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Sound Advice in a World Full of Noise

August 8, 2023

Don Horner
Rinse n Ride
840 N. Estrella Parkway
Goodyear, AZ 85338

Re: Mesa Rinse N Ride Car Wash(#23003)
Noise Assessment Report R2

Dear Mr. Horner,

We visited the proposed Rinse N Ride Car Wash project site to observe on-site existing conditions and conduct ambient noise level measurements at the location of the future car wash. Operational sound levels from noise generating equipment (car wash dryers and vacuum system) were evaluated to determine the noise impact on the surrounding residential community. The impact of noise generated by additional vehicular traffic to the car wash site was also assessed. This report summarizes our measurement results, noise impact evaluation, and recommendations.

On-Site Ambient Noise Measurements

Ambient noise level measurements were conducted to assess the existing acoustical environment at the site of the proposed Rinse N Ride Car Wash. The site is currently occupied by a fast-food restaurant that was not in operation during the site visit. Long-term and short-term measurements were performed. The sound measurement equipment used for this study is summarized in Table 1.

Table 1. Summary of Noise Measurement Equipment

Equipment Type	Manufacturer	Model No.	Equipment Quantity
Sound Level Meter	Larson Davis	831	1
Sound Level Meter	Larson Davis	831C	1
Preamplifier	PCB	PRM831	2
Microphone	PCB	377B02	2
Calibrator	Larson Davis	CAL200	1

One long-term noise measurement location and one short term noise measurement location were selected. These noise measurement locations are shown in Figure 1.

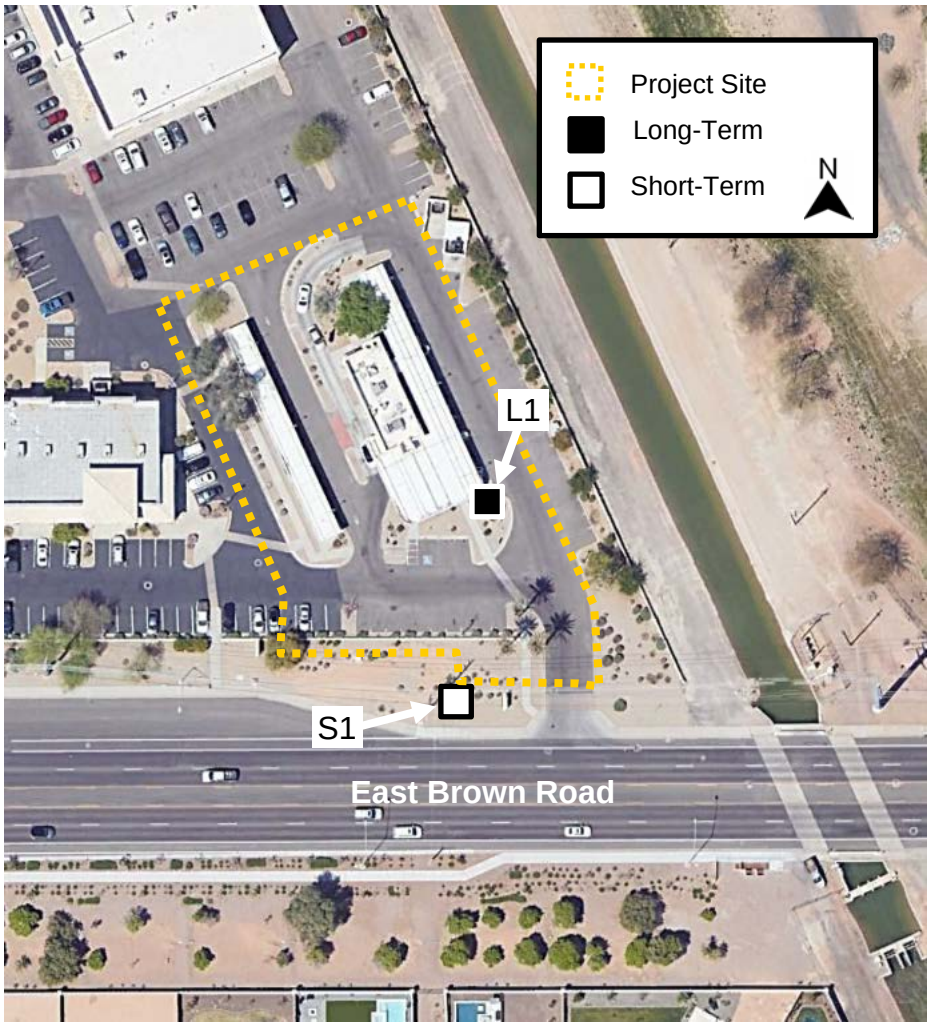

Figure 1: On-Site Noise Measurement Locations

Long-term Measurement

The long-term sound level meter was located at the edge of the existing restaurant building roofline and approximately 150 feet from the edge-of-pavement of East Brown Road, as shown on Figure 1. The microphone was attached to an extendable pole approximately 6 feet above the existing grade, as shown in Figure 2. The equipment collected data from March 7, 2023 to March 8, 2023. The dominant noise source at this location was traffic noise on East Brown Road. Secondary noise sources include overhead aircraft noise from the nearby municipal airport and environmental sources such as birds or wind.

