly over 6 miles. However, the main areas assessed were from Springs Drive on the north and west to Prospect Wash on the east and south (approximately four miles).

DMB is utilized by a diverse range of users, including residents, service vehicles, resort-goers, and construction traffic. On average, it carries approximately 10,000 vehicles per day south of Moore Road and about 5,000 vehicles per day north of Moore Road. These average daily traffic numbers indicate the street is busy but far from capacity. The capacity of a two-lane road is around 18,000 vehicles per day and a four-lane road is around 32,000 vehicles per day.

As development continues in the farthest reaches of the specific plan area, a few existing residents have expressed concerns about street traffic sounds. Specifically, they find that vehicle sounds generated on DMB have reached unwanted noise levels, interfering with their enjoyment of private outdoors spaces in their backyards. Some have also indicated these levels have gotten so high that it interferes indoors as well, especially in the early morning.

The Town has conducted 21 spot sound measurements on 11 different days at over 9 locations along DMB to evaluate street sound levels. The measurements were taken at locations that were 50 feet from the curb and the sound meter was mounted on a tripod 5 feet from the ground. These measurements were taken before and after the street resurfacing with a pavement treatment known to be “quieter.” Before resurfacing, the average sound levels ranged between 61.6 to 69.9 decibels. Post-resurfacing, the average sound levels ranged between 61 to 66.9 decibels. While there was some reduction, it’s important to consider the traffic sound and noise guidelines. FHWA and ADOT consider at least a 5 dBA reduction to be perceivable to the human ear. Thus, it appears that the resurfacing did achieve some sound reduction, but really was ineffective in achieving anything that was perceptible. It is important to note that FHWA still does not recognize pavement treatments as an effective noise mitigation measure. This is because it is not a sustainable treatment. As the pavement ages it typically will get louder.

**3. APPLICABLE GUIDELINES AND POLICIES**

Most traffic noise studies in Arizona involve federal funding and must be conducted in a manner consistent with the applicable National Environmental Protection Act (NEPA), FHWA and Arizona Department of Transportation (ADOT) guidelines and policies. These guidelines outline how traffic sound and noise should be measured, evaluated, modeled per FHWA’s Traffic Noise Model (TNM), and mitigated if they meet certain thresholds and are cost-effective. Including consideration of these guidelines is important as it provides a study process. However, other considerations, like conducting short-term noise measurements or modeling typical scenarios using TNM, have been used that are not necessarily a part of the FHWA or ADOT guidelines. This is a sound assessment, not a NEPA, FHWA or ADOT noise study. The Town is not bound by these guidelines and requirements, as federal funding is not involved.

**4. IMPORTANT DEFINITIONS**

The following are important definitions to remember as one reads this report.

1. **Sound:** Sound is an objective term referring to a physical property. When an object vibrates, the energy from those vibrations causes pressure fluctuations as it travels through air (or some other medium). If the pressure fluctuations reach a person’s ears, the person will perceive them as sound.
2. **Components of Sound:**
  - o **Source:** The origin of the sound.
  - o **Path:** The medium through which the sound travels.
  - o **Receptor:** The person or device that detects the sound.
3. **Noise:** Noise is a sound that can be loud and unpleasant, causing disturbance. Judging the unpleasantness of sounds at lower levels can often become subjective to the person or persons hearing the sound.
4. **Characteristics of Sound:**
  - o **Amplitude:** Perceived as loudness.
  - o **Frequency:** Determines the pitch.
  - o **Time:** Relates to the duration and variation of the sound.
5. **Reduction in Sound or Noise Reduction Design Goal:**

- A meaningful reduction in sound, commonly called insertion loss, is typically from 5 to 7 decibels, achievable through physical structures (such as noise barriers) located at the generator or the receptor (or both).
- A reduction of 5 decibels or more is readily perceptible. Ten is typically the upper limit of achievable reduction with outdoor mitigation such as noise walls.

#### 6. Interruption of Sound:

- Interruption of sound occurs when other sounds are used to mask the sound that might be perceived as noise. This is sometimes referred to as white noise.

## 5. PUBLIC MEETING

Both FHWA and ADOT always conduct public meetings to achieve input on highway projects, especially regarding traffic noise studies. Both have found that project development is more successful when communities are proactively engaged and educated. A community meeting on this DMB street traffic sound assessment was held at the Highlands at Dove Mountain Community Center on April 17, 2024. This meeting was held in conjunction with a traffic signal project that the Town is also doing on DMB. Over 50 people attended the meeting.

During this meeting, a half-hour presentation on sound and noise was held. Another half-hour was spent on questions, answers and discussions following the presentation. In addition to the presentation, educational handouts were given out and a citizen survey on Traffic Noise from DMB was passed out. Appendix B has a copy of the presentation, community survey, and handouts. It is important to note that the presentation contains a lot of information and illustrations in support of this report's content, findings, and recommendations.

## 6. FINDINGS FROM THE CITIZEN OR COMMUNITY SURVEY

This survey was conducted to gain input and information from those concerned about traffic sound and noise along DMB. The survey was also designed to help provide information about traffic sound and noise and the possible mitigations that might offer the opportunity to reduce those sounds regarded as noise. The survey is contained in Appendix C.

A total of 19 surveys were received, 18 by email and 1 by regular mail. Each survey was reviewed, and the responses were summarized in a series of 3 tables that are contained in the Appendices. Some respondents prepared sketches or sent pictures to help provide information on their physical arrangement with DMB. All the originals of the surveys have been saved as is and are available for inspection. One respondent sent a significant amount of additional information regarding the traffic noise issues and actions he and others have taken over the past few years regarding that. This includes sound measurements he did.



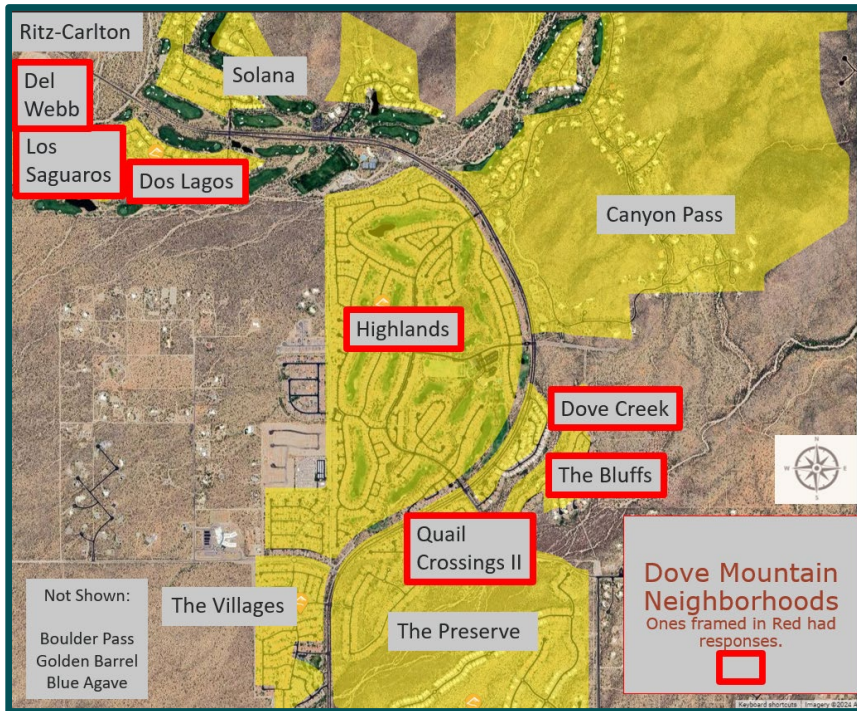


Figure 6 – Map of DMB Area Survey Responses.

Of the 19 surveys received, 9 were from the Highlands Neighborhood. One each from Dove Creek, The Bluffs and Quail Crossing (very close to Highlands). Two are from Dos Lagos, one is from Del Webb, one is from Los Saguaros, and one is to the south near Tangerine Road. One respondent’s location was not clear. Figure 6 maps out the developments or neighborhoods responses were received from. The number of responses received from the Highlands area was not surprising. DMB curves around this development, and in many places, the road is at or above the level of the adjacent houses. Plus, it is one of the largest developments in Dove Mountain.

The survey had a total of 17 questions. The questions and a summary of the responses are as follows. A complete listing of the responses is contained in Appendix D.

1. On a scale of 1 to 10 (with 1 being the best and 10 being the worst), do you think sound from Dove Mountain Boulevard is, at times, at a level that you consider noise?

**FINDINGS:** The average response was 8.4 with 8 at 10, 1 at 9, 7 at 8, 1 at 7, 1 at 5 and 1 at 3.

2. At what time(s) do you consider sound from Dove Mountain Boulevard to be noise? Circle all times that you think apply. Early Morning - Morning - Late Morning - Noon - Early Afternoon - Afternoon - Late Afternoon - All the time

**FINDINGS:** There were 7 “all of the time,” but most responded that early morning, morning and pretty much the entire afternoon, including late afternoon were the times they had issues with. One response said the noise began at 3:30 am in the morning.

3. Does this perceived noise occur on specific day(s) of the week, month, or year? Or is it all the time?

**FINDINGS:** There were 10 “all of the time” with 8 “Monday through Fridays” with 2 on “Monday through Saturday.”

4. Do weather conditions have any impact on your perception of the sound as noise?

**FINDINGS:** Thirteen said no and the remainder said yes. It is interesting to note that it is well known that weather (temperature and wind) has a significant impact on sound

transmission. This is probably an indication that we do not have enough bad weather for folks to notice.

5. *Do you feel that the noise is high and frequent enough that it needs to be mitigated in some fashion?*

**FINDINGS:** Eighteen said yes, with one saying, “not at this time.” This same responder said, “What is needed is more landscaping.” One yes commented that mitigations are only needed in specific locations, and another said the brick crosswalks need to be removed. But the bottom line is that all the responders agreed that something needs to be done.

6. *If you consider the sound to be noise, is it when you are inside your home, outside your home, or both?*

**FINDINGS:** Twelve respondents said both. The other 7 said outside.

7. *From that location (either indoors or outdoors), can you directly see Dove Mountain Boulevard? Circle which applies. Inside: Yes or No Outside: Yes or No Note: Line of sight is the path between the receiver (home/residence) and the source (vehicle on the street) and is very important in sound transmission. The rule of thumb is that if you can see the traffic, you may perceive its sound to be louder.*

**FINDINGS:** Eight said “yes and yes.” Five said “no and no” and the remainder were “no and yes.” So, the line of site impacts 13 of the responders.

8. *Are there any obstructions between you and Dove Mountain Boulevard that can interrupt that line of sight? If so, is that there all the time or only some of the time? Note: Traffic sound or noise is a moving line source, meaning it is generating that sound as it travels along the street or road. Sound or noise can be interrupted at times by something physical like a berm, wall, or vegetation that is on or off your property. These features can reflect and/or absorb sound.*

**FINDINGS:** Only four responders indicated they had a wall between them and the DMB. Three others said they had houses between them along with some vegetation.

9. *If you can see Dove Mountain Boulevard, have you noticed what type(s) of vehicle(s) are generating enough sound for you to consider it to be noise?*

**FINDINGS:** Big trucks, some with trailers, most associated with construction won this contest with 15 responders referring to them in some fashion. Some mentioned motorcycles. Only 4 responders said all traffic.

10. *Estimate or guess how far is your home from Dove Mountain Boulevard in feet or football fields?*

**FINDINGS:** Thirteen responders are 500 feet or less from DMB. Eleven are 200 feet or less. Most of those who are closest to DMB are at or below grade with it. The closest is 50 feet. The furthest is 6 football fields away, but they are downhill from DMB.

11. *Is your home above, below, or at the same level as Dove Mountain Boulevard? Or does it vary?*

**FINDINGS:** Ten said they are below. Six said same level. Three said above. Being below presents a real issue in providing some sort of barrier that is adjacent to their houses.

12. *What is the terrain like between you and Dove Mountain Boulevard? Is it flat, hilly, uphill, or downhill? Does the terrain have no vegetation, little vegetation, some vegetation, or much vegetation? Is the soil on the terrain soft, semi-soft, semi-hard, or hard?*

**FINDINGS:** Many said it was downhill even though they indicated they were below DMB. This question may have confused respondents as they should have responded uphill. But many indicated some vegetation, and many responded the ground was soft, semi-hard and soft.

13. Describe and/or sketch the location where you are when you consider the sound from Dove Mountain Boulevard to be noisy. Is there a wall between you and Dove Mountain Boulevard? If so, what type of wall and how high is it? Is it a solid wall or does it have openings? If it has openings or gaps, what are those openings made of?

**FINDINGS:** See Appendix D for the specific comments provided along with sketches and photographs. The photos used in Figure 5 of this report came from a survey respondent.

14. If you consider Dove Mountain Boulevard to have enough sound to be considered noise, have you done anything on your property to mitigate it? This could include heightening a solid wall or closing gaps in a solid wall with a solid material such as masonry, steel, aluminum, wood, or safety glass. See the companion handout for the transmission loss potential of different materials.

**FINDINGS:** Some have planted additional landscaping; some have done extensive mitigations including installing acrylic panels, walls, and fake grass. Many have water features, and one responder said they have replaced their windows. It appears some are very sophisticated in their approach to noise mitigation on their property. However, some do not appear to know exactly what to do and may feel a bit powerless or restricted by their builders or Homeowner Associations (HOA). So, a potential outcome will be to come up with some specific performance requirements for sound mitigations and then also work with the builders and the HOA to allow for these to be used. For instance, a five-foot-high masonry wall really does not do much for sound mitigation if the house is at grade or below the grade of DMB.

15. Have you tried any other mitigation measures, such as a water feature, to help mask the sound?

**FINDINGS:** Ten responded that they had some sort of water feature. Three did not answer this question. Two commented that the water feature does not help. The remainders were no. This is an indication that perhaps their water feature does not produce enough sound to help mask traffic noise. To produce enough masking sound typically takes an aggressive water feature. This is typically something you cannot buy from a garden shop. It is something you must design and build. To move enough water to mask noise it typically takes a large pump and water feature that can produce around 62 dBA of masking sound. This means a water pump of around 1 to 2 horsepower is needed. Typical garden shop water features pumps are substantially under 1 horsepower and do not produce that much sound. So, one of the outcomes of this study should be to make recommendations regarding water feature sound performance requirements.

16. Are you willing to allow the Town of Marana and its engineering consultant, Dibble, to take sound measurements at the location where you believe that sound is noise? The total time to take these measurements is estimated to be just under an hour.

**FINDINGS:** Sixteen said it would be ok for the Town to take sound measurements at their house. Two said no and one did not answer the question.

17. Please write any other questions and/or comments here.

**FINDINGS:** Many provided comments on their answers to other questions. See the appendix for all the comments. However the take away summary of the comments are: speeding is the key issue, speed limit needs to be enforced (automatic enforcement would help), take out the brick crosswalks, low frequency noise from heavy trucks causes windows to rattle, construction traffic is the main source of noise at all times, CCRs and builder restrictions need to be lifted so individuals and/or neighborhoods could enhance noise mitigations along their DMB frontage, smoother pavement would help reduce noise, more roundabouts to slow traffic down.

Summary tables of the responses are contained in the appendix. It is interesting to note that follow-ups with the various involved professional property management and community management companies

revealed that none of them have ever received a complaint from any of their members on DMB traffic noise. Additionally, they stated that they believe there are no specific CCRs that would prohibit a member from altering their properties' exteriors to provide noise mitigation. If a member wishes to do that, they should submit an architectural application along with plans so it can be reviewed and potentially approved per that process.

The backup on how these findings were derived is contained in Appendix D.

## **7. TRAFFIC DATA & SPEED LIMIT**

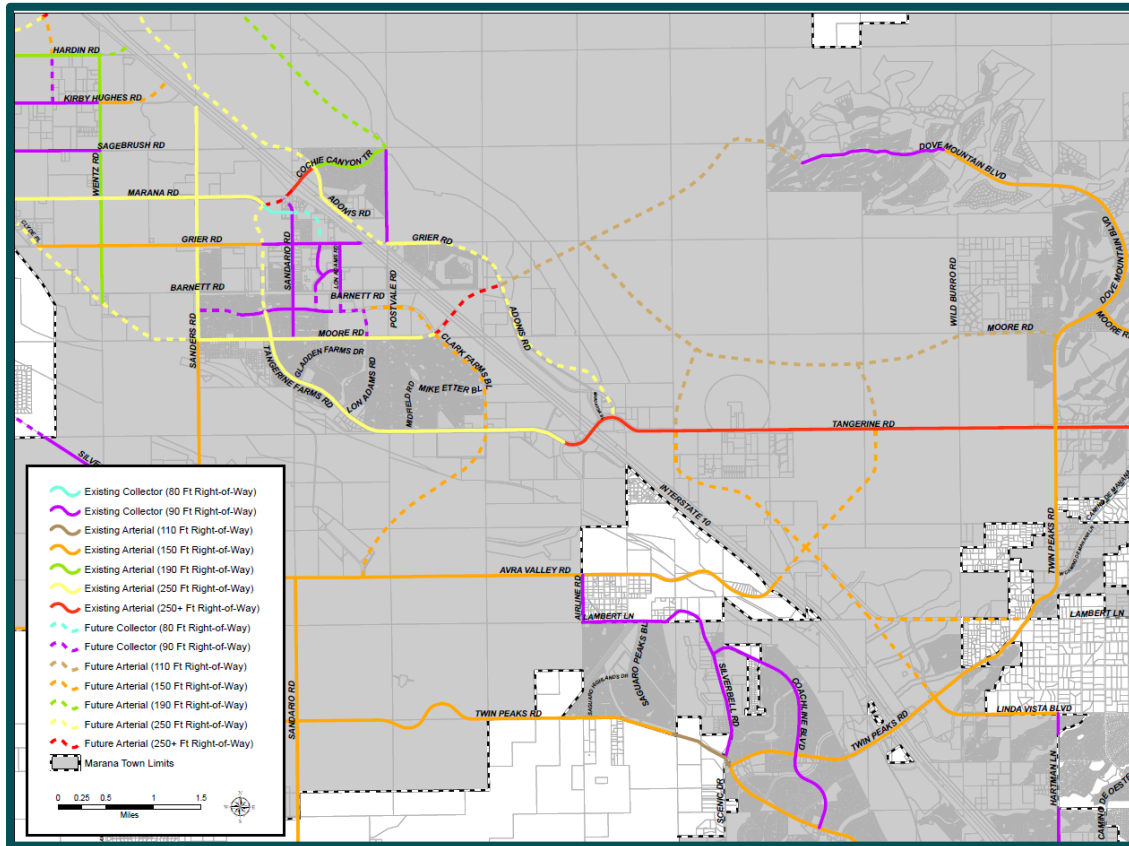
The Town of Marana collected traffic data on DMB near Sonoran Links Lane / Paseo Vista Solana intersection on July 14, 2022. This data reviewed the following:

- The average daily traffic was 4,162 vehicles on that day.
- The 85% speed was at 54 mph in both directions. This shows a very low compliance rate with the existing posted speed limits, which are at 35 mph and 40 mph. Thus, lowering the speed limit without specific periodic enforcement might not be impactful. The average speed was 46 mph. It is anticipated that a specific and periodically scheduled enforcement effort along DMB could change the story on speed.
- The average percentage of heavy trucks on DMB is 7%. This is high and shows the impact that continued construction is having on this area. If other trucks and buses are included this percentage rises to 21%. The citizen survey results reinforce the findings of this data. Many of the respondents complained about the heavy trucks as the biggest noise generators.

It should be noted that summertime is not necessarily a high traffic demand time for passenger vehicles. However, it should represent the amount of construction traffic and heavy trucks. Also, less traffic typically means higher speeds as well.

## **8. TRAFFIC NOISE IN MARANA**

Traffic-generated sound is everywhere in the Town of Marana. Measurements taken by the Town at other locations like DMB show that sound levels on DMB are like other streets. What is unusual about DMB is there have been several individuals who have been actively expressing their concerns and complaints about traffic noise.

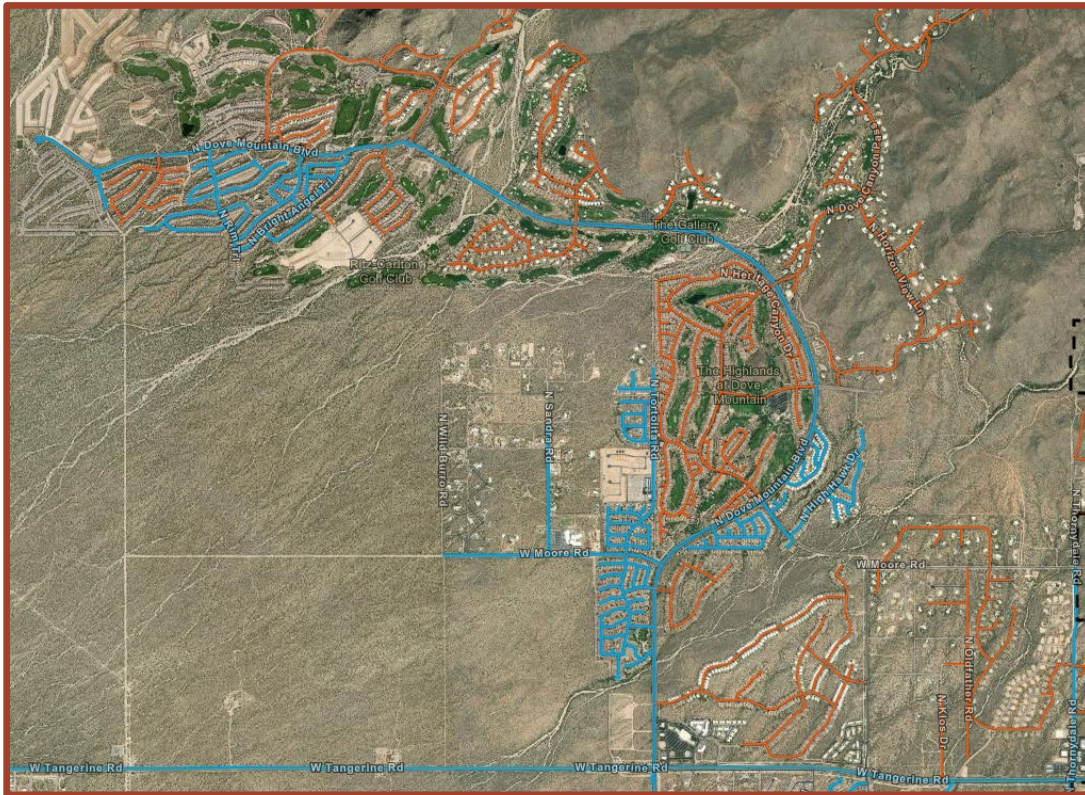


**Figure 7 - Town of Marana Major Streets & Functional Classification**

As this map shows, DMB is not unique or different from many of the major streets in the Town of Marana. It is part of the major street network. This map also shows the right of way width along DMB varies from 150 feet to 90 feet. The street functional classification also varies from an arterial to a collector.

## 9. STREET MAINTENANCE AND LICENSE AGREEMENT

It is important to realize that the Dove Mountain area has a mix of Town of Marana owned and maintained streets and privately owned and maintained streets. As shown in the following figure.



**Figure 8 - Town of Marana Owned and Maintained Streets (in blue) in Dove Mountain Area.**

The landscaping and many of the landscape features along DMB in the Town of Marana public right of way are operated and maintained by the Dove Mountain Community Association (DMCA). If additional landscaping and landscape features are to be provided, it would be the responsibility of DMCA. The license agreement between the Town of Marana and DMCA is contained in Appendix A. A listing of the items DMCA is allowed to do is per item #5. It is notable that the Town of Marana can change the agreement pretty much at will; this is per Item #9.

**10. ADDITIONAL STREET OR ACCESS ALTERNATIVES**

Some have suggested that additional streets that service the Dove Mountain area could be a possible traffic noise mitigation approach. As it is now, all the traffic coming into and out of Dove Mountain must use DMB to access Tangerine Road or use Moore Road to continue east. Providing an additional north-south street through the Tortolita Preserve is not an option, as the Town has set aside this land to be preserved and only to be used for recreational purposes. As seen by the map contained herein, the Preserve pretty much cuts off any possibility to the south, near Dove Mountain area. Additional access to this area is in the Town of Marana General Plan, which is referenced in this report. These additional accesses will have to go around the Tortolita Preserve. This would require a significant capital investment, currently there is no funding plan. Hence, these improvements will be in the future or will only be built if this area is developed. If it does develop that will mean more traffic. Plus, if this street ends up being parallel to Tangerine Road and goes all the way to I-10, there is a chance that a lot of Dove Mountain area traffic might use it.

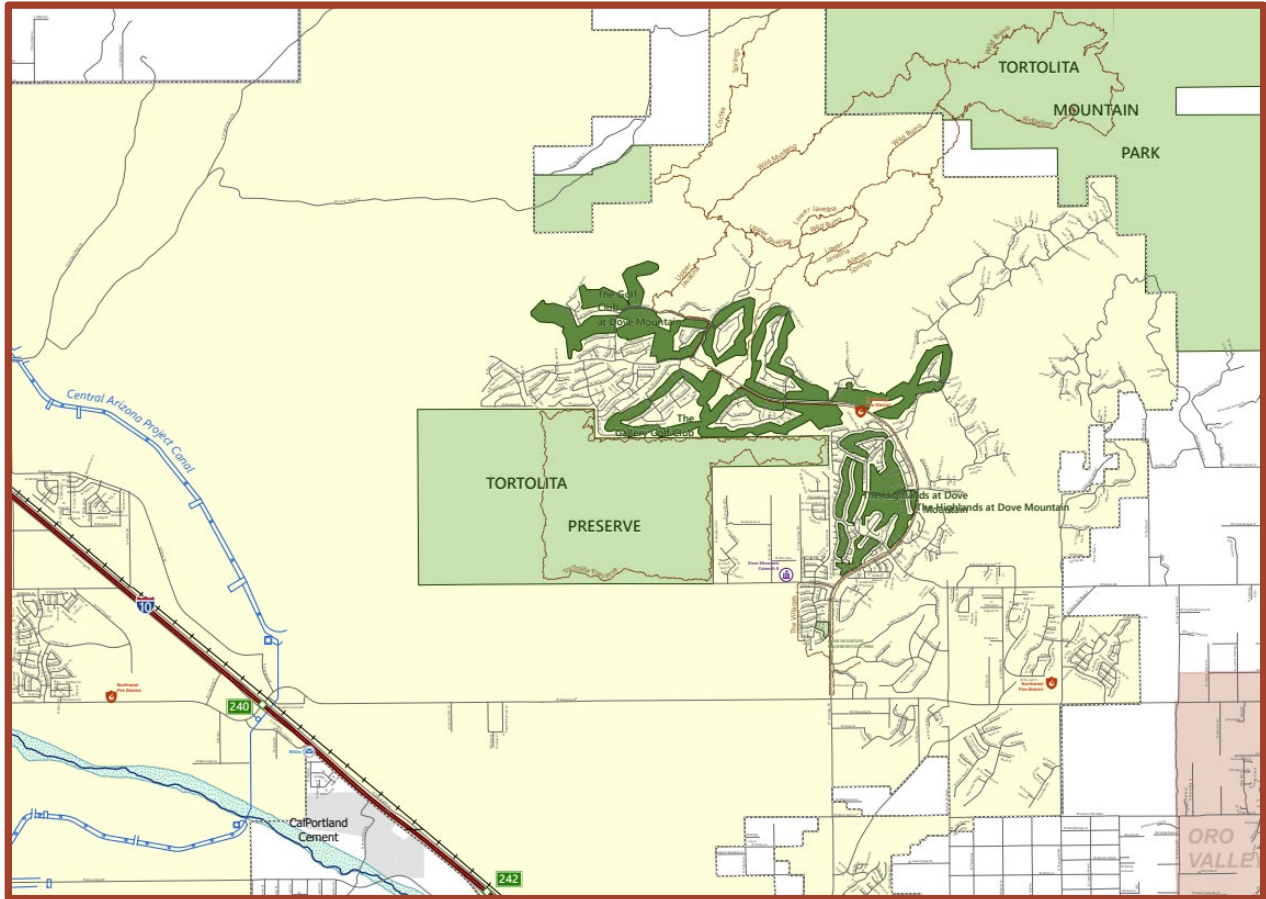


Figure 9 – Tortolita Preserve

The Tortolita Preserve (TP) is 2,399 acres or 3.8 square miles of undeveloped desert land. It is land leased from the Arizona State Land Department (ASLD) to the Town of Marana for open space and recreational purposes. The Town is responsible for the operations and maintenance of hiking, bicycling and equestrian trails. The lease has a 99-year term ending in 2099.

**11. DOVE MOUNTAIN & THE GENERAL PLAN**

The Dove Mountain area is within the Marana Municipal Planning area and is included in the officially approved “Make Marana 2040 General Plan” approved by the Town Council on December 10, 2019. Dove Mountain is referenced in the East Growth Area of the plan, but not included. The reason given is as quoted from the plan as follows: “The majority of the Dove Mountain neighborhood is not included in the East Growth Area since the master-planned community will generally remain as it is today.” Below is the figure showing the General Plans Growth Areas from page 2-9 Figure 2-2.

