NOISE REVIEW

GRANT ROAD

HAMPTON ST TO SANTA RITA RD

TUCSON, ARIZONA

Prepared for:

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COT Job # SR2A

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1.0 Summary

This noise impact report evaluating the projected noise impacts from the proposed widening and improvement project for Grant Road between Hampton Street and Santa Rita Road in Tucson, Arizona.

The front row of houses on the south side of Grant Road will be removed. There may be residential development in the future along the south side of Grant Road between Park Avenue and Santa Rita Road.

Future noise levels were predicted at the existing second row homes under two scenarios: redevelopment of the remnant parcels between Grant Road and those homes and open space between Grant Road and those parcels.

The predicted Future Build noise levels are below the Regional Transportation Authority (RTA) noise limits at all of the representative residential prediction locations along the project. No noise mitigation measures are needed.

2.0 Proposed Road Improvement

The second phase of the Grant Road Improvement Plan will widen the roadway from North Castro Avenue to North Santa Rita Avenue, as shown in Figure 1. When complete, Grant Road will greatly improve our region's east-west mobility by adding a new travel lane in each direction and significant enhancements to improve transit, bicycle, and pedestrian use.

New and wider sidewalks, more signalized crosswalks, improved bicycle lanes, and enhanced landscaping will improve both the pedestrian and bicyclist use and the appearance of Grant Road. A median and managed access to businesses will improve safety, and new local access lanes will provide a safer and easier way to get to and from residences and businesses in congested areas.

If appropriate, Rubberized Asphalt Concrete (RAC) may be used in this project in areas near sensitive noise receivers.

3.0 Noise Regulation

This project is funded by RTA which uses the Pima County Department of Transportation (PCDOT) noise criteria.

Potential negative impact from traffic noise is assessed on the basis of predicted noise levels approaching or exceeding Noise Abatement Criteria (NAC). Pima County NAC is described below.

The PCDOT Procedure Number 03-5, entitled "Traffic Noise Analysis and Mitigation Guidance for Major Roadway Projects," dated December 1, 2003, was developed to provide guidance for the development of noise mitigation for Pima County's major roadway projects and adopted by the RTA for all their roadway projects. The procedure, commonly called the Pima County Noise Abatement Procedure (PC NAP), contains methods for noise analysis, criteria for traffic noise abatement, and requirements for noise reports. Effective April 7, 2008, the Pima County "Revision of Traffic Noise Analysis and Mitigation Guidance for Major Road Projects" was implemented to address changes in the cost of noise mitigation measures. This report reflects the updated mitigation costs per benefited receiver and barrier construction cost per square foot.

According to the PC NAP, noise abatement should be considered if noise levels reach 66 dBA or higher at noise-sensitive properties. Additionally, mitigation measures will be considered for noise-sensitive properties if predicted traffic noise levels substantially exceed existing levels. "Substantially exceed" is defined as a 15 dBA increase between the existing noise levels and the future noise levels. The area at noise-sensitive properties from which the noise level is used to determine abatement consideration, is at an out-of-doors location assumed to be most frequented by the residents. For example, the noise levels used in consideration for abatement at a residence would be from a location outside of the house, but near the house. Noise abatement is only considered for the first floor of multi-floor units.

Noise-sensitive properties include single family or multi-family housing units. Each first floor apartment in an apartment complex or duplex is counted as a separate housing unit. Noise-sensitive properties may also include facilities such as picnic areas, recreation areas, playgrounds, active sports areas, parks, schools, churches, libraries, hospitals, places of worship, and cemeteries.

The PC NAP noise limit for traffic noise reaching commercial properties (and other properties not described above) is 71 dBA. At or above which noise abatement should be considered.

The PC NAP contains a provision allowing a noise reduction credit of 3 dBA for the use of Rubberized Asphalt Concrete (RAC). As part of the noise abatement procedure described in the PC NAP, this credit is applied during the mitigation determination process as described below.