Figure 2: Long-Term Measurement Location

Figure 3 shows the measured 15-minute average equivalent L_{eq} and L_{90} sound levels over the duration of the measurement period. Table 2 summarizes the 1-hour average equivalent sound level (L_{eq}), the 90% exceedance level (L_{90}) and the day-night level (L_{dn}) during the long-term measurement period. The L_{90} noise level is widely accepted as the standard for determining the background noise level. Noise receivers that are located at a comparable distance as the L1 meter from East Brown Road are expected to experience similar noise levels with the dominant noise source of vehicular traffic.

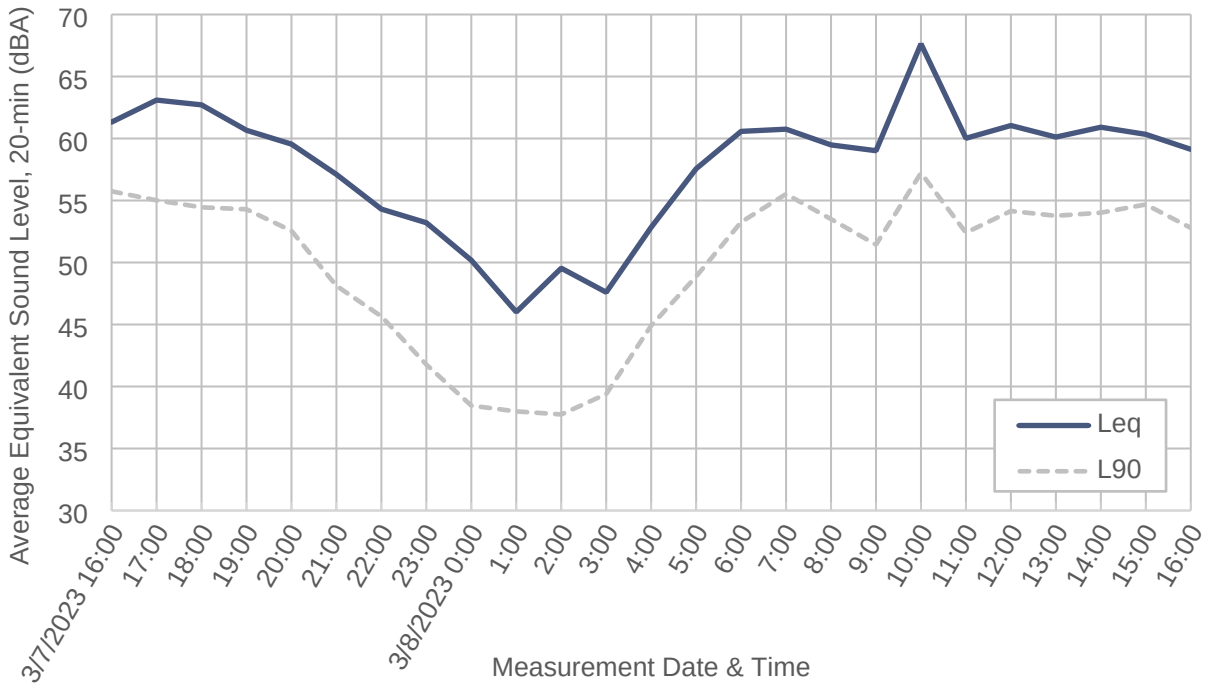

Figure 3: Long Term Measurements Results (15-min intervals)

Table 2: Noise Measurement Results Summary (1-hour average)

$L_{eq\ (day)}$[1]	$L_{90\ (day)}$[2]	L_{dn}[3]	Min. $L_{eq\ (1\text{-}HR)}$[4]	Max. $L_{eq\ (1\text{-}HR)}$[4]
62 dBA	54 dBA	63 dBA	57 dBA	68 dBA

Notes:
1. $L_{eq\ (day)}$ is an average of the equivalent sound levels during the daytime hours only (between 7am and 10pm) within a 24-hr measurement period.
2. $L_{90\ (day)}$ is an average of the 90% exceedance sound levels during the daytime hours only (between 7am and 10pm) within a 24-hr measurement period.
3. The L_{dn} is the 24-hr L_{eq} obtained after addition of 10 dBA to the sound levels from 10pm - 7am.
4. 1-hour L_{eq} maximum and minimum sound level provided for the daytime hours only (between 7am and 10pm).