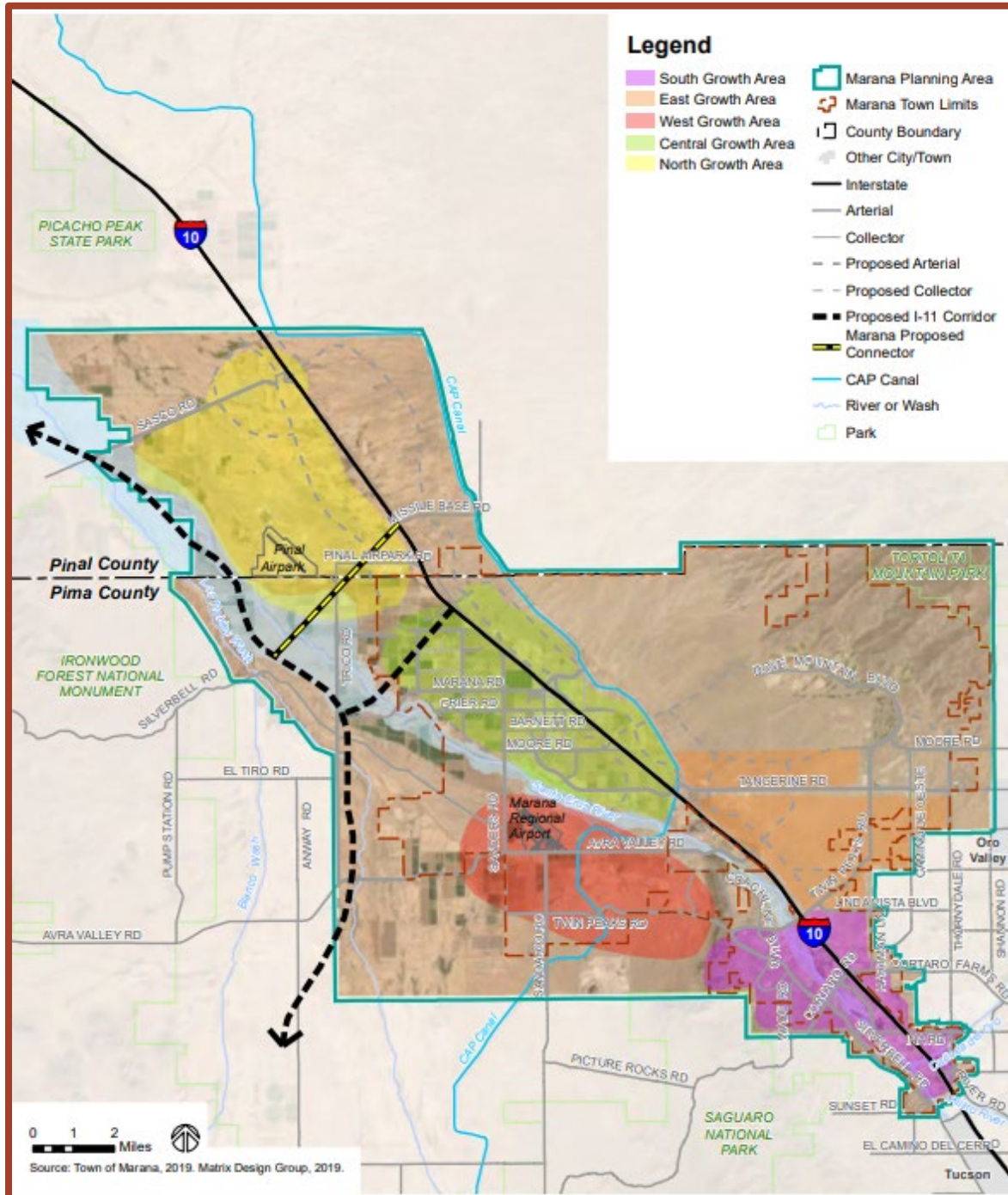


Figure 10 – Town of Marana General Plan Growth Areas

The following figure shows the current plans from the General Plan to provide additional access to the Dove Mountain Area per Figure 2-4 Future Circulation on page 2-27.



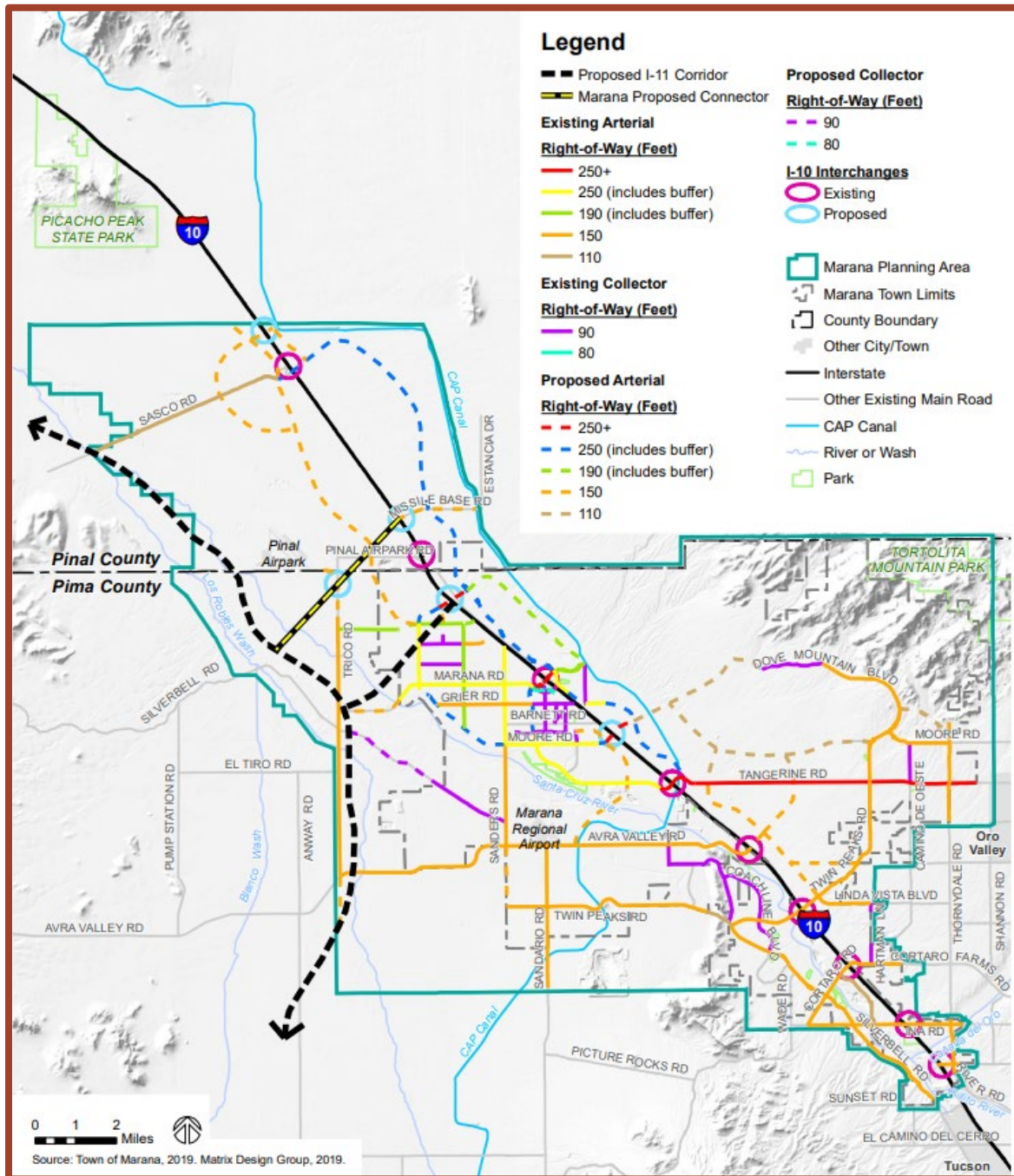


Figure 11 – Future access or street plan from the Make Marana 2040 General Plan.

As can be seen, the extension of DMB will be going around the Tortolita Preserve, and there is no plan to go directly through it. The Town of Marana is currently in the process of finalizing a new Transportation Master Plan. Alternative routes may be identified in this plan.

## 12. HOMEOWNER OR COMMUNITY ORGANIZATIONS

The following is a listing of homeowners and community organizations in the Dove Mountain neighborhood. Several homeowners’ associations (HOA) and one community center serve their members in the Dove Mountain neighborhood.

There is Canyon Pass, Dove Mountain, and Gallery, whose Property Management company is Associa Management.

Then there are the Highlands at Dove Mountain and the Del Webb at Dove Mountain.

Suppose a decision is made to proceed with physical sound mitigations that alter outdoor appearances. In that case, each HOA will need to be coordinated regarding what is restricted by their Covenants, Conditions, and Restrictions CCRs and/or architectural guidelines and requirements. Typically, HOAs require an architectural permit to be filled out and submitted for review and approval.

It is interesting to note that contact was made with each of the property management companies that manage these HOAs. In each case, the contacts with these HOA stated that they have never been contacted regarding traffic noise complaints on DMB, nor has any member made an architectural request regarding a noise mitigation measure.

### **13. PROACTIVE TRAFFIC NOISE MITIGATION APPROACH**

As mentioned in this report, the FHWA recommends traffic noise preventive measures. Addressing traffic noise proactively can save significant resources and improve the quality of residents' lives. The following is a summary listing of strategies for mitigating traffic noise that might be considered.

#### **1. Land Use Planning and Design**

**Zoning** – Implement zoning that separates noise-sensitive land uses far from major highways and streets. This would include creating wide buffer zones that gain meaningful distance in terms of sound attenuation. Include requirements for landscaping, berming and walls to help increase the mitigation potential of the buffer zone.

**Building Orientation** – Residential buildings should be oriented to place noise-sensitive rooms away from the street side and use rooms and spaces that are not as noise-sensitive as shields.

#### **2. Building Codes**

**Interior Sound Attenuation** – Require that all residential buildings include specific acoustical-rated materials that prevent noise from entering or propagating as much. Require all gaps to include sealing treatments.

**Exterior Sound Attenuation** – Require solid and tall walls that break the line of sight from the residence to the roadway.

**Landscaping:** Trees, shrubs, and hedges can absorb sound and create a visual barrier.

#### **3. Street Design and Maintenance**

**Geometrics** – Require vertical and horizontal street alignment to minimize potential noise impacts. This includes keeping grades at or below residential areas. If that is not always possible, consider using berming and walls to help minimize noise potential as feasible.

**Crosswalks** – Do not allow textured crosswalks on major roads.

**Speed Limits** – Set appropriate speed limits to reduce noise generated by vehicles.

**Pavement Design** – Do not use pavement treatments known to produce a lot of noise. Review pavement mix designs to determine if measures might be taken to make them less noisy. Note that the potential for

“quiet” pavements is difficult because the durability of those “quiet” pavements is not sustainable. FHWA still does not recognize “quiet” pavements as a valid sound mitigation. The findings are that pavement can be less noisy when it is new, but as it ages, it gets noisier. The Town of Marana's experience with the resurfacing of DMB provides some support that repaving, or surface treatments can result in some noise reduction; however, results vary, and it is difficult to achieve consistent and durable results. It is important to note that many of ADOT's “quiet” pavement areas are now being diamond grinding as a pavement preservation technique to replace the rubberized asphaltic overlays back to the original Portland Cement Concrete Pavement (PCCP) that has a concrete treated base. Diamond grinding cannot be used on PCCP that has an asphalt base. The diamond grinding helps to improve ride quality and does reduce noise. But it is not necessarily intended as a “quite” pavement, it is just a more sustainable and cost-effective solution that has approximately a 30-year service life compared to rubberized asphalt's service life of 10 to 15 years.

This report makes more specific recommendations. However, it is important to note that there is no perfect approach to preventing and dealing with traffic noise. It is important to be aware of traffic noise becoming an issue and address it proactively.

## 14. SUPPLEMENTAL SOUND MEASUREMENTS

The Town of Marana conducted several in-depth noise measurement studies along DMB as well as at other locations. The report on these measurement efforts and findings is contained in Appendix E.

## 15. TRAFFIC NOISE MODELING

Utilizing the FHWA Traffic Noise Model (TNM) was explored as a part of this assessment. The TNM is intended to help model the sound and noise issues and determine if they are reaching actionable levels and whether mitigations might be feasible in achieving a 5 dB or higher level of reduction. The FHWA TNM is a very useful tool, as it accounts for all sorts of factors that make its outcomes accurate. It is also free software that anyone can use. The National Highway Institute (NHI) also has extensive online free training on sound and noise and how the TNM can be used.

In terms of DMB, the intent was to set up the test model to make an estimate of potential sound reduction if an individual property owner, group of property owners, or HOA wishes to explore mitigation options such as extending the height of an existing wall on private property, so it becomes an effective noise barrier or adding a noise barrier wall on private property. Some test cases were run in the model to explore this further. Three typical applications were explored.

- #1 When DMB was at the same grade or level as the resident receiver.**
- #2 When DMB was above the grade or level of the resident receiver.**
- #3 When DMB was below the grade or level of the resident receiver.**

Because of complications in the terrain models, only #1 was modeled for one simple idealized case. Placing a 10-foot sound barrier at and around the resident receiver on private property did show promise in achieving a 5dB reduction. It is important to note that the noise barrier was assumed to be on private property at the resident receiver, and the wall went all the way around to prevent flanking. This means that the individual resident or group of residents would either extend their existing walls to this height or build new walls to this height or whatever height and length would achieve a reasonable and acceptable noise reduction. Additionally, it was assumed that this wall was a solid wall. Meaning that it would completely block all views.

If individuals, groups of individuals, HOAs, and/or DMCA wish to pursue the noise wall barrier mitigation approach, it does hold promise. However, each site and each application will need to be more carefully evaluated using the TNM to make a final evaluation of how high and long these walls need to be and how much they would cost. Again, the funding of any walls would need to be provided by the individual, group of individuals, HOA or DMCA. The evaluation done for this assessment only shows the possible potential.

Also, it is important to know that a sound barrier wall must extend a significant distance beyond each receiver, or it must surround the receiver so as to prevent noise flanking.

## 16. DOVE MOUNTAIN DEVELOPMENT HISTORY

Dove Mountain’s development has a long history that spans over 35 years. It was originally named Tortolita Mountain Properties and then later Redhawk. The first Specific Plan approving Tortolita Mountain Properties was passed and adopted by the Town Council on May 31, 1989. This original plan was changed through one Resolution and two other Ordinances.

The Redhawk development, which was under the ownership of RedHawk Marana LLC, Specific Plan was approved by the Town of Marana by Ordinance #96-46 and Resolution #96-111 on December 17, 1996. This plan was prepared by a team of consultants including The Planning Center, Greiner Engineering, Simons Li and Associates, Institute for American Research and Ruffner Associates.

The Planning Center is still in business and has offices in Tucson and Phoenix. Grenier Engineering is also still in business and has an office in Tucson. Simons, Li and Associates (specializes in drainage studies, etc) is still a company in Tempe. The Institute for American Research is an archaeological firm. It is not defined what Ruffner and Associates did in developing the Specific Plan.

The RedHawk Specific Plan covers over 5,567.9 acres of land. It calls for over 13,362 dwelling units and 1,600 resort/hotel rooms. In section B of the plan, the following Goals, Objectives, and Policies were established for the development.

|   |   |
|---|---|
| <ul style="list-style-type: none"> <li>o <i>URBAN FORM AND PATTERN GOAL</i></li> <br/> <li>o <i>LAND USE GOAL</i></li> <br/> <li>o <i>CIRCULATION GOAL</i></li> </ul> | <p><i>"Insure the character of a small town through the development of quality neighborhoods and balanced land uses".</i></p> <p>The RedHawk Specific Plan provides residential homes in various sizes along with additional commercial, campus park industrial, resorts and office uses which will benefit the entire area. It also provides guidelines to promote a level of design quality.</p> <p><i>"To develop a zonal land use pattern which meets the basic needs of Marana residents for essential services, working and living environments and areas for pursuit of leisure time activities and the economic benefit of all."</i></p> <p>The RedHawk Specific Plan provides a balanced, self-sufficient autonomous community with a full range of residential product types, commercial, office and recreational uses. Job opportunities are provided which will reduce long distance commuting and associated air quality impacts.</p> <p><i>"To develop a town-wide hierarchy of major streets, routes, trails and pedestrian ways to ensure transportation for a multi-modal community."</i></p> <p>The Circulation Plan in the RedHawk Specific Plan is designed to utilize existing circulation routes and provide additional circulation components and/or improvements where necessary.</p> |
|---|---|

**Figure 12 – Original Goals, Objects, and Policies.**

These are referenced here to provide context to determine for the current configuration of the development in meeting the goals that were originally set. One of the main roots of this issue is that the grading and wall standards were not necessarily devised to help shield residential properties from DMB. However, the wide right-of-way and the lush desert landscaping has accomplished this in some areas. Clearly, the intent was

to provide offset and shielding, as can be seen in the typical sections. The perimeter walls around individual developments also did not necessarily contemplate the need to shield those developments from DMB.

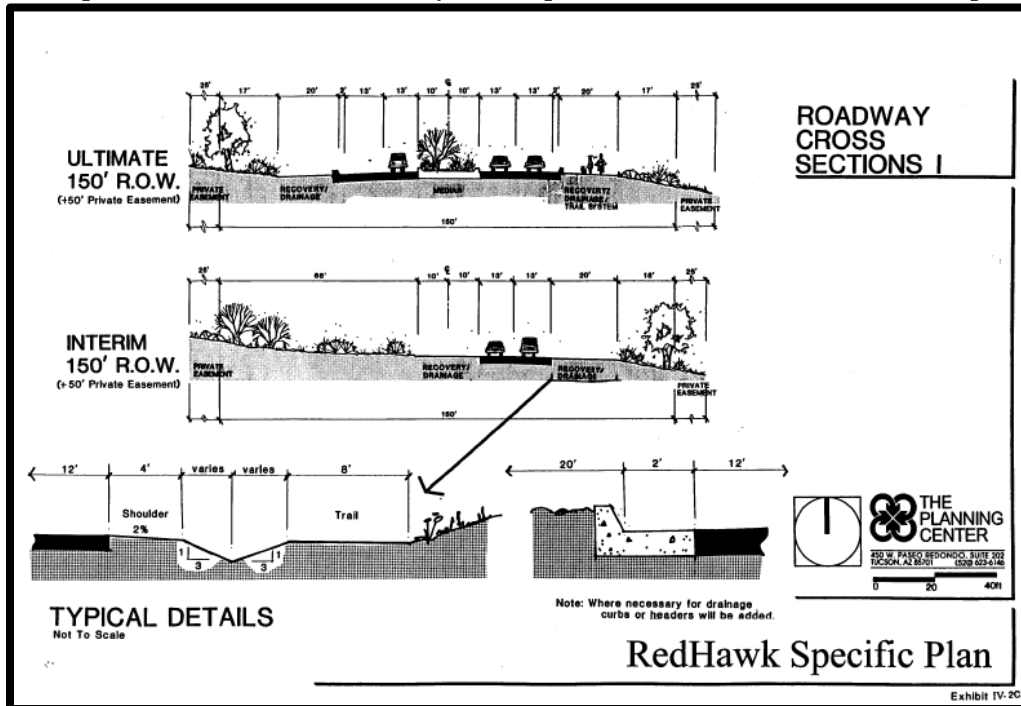


Figure 13 – Original Dove Mountain Boulevard Street Typical Sections.

4. Individual Development Theme Wall
- Walls built around individual developments provide individual project identity but should also be consistent with community character.
- The walls should be solid or semi-open in design and typically be three (3) to six (6) feet in height.
  - The wall should be constructed of material similar to the building materials, including stone, and be consistent throughout each individual development where possible.
  - Semi-open walls should be constructed of such materials as stone pilasters with brick caps or similar materials that portray the image of the area.

Figure 14 – Original Wall Concepts.

The only content regarding walls is as shown above from the original RedHawk Specific Plan. As can be seen, the thought of the walls acting as a sound barrier was not considered.

**Online Links to Reports and References used in this report:**

- [Living With Noise | FHWA \(dot.gov\)](https://www.fhwa.gov/living-with-noise/)
- [Noise | Department of Transportation \(azdot.gov\)](https://www.azdot.gov/noise/)
- [SERVICES -Maps – Town of Marana \(maranaaz.gov\)](https://www.maranaaz.gov/services-maps/)
- [Make+Marana+General+Plan+2040+FINAL+Amended+Dec+22+c.pdf \(squarespace.com\)](https://www.squarespace.com/make-marana-general-plan-2040-final-amended-dec-22-c.pdf)
- [CHEAPEST Budget way For SOUNDPROOFING a Room \(youtube.com\)](https://www.youtube.com/watch?v=CHEAPEST)



# **Appendix A – Town of Marana & Dove Mountain Community Association (DMCA) License Agreement**

Reference # LCA0703-001

F. ANN RODRIGUEZ, RECORDER  
Recorded By: MN  
DEPUTY RECORDER  
4913



SEQUENCE: 20133050135  
NO. PAGES: 6  
RWAY 11/01/2013 13:03  
PICK UP  
AMOUNT PAID: \$7.50

SMARA  
TOWN OF MARANA  
PICKUP

**TOWN OF MARANA RIGHT-OF-WAY LICENSE**

**(Dove Mountain Community Association)**

LICENSOR: TOWN OF MARANA  
11555 W. Civic Center Drive  
Marana, AZ 85653

LICENSEE: DOVE MOUNTAIN COMMUNITY ASSOCIATION  
3567 East Sunrise Drive #219  
Tucson, Arizona 85718

1. In consideration of Licensee's payment of a license fee, the receipt of which is acknowledged by the Licensor, and Licensee's performance of its obligations under this License, Licensor hereby authorizes Licensee to use, in conformance with this License and all applicable local, state, and federal laws and regulations, Licensor's public right-of-way referred to in this License as the "License Area," which consists of that public right-of-way described in Exhibit A attached to and incorporated by this reference in this License.
  2. This License modifies, supersedes, and replaces the "License Agreement" issued to Dove Mountain Community Association recorded in the office of the Pima County Recorder on May 11, 2007 at Docket 13053 Page 2245 (Town of Marana Reference Number LCA0703-001).
  3. This License now incorporates, supersedes and takes the place of the following licenses:
    - The "License Agreement" issued to Dove Mountain Retail LLC recorded in the office of the Pima County Recorder on November 6, 2008 at Docket 13429, Page 1147 (Town of Marana Reference Number LCA0803-001)
    - The "Town of Marana Right-of-Way License Agreement (Signage for Dove Mountain Centre II)" issued to Dove Mountain Retail II LLC recorded in the office of the Pima County Recorder on September 23, 2011 at Sequence No. 20112660040 (Town of Marana Reference Number LCA1103-001).
- Any Town of Marana permits that cross-reference Town of Marana LCA0803-001 or LCA1103-001 shall now cross-reference this License (Town of Marana LCA0703-001).
4. "Licensee" includes any person or entity employed by, contracted by, or acting on behalf of Licensee.
  5. Licensee may use the License Area for landscape, irrigation, decorative pavement, decorative stamped concrete, walls, signage, pedestrian paths, golf cart paths, lighting, directional signage, monumentation, and custom traffic control devices in a manner consistent with this License and conforming to plans approved and permits issued by the Town of Marana.

6. Licensee's use of the License Area shall comply with all applicable local, state, and federal requirements.
7. Licensee shall bring into compliance with Town-approved plans and all applicable local, state, and federal requirements any use of the License Area installed by or on behalf of Licensee, or by or on behalf of a builder and then accepted for maintenance by Licensee. If Licensee is unable to bring any such use of the License Area into compliance, Licensee shall remove such use at Licensee's cost.
8. Licensee shall maintain any use of the License Area installed by or on behalf of Licensee, or by or on behalf of a builder and then accepted for maintenance by Licensee.
9. Licensor shall have the right to modify or terminate this License at any time.
10. This License shall remain in effect unless and until it is terminated (a) by and at the sole discretion of Licensor or (b) by written agreement of the parties.
11. Licensor shall give Licensee written notice of full or partial termination of this License at least 60 calendar days before the termination unless an emergency requires a shorter notice period, and in that event Licensor shall notify Licensee as early as practicable.
12. Upon full or partial termination of this License for any reason, including without limitation Licensor's construction of a road widening or other capital project, Licensee shall at its sole cost either (i) restore the portion of the License Area affected by the termination to Town of Marana standards for restoration as determined by the Town at the time this license is terminated, or (ii) completely remove everything maintained by Licensee in the portion of the License Area affected by the termination and replace it with native landscape material not requiring irrigation.
13. This License shall not be assigned by Licensee, but Licensee's obligations under this License shall be binding upon Licensee's heirs, contractors, assignees, designees, agents, and representatives.
14. Licensor issues this License to Licensee as an accommodation for the Dove Mountain project.
15. Licensee shall defend, indemnify and hold harmless Licensor, its officers, agents, and employees from and against any and all claims, demands, causes of action, complaints, suits, losses, damages, injuries, and liabilities whatsoever (including those for costs, expenses, and attorneys' fees) to any person, persons, or property arising out of either (i) Licensee's use or maintenance of the License Area or (ii) Licensee's negligent acts or omissions in connection with anything installed by or on behalf of Licensee, or by or on behalf of a builder and then accepted for maintenance by Licensee, in the License Area.
16. Licensee shall obtain liability insurance for the term of this License in minimum amounts of \$1,000,000.00 per occurrence and \$2,000,000.00 per occurrence for general aggregate. Licensee may satisfy the minimum insurance requirement with excess or umbrella liability coverage. This insurance shall be updated annually and shall be kept in force while this License is in force. Licensor may, if it deems necessary, require additional coverage. Licensor shall be named as an "additional insured" endorsee for the coverage, evidenced by endorsement number on the face of the insurance certificate and submittal of a copy of the additional insured endorsement or any other required endorsement. If available through Licensee's insurance carrier, Licensee shall obtain a "cancellation notice recipient"



endorsement, evidenced by endorsement number on the face of the insurance certificate and submittal of a copy of the cancellation notice recipient endorsement, in all its insurance policies, requiring Licensee's insurance carrier to provide notice to Licensor of cancellation or reduction of insurance coverage. CERTIFICATES OF INSURANCE FOR COVERAGE AS DESCRIBED IN THIS LICENSE SHALL BE FILED WITH LICENSOR PRIOR TO COMMENCEMENT OF ANY ACTIVITY UNDER THIS LICENSE. LICENSEE SHALL ALSO FILE ALL CERTIFICATES OF INSURANCE AND REQUIRED ENDORSEMENTS EACH TIME THE POLICY IS UPDATED OR RENEWED. Certificates of insurance and endorsements shall be sent to the Town of Marana Planning Department, attention Development Coordinator, 11555 West Civic Center Drive, Marana Arizona 85653, annually commencing on the date of execution of this License.

17. Licensee shall give Licensor written notice within two working days after Licensee receives notice of any cancellation or reduction of its insurance coverage.

18. If Licensee causes any damage to the License Area, Licensee shall promptly make and pay for the repairs necessary to restore the License Area to its pre-damaged condition. At the discretion of Licensor, if repairs are not initiated and completed within a reasonable length of time, but in any event within 14 calendar days after Licensor gives written notice of damage to Licensee, Licensor may make the repairs and bill Licensee for all costs plus a 25% administrative fee. Licensee shall pay the bill within ten calendar days of receipt.

19. This License is subject to cancellation for conflict of interest pursuant to A.R.S. § 38-511.

IN WITNESS WHEREOF, the parties have executed this License effective as of the Licensor's signature date below.

"LICENSOR":

TOWN OF MARANA, an Arizona municipal corporation

By: [Signature]  
Keith Brann, P.E., Town Engineer

"LICENSEE":

DOVE MOUNTAIN COMMUNITY ASSOCIATION, an Arizona non-profit corporation

By: [Signature]  
William Hallinan, Secretary

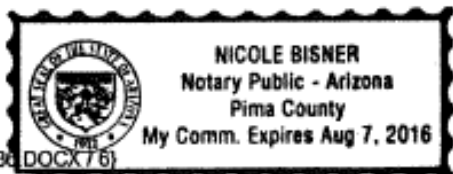
APPROVED AS TO FORM:

[Signature]  
Frank Cassidy, Town Attorney

STATE OF ARIZONA     )  
  ) ss.  
County of Pima         )

The foregoing instrument was acknowledged before me this 2nd day of October, 2013 by William Hallinan, Secretary of DOVE MOUNTAIN COMMUNITY ASSOCIATION, an Arizona non-profit corporation, on behalf of the corporation.

(Seal)



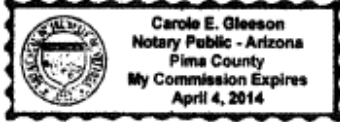
[Signature]  
Notary Public

8/7/2013 4:17 PM FJC

STATE OF ARIZONA )  
 ) ss.  
County of Pima )

The foregoing instrument was acknowledged before me this 8<sup>TH</sup> day of ~~August~~ OCTOBER, 2013 by Keith Brann, P.E., Town Engineer for the Town of Marana, an Arizona municipal corporation.

(Seal)



*Carole E. Gleeson*  
Notary Public

## EXHIBIT A: THE "LICENSE AREA"

1. The public rights-of-way owned by the Licensor as recorded with the Pima County Recorder's office as follows:
  - a. That segment of Tangerine Road No. 921 as established by Pima County, recorded in Book 7 at Page 83, located from 1150 feet west of the Tangerine Road and Dove Mountain Boulevard/Twin Peaks Road intersection to the Tangerine Road and Camino de Oeste intersection, including all public right-of-way acquired within said segment of Tangerine Road since its original establishment
  - b. That segment of Moore Road No. 1037 as established by Pima County, recorded in Book 8 at Page 61, located from the intersection of Moore Road and Owl Head Canyon Road to the west line of The Villages at Dove Mountain subdivision, recorded in the Pima County Recorder's office at Book 51 of Maps and Plats, Page 20, including all public right-of-way acquired within said segment of Moore Road since its original establishment
  - c. Redhawk Boulevard & Moore Road recorded in in Docket 10293 at Page 1013 and 1742
  - d. Dove Mountain Boulevard recorded in Docket 10765 at Page 1049
  - e. Dove Mountain Boulevard, Secret Springs Drive, & Saguaro Forest Loop recorded in Docket 12085 at Page 2477
  - f. Dove Mountain Boulevard recorded in Docket 12085 at Page 2493
  - g. Red Hawk Boulevard recorded in Docket 10227 at Page 365
  - h. Camino de Oeste Road No. 1429 as established by Pima County, recorded in Book 11 at Page 69
2. The public rights-of-way owned by the Licensor dedicated by the following subdivision plats recorded with the Pima County Recorder's office:
  - a. The Villages at Redhawk, Map and Plats Book 49 at Page 31
  - b. The Villages at Dove Mountain, Map and Plats Book 51 at Page 20
  - c. The Villages III at Dove Mountain, Map and Plats Book 53 at Page 94
  - d. The Villages IV at Dove Mountain, Map and Plats Book 60 at Page 18
  - e. Quail Crossing, Map and Plats Book 49 at Page 4
  - f. Quail Crossing II, Map and Plats Book 55 at Page 22
  - g. Bluffs at Dove Mountain, Maps and Plats Book 50 at Page 95
  - h. The Bluffs at Dove Mountain Phase II, Maps and Plats Book 54 at Page 61
  - i. Heritage Highlands at Redhawk, Maps and Plats Book 48 at Page 31
  - j. Canyon Pass IV-B at Dove Mountain, Map and Plats Book 59 at Page 6
  - k. Preserves III at Dove Mountain, Map and Plats Book 61 at Page 54
  - l. Dove Mountain Retail Centre, Map and Plats Book 61 at Page 70
  - m. Dove Mountain Centre II, Map and Plats Book 64 at Page 73

n. Dove Mountain Resort, Map and Plats Book 62 at Page 71

3. All public right-of-way dedicated hereafter for further extensions of the right-of-way known as Dove Mountain Boulevard that are within the boundaries of the Dove Mountain Specific Plan; effective upon submission of evidence of insurance coverage and evidence of endorsements for said extension that satisfies the requirements of paragraph 16 of this License



# Appendix B – Public Involvement Materials Presentation and Handouts



# Dove Mountain Boulevard Sound Assessment



## Workshop Presentation

April 17, 2024 | 2–3 pm

By Seth Chalmers, PE

Director of Traffic Engineering, Dibble

[seth.chalmers@dibblecorp.com](mailto:seth.chalmers@dibblecorp.com) / 602.363.1854

*Please sign in and  
pick up questionnaire  
and handouts*

# Questionnaire, Map, and Handouts

**Questionnaire:** Contact information (optional) or general location, instructions, assessment objectives, some important definitions, and 17 questions to help define the sound and noise issues and details.

**11" x 17" Color Map:** Gives you the opportunity to mark your location and line out the areas that are causing you (the receptor) issues.