The PC NAP provides criteria for use of noise walls for noise abatement mitigation. Where a sound wall is considered all of the following criteria must be met in order to recommend the barrier:

- A reduction of at least 5 dBA must be achieved at noise sensitive receivers
- The barrier must benefit two or more adjacent receivers
- The cost of the barrier will not exceed $35,000 per benefitted receiver (using a cost of $25/ft^2)
- A majority of the property owners must approve the mitigation
- Mitigation is for only the first floor of multi-story residences
- Barriers must be less than 10 feet tall
- No mitigation will be provided for undeveloped properties unless building permit issued prior to the final environmental document

4.0 Noise Model Approach and Assumptions

For this study, the methods for determining the future noise levels and identifying possible mitigation measures to address future noise levels involved the following series of steps:

- Assess the existing and planned land uses (residential, commercial, industrial, etc.) and determination of sensitive noise receivers within the project corridor.
- Assess the existing conditions (including: traffic volumes; vehicle types; vehicle speeds; roadway layout; area topography; existing walls, and; locations of residences relative to the roadway).
- Predict the existing and future build scenario for a reasonable worse case noise condition using the Federal Highway Administration (FHWA) Traffic Noise Model version 2.5 (TNM 2.5).
- Verify the noise model by measuring the existing noise levels at representative noise sensitive receivers.
- Compare the modeled results with the noise abatement criteria established by the RTA. Based on the results of the noise monitoring and modeling, potential noise mitigation was examined. This task included noise barrier modeling for noise mitigation as warranted by the results of the noise analysis. Reasonable and feasible mitigation, based on current RTA Procedures, is then recommended.

4.1 Overview

An assessment of existing and planned land uses (residential, commercial, industrial, etc.) and determination of sensitive noise receivers was undertaken within the project corridor. Aerial photographs and field reconnaissance were used to determine the approximate locations and land use activities of potential sensitive receivers near the roadway. Field measurements were used to determine the existing noise levels throughout the Study Area, as described in Section 5.0, *Noise Model Verification*. Noise levels were measured at three sensitive receiver locations within the project area. The noise measurement locations are representative locations selected to determine the noise impacts along the project.

The TNM 2.5 model was used to predict the noise levels that would occur with the proposed improvements to Grant Road receiver locations. Roadway geometry and topography, traffic volumes, existing barriers, land features, and the representative sites were entered into TNM 2.5 to replicate the conditions under which the noise level measurements were taken. Modeled noise levels were calculated and compared with the noise levels measured at sensitive receiver locations. This process examines the accuracy of the traffic noise model in performing noise level calculations for this project. Discrepancies in the model's calculations were addressed prior to using it for predicting future noise levels. Traffic volumes and speeds used in the modeling for this project represent "worst case" peak-hour traffic conditions.

Two conditions were modeled using TNM 2.5. Traffic volumes and mix used in the model were based on a traffic counts done by Psomas in October, 2015. Future predictions were based on the

Pima Association of Governments (PAG) regional travel demand model. The model estimated the peak-hour traffic noise levels for:

- Existing traffic conditions – the model included the current street configuration and 2015 traffic volumes.
- Future build condition – the model included proposed road improvements and future projected 2037 traffic volumes.

Noise levels for the 2037 traffic and improved roadway conditions were compared with the appropriate noise abatement criterion to determine whether traffic noise mitigation should be considered. Generally, the mitigation considerations consist of rubberized asphalt concrete (RAC) and/or noise barriers in the right-of-way (R/W). Although other mitigation considerations are possible, RAC and noise barriers are considered the most cost-effective and accepted technique when they are warranted.

4.2 TNM 2.5 Modeling

The TNM 2.5 model translated the roads in the Study Area into a series of endpoints on a three-dimensional X, Y, and Z coordinate system. This computer model was developed to comply with FHWA noise regulations and is considered the current standard for roadway noise analyses.