Short-term Measurements

Short-term measurements were performed in the area near the future car wash, approximately 22 feet from the road edge, to determine the influence of vehicular traffic noise on the existing ambient noise environment. Noise levels were recorded for approximately 20 minutes and were performed during midday measurement sessions on March 7 and March 8, 2023. Short-term measurement results are shown in Table 3.

Table 3. Short-Term Measurement Results Summary (20-minute L_{eq})

Measurement Start Time	Average Sound Level
03/07/2023 2:53 PM	72 dBA
03/08/2023 3:37 PM	71 dBA

Acoustical Design Criteria

Mesa, AZ Noise Rule

The State of Arizona does not have a comprehensive state-wide regulation or statute related to the control of noise. Several Arizona municipalities, including Mesa, have enacted an ordinance to regulate noise. The noise regulations for Mesa, Arizona are defined in Title 6, Chapter 12 of the Code of Ordinances, entitled *"Offensive, Excessive, and Prohibited Noises"*. This noise ordinance generally relates to nuisance noise sources such as animals and motor vehicles but there are no limitations for stationary mechanical equipment noise. Per the Mesa Planning Division, noise from a car wash facility must comply with the following noise requirement:

> *"Sound attenuating measures shall be incorporated into the building design and construction to absorb noise such that the sound level readings at the street and at interior property lines are no more than 55 decibels. Mechanical equipment for centralized vacuum equipment shall be housed in an enclosed room."*

For the areas surrounding the proposed project site, the noise ordinance from the nearby town of Tempe, Arizona can be used as a best practice. Section 20-6 of the City of Tempe Code (repealed 03/03/22) establishes allowable noise levels to regulate noise sources. Table 4 summarizes the Community Noise Standard maximum sound levels for each zoning district. The actual ambient noise levels may become the maximum noise limit if ambient noise levels are less than 40 dBA at night (in residential areas) or more than the limits specified in Table 4. A violation occurs when the measured sound level exceed the maximum limit by 5 dB or more. Although this section of Tempe's City Code was repealed, the limits shown in Table 4 will be used as the design criteria in this noise study as best practice limits.

Table 4: City of Tempe, AZ Noise Code (Section 20-6)

Zone	Community Noise Standard Maximum Noise Limit	
	Day (7am – 10pm)	Night (10pm – 7am)
Residential	55 dBA	45 dBA
Commercial	65 dBA	55 dBA
Industrial	70 dBA	60 dBA

Estimation of Community Response

The ability of the average person to perceive increases in noise has been documented by various government agencies, including the Federal Highway Administration (FHWA) and the International Standards Organization (ISO). ISO has developed a scale, as shown in Table 5, for estimating community response to increases in noise levels. This scale relates changes in noise levels to the subjective response of the community. The scale also allows for a direct estimation of the community's probable response to a predicted change in noise level. An increase in environmental noise levels of more than 5 dBA is commonly considered to be substantial. This is consistent with the City of Tempe Noise Code which states that "a noise level which exceeds the community noise standard of 5 dBA or more, shall be deemed a violation".

Table 5: Community Response to Changes in Noise Level

Sound Level Change (dB)	Change in Apparent Loudness	Public Reaction
1	Not Perceptible	No impact
3	Just perceptible	Normally acceptable
5	Clearly noticeable	Moderate impact, complaints possible
10	Twice as loud	Substantial impact, complaints likely
20	Four times as loud	Major impact, action likely

Project Design Goals

The design goals of noise mitigation measures for the proposed Mesa Rinse N Ride Car Wash are to:

1. Comply with the Mesa Planning Division noise limit of 55 dBA at the street and at interior property lines.

2. As a best practice for the surrounding community, reduce sound levels from the noise generating equipment (car wash dryers and vacuum system) such that they comply with the City of Tempe, AZ daytime community noise standard maximum sound level of 55 dBA for residential properties and 65 dBA for commercial properties. The hours of operation of the proposed car wash will fall within the daytime hours defined in the Noise Rule (i.e., 7:00 am to 10:00 pm).

3. An increase in ambient noise levels (L_{90}) of 5 dB or less should have no-to-minimal impact on the surrounding community. In other words, the proposed car wash noise levels should not exceed 59 dBA at the surrounding commercial and residential buildings.

Project Noise Sources

The proposed Rinse N Ride Car Wash will have multiple noise emitting pieces of equipment. The primary noise sources are the car wash dryer system located near the exit of the car wash building, the vacuum turbines located in an enclosure on the plan west of the project site, and the vacuum systems located on the plan west and south sides of the project site. A description of the noise sources is provided below, and a summary of the sound pressure levels is shown in Appendix A.