**Handouts:** Provide you with information about sound and noise. Two are from the Arizona Department of Transportation (ADOT) and the other is a compilation of information from the Federal Highway Administration (FHWA) National Highway Institute (NHI).

**Please Fill Out the Questionnaire and Map: This is a key aspect of this assessment, as it will help us know what and where your issues are.**

# Authorities on Street Traffic Sound and Noise – Local

**Local Law:** The Town of Marana does have a noise ordinance (Chapter 11-5. Noise), but it applies to stationary noise sources. Traffic sound and noise are a line source that is moving, so it does not apply.



**Local Law:** Pima County also has a noise ordinance (Chapter 9.30, Regulation of Excessive, Unnecessary and Annoying Noises), that includes Section 9.30.060, Vehicular Noise.



## **9.30.060 Vehicular noise.**

A. It shall be unlawful for any person within any residential area of this county to repair, rebuild or test any motor vehicle between the hours of 10:00 p.m. of one day and 7:00 a.m. of the next day in such a manner as to create an excessive, unnecessary or offensive noise that a reasonable person of normal sensitivity residing in the area is caused discomfort or annoyance.

B. No person shall operate or cause to operate any motor vehicle unless the exhaust system of such vehicle:

1. Is free from defects which may cause sound level magnification,
2. Is equipped with a muffler,
3. Has not been modified in such a manner which will amplify or increase the sound level emitted by the motor of such vehicle above that emitted by a muffler originally installed on the vehicle as manufactured for initial sale.

C. No person shall operate a motor vehicle in such a manner which creates the squealing of tires in the roadway.

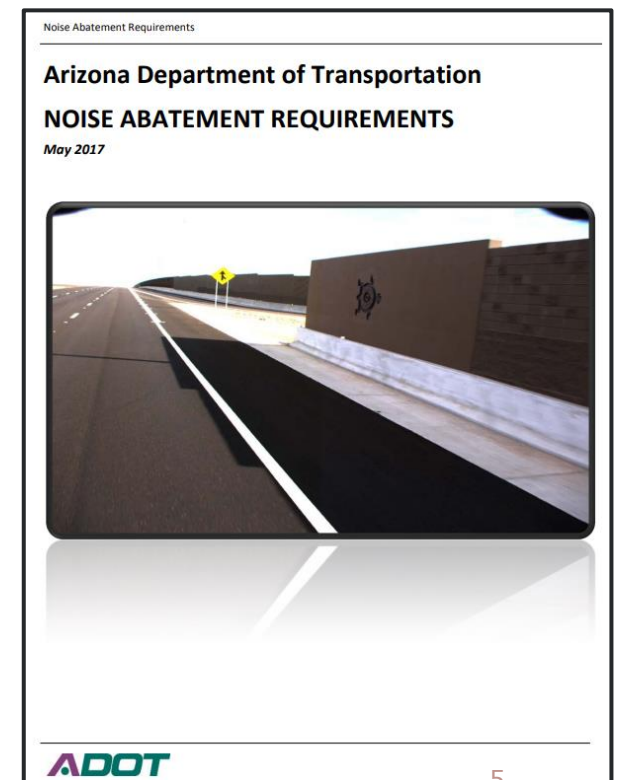
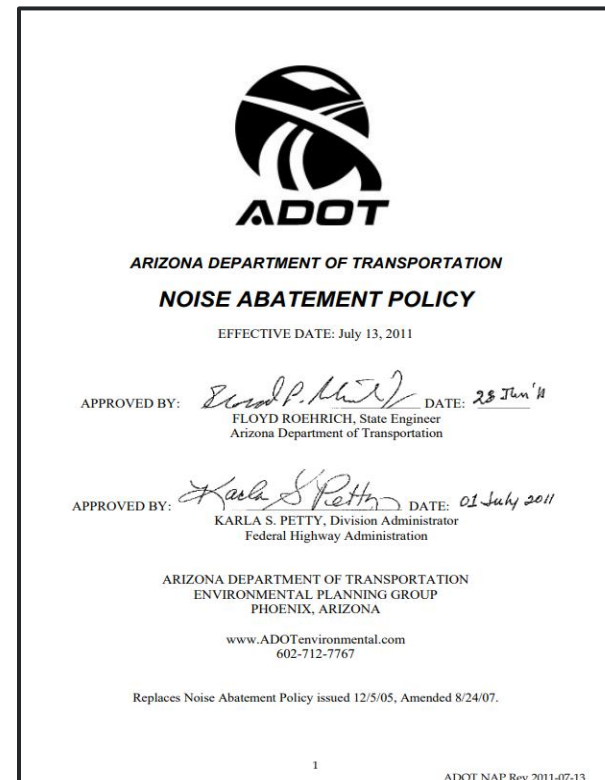
(Ord. 1999-61 § 1 (part), 1999)



# Authorities on Street Traffic Sound and Noise – State and Federal

**State Law:** Arizona Revised Statutes (ARS) Section 28-955 is targeted mostly at excessive noise a motor vehicle might emit via its exhaust system.

**Federal Laws:** The National Environmental Policy Act (NEPA) of 1969, Federal Aid Highway Act of 1970, and Noise Control Act of 1972 initiated methods to research, study, and mitigate noise, especially caused by vehicles. The NEPA and Highway Acts have targeted noise issues related to federal aid projects. Each state department of transportation must adopt a noise abatement policy.



# ADOT Noise Abatement Requirements



## Chapter 6

### Reasonableness

There are three reasonableness factors or “tests” that must collectively be achieved in order for a noise abatement measure to be deemed reasonable. These are:

1. Viewpoints or Preferences of Property Owners and Residents
2. Noise Reduction Design Goal, and
3. Cost-effectiveness

#### 6.1 Viewpoints or Preferences of Property Owners and Residents

The preferences of the property owners and residents of the benefited Receptors of a noise barrier will be taken into account when determining whether the barrier is considered reasonable. Noise barriers that are otherwise feasible and reasonable will automatically be considered to be desired unless the public involvement aspect of the NEPA process indicates that a substantial portion of benefited Receptors are opposed to the barriers. In that case, ADOT will make a good faith effort to determine the preferences of the property owners and/or legal occupants of each benefited Receptor location through a survey process. If less than a 50% response rate of property owner and residents is achieved and a substantial portion of the received responses are opposed to the recommended abatement measures, then further outreach will be attempted through the use of public meetings until either a 50% response rate is achieved or it becomes apparent that such a level of response is not possible due to situational concerns. ADOT will make a decision as to the reasonableness of the recommended mitigation based on the results of this process.

#### 6.2 Noise Reduction Design Goal

Noise barriers should be designed to reduce projected unmitigated noise levels by at least seven dB(A) for benefited Receptors closest to the transportation facility. To be considered reasonable, at least half of the benefited Receptors in the first row shall achieve this level of noise reduction. Any Receptor that meets or exceeds the design goal counts toward satisfying the noise reduction design goal of the reasonableness criterion. Benefited Receptor does not have to be necessarily impacted.

#### 6.3 Cost Effectiveness

The maximum reasonable cost of abatement is \$49,000 per benefited Receptor (cost-per-benefited- Receptor) with barrier costs calculated at \$35 per square foot, \$85 per square foot if constructed on a structure. Any cost of removal of previously built walls, drainage, and other similar construction work shall be included in the cost assessment above.

The cost of an abatement measure is the total cost of that measure divided by all the benefited Receptors protected by that abatement. The cost-per-benefited Receptor and barrier-cost-per-square-foot require FHWA approval, and will be re-calculated on a regular interval, not to exceed five years, in the following manner:

1. The cost-per-benefited Receptor is determined by taking the square-foot cost of barriers determined below and multiplying by 1400 sqft.

### Noise Abatement Requirements

2. The square-foot cost of barriers is determined by taking the greater of the current square-foot cost value or the average cost of construction of actual barriers for the preceding five years + 20%.

The current values were approved by FHWA on May 4, 2017.

#### 6.1.1 Third Party Funding



Third party funding cannot be used to make up the difference in cost between the reasonable cost-per-benefited-Receptor and the actual cost of the barrier. Third party funding can only be used to pay for additional features such as landscaping, aesthetic treatments, alternative barrier materials including sound absorptive materials, for noise barriers that are feasible and already meet cost-effectiveness criteria.

# FHWA Noise Measurement Handbook

**FINAL REPORT**

**Noise Measurement Handbook**

6.1.2018

**U.S. Department of Transportation**  
**Federal Highway Administration**

| Technical Report Documentation Page  |   |   |   |
|--|---|---|---|
| 1. Report No.<br>FHWA-HEP-18-065   | 2. Government Accession No.<br>(Remove; Insert Information Here or leave blank) | 3. Recipient's Catalog No.<br>(Remove; Insert Information Here or leave blank)            |   |
| 4. Title and Subtitle<br><b>Noise Measurement Handbook</b>   |   | 5. Report Date<br>September 15, 2017  |   |
|  |   | 6. Performing Organization Code   |   |
| 7. Author(s)<br>RSG  |   | 8. Performing Organization Report No.   |   |
| 9. Performing Organization Name And Address<br>RSG<br>55 Railroad Row<br>White River Junction<br>VT 05001  |   | 10. Work Unit No. (TRAILS)<br>(Remove; Insert Information Here or leave blank)            |   |
|  |   | 11. Contract or Grant No.<br>(Remove; Insert Information Here or leave blank)             |   |
| 12. Sponsoring Agency Name and Address<br>U.S. Department of Transportation<br>1200 New Jersey Ave. SE<br>Washington, D.C.   |   | 13. Type of Report and Period Covered<br>(Remove; Insert Information Here or leave blank) |   |
|  |   | 14. Sponsoring Agency Code<br>(Remove; Insert Information Here or leave blank)            |   |
| 15. Supplementary Notes<br>Other authors: Bowly & Associates, Inc.; ATS Consulting; Environmental Acoustics; Illingworth & Rodkin  |   |   |   |
| 16. Abstract<br>This handbook provides best-practice guidance on recognizing which measurement methodologies apply to which project type (Section 1.0), how to plan a noise measurement program (Section 2.0), descriptions of measurement methodologies and related considerations (Sections 3.0-15.0), terminology (Section 16.0, Appendix A) and measurement instrumentation (Section 17.0, Appendix B) related to highway traffic noise, example report documentation for measurements (Section 18.0, Appendix C), and supporting material for various methodologies (Sections 19.0-21.0, Appendices D-F). Sections 3.0 and 4.0 are directly applicable to the conduct of traffic noise studies required by the Federal Highway Administration (FHWA) noise regulation in 23 CFR 772. Section 22 is a bibliography.<br><br>The information provided in this handbook is based on the 1996 FHWA Measurement of Highway-Related Noise, and is based upon current national and international standards and practice updates. This handbook should be viewed as best-practice guidance and not direction as to how the work must be done. Some project sponsors have established and use their own procedures, which typically would be followed in the event of a conflict. |   |   |   |
| 17. Key Words<br>Highway traffic noise, Noise measurement methodologies; traffic noise studies, noise regulations, best practices  |   | 18. Distribution Statement<br>(Remove; Insert Information Here or leave blank)            |   |
| 19. Security Classif. (of this report)<br>Unclassified   | 20. Security Classif. (of this page)<br>Unclassified                            | 21. No. of Pages<br>188   | 22. Price<br>(Remove; Insert Information Here or leave blank) |

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

The handbook is 205 pages



# Resources to Learn About Sound and Noise and How They Relate to Federal Aid Projects

## Highway Traffic and Construction Noise

|                        |   |
|------------------------|---|
| <b>FHWA-NHI-142086</b> | <b>Acoustics of Highway Traffic and Construction Noise</b>                    |
| <b>FHWA-NHI-142087</b> | <b>Highway Traffic and Construction Noise Regulations</b>                     |
| <b>FHWA-NHI-142088</b> | <b>How to Measure Highway Traffic Noise</b>                                   |
| <b>FHWA-NHI-142089</b> | <b>Abatement and Design Considerations for Highway Traffic Noise</b>          |
| <b>FHWA-NHI-142090</b> | <b>An Introduction to the Traffic Noise Model 3.0</b>                         |
| <b>FHWA-NHI-142091</b> | <b>Public Involvement for Highway Traffic and Construction Noise Projects</b> |
| <b>FHWA-NHI-142092</b> | <b>How to Mitigate Construction Noise</b>                                     |
| <b>FHWA-NHI-142093</b> | <b>How to Document Highway Traffic Noise Study Results</b>                    |
| <b>FHWA-NHI-142094</b> | <b>Noise Compatible Planning for Highway Traffic Noise</b>                    |

The foundation is  
23 CFR 772 NEPA

Bottom Line: These regulations only apply to federal aid projects. Most town streets are not federal aid. While the methods to assess and evaluate sound and noise may apply, the regulations do not.

# What the Town Has Already Done to Address Concerns



1. Micro-slurry seal resurfacing to smooth the road.
2. Spot pavement repair and adjustment of manholes to remove exposed edges and rough spots.
3. Periodic street sweeping to remove loose gravel and rocks.
4. Speed feedback signs complemented by increased police presence to help encourage good speed behavior.
5. Spot sound measurements to determine the impacts of these measures and provide a means to compare sound levels on other Town streets.
6. Commission this study to for additional assessment and follow up on what has already been done.

# Previous Sound Measurement Data Collected by the Town



| Date       | End Time | Location   | BEFORE RESURFACING |        |      |      |                | AFTER RESURFACING |          |      |        |      |       | LAeq DELTA |                |
|------------|----------|--|--------------------|--------|------|------|----------------|-------------------|----------|------|--------|------|-------|------------|----------------|
|            |          |  | LAeq               | LCpeak | LMax | TWA  | Duration (min) | Date              | End Time | LAeq | LCpeak | LMax | TWA   |            | Duration (min) |
| 9/3/2020   | 8:41     | Same location as class_speed_noise level measurements                      | 64.3               | 105    | 83.5 | 40.2 | 16             |                   |          |      |        |      |       |            |                |
| 9/11/2020  | 10:45 AM | West side of roadway Going South 50' off roadway                           | 68.2               | 102.3  | 83.6 | 43.3 | 15:03          | 1/11/2022         | 8:57     | 63.6 | 96.4   | 75.7 | 15:08 | -4.6       |                |
| 9/11/2020  | 10:22    | East side of roadway going North 30' from roadway                          | 67.7               | 102.6  | 84.6 | 35   | 15:28          | 1/11/2022         | 8:59     | 64.4 | 99.7   | 80.8 | 15:01 | -3.3       |                |
| 9/24/2020  | 8:55 AM  | 150' N of Moore Rd west shoulder 50' off of curb SB travel                 | 68.8               | 101.1  | 84   | 36.4 | 15:03          | 4/14/2022         | 9:05     | 66.9 | 106.2  | 87.8 | 46.4  | 15:02      | -0.4           |
| 9/24/2020  | 8:35 AM  | 150' N of Moore Rd east shoulder 50' off of curb NB travel                 | 67.3               | 103.9  | 85.5 | 43.9 | 15:03          | 1/20/2022         | 8:36     | 66.6 | 104.2  | 85.8 | 15:14 | -3.2       |                |
| 9/25/2020  | 8:42 AM  | 250' N of Heritage Club Blvd east shoulder 50' from curb                   | 69.8               | 111.9  | 89.5 | 50.8 | 17:28          | 1/20/2022         | 8:53     | 66.5 | 97.8   | 77.6 | 15:21 | 0.3        |                |
| 9/25/2020  | 9:00 AM  | 250' N of Heritage Club Blvd west shoulder 50' from curb                   | 66.2               | 100.9  | 82.1 | 34.1 | 16:43          | 4/14/2022         | 8:45     | 63.8 | 101.7  | 82.0 | 30.5  | 17:41      | -1.8           |
| 9/28/2020  | 8:59 AM  | 450' west of Gallery Pl west shoulder 50' off of curb                      | 65.6               | 100.4  | 82.3 | 39.1 | 17:36          | 4/14/2022         | 8:26     | 61.0 | 99.5   | 81.3 | 25    | 16:46      | -3.4           |
| 9/28/2020  | 9:16 AM  | 450' west of Gallery Pl east shoulder 50' off of curb                      | 64.4               | 96     | 76.4 | --   | 15:06          |                   |          |      |        |      |       |            |                |
| 11/5/2020  | 8:17 AM  | Dove Mtn Bl south Shoulder 50' off curb at speed radar sign                | 65.5               | 108.3  | 87.2 | 47.7 | 1:00:11        |                   |          |      |        |      |       |            |                |
| 11/17/2020 | 7:56 AM  | Dove Mnt Blvd south just north of Heritage Club Dr west shoulder 50 ft off | 65.7               | 102    | 79.4 | --   | 15:08          |                   |          |      |        |      |       |            |                |
| 11/17/2020 | 7:36 AM  | 150' N of Moore Rd east shoulder 50' off of curb NB travel                 | 68.3               | 110.3  | 88.9 | 49.2 | 18:26          |                   |          |      |        |      |       |            |                |
| 1/20/2021  | 7:44 AM  | 50' off roadway west shoulder south bound travel at radar sign             | 62.6               | 93.1   | 78.4 | --   | 15:59          |                   |          |      |        |      |       |            |                |
| 1/21/2021  | 8:01 AM  | East shoulder 50' off road way for north bound travel                      | 65.8               | 98.7   | 78.5 | --   | 12:55          |                   |          |      |        |      |       |            |                |

| Date      | Time    | Location  | LAeq | LCpeak | LMax | TWA  | (min) |
|-----------|---------|---|------|--------|------|------|-------|
| 10/5/2020 | 7:44 AM | Clayton Rd south of pole, see location map                      | 77.4 | 110.5  | 93.5 | 61.8 | 17:12 |
| 10/5/2020 | 8:05 AM | Along canal 15 ft south of north end of canal, see location map | 74.2 | 107.1  | 89.6 | 57.3 | 15:09 |
| 2/2/2021  | 8:03 AM | East of Waste management Road north shoulder east bound travel  | 66.6 | 122.7  | 97   | 46   | 15:03 |
| 2/2/2021  | 7:46 AM | South shoulder along irrigation canal east bound travel         | 68.4 | 103.3  | 88.9 | 48   | 16:26 |
| 2/1/2021  | 9:13 AM | Clayton Rd 50' from edge of curb at Clayton south shoulder      | 72.2 | 108.2  | 90.4 | 53.7 | 15:04 |

| Date       | Time    | Location   | LAeq | LCpeak | LMax | TWA  | Duration (min) |
|------------|---------|--|------|--------|------|------|----------------|
| 10/16/2020 | 7:39 AM | 250' N of Blue Bonnett Rd eas shoulder 50 ft off of curb Northbound 7:28   | 65.4 | 106.6  | 82.7 | 40.1 | 15:02          |
| 10/16/2020 | 8:00 AM | 250' N of Blue Bennett Rd west shoulder 50' off of curb South bound 8:00am | 69   | 105.8  | 83.8 | 43.0 | 15:02          |

# Available Sound Level Descriptors



| Descriptor      | Definition                               |
|-----------------|--|
| $L_{A_{EQ}}(h)$ | Hourly A-weighted equivalent sound level |
| $L_{10}(h)$     | Sound level exceeded 10% of the time     |
| $L_{50}(h)$     | Sound level exceeded 50% of the time     |
| $L_{DN}$        | Day-night average sound level (DNL)      |
| $L_{DEN}$       | Community Noise Equivalent Level (CNEL)  |

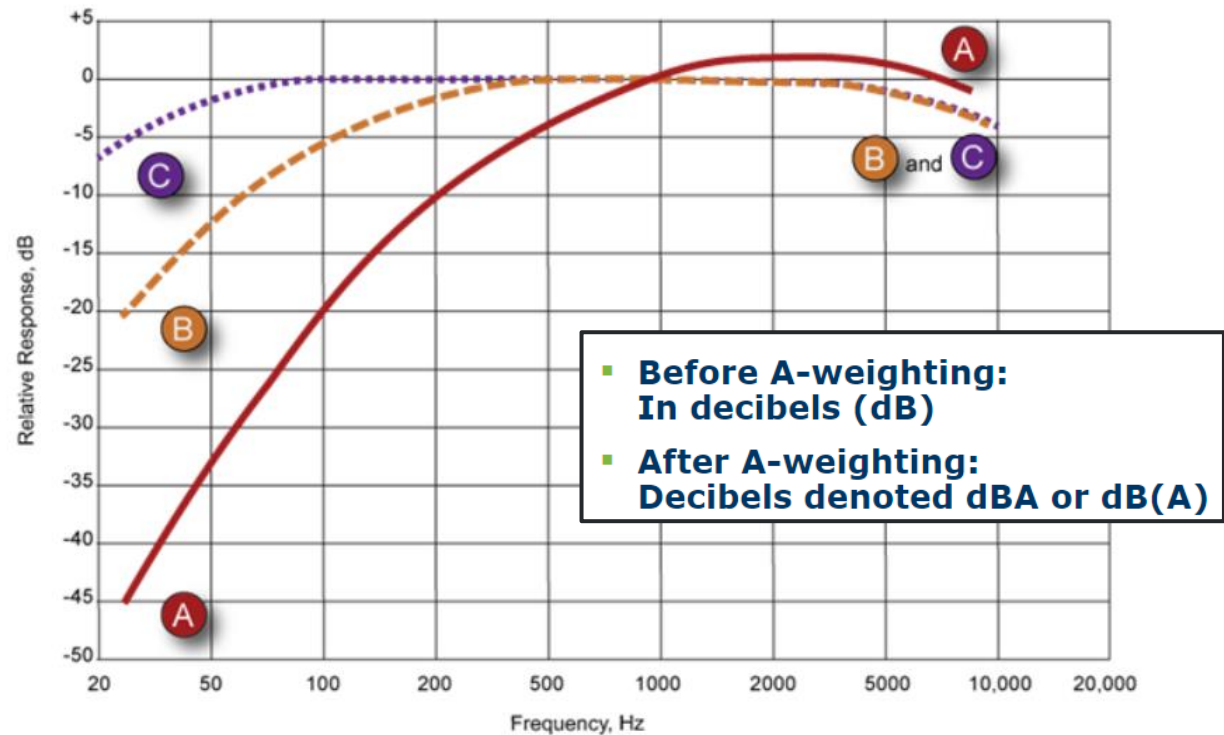
Source: FHWA-NHI-142086, Acoustics of Highway Traffic and Construction Noise

# Measuring Sound

## A

A-weighting, which adjusts the actual sound pressure levels to simulate the response of the human ear to moderate sound levels, has become the standard for most noise analysis. In this example, the line for A-weighted results starts at about 25 hertz, -45 decibels, reaches its highest point at about 2500 hertz, 1.3 decibels, then drops off slightly to end at about 10,000 hertz, -2.5 decibels.

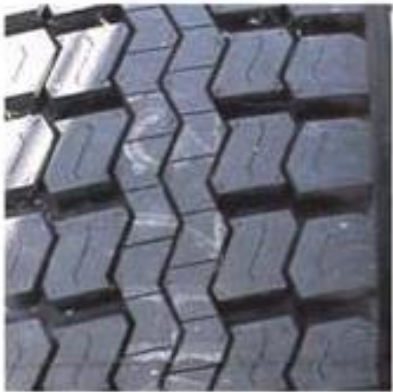
## A, B, and C-Weighting Network Filters



Source: FHWA-NHI-142086, Acoustics of Highway Traffic and Construction Noise



**Tires**



**Quieter**

**Louder**

**Pavements**



Source: *Physics Today*, Vol. 62, No. 12,  
December 1, 2009  
Figure 2. Tires and Pavements



# Basic Findings/Research on Tires and Pavements

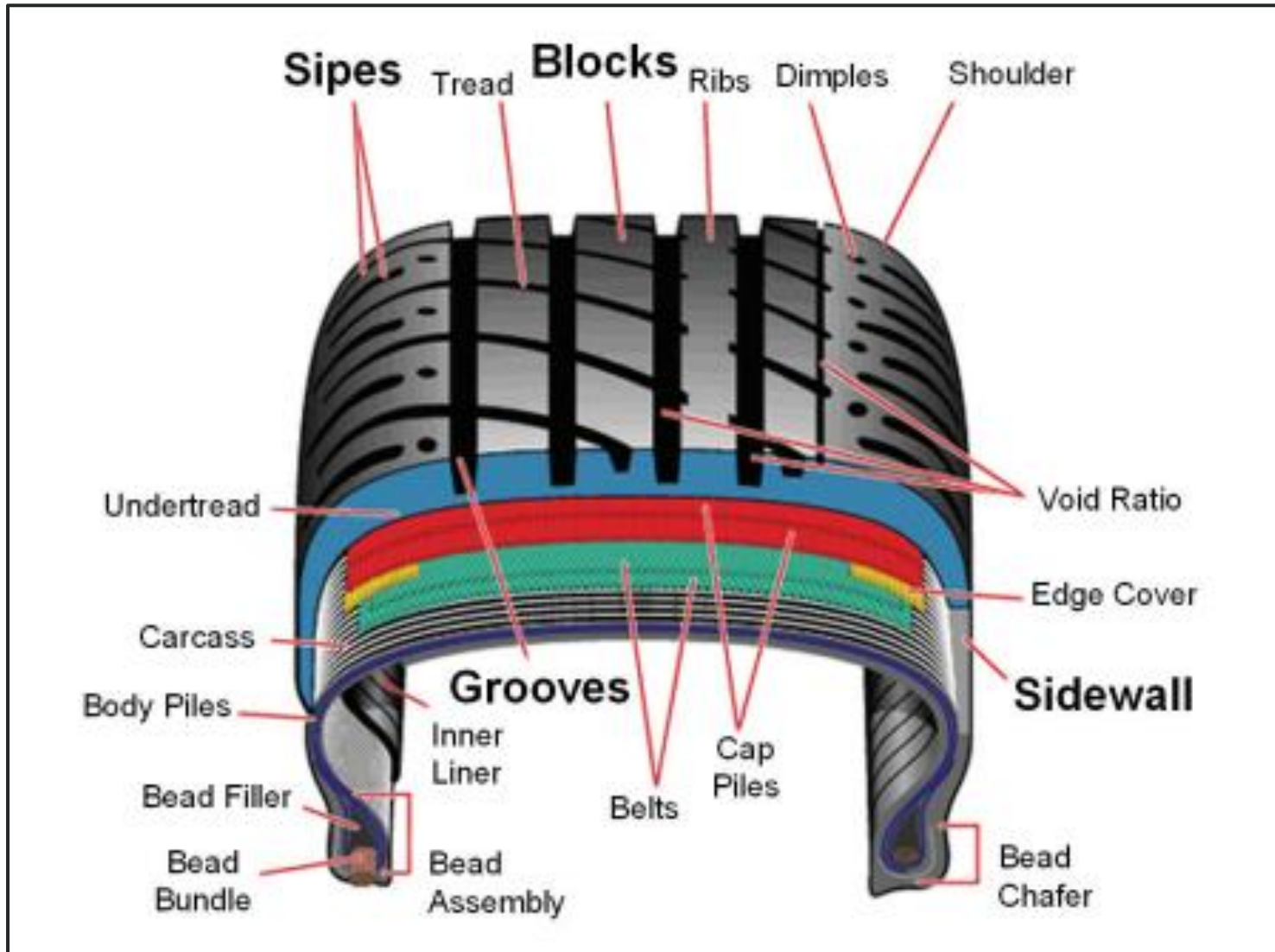
1. Texture with a significant amplitude is to blame for the bad all-around wavelength, low-frequency texture.
2. This causes a rough ride. Noise is mostly caused by short-wavelength, high-frequency texture.
3. Texture with significant amplitudes of about 10-50 mm or 0.4 inches to 2 inches is largely to blame for noise that is readily radiated away from the vehicle.
4. Texture with wavelengths of 20-200 mm is responsible for in-vehicle noise.
5. In both cases, the dominant noise-producing mechanism is termed "impact."
6. As the tire rolls over the pavement, displacements in the road surface or tire-read pattern create vibrations in the tire structure. These vibrations, in turn, lead to acoustical energy being radiated from the tire-tread elements and sidewall.
7. Even if the road were perfectly flat, the road would still produce noise. Additionally, roads cannot be perfectly flat because there is a need for a certain amount of dry friction and the ability of the road to support drainage to help prevent hydroplaning.
8. The key in terms of noise lies in the mechanism of the tire and pavement interaction – it is a complex relationship between the texture of the road, the tire tread, and the noise they produce.