The TNM model requires input data regarding the geometry of roadways in the Study Area, vehicle mix, traffic volumes, and vehicle speeds. The following data were used in the models:

- Vehicle Speeds – 40 mph on Grant Road
- Traffic Volumes were provided by Psomas, shown in Table 2.
- Vehicle Mix was provided by Psomas.
    - 79% automobiles
    - 15% light trucks (pick up trucks)
    - 1% medium trucks
    - 4% heavy vehicles (tractor trailers)
    - 1% motorcycles
- Elevations – topographic information was used for the roads and receivers. Topographic information was provided by Psomas.
- Ground – “Hard soil” (the ground type was selected in TNM to represent current conditions and to provide predictions that are close to the measurement results)
- Receiver heights – 5 feet above the ground

The proposed roadway and the surrounding arterial streets were defined by a series of roadway segment endpoints. Existing barriers, including residential privacy walls, were included in the model. Receivers were identified as single points and assigned an elevation of 5 feet above the ground to simulate the average height of human hearing. The sound levels were modeled using the A-weighted decibel (dBA), which is the measurement of sound that most closely approximates the sensitivity of the human ear. The noise level results are presented in LAeq1h, the equivalent average sound level measured for 1 hour, approximating the sensitivity of the human ear.

Table 2: Peak Hour Traffic Volumes

Road	Existing Volumes (2015)	Future Volumes (2037)
Grant Road - Eastbound	1576	4656
Grant Road - Westbound	1328	
Park Ave	850	1095

The vehicles were classified as automobiles (four wheels), medium trucks (2-axle long, buses, 2-axle 6 tire), and heavy trucks (3 to 6-axle vehicles). Each of these vehicle types generates noise from a different height above the roadway, called the source height.

TNM 2.5 uses the above-described information to calculate the noise contribution from each roadway segment to each receiver and then determine the cumulative effect of all roadway noise sources for each receiver. Validation studies conducted at the Volpe National Transportation Systems Center, a facility of the United States Department of Transportation Research and Innovative Technology Administration, show that the TNM 2.5 model typically predicts noise levels within an acceptable range of accuracy.

4.3 Analysis Limitations

This noise analysis is based on design and traffic information available at the time of the analysis. The following assumptions were made to reach conclusions during the analysis phase:

- The project designs as evaluated in this report will not change.
- Future traffic volumes, vehicle mix and speed will remain consistent with those predicted in the traffic study for this project.
- The nature of the land use will remain consistent with current use and planned development (i.e., industrial businesses will not be constructed where retail and professional offices are currently planned)
- The area where people are most likely to spend time outside of their homes is in their yards, near their homes.

While the TNM 2.5 model has been calibrated and tested against actual noise measurements for several years, it should be noted that it is still a noise prediction model. The results of this analysis assume the predicting capabilities of TNM are sufficient. Assumptions have been made to simplify the calculations for TNM.

- The receiver (representing human hearing) is 5 feet above ground.
- The angle of view from the receiver to the road is 180 degrees.
- The terrain between the roadway and the receiver is flat.
- The ground type is consistent throughout the project area.

The noise levels used in the predictions are measured as peak hour A-weighted Leq (LAeq1h), described in Appendix C. The A-weighted average that represents the steady level over 1 hour that would produce the same energy as the actual signal. The actual instantaneous noise levels fluctuate above and below the measured Leq during the measurement period (e.g., a police siren, a particularly noisy truck, or unusually high traffic volumes). Therefore, the use of LAeq1h for predicting noise levels and conducting the noise evaluation does not consider the noise levels as they may occur in their full range. The fluctuation of instantaneous noise levels will result in sounds that temporarily exceed (and be below) the Leq noise levels as they have been presented in the noise evaluation.

5.0 Noise Model Verification

Noise measurements are conducted to verify and calibrate the noise model. Noise measurement locations are selected in each representative area with varying traffic conditions, topography, distance from the noise source and obstructions (FHWA "Measurements of Highway Related Noise"). There is no clearly defined number or location of required noise measurements; however, each distinct part of a project should be verified with at least one noise level measurement.

Table 3 shows the measured and predicted noise levels at the three locations. Noise measurements were made on Thursday, October 15, 2015 between 5:10 PM and 6:40 PM. The purpose of the noise level measurements was to document the existing noise level environment in the project area and capture the contribution of traffic noise from Grant Road.