Car Wash Dryer System

The dryer system at the car wash exit is the dominant noise source. Overall sound power and pressure levels were provided by the car wash manufacturer. Sound data from two manufacturers were considered for this analysis and the Predator 80 system was selected for project implementation as it has the lowest noise emissions.

Car Wash Pumps and Mechanical Equipment

All other noise-producing equipment from the car wash (e.g., compressors, pumps) will be housed within mechanical equipment rooms and were not included in the noise assessment.

Vacuum System

The dominant noise source of a vacuum system is the vacuum turbine. An overall sound pressure level was provided by the manufacturer, the turbine was measured outdoors at a distance of 10 feet. At the proposed project site, the vacuum turbines will be installed inside a 10’ high CMU open top enclosure.

The vacuums themselves also generate noise when in use. Sound pressure data for a Vacutech System was obtained from a noise study for a car wash located in Chula Vista, AZ. The measurements were performed a distance of 1.5 feet of the vacuum nozzle inside a car.

Noise Impact Analysis

Using the sound source data described in the sections above and the project drawings dated 05/15/23, a sound propagation model was developed using the Datakustik CadnaA software to calculate noise levels from the proposed Mesa Rinse N Ride Car Wash to the surrounding community.

The model assumes that the car wash tunnel is approximately 2,400 square feet in length with 12-foot-tall by 14- foot-wide exit and entrance openings. Two sets of blowers will be located approximately 15 feet inside the exit of the tunnel. The blowers (two Predator 80 hp systems consisting of two side blowers and 3 overhead blowers) were modeled as a vertical area source at the entrance and exit of the car wash building.

For the vacuum system, a total of 17 vacuum stations[1] and two vacuum turbines were evaluated as point sources. The proposed project includes locating the vacuum turbine motors inside a 10’ high CMU enclosure with an open roof. The model assumes that all components of the vacuum system are operating simultaneously (worst-case scenario) when in actuality, the noise will be intermittent and lower in noise level.

Ground and building reflections were considered “reflective” in the analysis and it was assumed that the site and surrounding areas are flat. The existing 6’ high perimeter wall surrounding the residential neighborhood south of East Brown Road and the 6’ high perimeter wall along the east side of the commercial area were included in the noise model.

Receiver analysis locations include the nearest residences in The Grove neighborhood to the south of the proposed project site, the nearest residence to the east of the proposed project site, the surrounding commercial buildings, and Princess Park to the north of the project site, as shown in Figure 4. Distances from each receiver location to the proposed car wash are shown in Table 6. The noise model calculated noise levels at a height of 5 feet for ground level receivers and at the height of 15’ for second story window receivers (for residences at The Grove only).

Footnote:
1 – Per the latest site plans, the total number of vacuum stations has been reduced to 14. However, the noise level predictions contained in this report are based on a total of 17 vacuum stations.