# Textures for Loud and Quiet Pavement



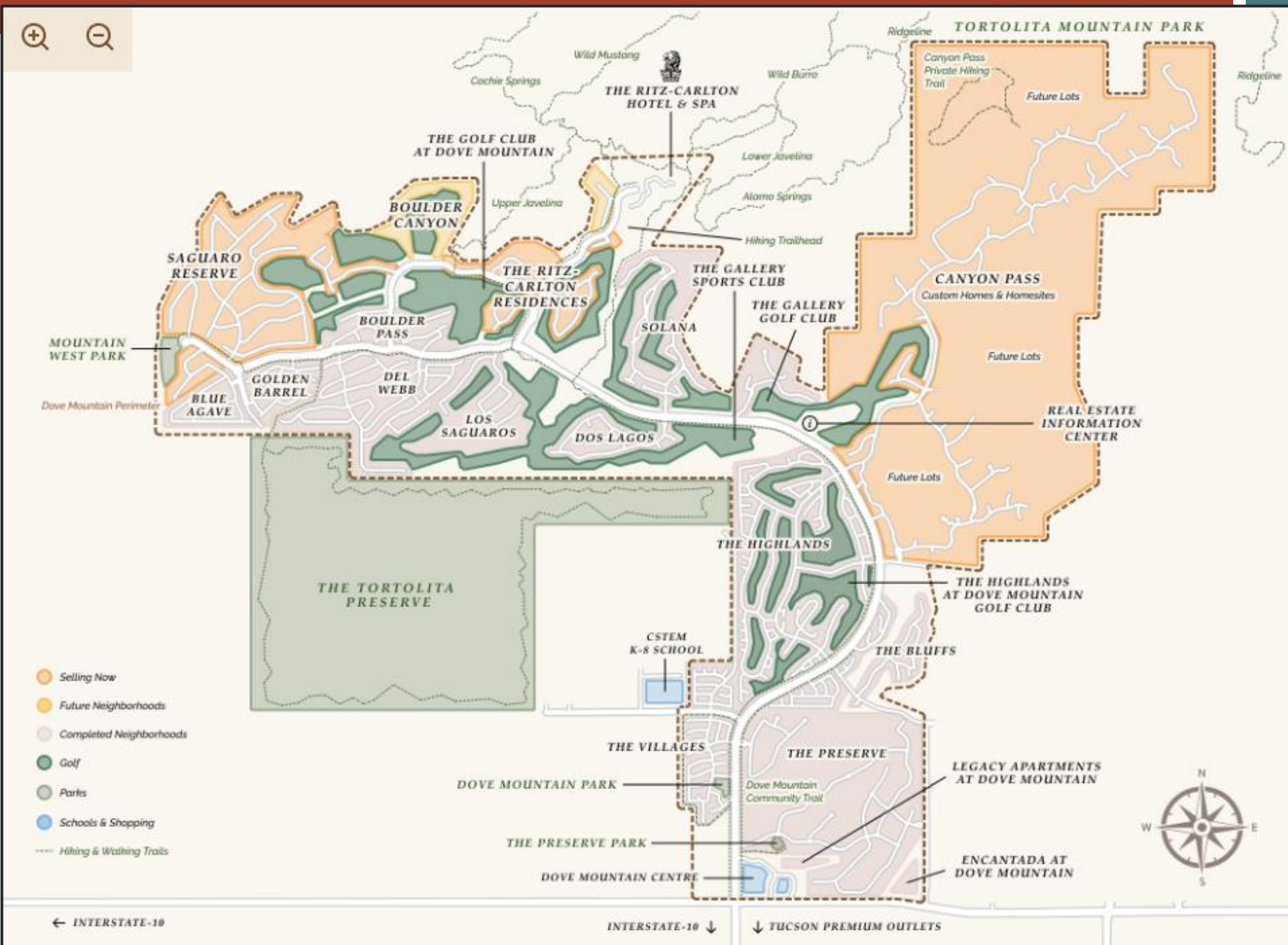
Source: *Tech Brief: The Language of Noise and Quieter Pavements*, Concrete Pavement Surface Characteristics Program, October 2010  
Figure 5. Idealized textures for loud and quiet pavement

# Tire Components



Source: *Tech Brief: The Language of Noise and Quieter Pavements*, Concrete Pavement Surface Characteristics Program, October 2010

Figure 4. Typical components of a tire (relevant ones shown in boldface type)



# Dove Mountain Map



**Neighborhoods** ▾

- Canyon Pass
- The Ritz-Carlton Residences
- Golden Barrel
- Blue Agave
- Boulder Pass
- Del Webb
- Los Sagueros
- The Bluffs
- The Preserve
- The Villages
- The Highlands
- Dos Lagos
- Solana

**Golf** ▶

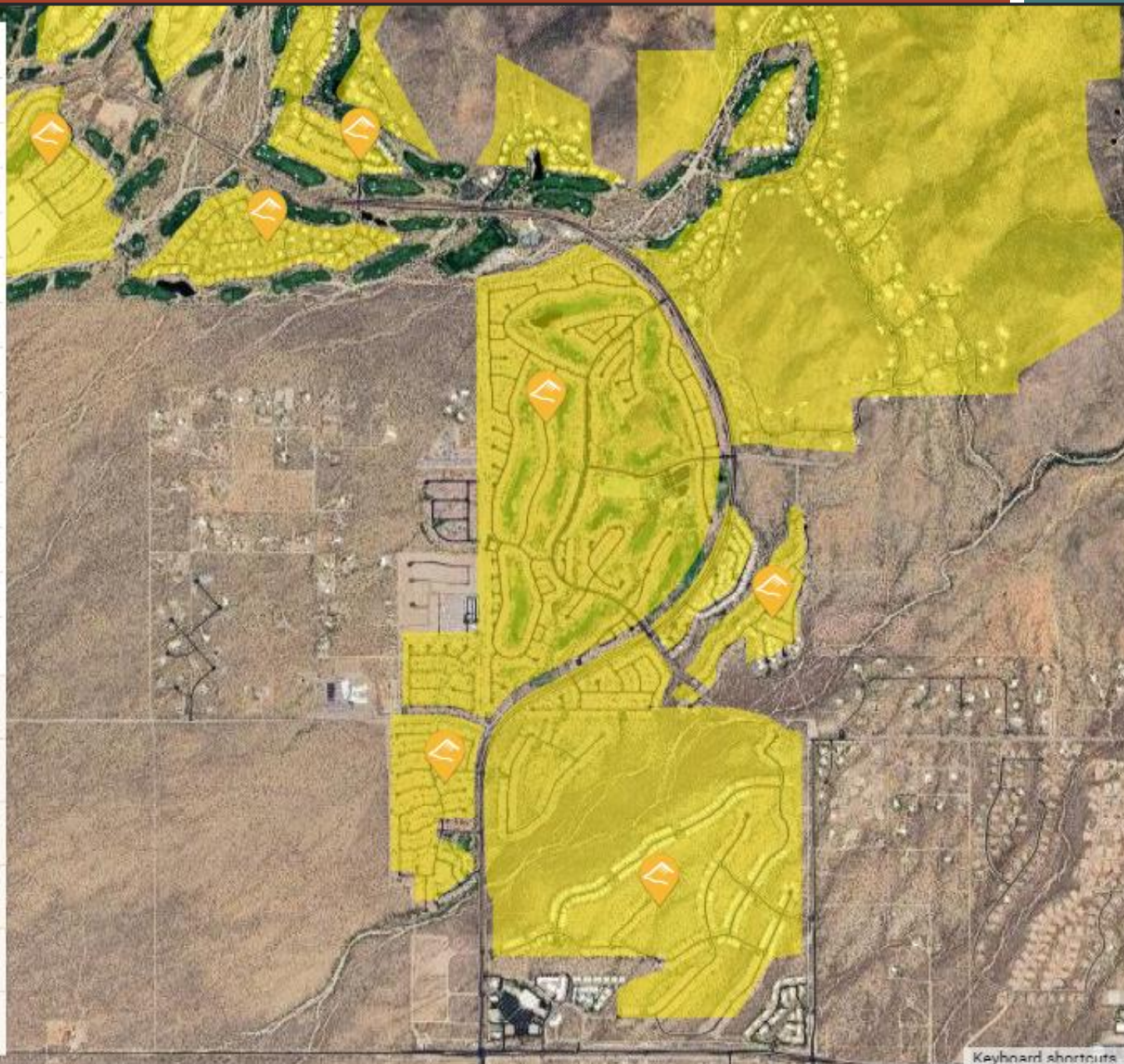
**Parks** ▶

**Hiking Trails** ▶

**Apartments** ▶

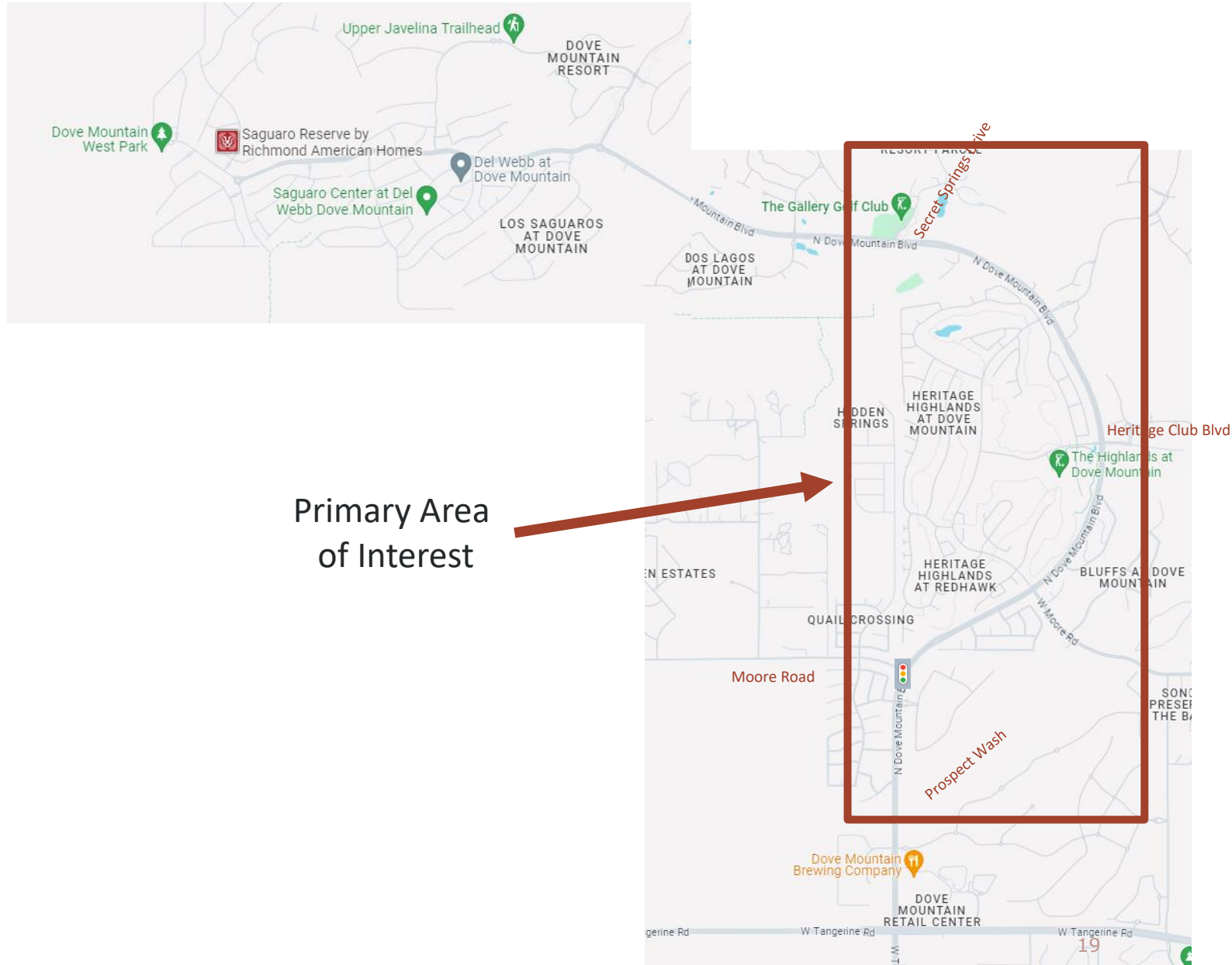
**Other** ▶

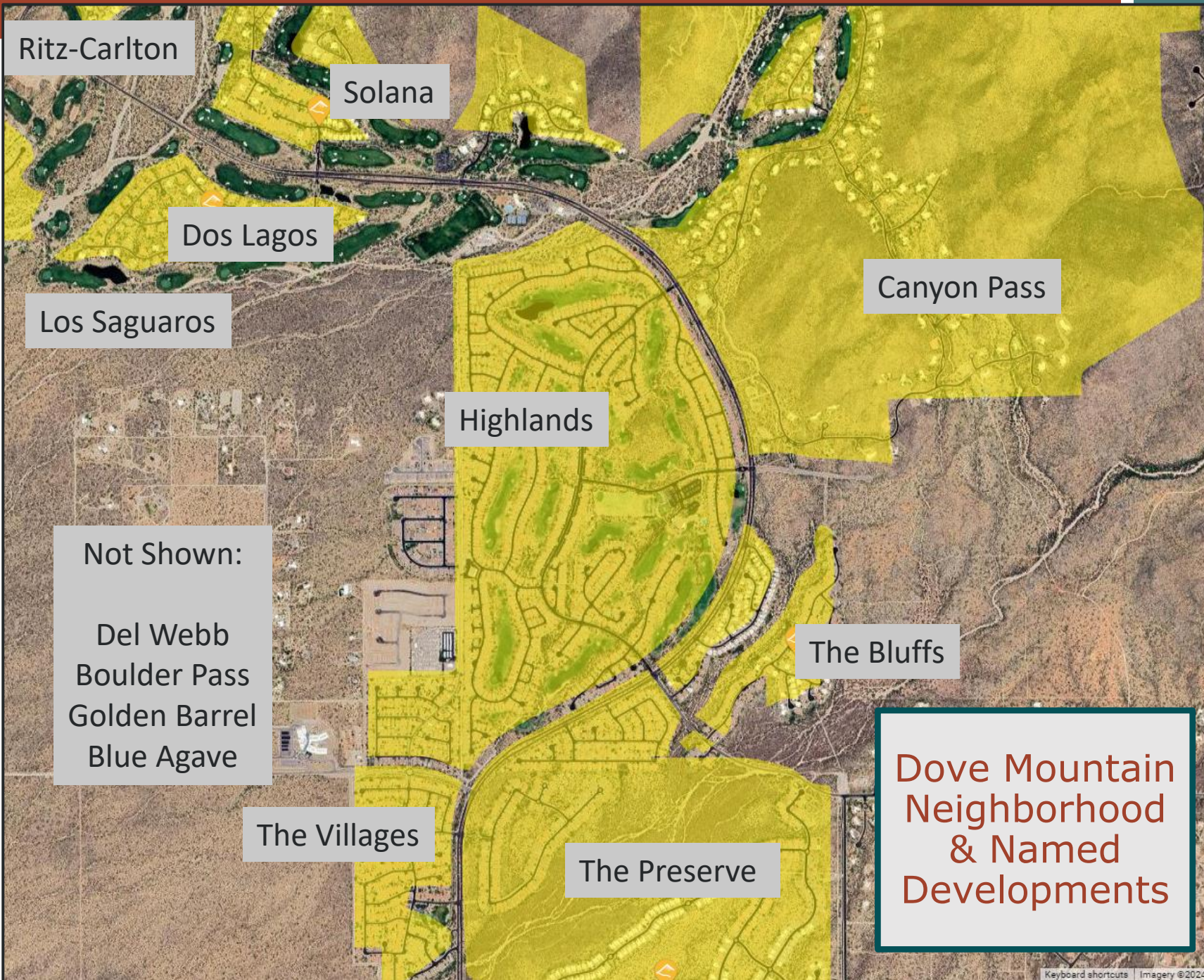
**⊗ Clear All**



## Dove Mountain Named Neighborhoods

# Town of Marana: Dove Mountain Boulevard Traffic Sound Assessment Area





Ritz-Carlton

Solana

Dos Lagos

Los Saguaros

Highlands

Canyon Pass

Not Shown:

Del Webb  
Boulder Pass  
Golden Barrel  
Blue Agave

The Bluffs

The Villages

The Preserve

Dove Mountain  
Neighborhood  
& Named  
Developments



# Highway Traffic and Construction Noise

|                        |   |
|------------------------|---|
| <b>FHWA-NHI-142086</b> | <b>Acoustics of Highway Traffic and Construction Noise</b>                    |
| <b>FHWA-NHI-142087</b> | <b>Highway Traffic and Construction Noise Regulations</b>                     |
| <b>FHWA-NHI-142088</b> | <b>How to Measure Highway Traffic Noise</b>                                   |
| <b>FHWA-NHI-142089</b> | <b>Abatement and Design Considerations for Highway Traffic Noise</b>          |
| <b>FHWA-NHI-142090</b> | <b>An Introduction to the Traffic Noise Model 3.0</b>                         |
| <b>FHWA-NHI-142091</b> | <b>Public Involvement for Highway Traffic and Construction Noise Projects</b> |
| <b>FHWA-NHI-142092</b> | <b>How to Mitigate Construction Noise</b>                                     |
| <b>FHWA-NHI-142093</b> | <b>How to Document Highway Traffic Noise Study Results</b>                    |
| <b>FHWA-NHI-142094</b> | <b>Noise Compatible Planning for Highway Traffic Noise</b>                    |

## What is Sound?

---

Let's start with the definition of sound. "Sound" is an objective term; it refers to a physical property. When an object vibrates, the energy from those vibrations causes pressure fluctuations as it travels through air (or some other medium). If the pressure fluctuations reach a person's ears, the person will perceive them as sound.

**Noise is simply *unwanted* sound; sound that a receptor perceives *negatively*. Remember the sound of that truck horn?**

**Noise is subjective to the receptor. One person's noise may be another person's music!**

# Negative Noise Effects

**Quality of Life**

**Productivity**

Noise can negatively affect our quality of life. It can impact our sleep and reduce our ability to relax. Sleep disturbance can lead to health impacts such as cardiovascular issues and can contribute to increased workplace accidents.

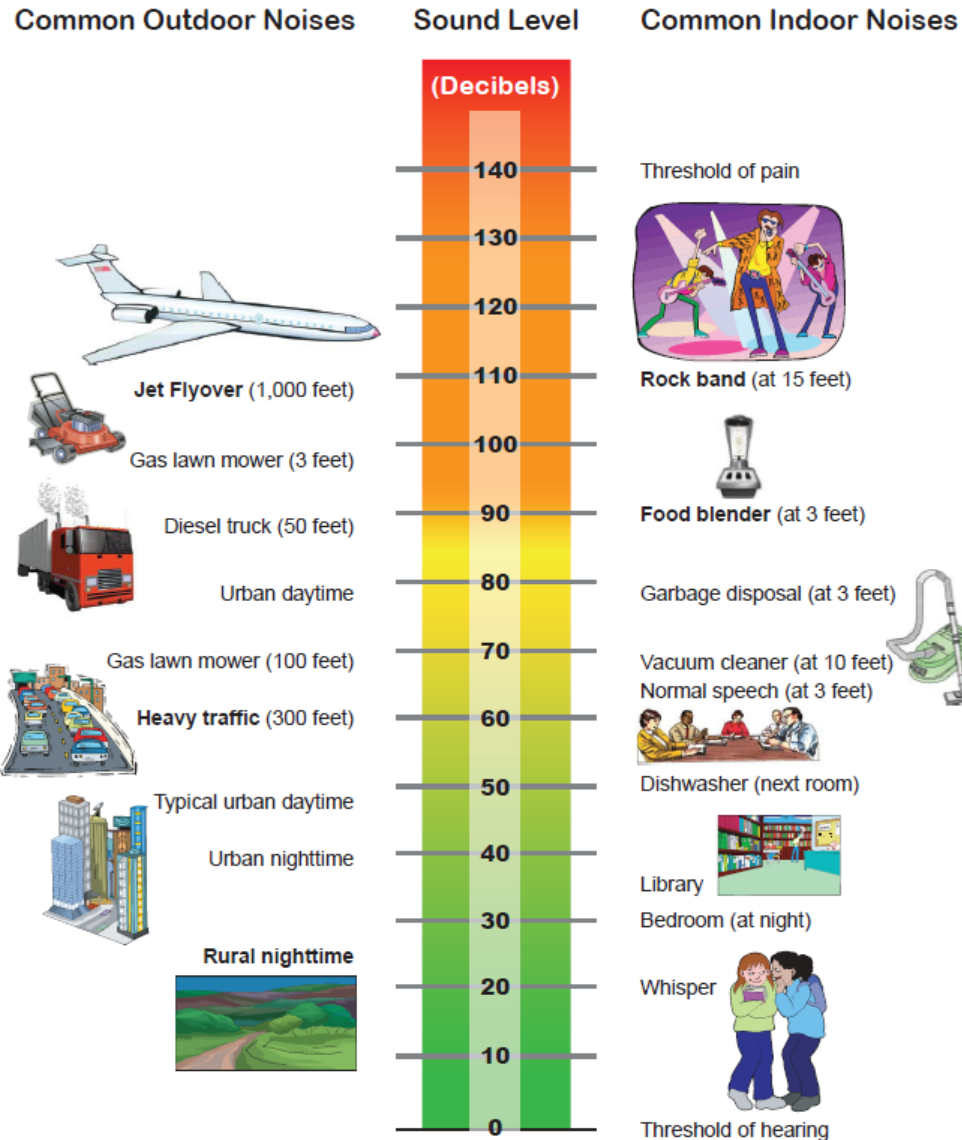
# Negative Noise Effects

**Quality of Life**

**Productivity**

Noise can negatively impact productivity by interfering with communication, task performance, and our ability to absorb and recall information.

# Common Indoor and Outdoor Noise Levels



Note: Sound is perceived differently by every individual



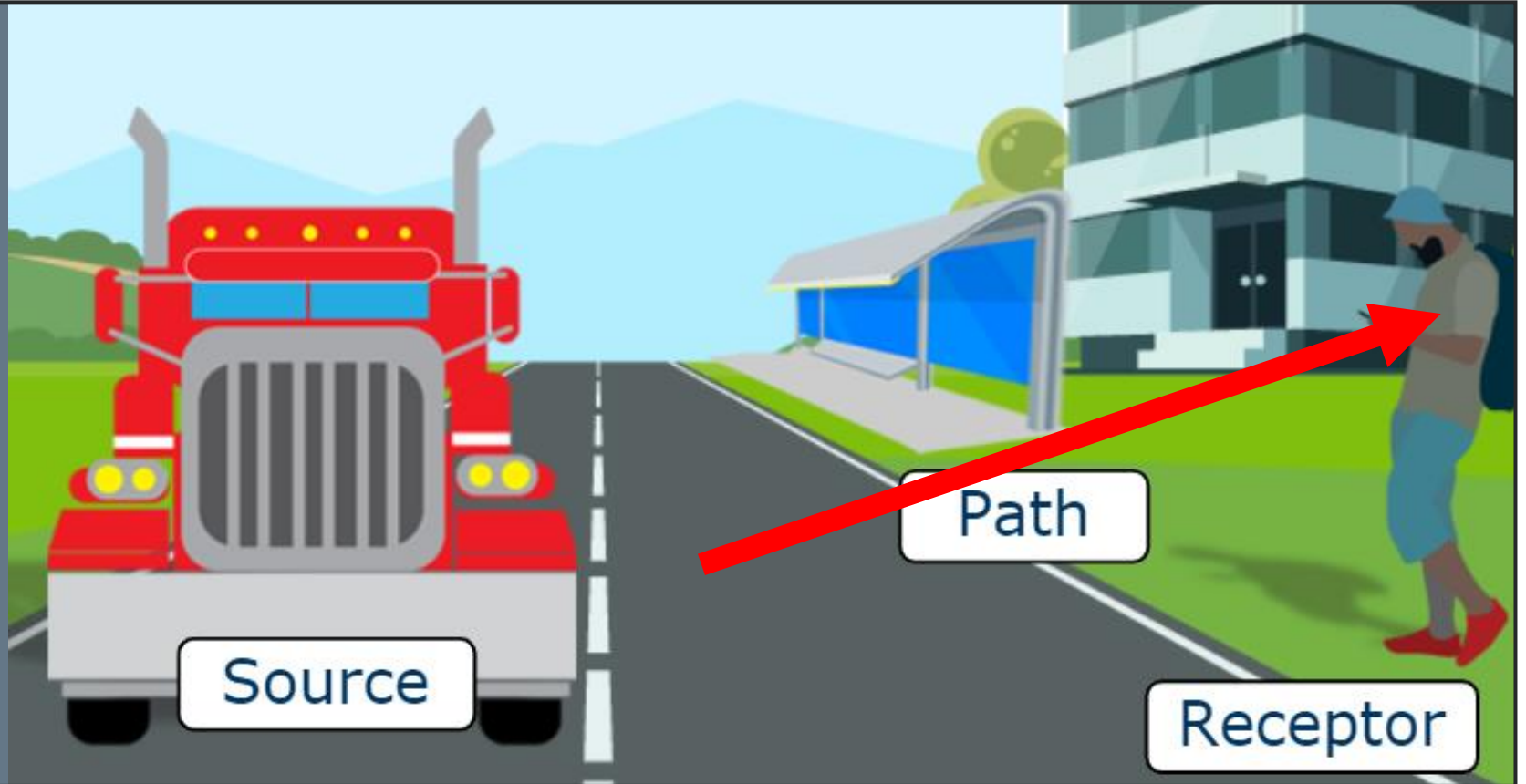
# Facts about Noise

- Noise is unwanted sound. Noise is perceived differently by every individual. A noise that is irritating to one person may be tolerable to another.
- Noise is measured in decibels on a logarithmic scale.
- An increase of 10 decibels will cause the noise to be perceived as sounding twice as loud to the average listener.
- The smallest change in noise level that can be detected by the human ear is about 3 decibels.
- Doubling the traffic volume on a highway will increase the noise level by 3 decibels.
- The noise level will decrease by about 3 to 4.5 decibels for each doubling of the distance from the source roadway. The amount of decrease depends on the absorptive characteristics of the ground.
- The Arizona Department of Transportation uses a noise level of 66 decibels as the criterion for considering noise barriers, which is lower than the 67 decibels specified in the federal regulations.
- Noise barriers can be noise walls, earth berms or a combination of walls and berms.
- Even with noise barriers, residents within 500 to 1,000 feet of the highway will likely be able to hear the traffic. Barriers are designed to reduce noise to an acceptable or tolerable level. They cannot completely eliminate noise.
- Noise barriers along a highway are most effective for homes within about 300 feet of the highway. Beyond that, noise barriers are less effective, but the natural decrease in noise with distance usually reduces noise levels to acceptable levels.
- Noise walls range in height from 8 to 20 feet, depending on what height is needed to reduce the noise to an acceptable level. Noise walls cost about \$250 to \$700 per linear foot, depending on the height.
- An earth berm (a large mound of packed dirt usually with landscaping) of a given height will provide slightly more noise reduction than a vertical barrier wall of the same height.
- In some cases, existing dense vegetation can reduce traffic noise levels. Vegetation that is a minimum of 100 feet in depth, at least 15 feet high and dense enough that you cannot see the highway through it, can reduce noise levels by approximately 5 decibels. Typical roadside landscaping does not affect noise levels.
- As a general rule-of-thumb, a noise barrier that is high enough to break the line of sight between the source (traffic) and the receiver (residents) reduces noise by approximately 5 decibels. Each additional foot of height added to the barrier reduces the noise level by another half decibel.



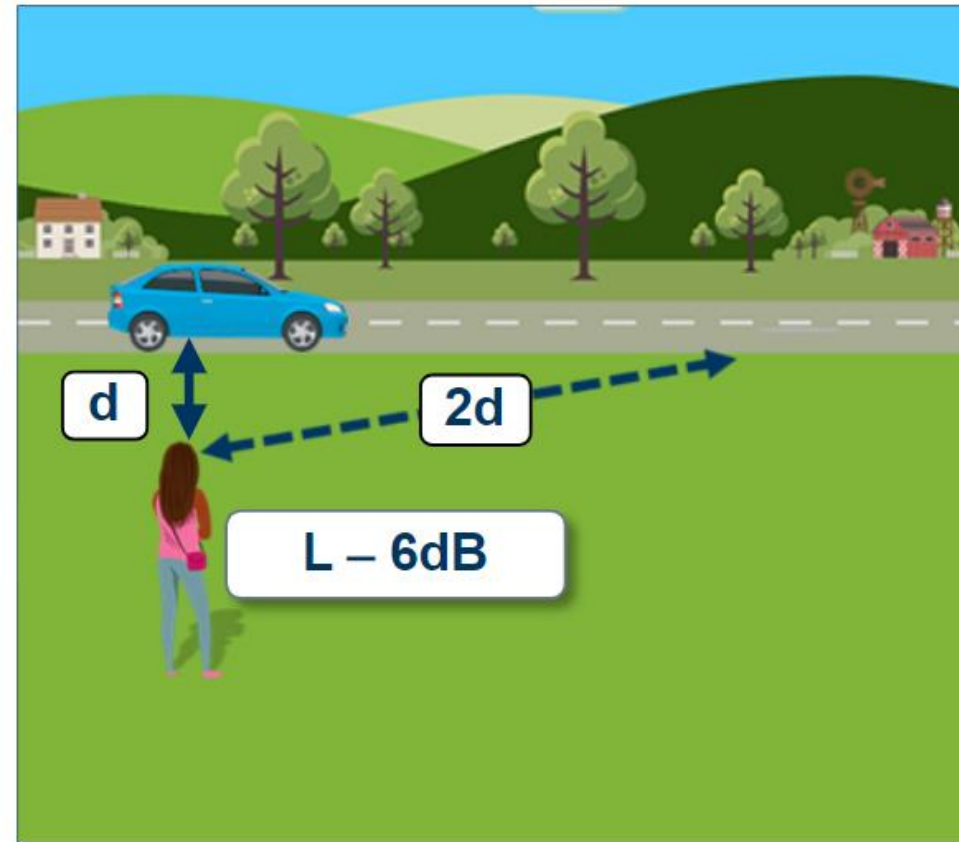
## Components of Sound

We can think of sound as having three basic components: a **source** of the sound and its cause and characteristics; the **path** over which the sound travels, including how sound propagates, or spreads, from the source and the influences on that propagation; and the **receptor** who hears the sound, with emphasis on their sensitivity and response.