The equipment used for the noise level measurements were Larson Davis (LD) Models 820 precision integrating sound level meters (SLMs). The SLMs were calibrated in the field before use with an LD Model CAL-200 acoustical calibrator. The SLMs used for noise level measurements comply with the American National Standards Institute (ANSI) S1.4-1971 for a Type 1 SLM. The methodology used for the noise level measurements complied with procedures specified in Section 4 of the FHWA document FHWA-PD-96-046/DOT-VNTC-FHWA-96-5, Measurement of Highway-Related Noise (FHWA, 1996).

Noise measurements were made at Locations A (near Grant Rd and Hampton St), Location B (Park Ave and Grant Rd), and Location C (near Grant Rd and Santa Rita Rd), shown in Figure 2. Noise measurement forms are located at the back of this report. The measured and predicted noise levels at these locations is shown in Table 3.

Table 3: October 15, 2015 Noise Measurements and Predictions

Site ID	Location Description	Measured Noise Level (Leq)	Predicted Noise Level
A	2340 N Hampton	59	60
B	973 E Edison St	63	63
C	1137 E Edison St	61	60

The predicted noise levels are within 1 dBA of the measured noise level. This verifies the accuracy of the noise model. Note that the blockage from existing homes was considered in the predicted noise level at 2340 N Hampton.

6.0 Noise Model Predictions Results

Future noise levels were predicted at the existing second row homes under two scenarios:

1. open space between Grant Road and those parcels, and
2. redevelopment of the remnant parcels between Grant Road and those homes.

6.1 Open Space between Homes and Grant Road

Noise levels were evaluated at five locations in the project area. Locations 1-5 are existing homes that will be the front row of homes. No barriers were assumed for these predictions.

Table 4: Predicted Noise Levels from Grant Road with Open Space between Residences and Grant Road

Receiver ID	Receiver Location	Predicted Before Project[1] (2015) Hourly Leq (dBA)	Future (2037) Hourly Leq (dBA)	Noise Limit (dBA)
1	2340 N Hampton	60	63	66
2	917 E Edison St	55	61	66
3	973 E Edison St	60	64	66
4	1045 E Edison St	57	63	66
5	1137 E Edison St	55	62	66

1 prior to demolition of front row homes

As shown in Table 4, the predicted future noise levels, without RAC or any barriers, is below the RTA noise limit. No attenuation was considered for the existing line fences between the homes and Grant Road.

For the predictions shown in Table 4, the prediction locations are in the back yard of the residence. For the predictions shown in Table 3, the prediction locations are at the measurement location, which is closer to Grant Road. The prediction results in Table 4 “Before Project” assumes the front row of homes is in place between Grant Road and the residences, which provides 3 to 5 dBA of noise reduction.

6.2 Development between Homes and Grant Road

Future noise levels were predicted assuming that a development was constructed between the residences and Grant Road. It was assumed that homes with 5 foot privacy walls (between Grant and the new homes) would be constructed on the remnant parcels.

Table 5: Predicted Noise Levels from Grant Road with Development between Residences and Grant Road

Receiver ID	Receiver Location	Predicted Future (2037) Hourly Leq (dBA)		Noise Reduction (dBA)
		Open Space between Homes and Grant Road	Development between Homes and Grant Road	
4	1045 E Edison St	63	59	4
5	1137 E Edison St	62	57	5

As shown in Table 5, a development between the existing homes and Grant Road would reduce the noise level from Grant Road at the homes by 4 to 5 dBA.