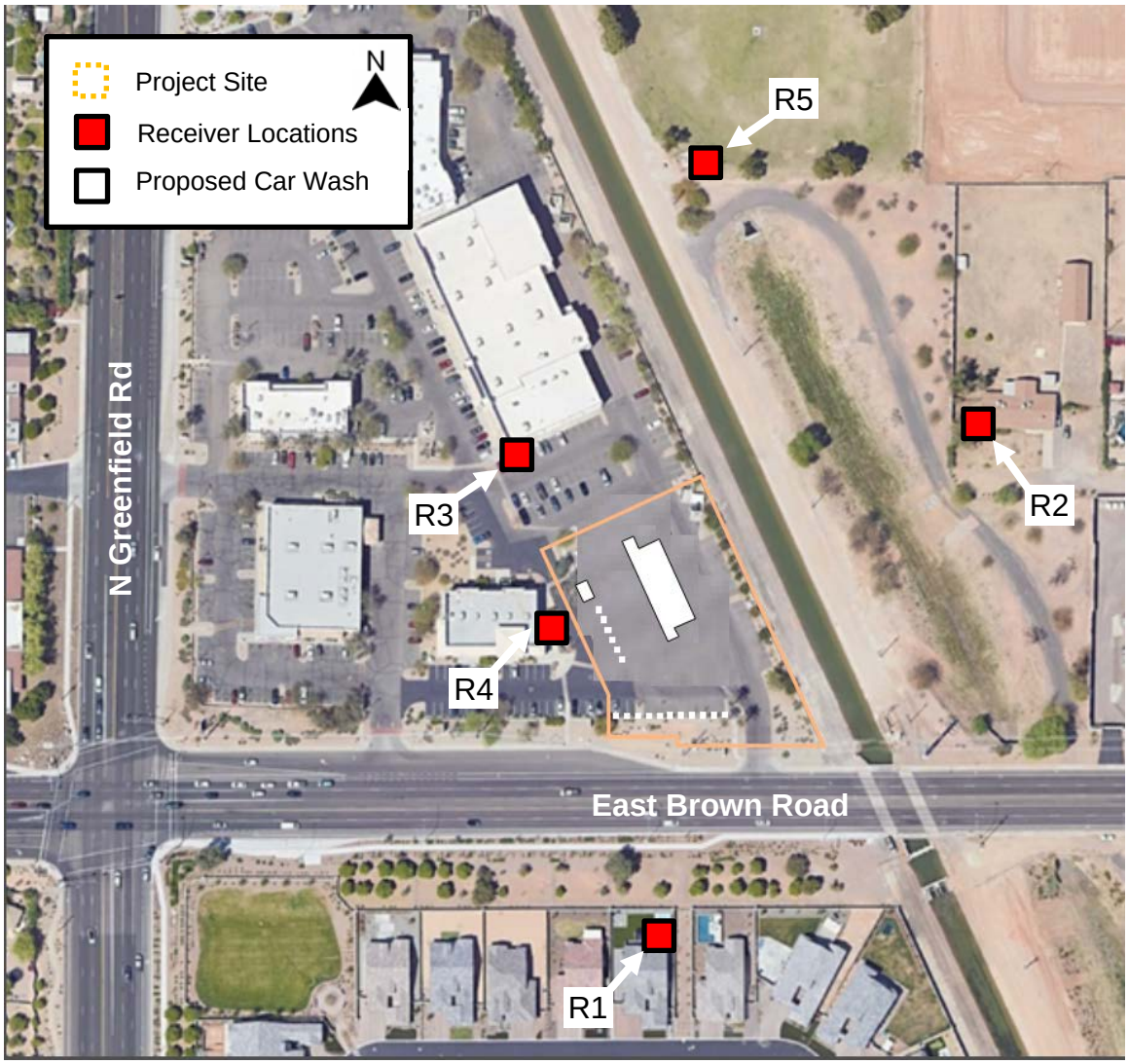

Figure 4: Noise Impact Assessment Receiver Locations

Table 6: Predicted Car Wash Dryer and Vacuum Noise Levels (dBA)

Nearest Receiver	Approx. Distance to Car Wash [ft]	Best Practices Noise Limit	Car Wash Only L_{eq}	Vacuum Only L_{eq}	Predicted Combined L_{eq} [2]
R1a - The Grove (5' height)	340	55	27	30	32
R1b -The Grove (15' height)	340	55	32	36	37
R2 - 1236 N 46th St	370	55	41	24	41
R3 -1253 N Greenfield Rd	140	65	56	40	56
R4 - 4434 East Brown Rd	120	65	33	48	48
R5 - Princess Park	400	55[1]	41	32	41

Notes:
1 – Public parks are not addressed in the City of Tempe, AZ Noise Code so the best practices limit for residential areas was utilized.
2 – The sound pressure level that results from the combined car wash and vacuums is not the arithmetic sum of the individual sound sources, but rather the logarithmic sum. Please refer to Appendix B which provides additional information about acoustical terminology.

The results of the noise impact analysis are also presented as a noise contour map for each scenario. This is a graphical representation of the predicted combined noise levels of the car wash and vacuum system (refer to enclosed Figures 5, 6, and 7).

Vehicular Traffic Noise
Per the July 13, 2023 *Traffic Impact Statement,* the existing traffic volume along East Brown Road is approximately 19,300 daily trips east of Greenfield Road. The proposed car wash development is expected to generate 897 weekday daily trips while the previous development on the site is estimated to have 728 daily trips. Therefore, future vehicular traffic along East Brown Road due to the proposed project is predicted to be 169 weekday daily trips. Typically, a doubling of traffic volume is required to have a perceptible, i.e., 3 dB, increase in noise. The increase in traffic noise is considered not significant and will not impact the surrounding areas.

Noise Analysis Conclusions

The predicted combined noise levels from the car wash dryers and vacuum system are within the Mesa Planning Division noise limit of 55 dBA at the south, east, and west property lines. This is demonstrated by the location of the orange noise contour (55-60 dBA) within the project site property lines shown in Figure 7. However, car wash equipment noise will exceed the 55 dBA noise limit at the north property line. As part of the noise analysis, two different car wash blower systems were evaluated and the quieter model with low-noise blowers was selected for the project. Additional noise mitigation such as a sound barrier wall along the north property line would be impractical as it would be located in the middle of the parking lot.

The predicted noise levels at all receiver locations surrounding the proposed project site meet the best practices noise limits for their respective zoning district, as shown in Table 6 above. No noise mitigation measures for the Mesa Rinse N Ride Car Wash are required at this time.