# Point Source Divergence

- Distance from point source is doubled – sound level decreases 6 dB
- $dB(A)_2 = dB(A)_1 + 20 \log \left( \frac{D_1}{D_2} \right)$



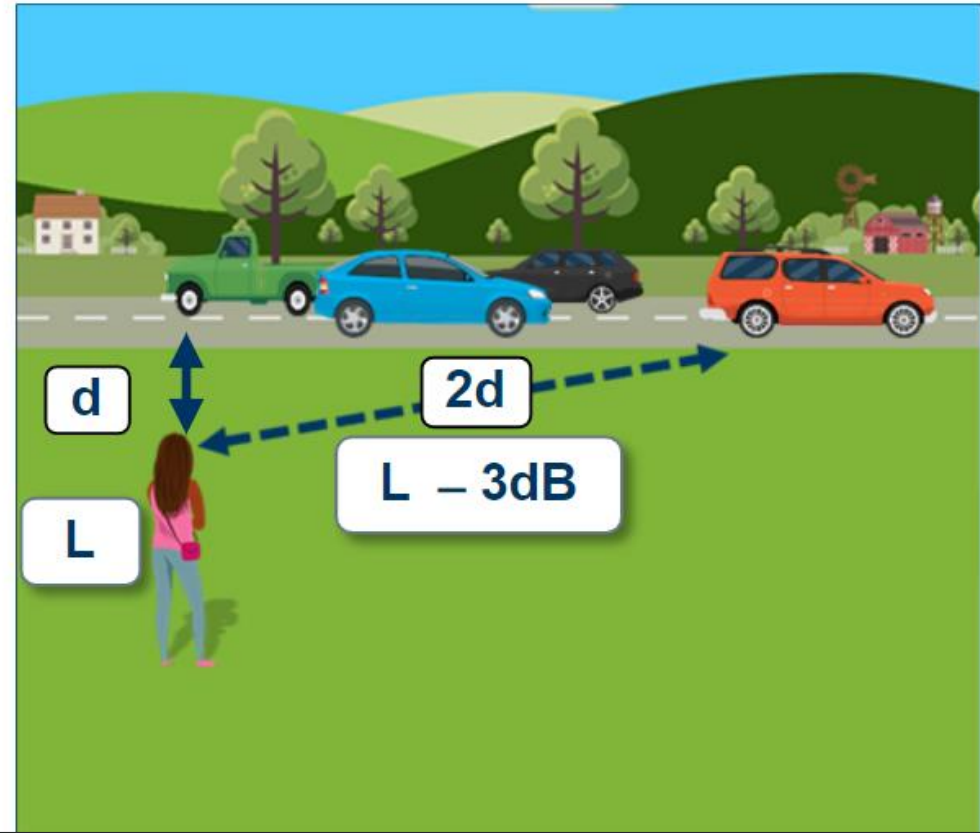
See also FHWA-NHI-142090:  
*An Introduction to the  
Traffic Noise Model (TNM).*



# Line Source Divergence

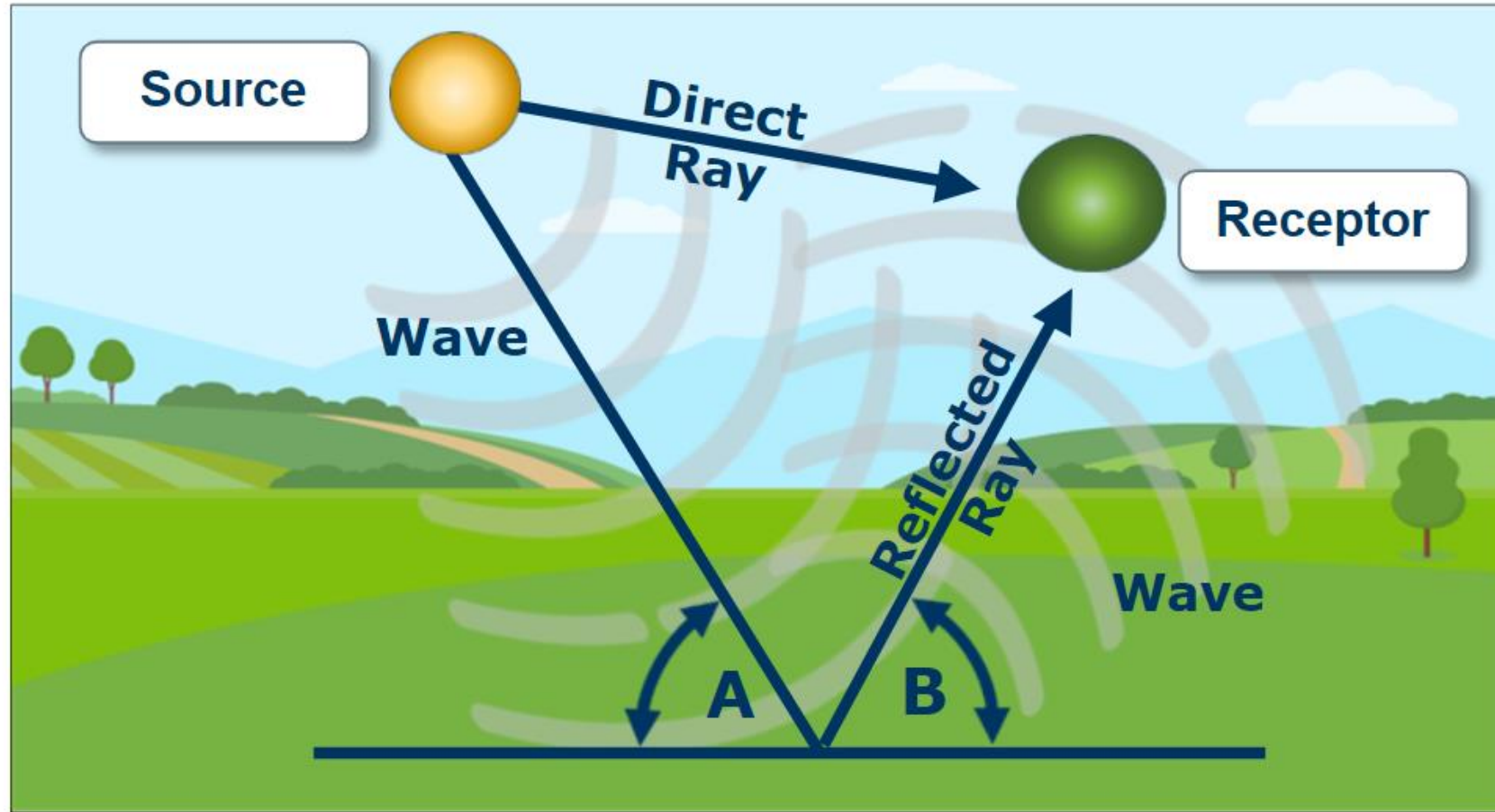
- Level decreases 3 dB each time distance is doubled

$$dB(A)_2 = dB(A)_1 + 10 \log \left( \frac{D_1}{D_2} \right)$$





# Ground Attenuation



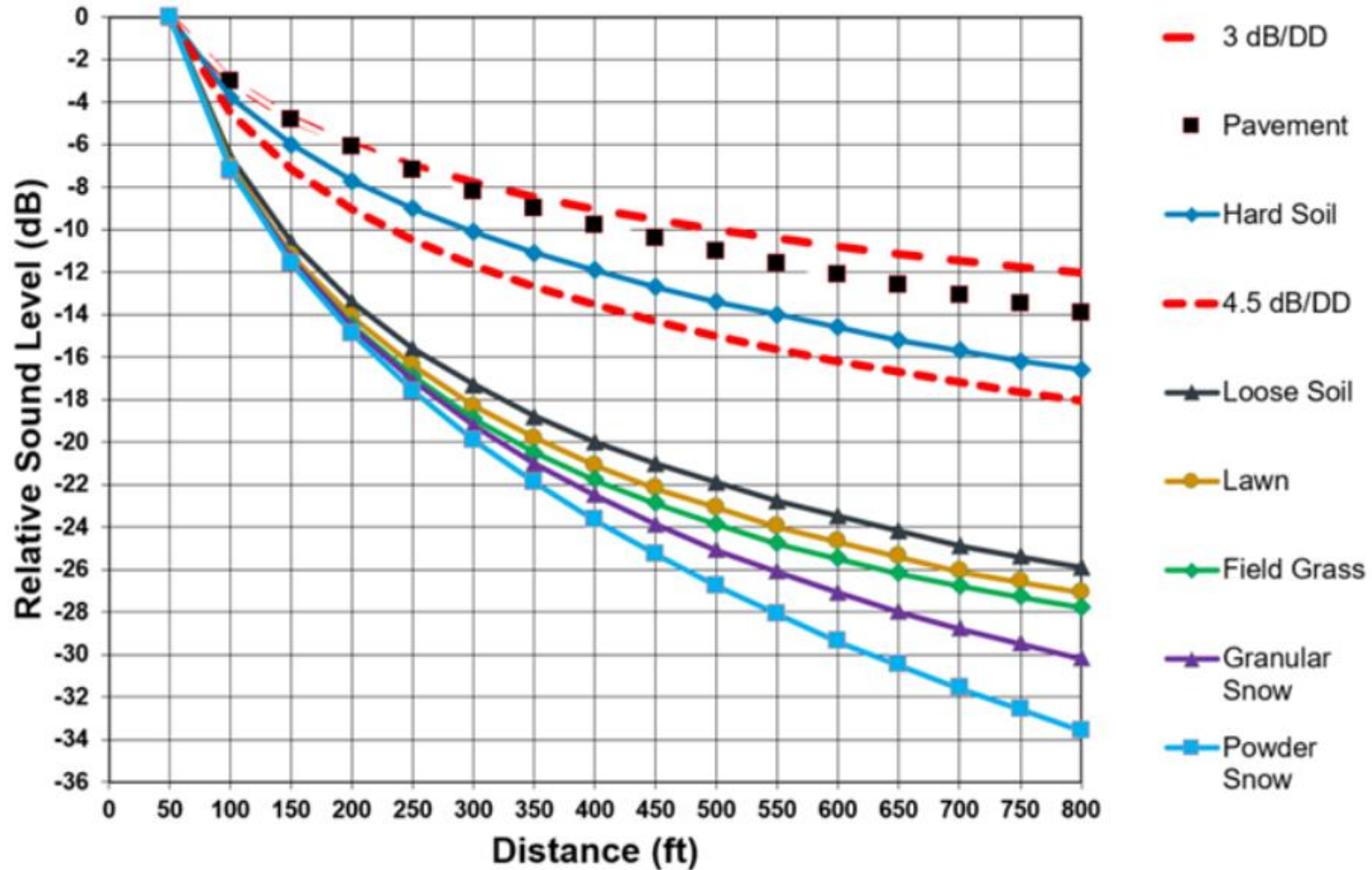
$$A = B$$

# Acoustically Hard and Soft Ground

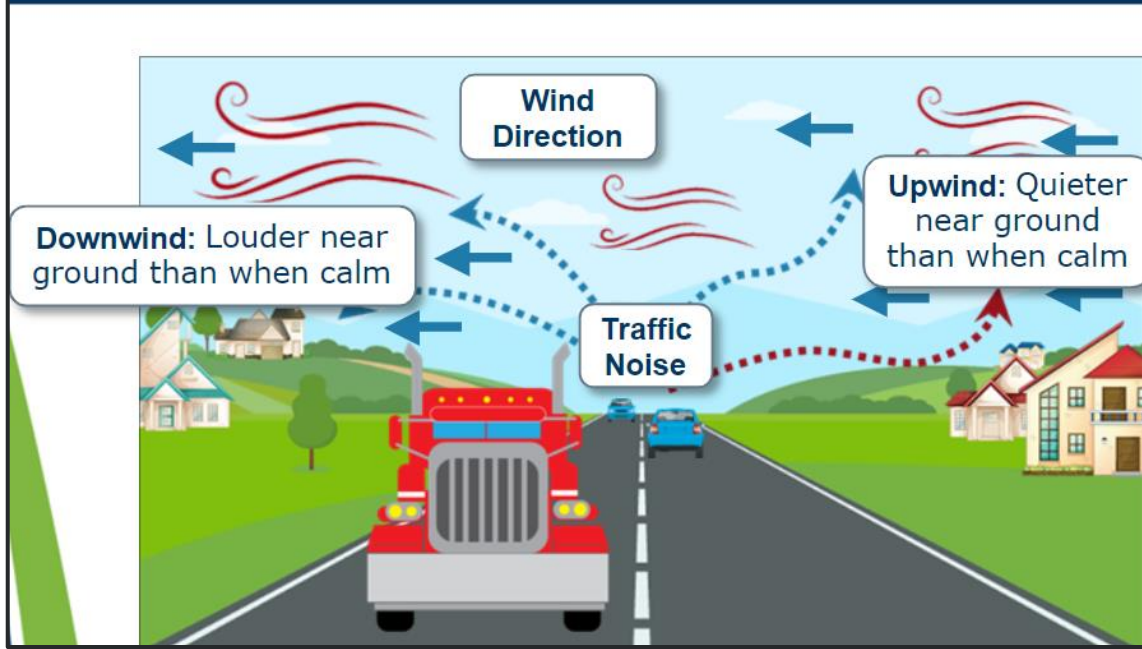


# Attenuation Rates by Ground Type

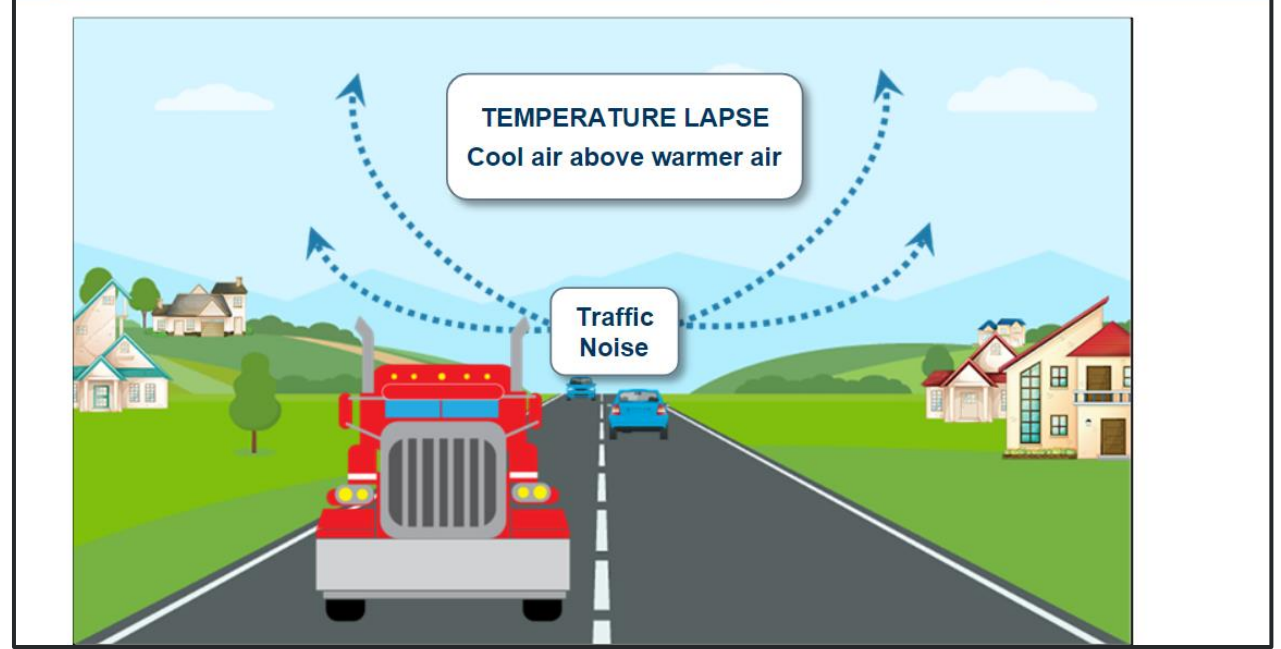
Fall off Comparison for 1,000 Autos at 55 mph



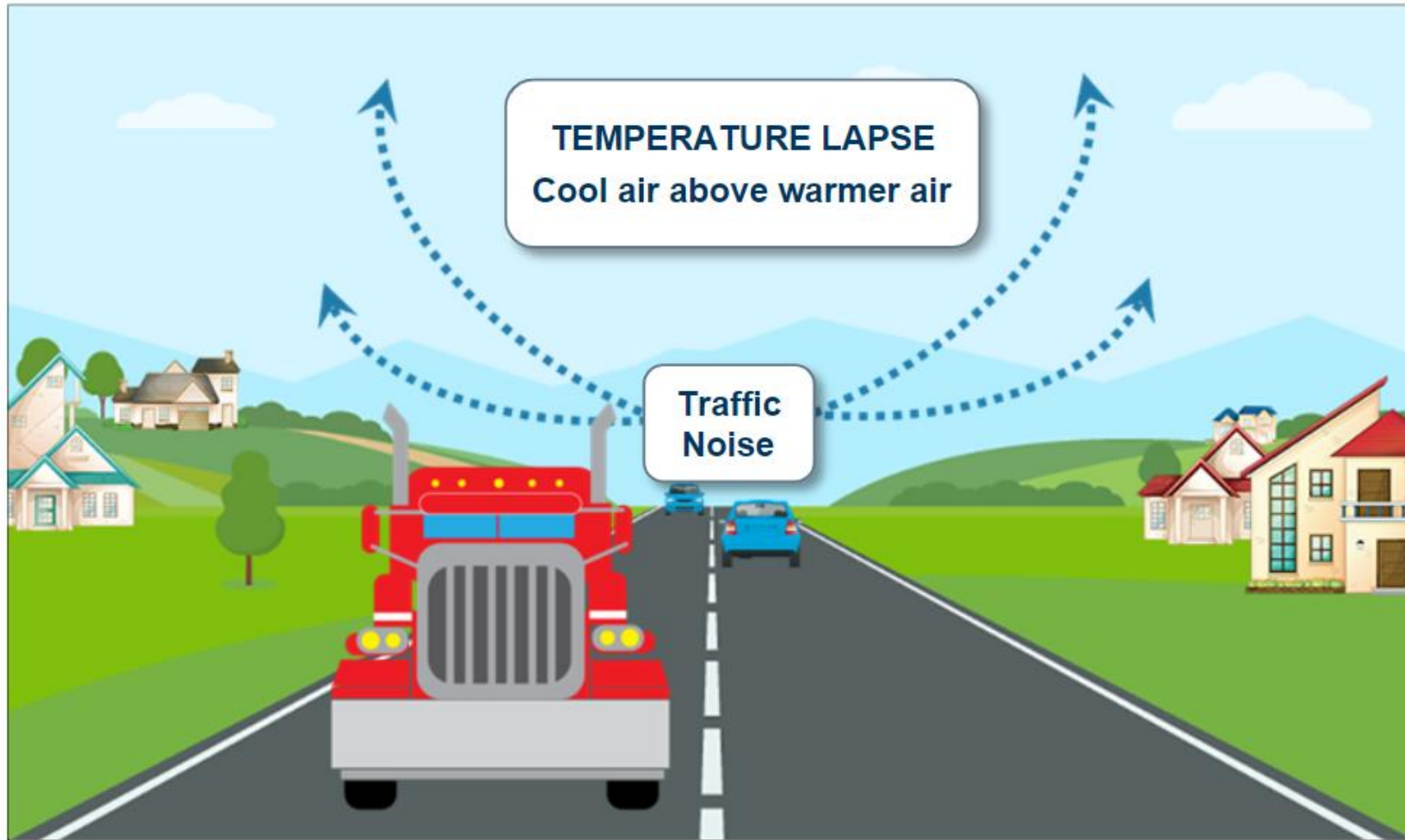
## Refraction Due to Wind Shear



## Upward Refraction due to Temperature Lapse Rate

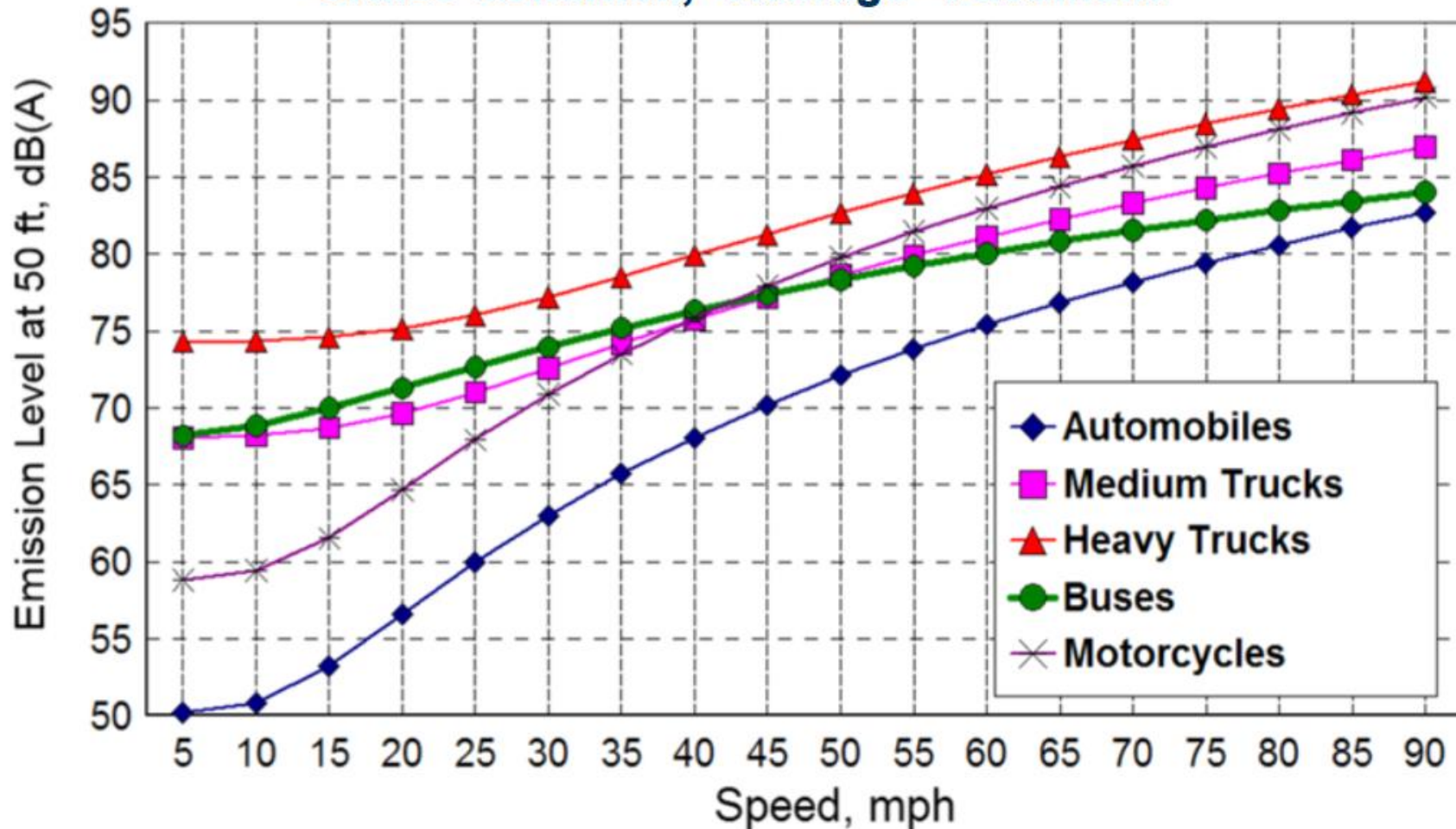


# Upward Refraction due to Temperature Lapse Rate



# REMELs by Vehicle Type and Speed

Cruise Condition, "Average" Pavement



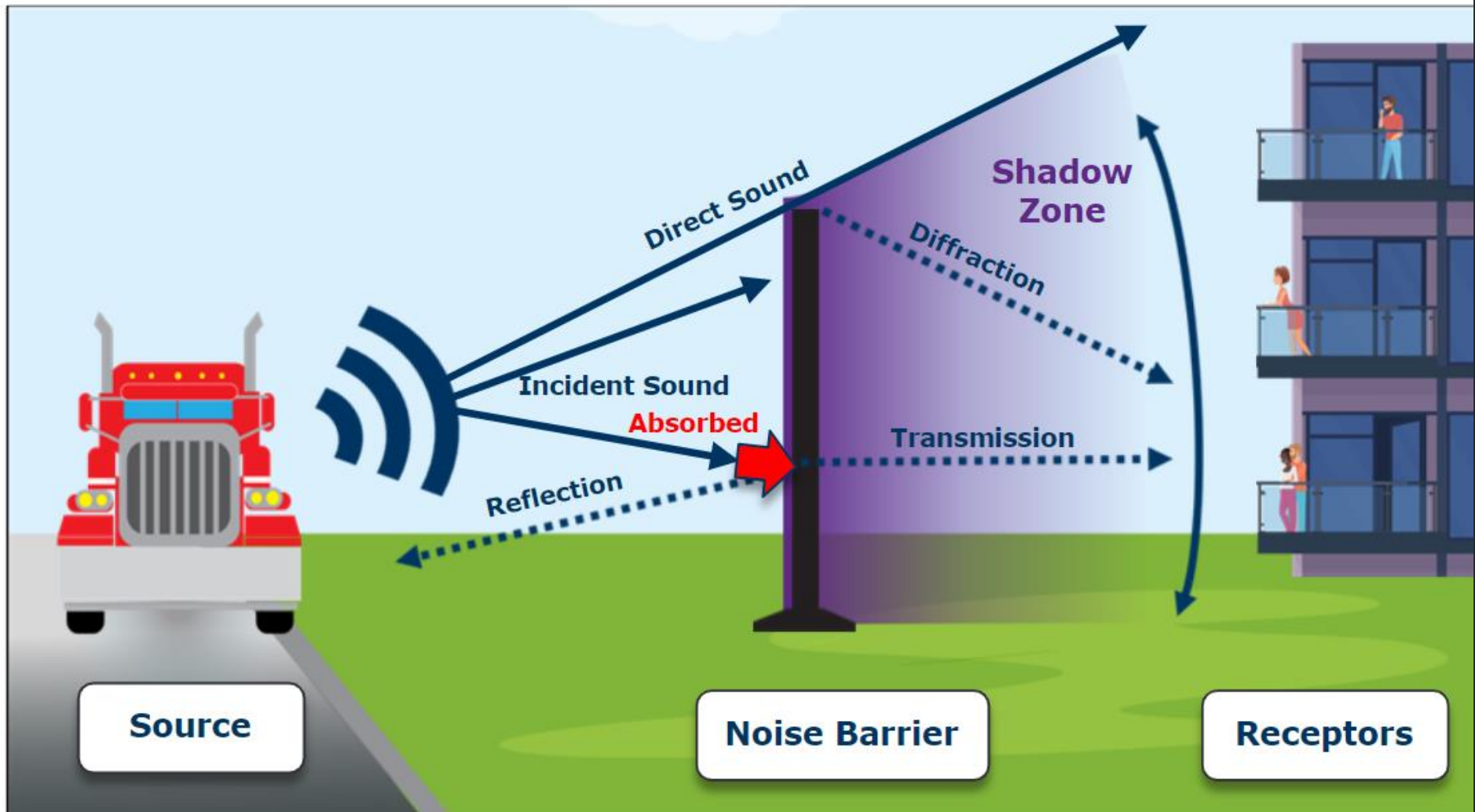
Reference Energy Mean Emission Levels (REMELs)

# What is a Noise Barrier?

- **Shielding disrupts the path between sound source and receptor.**
- **Noise barriers are solid obstructions.**



# Sound Propagation and Noise Barriers





# Insertion Loss (IL)

- **Difference in sound levels after barrier is inserted between source and receiver**
  - **Attenuation by diffraction**
  - **Shielding by other objects**
  - **Transmission through barrier**
  - **Reflection off any surfaces**
  - **Flanking around ends of barrier**
  - **Loss of excess ground attenuation**



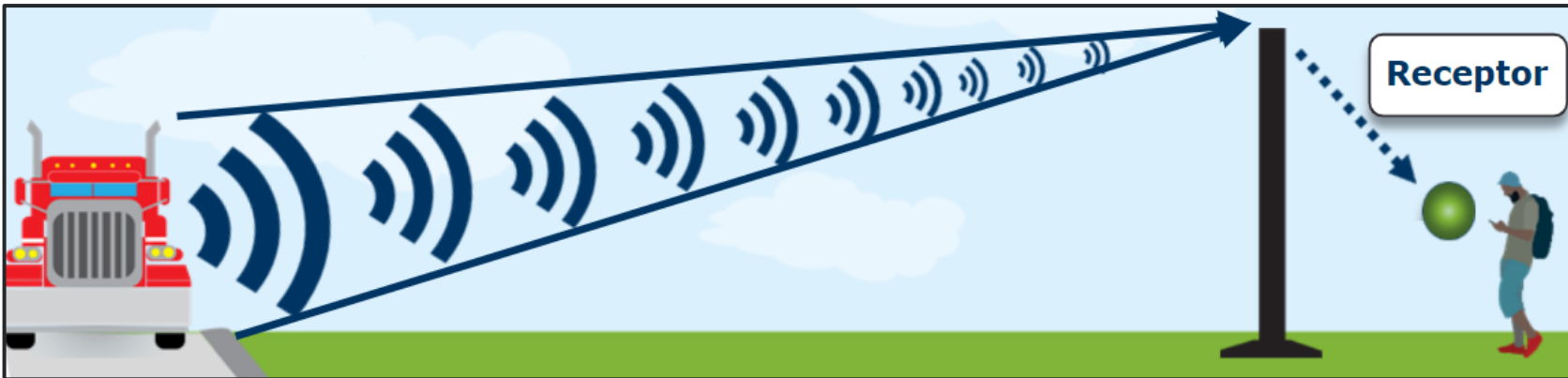
Insertion loss is referred to as “noise reduction” in 23 CFR 772 and TNM.