APPENDIX A

Figures

NE Project: 15101	October 28, 2015	Beth Holliday

Figure No. 1

NoiseExpert.com

Phoenix, AZ 480-332-9325
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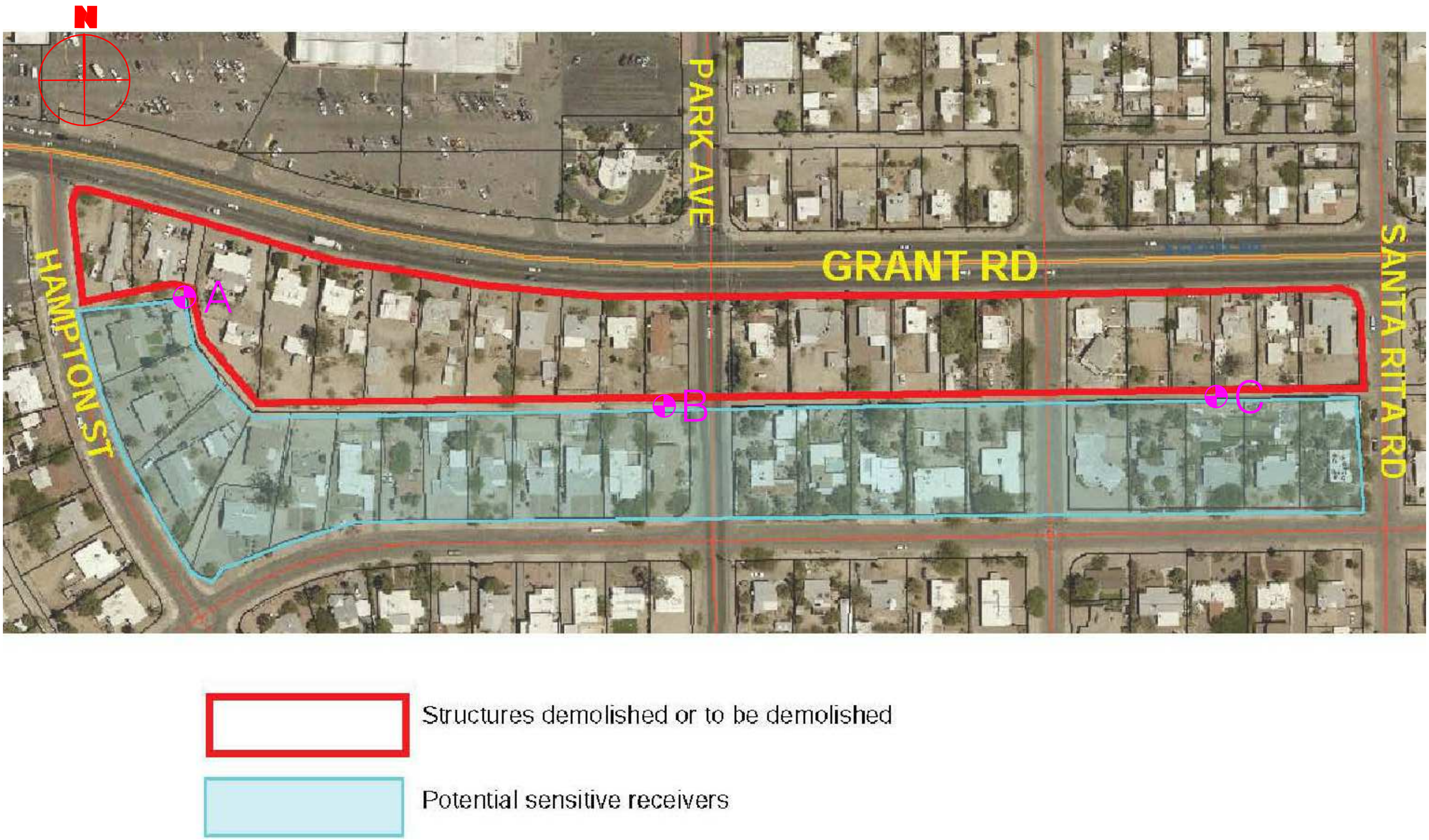
Grant Road, Hampton St to Santa Rita Rd
Tucson, Arizona

DESCRIPTION: Vicnity Map

SCALE: N/A



NE Project: 15101	October 28, 2015	Beth Holliday

Figure No. 2

NoiseExpert.com

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Grant Road, Hampton St to Santa Rita Rd
Tucson, Arizona

DESCRIPTION: Measurement Locations

SCALE: N/A

NE Project: 15101 | October 28, 2015 | Beth Holliday

Figure No. 3

NoiseExpert.com

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Grant Road, Hampton St to Santa Rita Rd
Tucson, Arizona