To evaluate the community noise impact from the proposed Mesa Rinse N Ride Car Wash to the surrounding community, the projected noise levels can be compared to the existing ambient noise environment. An increase in ambient noise levels (L_{90}) of 5 dB or less should have no-to-minimal impact on the surrounding community. From the noise data presented in Table 2, the daytime L_{90} ambient noise level at the project site is 54 dBA which is primarily due to traffic noise from East Brown Road. The ambient noise environment at the adjacent commercial buildings is expected to be similar. The future combined noise levels due to the proposed project are projected to be 56 and 48 dBA at the commercial receivers R3 and R4, respectively. This is a 0 to 2 dB increase over the existing daytime L_{90} level, which is not considered a substantial increase. At the

residential receivers R1 and R2, the future noise levels due to the proposed project are projected to be 32 to 41 dBA. Traffic noise from East Brown Road and other ambient noise sources will likely mask noise from the proposed car wash equipment. While car wash noise may be still be audible at the surrounding receiver locations when traffic volumes are low, a negative response from the community is not anticipated and a noise impact due to the proposed project is not expected.

Please let us know if you have any questions about the information in this report.

Best Regards,

Dana Dorsch
Senior Project Manger
CENSEO AV+Acoustics LLC

Appendix A – Sound Data for Project Equipment

A summary of the octave band sound pressure levels (Lp) for the car wash dryers, vacuum system and vacuum producer is shown below:

Table A1: Sound Pressure Levels of Car Wash Equipment

	Octave Band Center Frequency (Hz)							
	63	**125**	**250**	**500**	**1000**	**2000**	**4000**	**SPL**
80 hp Predator Quiet Dryer System (20 feet from source)[1]								
Outdoor Lp (dB)	45	53	66	67	65	64	58	**72dBA**
Vacutech Vacuum System – Vacuum Nozzle (1.5 feet from source)[2]								
Inside Car Lp (dB)	45	52	61	59	56	57	57	**70 dBA**
AutoVac – Centrifugal Vacuum Producer (10 feet from source)[3]								
Outdoor Lp (dB)	---	---	---	---	---	---	---	**74 dBA**

Notes:
1. Overall sound pressure data for the 80 hp Predator Quiet Dryer System (qty. 1) was provided by the manufacturer.
2. Octave band sound pressure data for the Vacutech System was sourced from the 2990 W Valley Blvd Automated Express Car Wash Noise Impact Study (Chula Vista, AZ), October 1, 2020.
3. Overall sound pressure data for the AutoVac 30 hp 600 Series centrifugal vacuum producer was provided by the manufacturer. Octave band data was not available.

Appendix B – 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 in Table B1.

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.

Statistical Sound Level

L90 is the level exceeded for 90% of the time. For 90% of the time, the noise level is above this level. It is generally considered to be representing the background or ambient level of a noise environment.

Table B1: 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**	Newspaper press Textile mill	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’ Clothes washer at 2'	Loud
Automobile at 55 mph at 150’ Urban residential	**60**	Normal conversation at 3’ Window air conditioning unit	
Birds at 25' Small town residence	**50**	Office noise Conference room background	Moderate
Wind in trees (5 mph) Farm valley	**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)	

FIGURE 5 - NOISE CONTOUR MAP 08/08/2023

Future Noise Impact due to Car Wash Only (Predator 80 HP Dryer System)