# IL: Obtaining Noise Reduction with Barriers

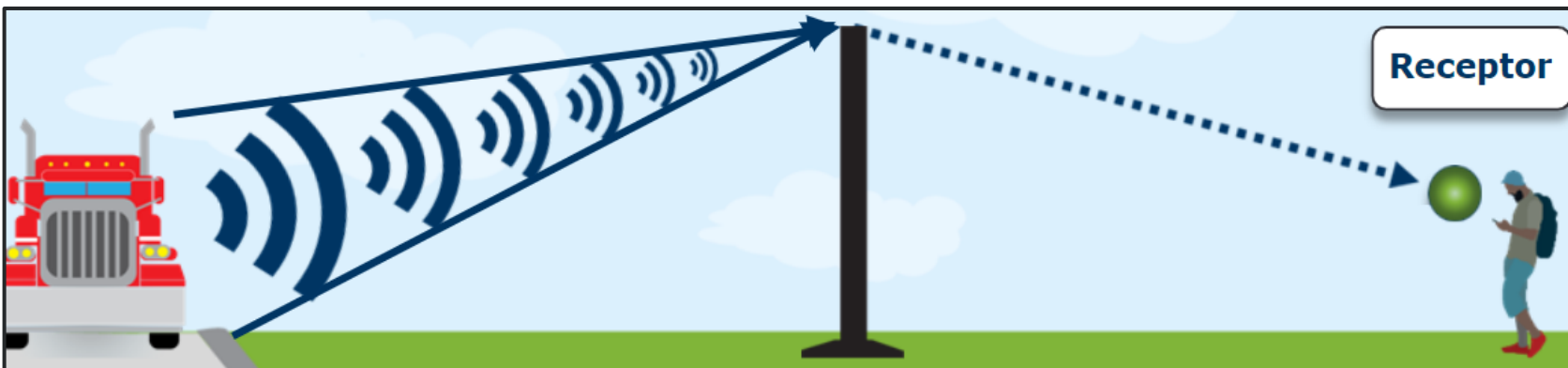
| Insertion Loss | Degree of Difficulty | Reduction in Sound Energy | Relative Reduction in Loudness |
|----------------|----------------------|---------------------------|--------------------------------|
| 5 dB           | Simple               | 68%                       | Readily perceptible            |
| 10 dB          | Attainable           | 90%                       | Half as Loud                   |
| 15 dB          | Very difficult       | 97%                       | One-third as loud              |
| 20 dB          | Nearly impossible    | 99%                       | One-fourth as loud             |



GOOD



GOOD



BAD

# Transmission Loss of Different Materials

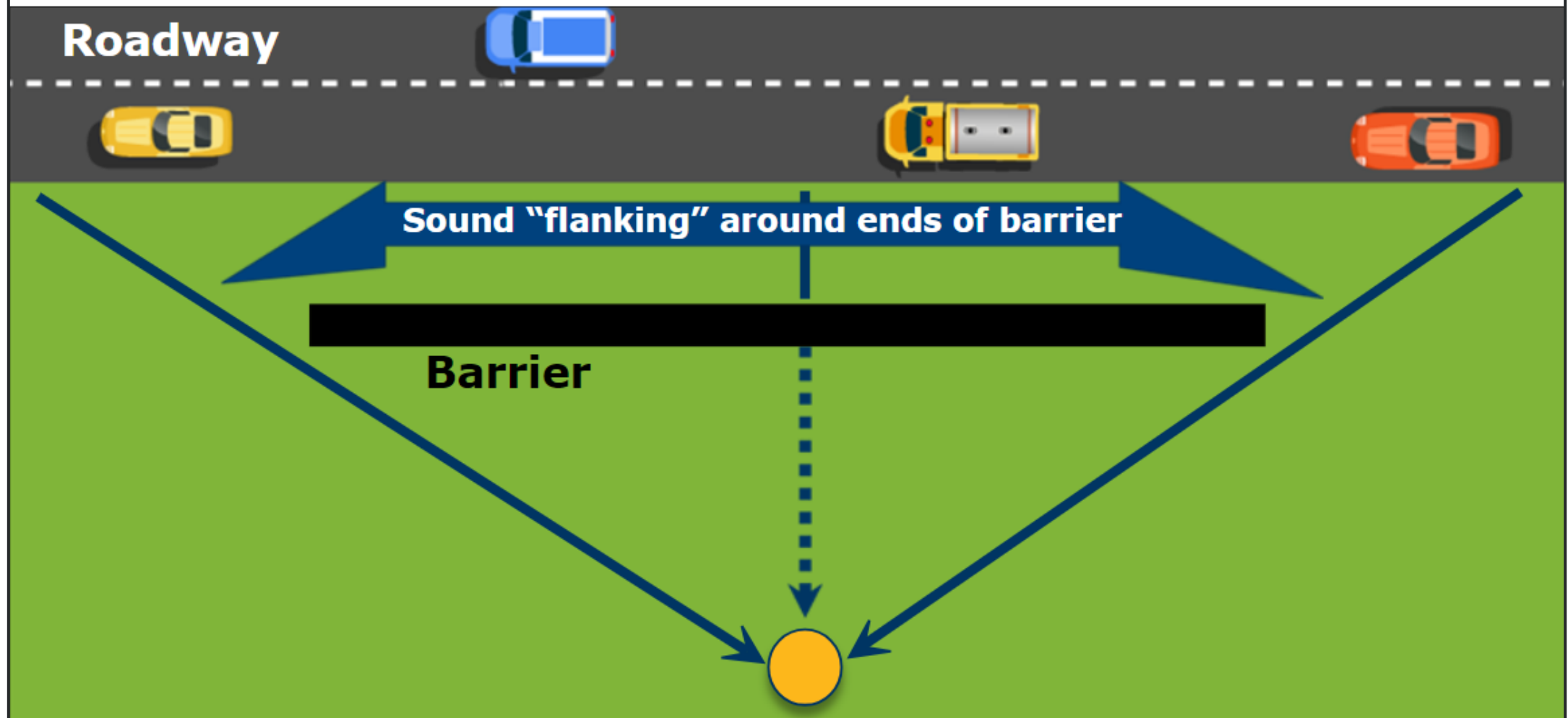
| Material                                    | Thickness (inches) | Weight (lb/ft <sup>2</sup> ) | A-weighted TL (dB) |
|---|--------------------|------------------------------|--------------------|
| Concrete Block, 8" x 8" x 16", light weight | 8                  | 31                           | 34                 |
| Dense Concrete                              | 4                  | 50                           | 40                 |
| Light Concrete                              | 4                  | 33                           | 36                 |
| Steel, 18 gauge                             | 0.050              | 2.0                          | 25                 |
| Steel, 24 gauge                             | 0.025              | 1.0                          | 18                 |
| Aluminum, Sheet                             | 0.125              | 1.8                          | 25                 |
| Wood, Fir                                   | 2 (nominal)        | 6.7                          | 24                 |
| Plywood                                     | 1                  | 3.3                          | 23                 |
| Glass, Safety                               | 0.125              | 1.6                          | 22                 |
| Acrylic                                     | 0.25               | 1.5                          | 22                 |

20 or more provides adequate performance as a sound barrier

Source: Chart from the *FHWA Noise Barrier Design Handbook*

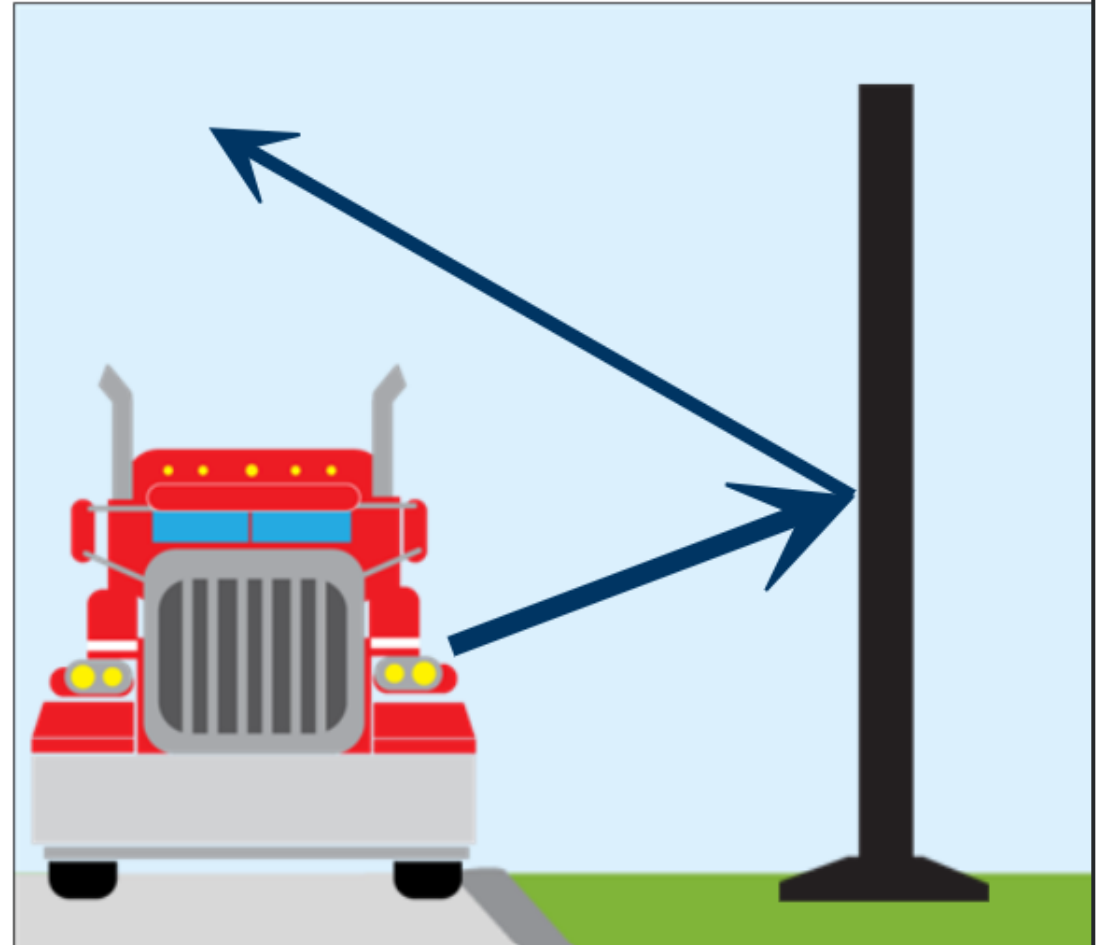


# Barrier Length and Flanking

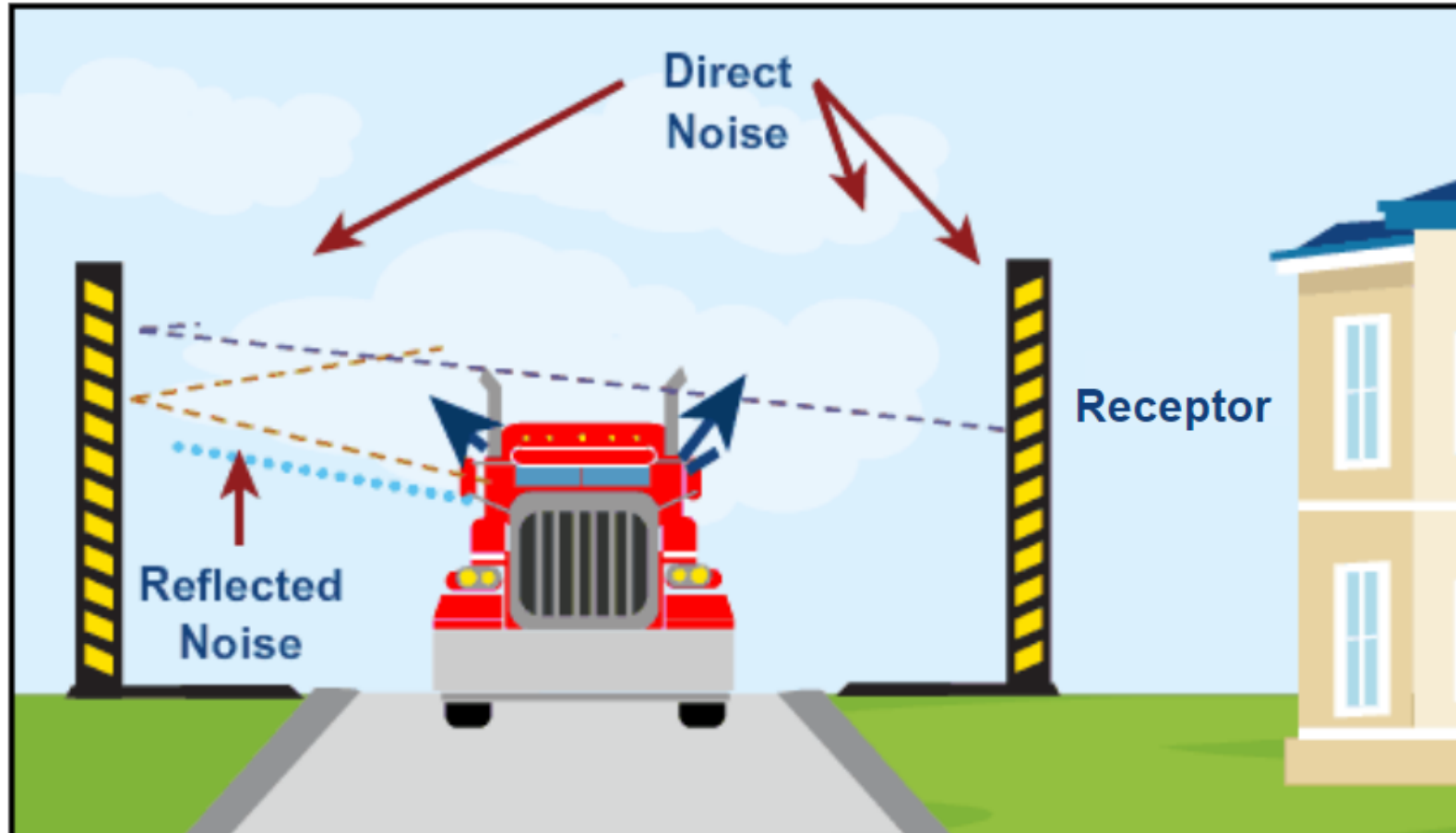


# Reflections off a Single Wall

- Barrier or building on one side of roadway can reflect sound energy back across roadway
- Only 1-3 dB increase, yet residents often perceive difference
- Change in sound frequency content may occur



# Multiple Reflections Between Parallel Barriers

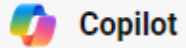




What can be done to mitigate noise or sound coming from a street?



Your everyday AI companion



**Copilot**

Mitigating street noise can be approached in several ways, depending on whether you're looking to make changes inside your home or in your outdoor space. Here are some effective strategies:

#### **Outdoor Noise Reduction:**

1. **Noise Reduction Fence:** Install a solid, high fence without gaps, as sound waves can pass through any holes. Materials like masonry—stone, brick, or stucco-covered concrete—are best for blocking sound due to their mass<sup>1</sup>.
2. **Landscaping:** Use dense plantings and hedges, like Juniper, which can help soften sounds that make it past other barriers<sup>2</sup>.
3. **Water Features:** Adding water features such as fountains can create a pleasant white noise that helps mask traffic sounds<sup>2</sup>.
4. **Sound Barriers:** Erecting physical barriers like soil berms or walls can block noise. The taller and denser the barrier, the more effective it will be<sup>2</sup>.

#### **Indoor Noise Reduction:**

1. **Soundproof Curtains:** Hang heavy, sound-dampening curtains on windows facing the street.
2. **Window Upgrades:** Consider double-glazing or acoustic windows that can significantly reduce noise transmission.
3. **Seal Gaps:** Ensure that all gaps around doors and windows are sealed to prevent sound leaks.
4. **White Noise Machines:** Use devices that produce white or pink noise to help mask outdoor sounds<sup>3</sup>.

Remember, combining several of these methods will likely yield the best results in reducing street noise.

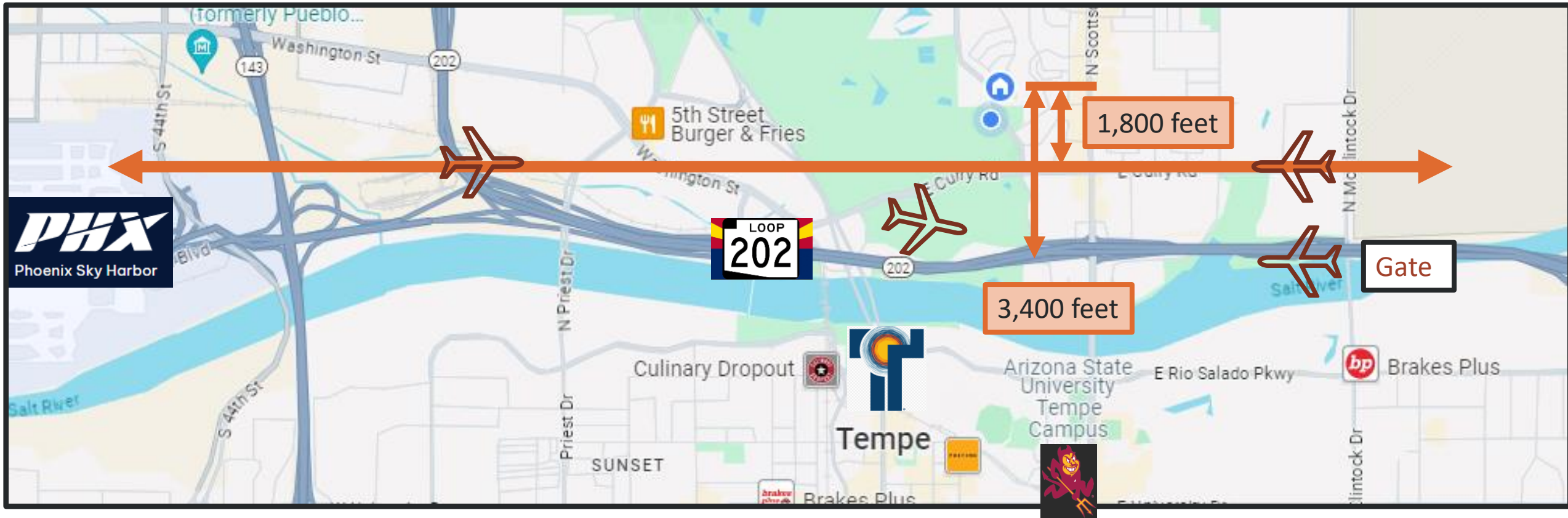
Learn more <sup>1</sup> [thisoldhouse.com](#) <sup>2</sup> [howtogardendesign.com](#) <sup>3</sup> [thespruce.com](#) <sup>4</sup> [gentlehush.com](#)



Example Noise  
Mitigation by  
Seth Chalmers, PE



# House From Flight Path In and Out of North Runway



## Water Feature Performance

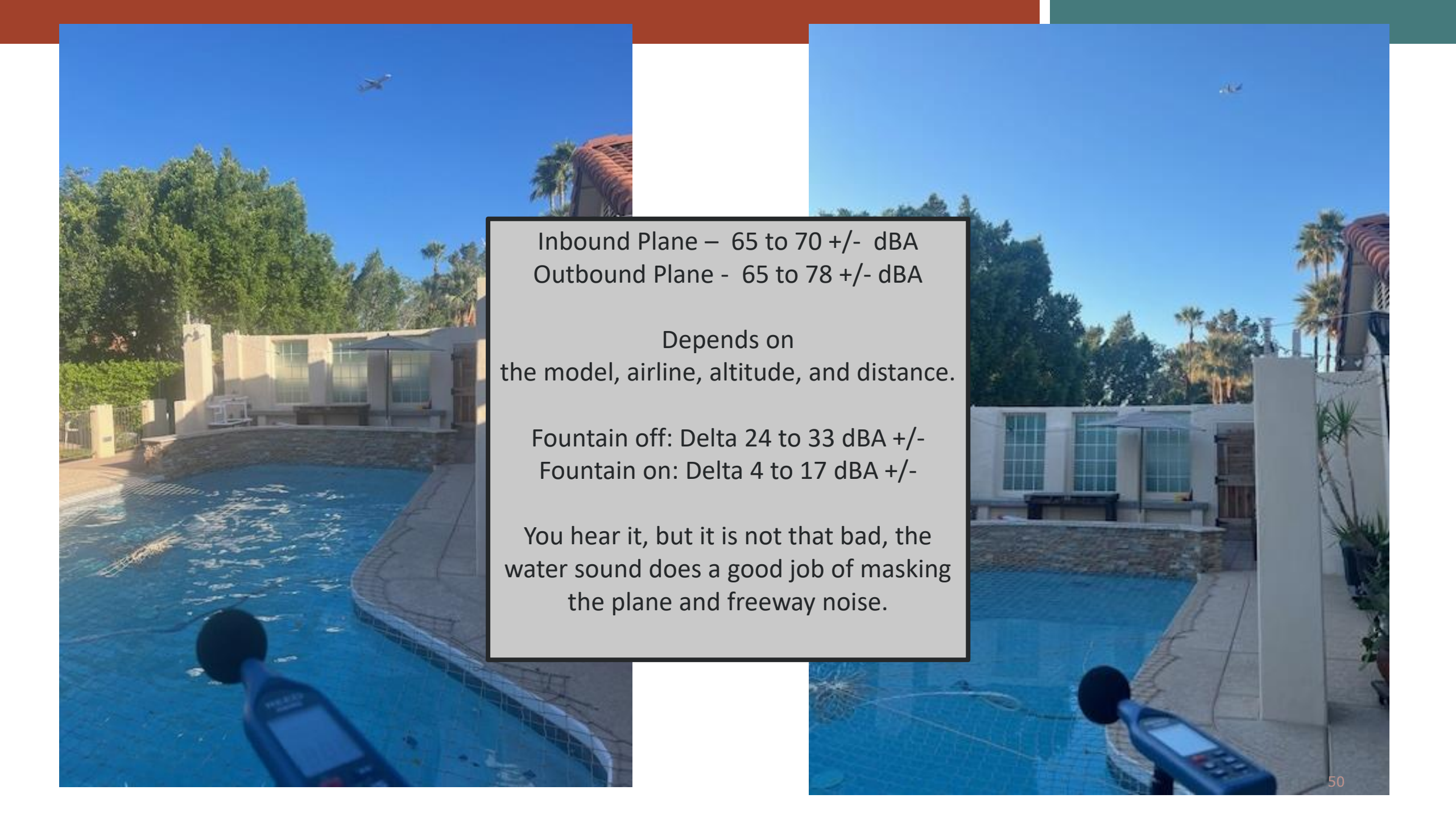
Fountain off 42 +/- dBA warm air PM peak on Loop 202

Fountain off 51 +/- dBA cool air AM peak on Loop 202

Fountain On 61 +/- dBA with both "**ambient**" conditions

No planes in ear shot.





Inbound Plane – 65 to 70 +/- dBA  
Outbound Plane - 65 to 78 +/- dBA

Depends on  
the model, airline, altitude, and distance.

Fountain off: Delta 24 to 33 dBA +/-  
Fountain on: Delta 4 to 17 dBA +/-

You hear it, but it is not that bad, the  
water sound does a good job of masking  
the plane and freeway noise.

# Building a Ramada and Extending the Roof Line to Break the Line of Sight to Planes More



# Discussion / Questions / Questionnaire Assistance

**Seth Chalmers, PE**

Director of Traffic Engineering, Dibble

[seth.chalmers@dibblecorp.com](mailto:seth.chalmers@dibblecorp.com) / 602.363.1854



**DIBBLE**





**DOVE MOUNTAIN BOULEVARD TRAFFIC SOUND ASSESSMENT  
(SECRET SPRINGS DRIVE TO PROSPECT WASH  
AREA OF PRIMARY INTEREST)  
Questionnaire/Survey/Comment Input Form**

**CONTACT INFORMATION**

|  |  |                   |  |
|--|--|-------------------|--|
| Dove Mountain Neighborhood Area (see map):         |  |                   |  |
| Name (optional):                                   |  |                   |  |
| Address (optional) or Nearest Minor Cross-Streets: |  |                   |  |
| E-mail (optional):                                 |  | Phone (optional): |  |

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**ASSESSMENT OBJECTIVE:** The objective of this assessment is to continue sound evaluation efforts and arrive at an actionable or non-actionable conclusion. This includes an effort to help educate interested parties on the principles and processes involved in street traffic sound assessment and to gain input from those individuals regarding their issues. This assessment will consider whether additional data collection and evaluation are required to determine if the sound qualifies as noise. If additional data are needed, reasonable alternatives for potential mitigations may be developed and evaluated, and suitable locations for their implementation may be identified. If mitigations are deemed effective and cost-efficient, the next step will involve determining how these mitigations will be funded. Given that this situation pertains to a planned community, it may fall upon the Dove Mountain Community Association and individual residents to explore mitigations and fund them. While the Town of Marana can offer technical assistance, it is currently not positioned to directly participate in funding additional mitigations, particularly if they involve private property.

**IMPORTANT DEFINITIONS**

- Sound:** Sound is an objective term; it refers to a physical property. When an object vibrates, the energy from those vibrations causes pressure fluctuations as it travels through air (or another medium). If the pressure fluctuations reach a person's ears, the person will perceive them as sound.
- Components of Sound:**
  - Source:** The origin of the sound.
  - Path:** The medium through which the sound travels.
  - Receptor:** The person or device that detects the sound.
- Noise:** Noise is a sound that can be loud and unpleasant, causing disturbance. The judgment of the unpleasantness of sounds at lower levels is often subjective to the individuals hearing the sound and where they hear it.
- Reduction in Sound or Noise Reduction Design Goal:**
  - A meaningful reduction in sound is typically from 5 to 7 decibels, achievable through physical structures (such as noise barriers) located at the source or receptor (or both).
  - A reduction of 5 decibels or more is readily perceptible.

**5. Interruption of Sound:**

- Interruption of sound occurs when other sounds are used to mask the sound that might be perceived as noise. This is sometimes referred to as white noise. Water features that have fountains are typically used to interrupt unwanted sounds or noise outdoors at a specific location.

**SOUND AND NOISE ASSESSMENT QUESTIONNAIRE (please answer whatever questions apply to you)**

- On a scale of 1 to 10 (with 1 being the best and 10 being the worst), do you think sound from Dove Mountain Boulevard is, at times, at a level that you consider noise?
- At what time(s) do you consider sound from Dove Mountain Boulevard to be noise? Circle all times that you think apply.  
  
Early Morning - Morning - Late Morning - Noon - Early Afternoon - Afternoon - Late Afternoon - All the time
- Does this perceived noise occur on specific day(s) of the week, month, or year? Or is it all the time?
- Do weather conditions have any impact on your perception of the sound as noise?
- Do you feel that the noise is high and frequent enough that it needs to be mitigated in some fashion?
- If you consider the sound to be noise, is it when you are inside your home, outside your home, or both?
- From that location (either indoors or outdoors), can you directly see Dove Mountain Boulevard? Circle which applies.  
  
Inside: Yes or No    Outside: Yes or No  
  
**Note:** Line of sight is the path between the receiver (home/residence) and the source (vehicle on the street) and is very important in sound transmission. The rule of thumb is that if you can see the traffic, you may perceive its sound to be louder.
- Are there any obstructions between you and Dove Mountain Boulevard that can interrupt that line of sight? If so, is that there all the time or only some of the time?  
  
**Note:** Traffic sound or noise is a moving line source, meaning it is generating that sound as it travels along the street or road. Sound or noise can be interrupted at times by something physical like a berm, wall, or vegetation that is on or off your property. These features can reflect and/or absorb sound.
- If you can see Dove Mountain Boulevard, have you noticed what type(s) of vehicle(s) are generating enough sound for you to consider it to be noise?

10. Estimate or guess how far is your home from Dove Mountain Boulevard in feet or football fields?
11. Is your home above, below, or at the same level as Dove Mountain Boulevard? Or does it vary?
12. What is the terrain like between you and Dove Mountain Boulevard? Is it flat, hilly, uphill, or downhill? Does the terrain have no vegetation, little vegetation, some vegetation, or much vegetation? Is the soil on the terrain soft, semi-soft, semi-hard, or hard?
13. Describe and/or sketch the location where you are when you consider the sound from Dove Mountain Boulevard to be noisy. Is there a wall between you and Dove Mountain Boulevard? Is so, what type of wall and how high is it? Is it a solid wall or does it have openings? If it has openings or gaps, what are those openings made of?
14. If you consider Dove Mountain Boulevard to have enough sound to be considered noise, have you done anything on your property to mitigate it? This could include heightening a solid wall or closing gaps in a solid wall with a solid material such as masonry, steel, aluminum, wood, or safety glass. See the companion handout for the transmission loss potential of different materials.
15. Have you tried any other mitigation measures, such as a water feature, to help mask the sound?
16. Are you willing to allow the Town of Marana and its engineering consultant, Dibble, to take sound measurements at the location where you believe that sound is noise? The total time to take these measurements is estimated to be just under an hour.
17. Please write any other questions and/or comments here.



# **Appendix C – Community Handouts** – Survey – Facts on Noise – Common Indoor & Outdoor Noise Levels – NHI Information on Noise

**DOVE MOUNTAIN BOULEVARD TRAFFIC SOUND ASSESSMENT  
(SECRET SPRINGS DRIVE TO PROSPECT WASH  
AREA OF PRIMARY INTEREST)  
Questionnaire/Survey/Comment Input Form**

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  - o A reduction of 5 decibels or more is readily perceptible.

5. **Interruption of Sound:**

- o Interruption of sound occurs when other sounds are used to mask the sound that might be perceived as noise. This is sometimes referred to as white noise. Water features that have fountains are typically used to interrupt unwanted sounds or noise outdoors at a specific location.

**SOUND AND NOISE ASSESSMENT QUESTIONNAIRE (please answer whatever questions apply to you)**

1. On a scale of 1 to 10 (with 1 being the best and 10 being the worst), do you think sound from Dove Mountain Boulevard is, at times, at a level that you consider noise?

2. At what time(s) do you consider sound from Dove Mountain Boulevard to be noise? Circle all times that you think apply.

Early Morning - Morning - Late Morning - Noon - Early Afternoon - Afternoon - Late Afternoon - All the time

3. Does this perceived noise occur on specific day(s) of the week, month, or year? Or is it all the time?

4. Do weather conditions have any impact on your perception of the sound as noise?

5. Do you feel that the noise is high and frequent enough that it needs to be mitigated in some fashion?

6. If you consider the sound to be noise, is it when you are inside your home, outside your home, or both?

7. From that location (either indoors or outdoors), can you directly see Dove Mountain Boulevard? Circle which applies.

Inside: Yes or No    Outside: Yes or No

**Note:** Line of sight is the path between the receiver (home/residence) and the source (vehicle on the street) and is very important in sound transmission. The rule of thumb is that if you can see the traffic, you may perceive its sound to be louder.

8. Are there any obstructions between you and Dove Mountain Boulevard that can interrupt that line of sight? If so, is that there all the time or only some of the time?

**Note:** Traffic sound or noise is a moving line source, meaning it is generating that sound as it travels along the street or road. Sound or noise can be interrupted at times by something physical like a berm, wall, or vegetation that is on or off your property. These features can reflect and/or absorb sound.

9. If you can see Dove Mountain Boulevard, have you noticed what type(s) of vehicle(s) are generating enough sound for you to consider it to be noise?

10. Estimate or guess how far is your home from Dove Mountain Boulevard in feet or football fields?
11. Is your home above, below, or at the same level as Dove Mountain Boulevard? Or does it vary?
12. What is the terrain like between you and Dove Mountain Boulevard? Is it flat, hilly, uphill, or downhill? Does the terrain have no vegetation, little vegetation, some vegetation, or much vegetation? Is the soil on the terrain soft, semi-soft, semi-hard, or hard?
13. Describe and/or sketch the location where you are when you consider the sound from Dove Mountain Boulevard to be noisy. Is there a wall between you and Dove Mountain Boulevard? If so, what type of wall and how high is it? Is it a solid wall or does it have openings? If it has openings or gaps, what are those openings made of?
14. If you consider Dove Mountain Boulevard to have enough sound to be considered noise, have you done anything on your property to mitigate it? This could include heightening a solid wall or closing gaps in a solid wall with a solid material such as masonry, steel, aluminum, wood, or safety glass. See the companion handout for the transmission loss potential of different materials.
15. Have you tried any other mitigation measures, such as a water feature, to help mask the sound?
16. Are you willing to allow the Town of Marana and its engineering consultant, Dibble, to take sound measurements at the location where you believe that sound is noise? The total time to take these measurements is estimated to be just under an hour.
17. Please write any other questions and/or comments here.

# Facts about Noise

- Noise is unwanted sound. Noise is perceived differently by every individual. A noise that is irritating to one person may be tolerable to another.
- Noise is measured in decibels on a logarithmic scale.
- An increase of 10 decibels will cause the noise to be perceived as sounding twice as loud to the average listener.
- The smallest change in noise level that can be detected by the human ear is about 3 decibels.
- Doubling the traffic volume on a highway will increase the noise level by 3 decibels.
- The noise level will decrease by about 3 to 4.5 decibels for each doubling of the distance from the source roadway. The amount of decrease depends on the absorptive characteristics of the ground.
- The Arizona Department of Transportation uses a noise level of 66 decibels as the criterion for considering noise barriers, which is lower than the 67 decibels specified in the federal regulations.
- Noise barriers can be noise walls, earth berms or a combination of walls and berms.
- Even with noise barriers, residents within 500 to 1,000 feet of the highway will likely be able to hear the traffic. Barriers are designed to reduce noise to an acceptable or tolerable level. They cannot completely eliminate noise.
- Noise barriers along a highway are most effective for homes within about 300 feet of the highway. Beyond that, noise barriers are less effective, but the natural decrease in noise with distance usually reduces noise levels to acceptable levels.
- Noise walls range in height from 8 to 20 feet, depending on what height is needed to reduce the noise to an acceptable level. Noise walls cost about \$250 to \$700 per linear foot, depending on the height.
- An earth berm (a large mound of packed dirt usually with landscaping) of a given height will provide slightly more noise reduction than a vertical barrier wall of the same height.
- In some cases, existing dense vegetation can reduce traffic noise levels. Vegetation that is a minimum of 100 feet in depth, at least 15 feet high and dense enough that you cannot see the highway through it, can reduce noise levels by approximately 5 decibels. Typical roadside landscaping does not affect noise levels.
- As a general rule-of-thumb, a noise barrier that is high enough to break the line of sight between the source (traffic) and the receiver (residents) reduces noise by approximately 5 decibels. Each additional foot of height added to the barrier reduces the noise level by another half decibel.