DESCRIPTION: Prediction Locations

SCALE: N/A

APPENDIX B

Noise Measurement Field Forms

Noise Expert
Acoustical Consulting

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D ate _10/15/15_ Project Number ________________ Project Name _Grant Rd between Hampton and Santa Rita ___

Project Location ___PIMA COUNTY, ARIZONA __________ Measurement Location Number_____A_________

Measurement Location Description_____South side of Grant – west end of project ______________________________________

Measurement Location (address)________2340 N Hampton __________ Time _5:10 PM_ Duration___30 min___

Day of the Week ___Thursday________ Wind Speed ___2-5 mph_ Wind Direction __from E_ Clouds _____cloudy_____

Temperature_79 F__ Humidity ___34___ Weather Condition________cloudy_______________________________________

Average Noise Level ______59______ Max Noise Level ____766_______ Min Noise Level ______50_________

Measurement Data						Traffic Count Data									
Sample	Time		Sound Level (dBA)			Auto		Med Truck		Heavy Truck		Bus		Motorcycle	
	Start	Duration	Leq	Lmin	Lmax	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB
1	5:10	10	58	50	66	124	160	0	1	1	0	0	0	0	0
2	5 20	10	60	50	76	154	158	0	0	0	1	0	0	0	1
3	5:30	10	59	50	65	147	164	1	0	0	0	0	0	0	0

Sample	Background Noise	Unusual Noise Event
1.	traffic on grant	
2.	traffic on grant	
3.	traffic on grant	

Observations

Measurement location is on the road side of the barrier
Front row homes are still in place

Photos


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D ate _10/15/15_ Project Number ________________ Project Name _Grant Rd between Hampton and Santa Rita ___

Project Location ___PIMA COUNTY, ARIZONA __________ Measurement Location Number_____B_________

Measurement Location Description_____South side of Grant – west end of project _____________________________________

Measurement Location (address)________973 E Edison__________ Time _5:45 PM_ Duration___30 min___

Day of the Week ___Thursday________ Wind Speed ___2-5 mph_ Wind Direction __from E_ Clouds _____cloudy_____

Temperature_78 F__ Humidity ___40___ Weather Condition________cloudy_____________________________________

Average Noise Level ______63______ Max Noise Level ____78_______ Min Noise Level ______52_________

Measurement Data						Traffic Count Data									
Sample	Time		Sound Level (dBA)			Auto		Med Truck		Heavy Truck		Bus		Park Ave	
	Start	Duration	Leq	Lmin	Lmax	WB	EB	WB	EB	WB	EB	WB	EB	NB	SB
1	5:45	10	64	54	78	150	168	1	0	0	1	0	0	22	14
2	5 55	10	63	53	69	148	159	0	2	0	0	0	1	21	15
3	6:05	10	63	52	70	153	161	1	0	1	0	0	0	25	18

Sample	Background Noise	Unusual Noise Event
1.	traffic on grant	
2.	traffic on grant	
3.	traffic on grant	

Observations
Measurement location is on the road side of the barrier
Front row homes removed

Photos

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D ate _10/15/15_ Project Number ________________ Project Name _Grant Rd between Hampton and Santa Rita ___

Project Location ___PIMA COUNTY, ARIZONA __________ Measurement Location Number_____C_________

Measurement Location Description_____SW of Grant and Santa Rita – east end of project___________________________

Measurement Location (address)________2327 N Santa Rita__________ Time _6:10 PM_ Duration___30 min___

Day of the Week ___Thursday________ Wind Speed ___2-5 mph_ Wind Direction __from E_ Clouds _____cloudy_____

Temperature_76 F__ Humidity ___44___ Weather Condition_________cloudy_______________________________

Average Noise Level ______61_______ Max Noise Level ____74_______ Min Noise Level ______46_________

Measurement Data						Traffic Count Data									
Sample	Time		Sound Level (dBA)			Auto		Med Truck		Heavy Truck		Bus		Motorcycle	
	Start	Duration	Leq	Lmin	Lmax	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB
1	6:10	10	60	46	67	155	157	2	0	0	0	0	0	0	0
2	6 20	10	62	47	74	160	152	0	0	1	1	0	0	0	0
3	6:30	10	61	47	71	158	160	1	0	0	0	0	0	0	0