Rinse N Ride *Car Wash, Mesa, AZ*

CASE # PRS22-01043

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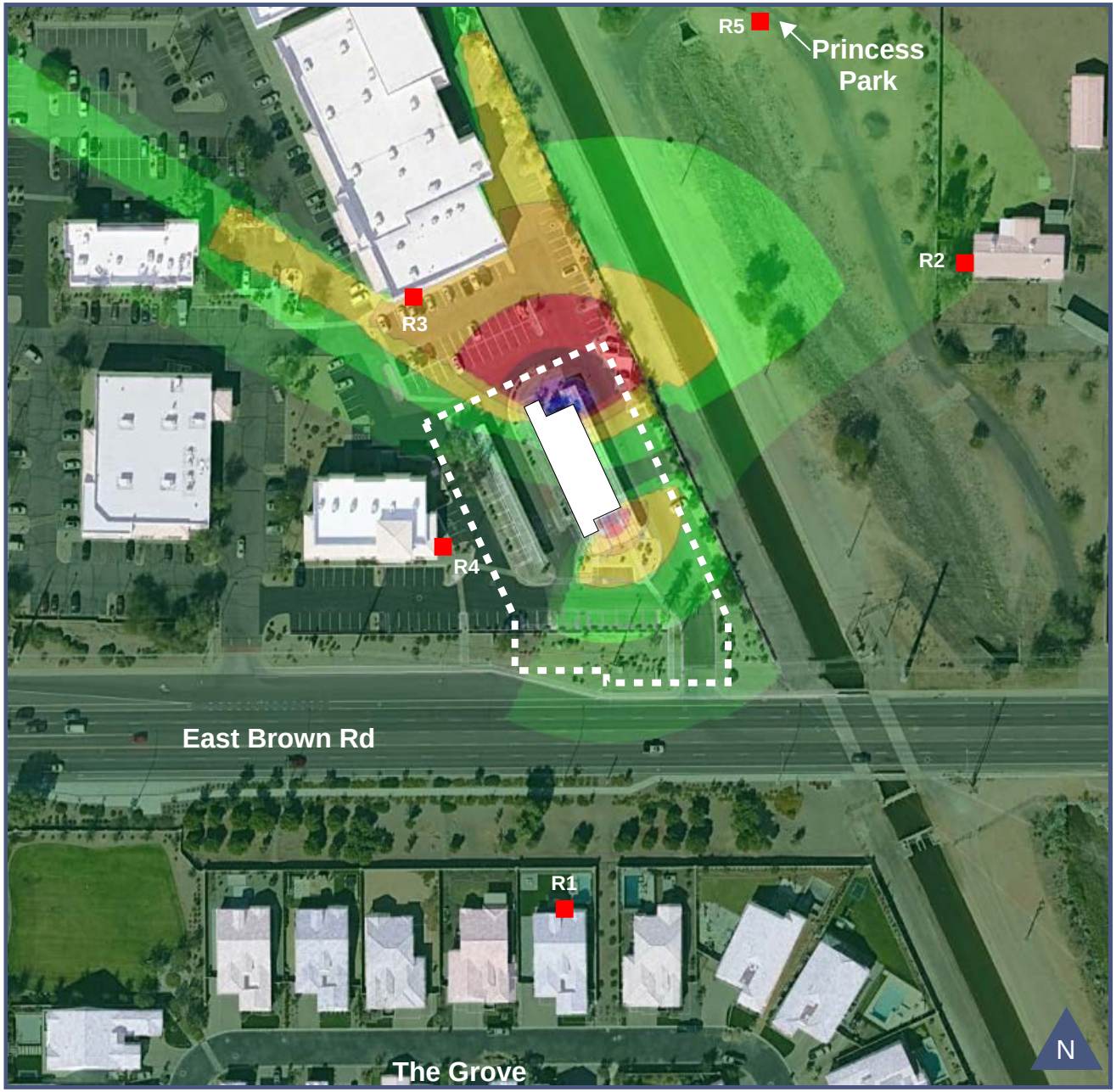

Receiver Location

Site Property Line

LEGEND (dB)

	40 - 45
	45 - 50
	50 - 55
	55 - 60
	60 - 65
	65 - 70
	70 - 75
	75 - 80
	80 - 85

SCALE

0 125 250 500

feet

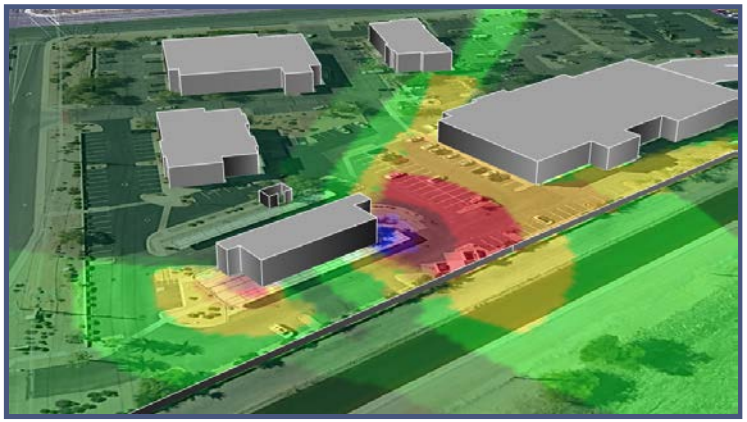

FIGURE 6 - NOISE CONTOUR MAP

Future Noise Impact due to Vacuum System Only (Vacutech)