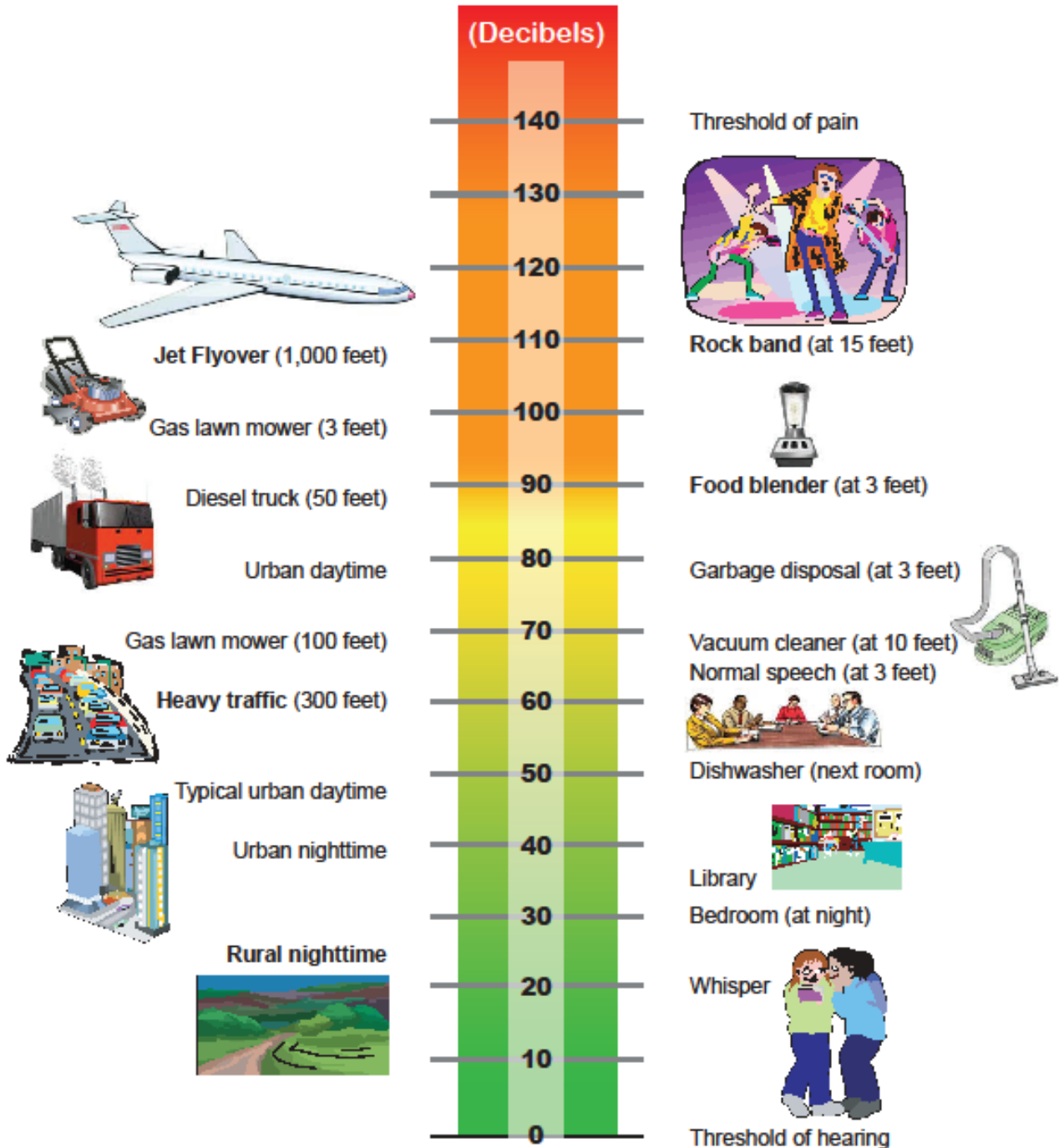


# Common Indoor and Outdoor Noise Levels

## Common Outdoor Noises

## Sound Level

## Common Indoor Noises



Note: Sound is perceived differently by every individual





# DOVE MOUNTAIN BOULEVARD TRAFFIC SOUND ASSESSMENT

## Companion Handout on Sound and Noise Information

04/17/2024

The following figures help to explain the issues and considerations related to sound and noise assessment. Unless otherwise noted, figures and tables are taken from *FHWA-NHI-142086, Acoustics of Highway Traffic and Construction Noise*.

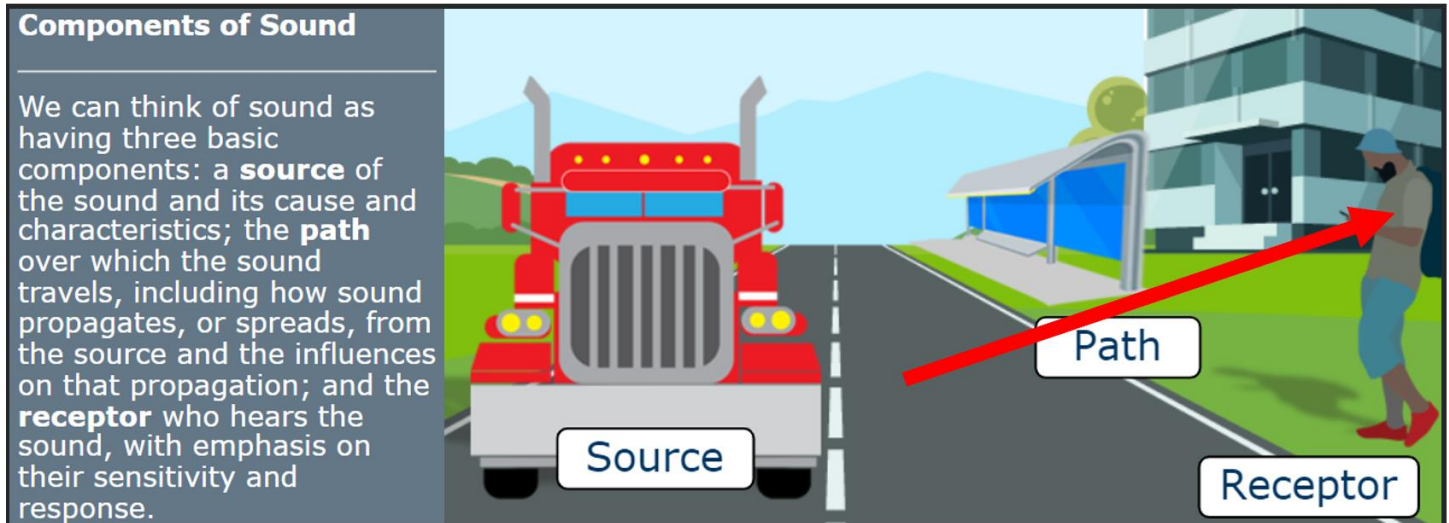


Figure 1 – Components of Sound

|   |   |
|---|---|
| <p><b>Characteristics of Sound</b></p> <p>There are three fundamental characteristics of sound:</p> <ul style="list-style-type: none"><li>• Amplitude (what is perceived as loudness);</li><li>• Frequency (or pitch); and</li><li>• Time (focusing mostly here on duration, but time also includes variation).</li></ul> | <p><b>Noise is simply <i>unwanted</i> sound; sound that a receptor perceives <i>negatively</i>. Remember the sound of that truck horn?</b></p> <p><b>Noise is subjective to the receptor. One person's noise may be another person's music!</b></p> |
|---|---|

Figure 2 – Characteristics of Sound and Definition of Noise

## Acoustically Hard and Soft Ground

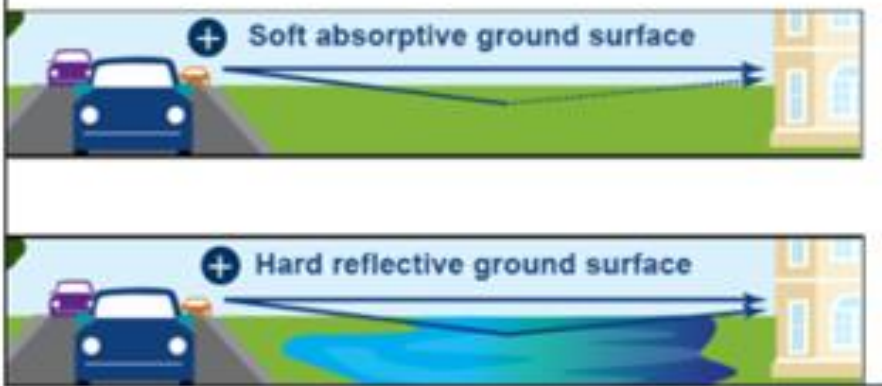


Figure 3 – Characteristics of Ground Surface on Sound



Figure 4 – Weather Impacts on Sound

## REMELs by Vehicle Type and Speed

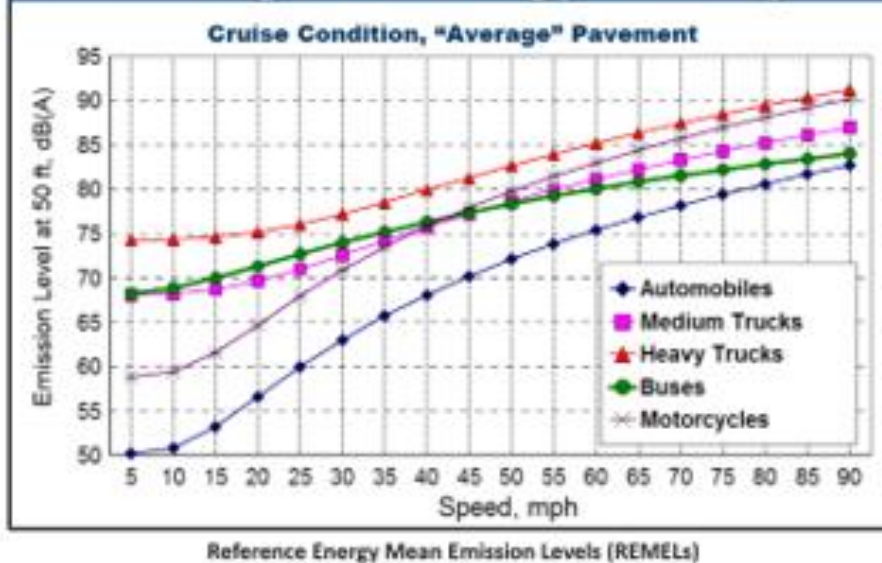


Figure 5 – Relation Between Vehicle Type, Speed, and Sound

# Sound Propagation and Noise Barriers

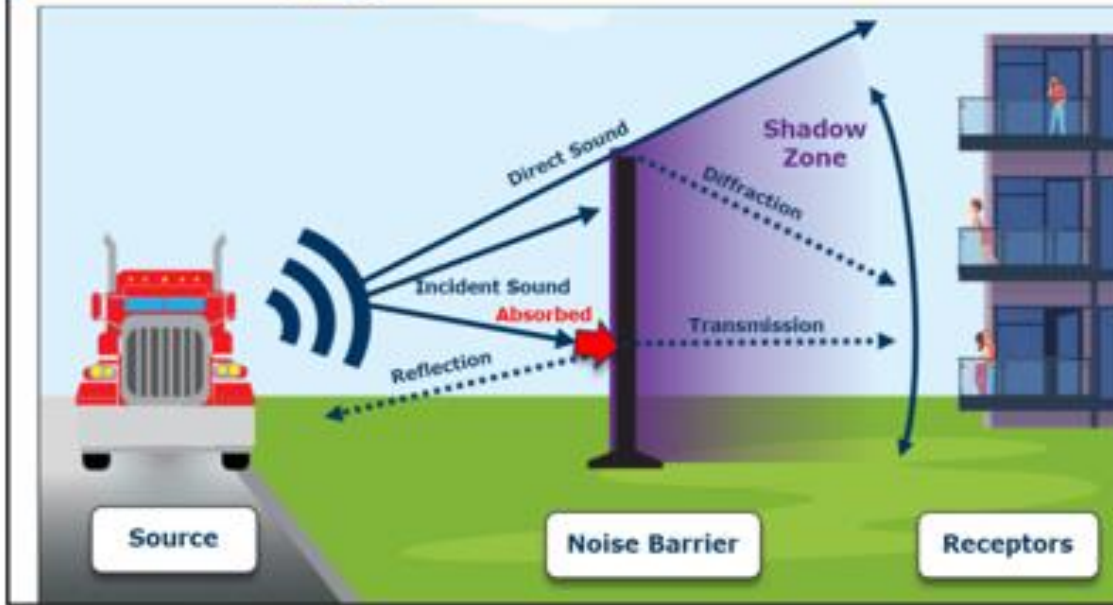


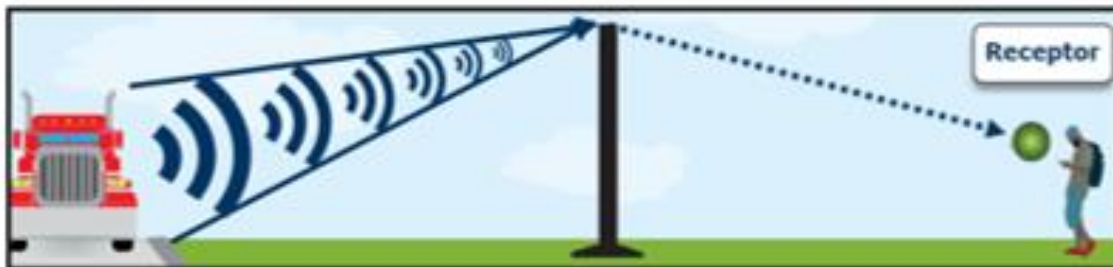
Figure 6 – Sound and Barriers



GOOD



GOOD



BAD

Figure 7 – Effective Location of Barriers

## Reflections off a Single Wall

- Barrier or building on one side of roadway can reflect sound energy back across roadway
- Only 1-3 dB increase, yet residents often perceive difference
- Change in sound frequency content may occur

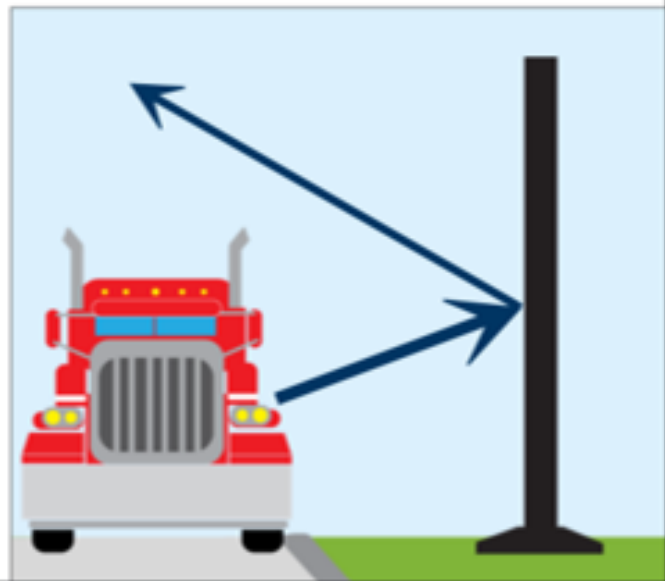


Figure 8 – Issue with a Single Side Barrier

## IL: Obtaining Noise Reduction with Barriers

| Insertion Loss | Degree of Difficulty | Reduction in Sound Energy | Relative Reduction in Loudness |
|----------------|----------------------|---------------------------|--------------------------------|
| 5 dB           | Simple               | 68%                       | Readily perceptible            |
| 10 dB          | Attainable           | 90%                       | Half as Loud                   |
| 15 dB          | Very difficult       | 97%                       | One-third as loud              |
| 20 dB          | Nearly impossible    | 99%                       | One-fourth as loud             |

Figure 9 – Insertion Loss Potential and Degree of Difficulty

## Transmission Loss of Different Materials

| Material                                    | Thickness (inches) | Weight (lb/ft <sup>2</sup> ) | A-weighted TL (dB) * |
|---|--------------------|------------------------------|----------------------|
| Concrete Block, 8" x 8" x 16", light weight | 8                  | 31                           | 34                   |
| Dense Concrete                              | 4                  | 50                           | 40                   |
| Light Concrete                              | 4                  | 33                           | 36                   |
| Steel, 18 gauge                             | 0.050              | 2.0                          | 25                   |
| Steel, 24 gauge                             | 0.025              | 1.0                          | 18                   |
| Aluminum, Sheet                             | 0.125              | 1.8                          | 25                   |
| Wood, Fir                                   | 2 (nominal)        | 6.7                          | 24                   |
| Plywood                                     | 1                  | 3.3                          | 23                   |
| Glass, Safety                               | 0.125              | 1.6                          | 22                   |
| Acrylic                                     | 0.25               | 1.5                          | 22                   |

\*20 or more provides adequate performance as a sound barrier

Figure 10 – Transmission Loss of Different Potential Barrier Materials (Source: FHWA Noise Barrier Design Handbook)

The End



# **Appendix D** – Summary and Evaluation Tables of Survey Responses to Support Findings

**Table 1 – Respondent Number, Location & Questions 1-7**

| No  | Neighborhood / Location  | 1- Noise Scale | 2- Times                           | 3 - Days                            | 4 - Weather        | 5 – Need for Mitigation                               | 6 - Where                       | 7 – Line of Sight to DM    |
|-----|--|----------------|------------------------------------|-------------------------------------|--------------------|---|---------------------------------|----------------------------|
| 1   | Highlands  | 5              | M, N, LA                           | ATT                                 | No                 | Yes   | Outside                         | Only outside               |
| 2   | NWC of the Highlands – Coyote Gulch Loop                               | 10             | ATT – LA is worst                  | ATT                                 | No                 | Yes   | Both                            | Yes and Yes                |
| 3   | South of the Preserve<br>Dove Mountain & Tangerine Rd                  | 8-10<br>Say 9  | EM                                 | weekdays                            | Yes - wind         | Yes   | Both                            | No and no<br>See Tangerine |
| 4   | Quail Crossing II<br>5004 W Tipperary                                  | 8              | ATT                                | Mostly Mon - Friday                 | No                 | Yes   | Both                            | Yes and Yes<br>stop sign   |
| 5   | The Bluffs<br>Moore & Ocotillo Pt Place                                | 10             | ATT except during lulls in traffic | ATT                                 | No                 | Yes   | Both worse when outside         | No and no                  |
| 6   | The Highlands<br>DMB & Heritage Gateway                                | 7              | EM, M EA, A                        | M-F                                 | Yes                | Yes   | Both                            | Yes, and Yes               |
| 7   | Dos Lagos<br>13906 N Easy Par Pl                                       | 8              | EM, LM, A, & LA                    | M-F<br>Some Sat                     | Yes                | Yes   | Outside                         | No and no                  |
| 8   | Dos Lagos<br>5940 West Clear Brook Lane                                | 10             | EM, LM, A, & LA (readings)         | M-S                                 | Yes                | Yes, at specific locations                            | Both                            | No and yes                 |
| 9   | Highlands<br>Vicinity of North Gate                                    | 8              | M thru LA                          | All the time                        | Don't know, say no | Yes   | Both                            | No and yes                 |
| 10  | Highlands<br>DMB at North Heritage Gateway                             | 10             | All the time                       | All the time                        | No                 | yes   | When windows are open & outside | Yes and yes                |
| 11  | Del Webb<br>6812 W Cliff Spring Trail                                  | 8              | M & LA                             | M - F                               | No                 | Yes!  | Outside                         | Yes and yes                |
| 12+ | Highlands<br>5186 West Desert Chicory Place                            | 10             | All the time                       | All the time                        | Not really, say no | Yes   | Mostly outside                  | No and no                  |
| 13+ | Desert ??<br>David Krueger   | 10             | Most of the time                   | All of the time                     | N/A                | yes   | Louder on patio                 | no and Yes                 |
| 14  | Entrance of the Highlands  | 10             | 3:30 am to 9 am<br>3 pm to 6:30 pm | All of the time                     | Yes                | Yes, replaced windows but still noisy                 | Both                            | No and yes                 |
| 15  | Dove Mtn Blvd & Highlands  | 10             | All of the time                    | All of the time                     | No                 | Yes   | Both                            | Yes and yes                |
| 16  | Highlands<br>5366 West Arid Canyon Dr                                  | 8              | EM & LA                            | Working Days<br>Contractor Vehicles | No                 | Yes   | Both                            | No and No                  |
| 17  | Los Saquaros 1<br>Whispering Windmill Ln & Los Saquaros Dr             | 3              | EM & LA                            | Mon - Fri                           | Not aware          | Not at this time – need more landscaping to hid views | Both                            | Yes and Yes                |
| 18  | Main Entrance of Highlands<br>with DMB<br>13382 North Heritage Club Pl | 8              | M thru Afternoon                   | Basically Mon - Fri                 | No                 | Yes, main issue is crosswalks                         | Both                            | Yes and yes                |
| 19  | Dove Creek<br>13226 N Dove Mountain Blvd                               | 8              | All the time<br>6 am to 6 pm       | All of the time                     | No                 | Speed is well over 50 mph                             | Outside                         | No and yes                 |

EM – Early Morning, M-Moring, N- Noon, LA – Late Afternoon. + 12 and 13 were sent together.

**Table 2 – Questions 8 - 15**

| No | 8 – Obstructions                            | 9- Noisy Vehicles  | 10 – Distance from DM | 11 – Elevation from DMB                            | 12 – Land In-between                             | 13 – Describe or Sketch                              | 14 – Done any Mitigations?                        | 15 – Water feature to Mask  |
|----|---|--|-----------------------|--|--|--|---|-----------------------------|
| 1  | Trees and other homes                       | Big Trucks and MC  | Football field        | Below  | Downhill a lot of vegetation                     | Not in favor of walls*                               | Just bushes and shade trees                       | Yes                         |
| 2  | No  | Concrete & Construction Trucks MC                                | 62 feet<br>See sketch | Mostly Below                                       | N/A  | Block and Open fence see sketch                      | N/A   | Yes                         |
| 3  | N/A   | Speed 50-55 mph  | 6 football fields     | Below  | Downhill   | Intersection of DM & Tangerine                       | No  | No                          |
| 4  | No  | Trucks and Race cars   | Estimate 50 ft        | Slightly below                                     | Some veg & walking trail                         | Solid Wall/Fence is 6ft slightly lower than the Road | No – What will HOA allow us to do?                | Plants & Fountain           |
| 5  | Block wall surrounding our backyard         | Cars and Large vehicles -can see the top of them                 | Estimate 100 ft       | A bit below or close to same level                 | Flat with hard sand with some veg                | Back Yard faces DMB 5 to 5.5 feet high               | No  | Water feature does not help |
| 6  | Yes, the homes across the street.           | Yes  | 1 football field      | Same Level   | Desert soil and rock on a relatively flat level  | Mixture of iron and block. Block wall is 5 ft        | Water feature                                     | Yes                         |
| 7  | Homes between, but can still hear the noise | Trucks and too many cars   | ½ football Field      | Same level   | Homes, still hear the noise                      | See sketch   | No, pot holes cause trucks to be bad              | Impossible roaring traffic  |
| 8  | Vegetation masks visibility                 | Trucks with trailers   | 500 feet              | DMB slopes up to the east                          | Flat with scrub vegetation                       | See attached   | Yes, acrylic panels, wall, fake grass             | Yes                         |
| 9  | No  | Large Trucks   | 1,500 feet            | Below grade wash                                   | See sketch                                       | See sketch   | Some plants                                       | No                          |
| 10 | No  | All traffic  | 100 ft +/-            | Below 10 ft +/-                                    | Uphill some veg semi soft soil                   | See comment  | Outdoor patio shades                              | No                          |
| 11 | Bushes along our fence                      | Construction traffic, school buses<br>constant stream of traffic | 350 ft +/-            | Mostly same level, DMB starts to rise to our right | Flat with vegetation soil is hard                | See sketch   | Two water features and outdoor speakers for music | Yes                         |
| 12 | Block wall all of the time                  | N/A  | 150 ft                | Above  | Some vegetation                                  | 6 ft block wall along DMB                            | Vegetation and water feature                      | Yes                         |
| 13 | N/A   | All traffic  | 80 ft                 | Above  | Open trees and bushes                            | Every morning  | N/A   | N/A                         |
| 14 | Block wall                                  | Concrete trucks and construction trucks                          | 75 to 100 feet        | Above  | Some vegetation & hard                           | Block wall which is 4 ft high                        | New windows                                       | N/A                         |
| 15 | No  | Motorcycles construction and delivery trucks, SUVs               | 100 ft                | Same level   | Flat desert plants and soft terrain              | Low 5' wall no openings, see sketch                  | Water pond feature                                | yes                         |
| 16 | Topography and Houses                       | Contractor vehicles  | 145 ft                | below  | Downhill mainly roads, driveways and landscaping | No wall, have a road that goes directly to DMB       | Keep our windows closed                           | N/A                         |



|    |                                  |   |        |                |  |   |  |             |
|----|----------------------------------|---|--------|----------------|--|---|--|-------------|
| 17 | Desert landscape & walking trail | Mostly construction vehicle and motorcycles sometimes | 100 ft | Slightly below | Desert vegetation – not enough to block walking path and traffic | No wall and do not what a wall. More vegetation would help                | No, but would be willing to fund more planting | Have a pool |
| 18 | Yes, Highlands at DMB water fall | Most trucks   | 600 ft | same           | Some vegetation and semi-hard                                    | Brick crosswalk on southbound lane of DMB at main guardhouse to Highlands | No, but take out brick crosswalks              | No          |
| 19 | N/A                              | All of them, they are all going to fast.              | 150 ft | Below          | N/A  | See comment   | no   | no          |

N/A – Not Answered

**Table 3– Questions 16 -17 and Additional Comments on Answers of Note**

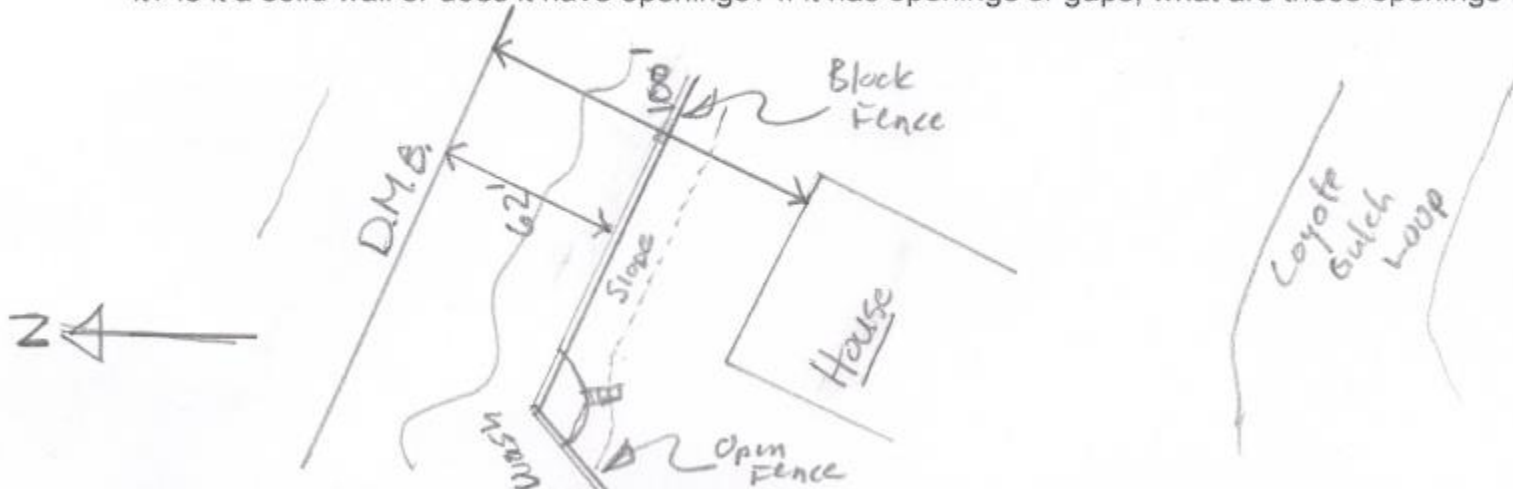
| No | 16 – Take Measurements at Home   | 17 – Other Comments  | Addition Comments on Answers of Note  |
|----|--|--|---|
| 1  | No   | Thanked us for the meeting   | * Does not like the soundwall that were put up by the County in the Catalina Foothills area.  |
| 2  | Yes  | N/A  |   |
| 3  | Yes  | Traffic speed is not enforced. Frequently awaked at 4 am – 5 am by large trucks speeding | Install speed cameras and a wall would help – referred to 2012 noise study done for Tangerine Rd by PSOMAS per the Final Design Concept Report for Tangerine Rd   |
| 4  | Yes  | Remove the crosswalks  | Some of the sound can be easily fixed by paving over the cross walks at DMB and Moore Road. When trucks stumble across, it sounds like the are dropping their whole load.   |
| 5  | Yes  | N/A  |   |
| 6  | Yes  | --   |   |
| 7  | Can measure in the front of my home                                    | Never chip seal. Should have been the same past Ritz Roundabout.                         |   |
| 8  | Yes<br>Best times to measure are 4:30 am to 9 am, 11 to 1, 3-4 and 5-6 | As noted in next column  | There were some resident measurements without auto logging (manual). The town did some measurements which were like residents but did not capture peaks. – Low frequency noise rattles windows and doors for some residents along DMB – heavy trucks and speed are primary sources. |
| 9  | Yes  | --   |   |
| 10 | Yes  | --   | Rear of house facing DMB, approx. 5 ft block wall at property line. Road noise has increased substantially since the number of homes has increased west of the Ritz hotel. Also, DMB was “chip sealed.” The micro chip reduced the noise level. But not to acceptable levels.       |
| 11 | Yes  | --   | Yes, we grow bushes along our open fence. But Del Web will not permit building a solid wall. In the 4 years we have lived here, traffic noise has increased   |

|    |                                    |   |  |
|----|------------------------------------|---|--|
|    |                                    |   | dramatically. So much so, I am considering moving. We cannot enjoy our outdoor space   |
| 12 | Yes – water feature and vegetation | CCRs do not allow raising of wall would not wish to do that anyway.   | 1-Noise increased after DMB was chip sealed several year ago. 2- Exponential growth of traffic with hundreds of homes being built. Large construction trucks workers and increase residence on mountain, no end in sight for these factors   |
| 13 | --                                 | --  | Too many cars and trucks as there is more housing further up the road.   |
| 14 | Yes                                |   | Perhaps a roundabout at the main entrance of highlands would make traffic slow down and be safer.  |
| 15 | Yes                                | Excessive traffic noise adversely impacts sleep   | Prolonged exposure to high levels of noise contributes to sleep deprivation, cognitive decline for vulnerable elderly residents. Consider rubberized asphalt, reduce speed, roundabout forces drivers to slowdown and speed cushions.  |
| 16 | Yes                                | Association rules severely limit building sound barriers.   | I suspect the noise issue is more due to the road surface – chip seal installed a few years ago made noise more of an issue.   |
| 17 | N/A                                | Being able to see walkers on path and vehicles on DMB bothers me.   | Would like to see additional bushes planted in wash between backyard fences and walking path/DMB – whether by us or HOA No other solutions needed.   |
| 18 | Ok                                 | But the sound is quite intermittent   | The issue is the brick crosswalk mentioned above. When DMB was repaved, that pavement is about 1” higher than the surface of the crosswalk. Not cars, but some trucks hit it. It sounds like the truck has hit a cement wall. Very loud and its has to occasionally cause damage to trucks and causes safety issues. Ask the guardhouse attendants about it. They are aware of the problems it does cause and could cause. |
| 19 | No                                 | DMB is a main throughfare when Maran redid the road surface, they used a road surface that was for a rural road | I walk Dove Creet 2 + miles everyday (almost) and the noise at the intersections is awful. Road surface needs to be redone; current coating contributes to the noise. The biggest problem is speeding which is causing the noise. The Marana Police Dept. should start tagging speeders.   |

Attached Sketches and Pictures send in as a part of the survey or as an attachment to the survey.