Sample	Background Noise	Unusual Noise Event
1.	traffic on grant	
2.	traffic on grant	
3.	traffic on grant	

Observations
Measurement location is on the road side of the barrier
Front row homes removed

Photos

APPENDIX C

Acoustic Terminology

Sound Pressure Level

Sound, or noise, is the term given to variations in air pressure that are capable of being detected by the human ear. Small fluctuations in atmospheric pressure (sound pressure) constitute the physical property measured with a sound pressure level meter. Because the human ear can detect variations in atmospheric pressure over such a large range of magnitudes, sound pressure is expressed on a logarithmic scale in units called decibels (dB). Noise is defined as “unwanted” sound.

Technically, sound pressure level (SPL) is defined as:

$$SPL = 20 \log (P/P_{ref}) \text{ dB}$$

where P is the sound pressure fluctuation (above or below atmospheric pressure) and P_{ref} is the reference pressure, 20 μPa, which is approximately the lowest sound pressure that can be detected by the human ear.

The sound pressure level that results from a combination of noise sources is not the arithmetic sum of the individual sound sources, but rather the logarithmic sum. For example, two sound levels of 50 dB produce a combined sound level of 53 dB, not 100 dB. Two sound levels of 40 and 50 dB produce a combined level of 50.4 dB.

Human sensitivity to changes in sound pressure level is highly individualized. Sensitivity to sound depends on frequency content, background noise, time of occurrence, duration, and psychological factors such as emotions and expectations. However, in general, a change of 1 or 2 dB in the level of sound is difficult for most people to detect. A 3 dB change is commonly taken as the smallest perceptible change and a 6 dB change corresponds to a noticeable change in loudness. A 10 dB increase or decrease in sound level corresponds to an approximate doubling or halving of loudness, respectively.

A-Weighted Sound Level

Studies have shown conclusively that at equal sound pressure levels, people are generally more sensitive to certain higher frequency sounds (such as made by speech, horns, and whistles) than most lower frequency sounds (such as made by motors and engines) at the same level. To address this preferential response to frequency, the A-weighted scale was developed. The A-weighted scale adjusts the sound level in each frequency band in much the same manner that the human auditory system does. Thus the A-weighted sound level (read as "dBA") becomes a single number that defines the level of a sound and has some correlation with the sensitivity of the human ear to that sound. Different sounds with the same A-weighted sound level are perceived as being equally loud. The A-weighted noise level is commonly used today in environmental noise analysis and in noise regulations. Typical values of the A-weighted sound level of various noise sources are shown below.

Equivalent Sound Level

The Equivalent Sound Level (L_{eq}) is a type of average which represents the steady level that, integrated over a time period, would produce the same energy as the actual signal. The actual *instantaneous* noise levels typically fluctuate above and below the measured L_{eq} during the measurement period. The A-weighted L_{eq} is a common index for measuring environmental noise.

Common Sound Levels in dBA

Common Outdoor Sounds	Sound Pressure Level (dBA)	Common Indoor Sounds	Subjective Evaluation
Auto horn at 10' Jackhammer at 50'	**100**	Printing plant	Deafening
Gas lawn mower at 4' Pneumatic drill at 50'	**90**	Auditorium during applause Food blender at 3'	Very Loud
Concrete mixer at 50' Jet flyover at 5000'	**80**	Telephone ringing at 8' Vacuum cleaner at 5'	
Large dog barking at 50' Large transformer at 50'	**70**	Electric shaver at 1'	Loud
Automobile at 55 mph at 150' Urban residential	**60**	Normal conversation at 3'	
Small town residence	**50**	Office noise Dishwasher in adjacent room	Moderate
	40	Soft stereo music in residence Library	
Rustling leaves	**30**	Average bedroom at night Soft whisper at 3'	Faint
Quiet rural nighttime	**20**	Broadcast and recording studio	
	10	Human breathing	Very Faint
	0	Threshold of hearing (audibility)	
Source: Noise Expert measurements and reference library			