For Response Number 2 Answer to Question 13 and 10. House is mostly below DMB. As shown wall does not do too much.:

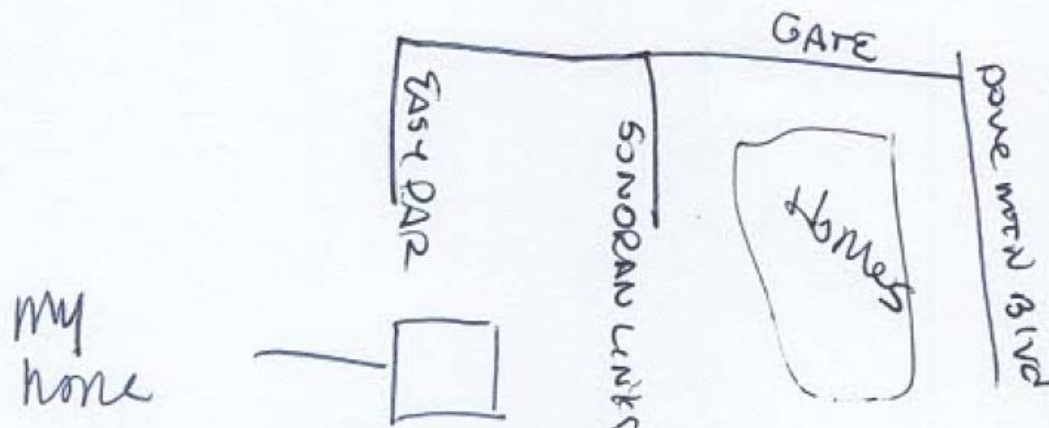
13. Describe and/or sketch the location where you are when you consider the sound from Dove Mountain Boulevard to be noisy. Is there a wall between you and Dove Mountain Boulevard? Is so, what type of wall and how high is it? Is it a solid wall or does it have openings? If it has openings or gaps, what are those openings made of?



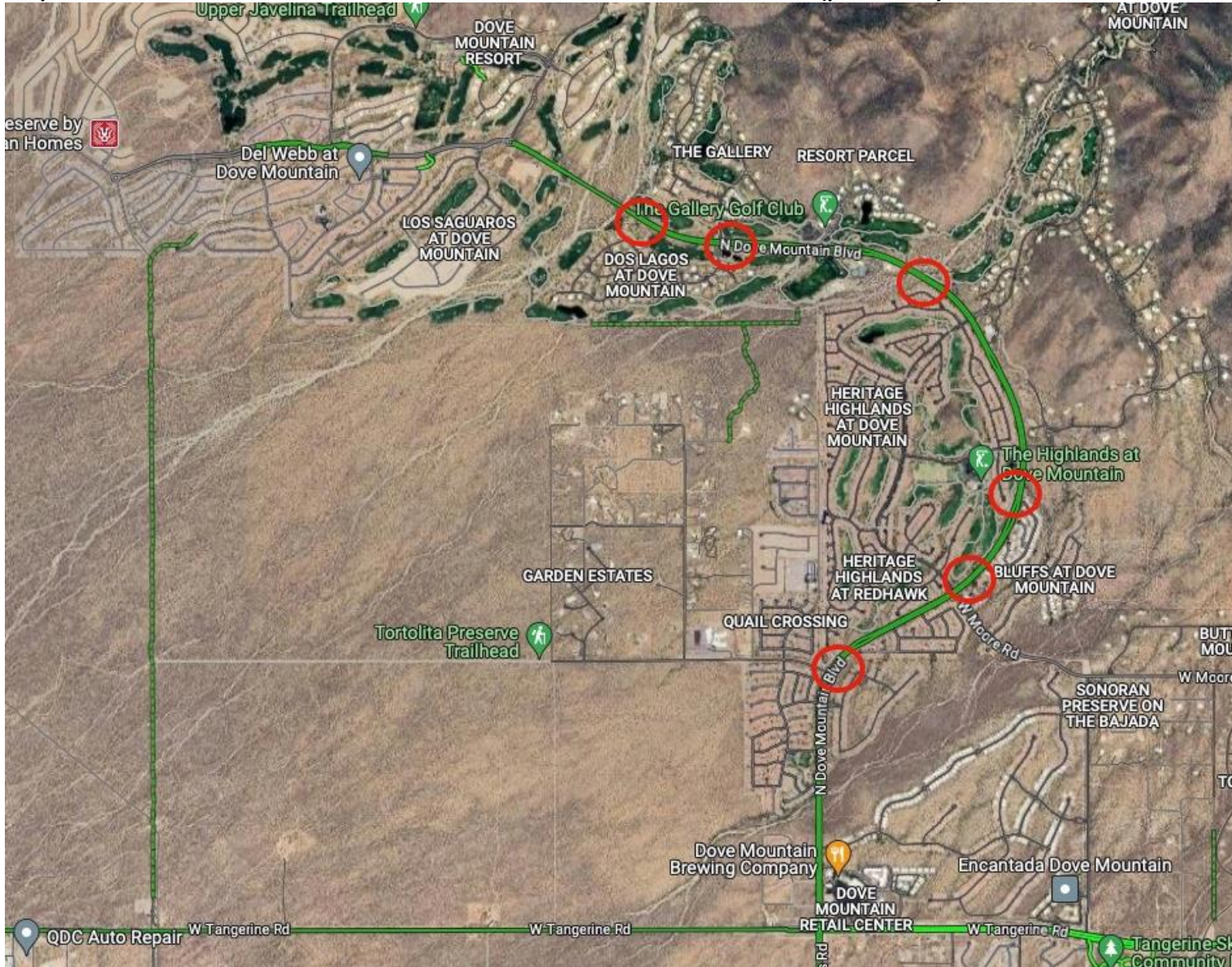
14. If you consider Dove Mountain Boulevard to have enough sound to be considered noisy, have you done

For Response Number 7 Answer to Question 13 and 10. House is 1/2 football field away and is at the same level of DMB:

13. Describe and/or sketch the location where you are when you consider the sound from Dove Mountain Boulevard to be noisy. Is there a wall between you and Dove Mountain Boulevard? Is so, what type of wall and how high is it? Is it a solid wall or does it have openings? If it has openings or gaps, what are those openings made of?

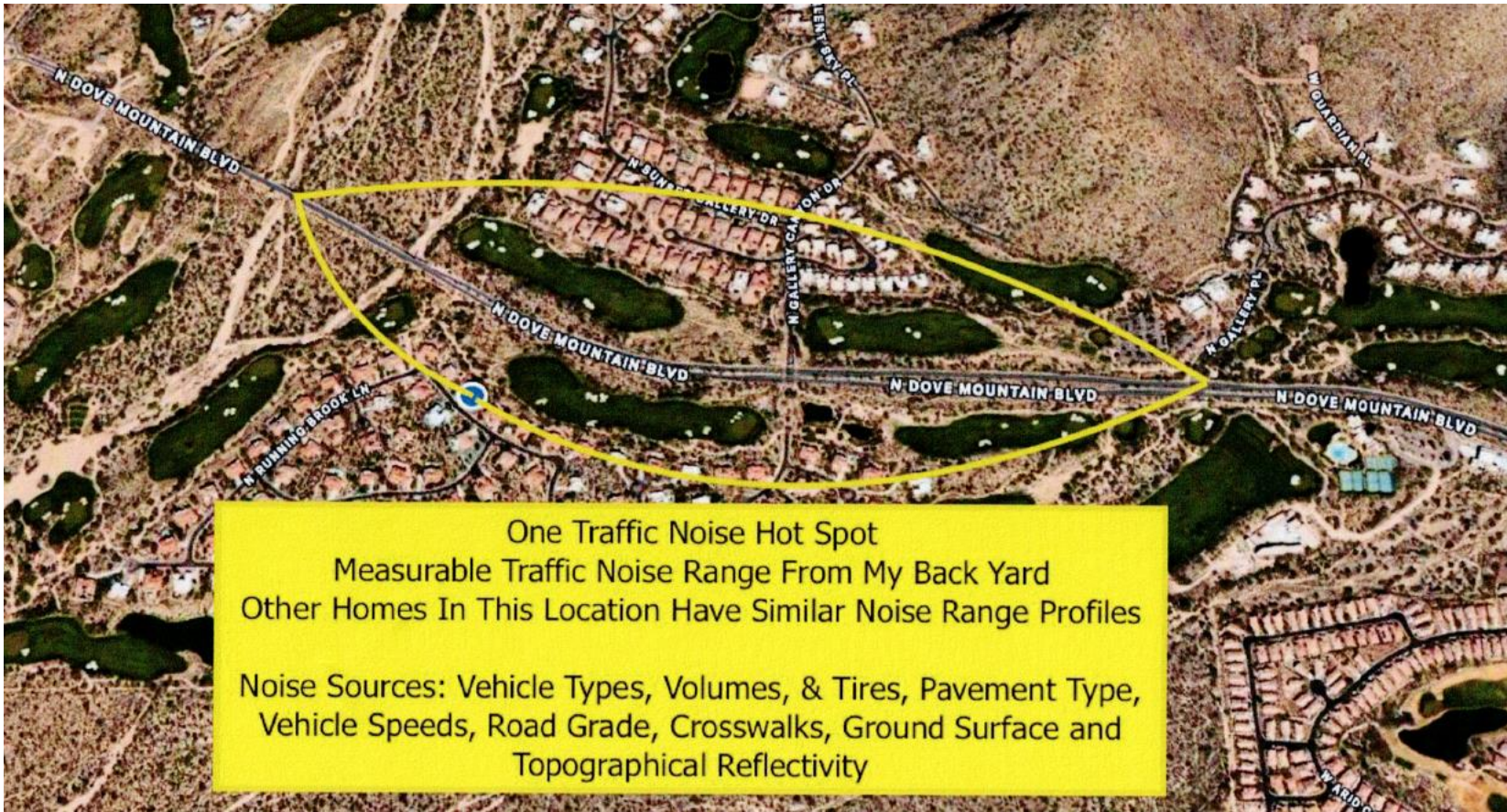


**Response 8 – Additional Attachments -Previous locations of sound measurements (provided by Calame William Paul 4-22-2024)**

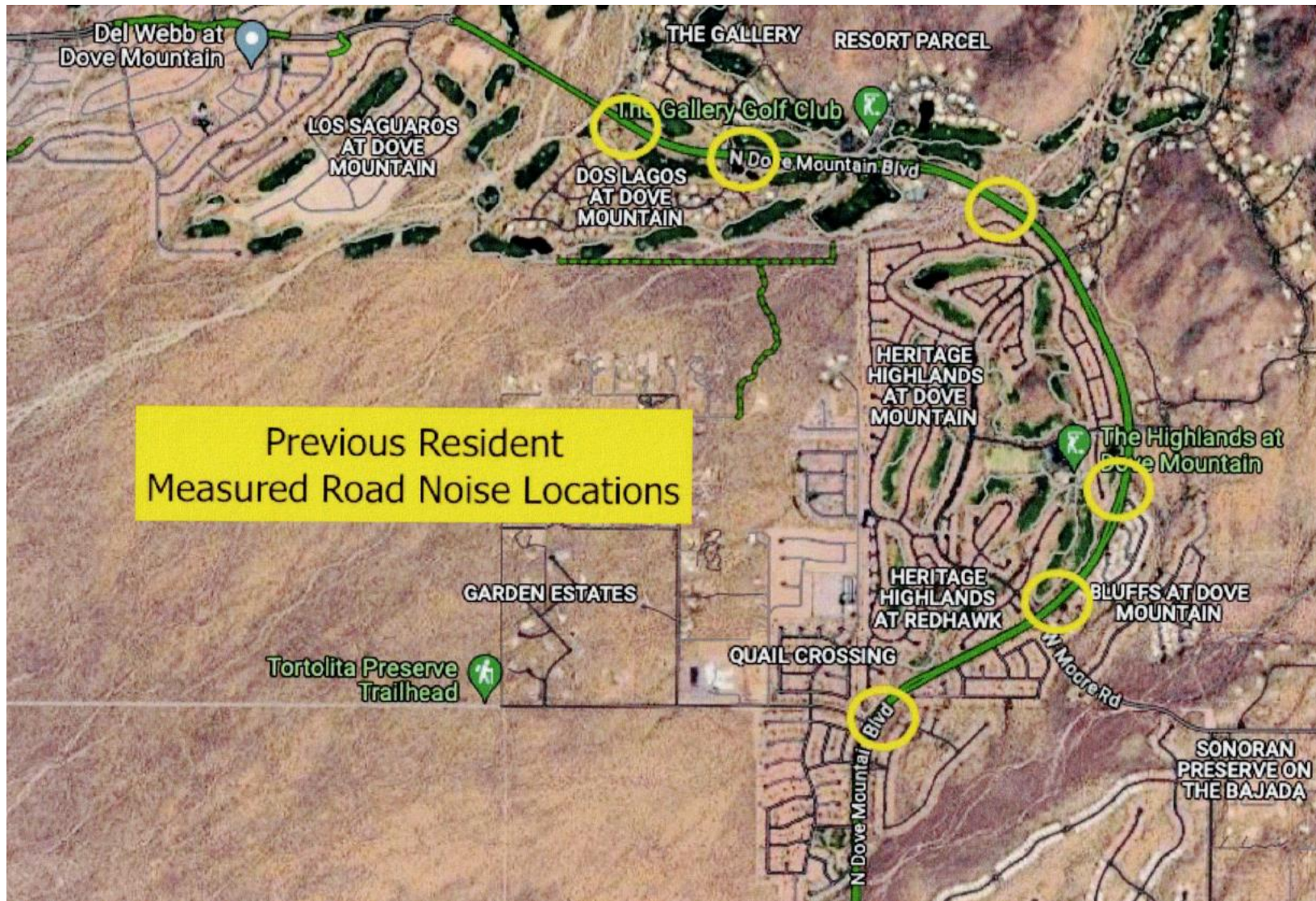


Paul's readings (in the Dos Lagos neighborhood) indicate morning traffic noise is at 55 to 65 decibels with peaks at 80 decibels and occasionally 80 to 120 decibels when heavy trucks come by.

**For Response Number 8 Additional Attachment Graphics:**

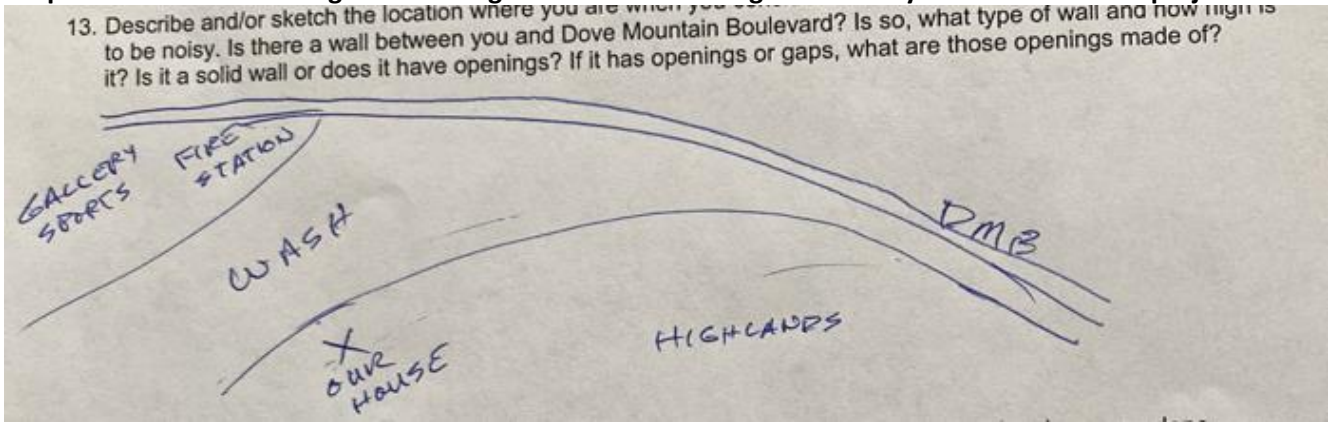


For Response Number 8 Additional Attachment Graphics:

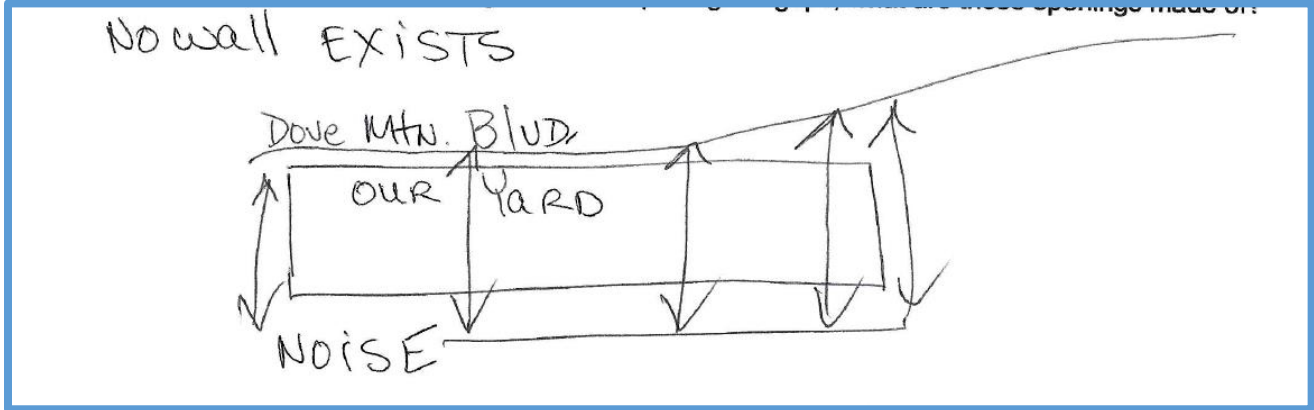


Previous Resident  
Measured Road Noise Locations

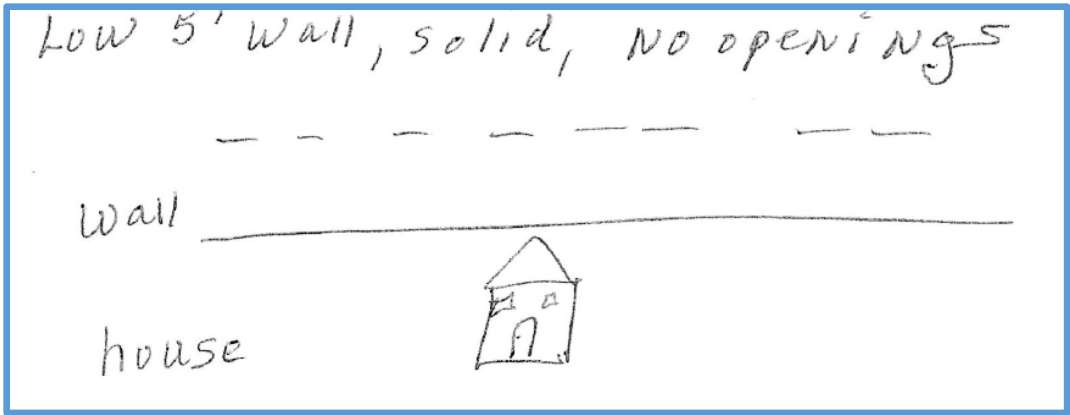
**Response Number 9 the Highlands – Large Wash and Road alignment really allows for a direct projection noise.**



**Response Number 11 (Del Webb – 6812 West Cliff Spring Trail) house & yard position related to DMB. Yard and DMB are at same level:**



**Response Number 15 (Highlands) house position related to wall and DMB. House and DMB are at the same level:**



Response Number 17 Pictures of house position related to DMB:



The End





# Appendix E – Town of Marana Sound Measurement Study

# Sound Level Measurement

*November 2, 2021 Update*

Two sound level testing efforts have been underway along Dove Mountain Boulevard:

- Correlation of speed, vehicle class and sound level.
- Taking 15-min sound level measurements to determine hourly equivalents (LAEqs). LAeqs are representative of the sound level experienced over a period of an hour.

Measurements were taken using the A-weighted decibel (dBA) scale, which more closely approximates human hearing than the decibel (dB) scale.

Because of heat-related limitations with the Ipad, an additional Sound Level Meter was purchased. This hand-held Sound Level Meter was used for the correlation of speed, vehicle class, and sound level. The Ipad sound level app was used to determine LAeqs.

## **SPEED, VEHICLE CLASS AND SOUND LEVEL**

### **Dove Mountain Boulevard**

Five vehicle classes have been used:

- passenger vehicles
- pickup trucks
- vans
- small trucks
- large trucks

Data have been broken down by vehicle class.

Sound level readings were taken during the a.m. peak hour, at locations that was measured to be 50 feet from the curb. A total of 427 samples were taken. Passenger cars had the greatest sample size (242), indicating their prevalence in the fleet. Pickups had the next largest sample size (133), followed by large trucks (20).

For all classes, the average vehicle speed ranged between 38 and 42 mph, with passenger vehicles on the higher end and large trucks on the slower end. The sound level readings were taken in proximity to the radar speed feedback sign, which may have had the effect of reducing travel speeds.

Average sound level reading (irrespective of speed) increased with the size of the vehicle:

- Passenger vehicles – 62.9 dBA
- Pickup trucks – 64.7 dBA
- Vans – 63.0 dBA
- Small trucks – 66.5 dBA
- Large trucks – 72.1 dBA

Generally, trucks were not operating at high speeds. With the exception of a single outlier operating at 48 mph, large truck speeds ranged between 32 mph and 43 mph, with the median speed at 38 mph.

A best fit line was determined for the speed vs sound level data. Using that trend line, sound level can be determined for various speeds. The following table shows the difference in sound levels for the different vehicle classes and speeds.

**Table 1**  
**Calculated Sound Level as a Function of Speed and Class on Dove Mountain Blvd**  
**(Sound Levels are in dBA)**

| Speed (mph) | Passenger Vehicles | Pickups | Vans | Small Trucks | Large Trucks |
|-------------|--------------------|---------|------|--------------|--------------|
| 30          | 60.1               | 61.9    | 59.7 | 64.1         | 69.4         |
| 35          | 61.3               | 63.2    | 61.3 | 65.3         | 71.0         |
| 40          | 62.5               | 64.5    | 62.9 | 66.5         | 72.6         |
| 45          | 63.7               | 65.8    | 64.6 | 67.7         | 74.2         |

**Twin Peaks Road**

To provide a comparison for data collected along Dove Mountain Blvd, sound level readings have been taken 50 feet from the edge of pavement on Twin Peaks Road within view of the radar-speed feedback sign south of Camino de Manana. While it is understood that the traffic conditions on Twin Peaks Road are different than those on Dove Mountain Boulevard in terms of roadway grade, posted speed limit, traffic volume and vehicle classification mix, the extent of the differences has not been quantified.

The data in the Twin Peaks Road data set include 115 passenger vehicles (average speed 50 mph), 55 pickup trucks (average speed 50 mph), 3 vans (average speed 51 mph), 3 small trucks (average speed 51 mph), and 20 large trucks (average speed 47 mph). As best fit line was determine and sound levels were calculated for the various speeds. Table 2 is that same as Table 1, but is based on Twin Peaks Road data.

**Table 2**  
**Calculated Sound Level as a Function of Speed and Class on Twin Peaks Road**  
**(Sound Levels are in dBA)**

| Speed (mph) | Passenger Vehicles | Pickups | Vans* | Small Trucks* | Large Trucks |
|-------------|--------------------|---------|-------|---------------|--------------|
| 30          | 58.9               | 60.7    | 58.3  | 27.8          | 75.8         |
| 35          | 59.6               | 61.4    | 59.3  | 38.2          | 74.5         |
| 40          | 60.3               | 62.2    | 60.3  | 48.7          | 73.2         |
| 45          | 61.0               | 62.9    | 61.3  | 59.1          | 71.9         |

# - Sample size was three vehicles, not a robust size

Unlike the other sample sets, the Twin Peaks Road data indicate a negative relationship between speed of large trucks and sound level. As speed increases, the sound level reading decreases. This may be a result of the down grade on Twin Peaks.

The difference in projected sound level readings between the highest and lowest speeds is slightly less for Twin Peak Road, as shown in the table below for the vehicle classes that had more samples.

**Table 3**  
**Difference Between Highest and Lowest Speeds (dBA)**

| Study Area | Passenger Vehicles | Pickups | Large Trucks |
|------------|--------------------|---------|--------------|
|------------|--------------------|---------|--------------|

|                    |     |     |      |
|--------------------|-----|-----|------|
| Dove Mountain Blvd | 3.6 | 3.9 | 4.8  |
| Twin Peaks Road    | 2.1 | 2.2 | -3.9 |

The down grade on Twin Peaks Road may explain the smaller difference in estimated sound level readings between the lowest and highest speeds, or this may be due to the other differences already mentioned, including sample size, speeds, traffic volumes, and different makeup of vehicle types.

## HOURLY EQUIVALENTS

Hourly equivalents were determined at eight locations along Dove Mountain Blvd, using sound level measurements that were at a minimum of 15 minutes in duration measured at 50 feet from curb. Figure 1 on the following page shows the LAeqs.

For comparison purposes, LAeqs were collected on Twin Peaks Blvd, also 50 feet from the edge of pavement. Two samples were taken 250 feet north of Blue Bonnet Road, both east and west of Twin Peaks Road.

The readings for Twin Peaks Road were:

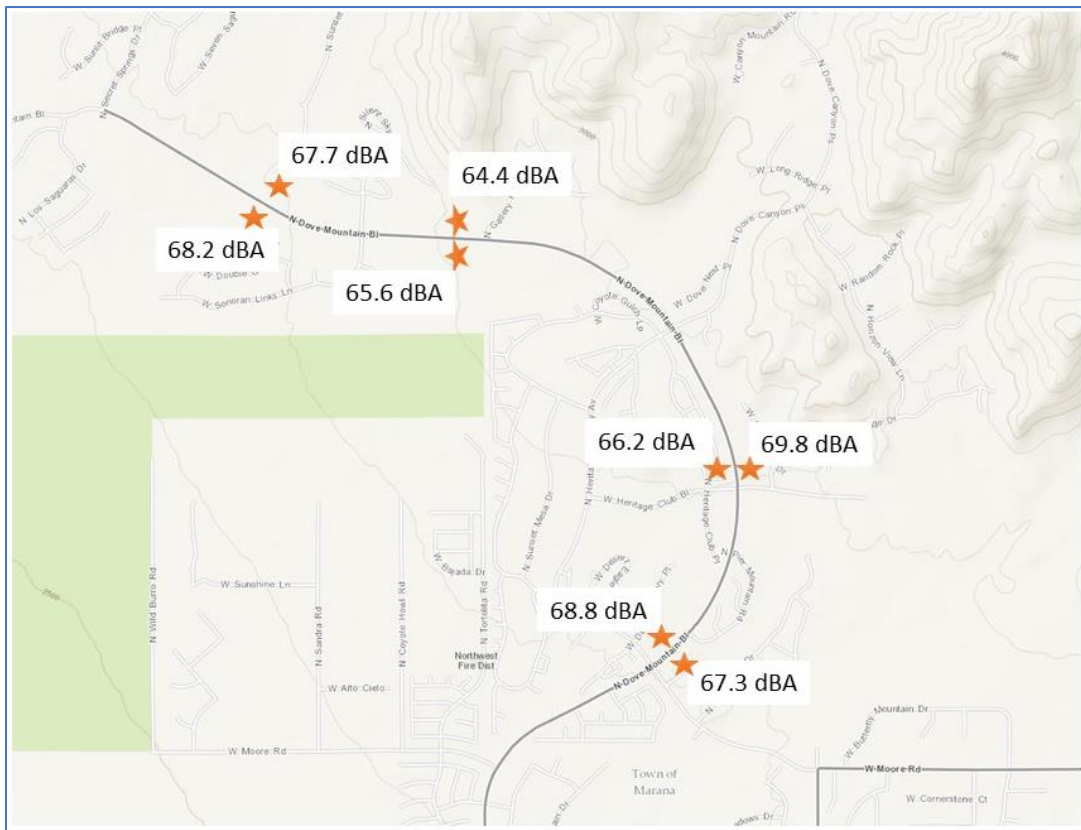
- 65.4 dBA (northbound)
- 69.0 dBA for (southbound)

These readings are within the range of noise level readings for Dove Mountain Boulevard. Interestingly, the reading for the downhill direction of travel is higher than for the northbound direction of travel. This is probably since both readings were taken during the a.m. peak hour, when traffic is heavier in the southbound direction.

## Avra Valley Road

The Town has also collected LAeq measurements along Avra Valley Road where the road was being reconstructed. As with Twin Peaks Road, information on the vehicle class, volumes, speeds, are not available. Measurements were taken before reconstruction and again following construction to evaluate the effects of new pavement surface on noise levels. The results are summarized in Table 4.

**Figure 1**  
**Hourly Equivalents (LAeqs) along Dove Mountain Blvd**



**Table 4**  
**Avra Valley Road Before and After Noise Level Readings (dBA)**

| Location   | “Before” Noise Level Reading | “After” Noise Level Reading |
|--|------------------------------|-----------------------------|
| Clayton Road<br>(south of Avra Valley Road)            | 77.4                         | 72.2                        |
| Near north end of canal<br>(north of Avra Valley Road) | 74.2                         | 68.4                        |

At both locations, the noise reduction in the “After” condition was more than 5 dBA. The reduction in noise level reading for the “After” condition is assumed to be related to the improvement in pavement condition, and specifically the rubberized surface treatment.

## Noise Level by Time of Day and Duration

Most noise level readings were a minimum of 15 minutes in duration. A noise level reading was taken for an hour duration to see how the reading compares to the 15-minute readings. The location selected was by the radar speed feedback sign, 50 feet south of the edge of pavement. Table 5 illustrates the range of values for that location.

**Table 5**  
**Comparison of Time Duration on Noise Level Reading (dBA)**

| <b>Date</b> | <b>End Time</b> | <b>Duration</b> | <b>Noise Level Reading</b> |
|-------------|-----------------|-----------------|----------------------------|
| 9/11/2021   | 10:45           | 15:03           | 68.2                       |
| 11/5/2021   | 8:17 AM         | 1:00:11         | 65.5                       |
| 1/20/2021   | 7:44 AM         | 15:59           | 62.6                       |

While each 15-minute reading compares reasonably well with the one-hour measurement, there is a 5.6 dBA difference between the two 15-minute readings, with the higher reading recorded during mid-morning. One explanation for this result could be that noise levels are highly sensitive to construction activities, which can vary on a day-by-day basis, and even on an hour-by-hour basis.