Rinse N Ride *Car Wash, Mesa, AZ*

08/08/2023

CASE # PRS22-01043

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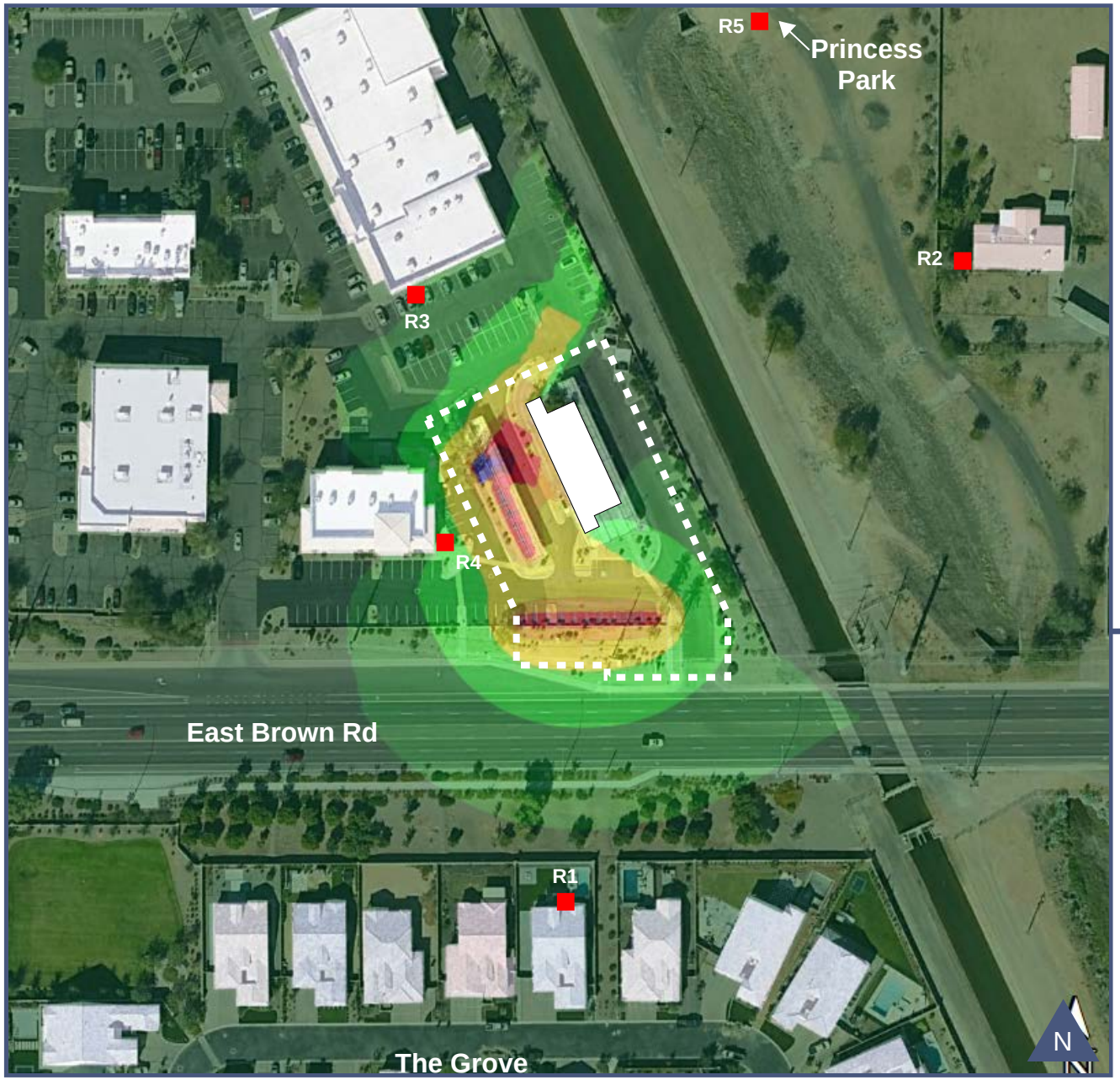

Receiver Location

Site Property Line

LEGEND (dB)

	40 - 45
	45 - 50
	50 - 55
	55 - 60
	60 - 65
	65 - 70
	70 - 75
	75 - 80
	80 - 85

SCALE

0 125 250 500

feet

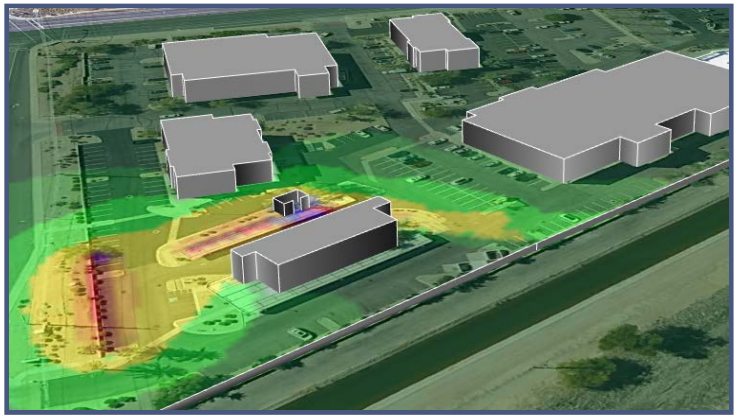

FIGURE 7 - NOISE CONTOUR MAP

Future Noise Impact due to Car Wash and Vacuum System

Rinse N Ride *Car Wash, Mesa, AZ*

08/08/2023

CASE # PRS22-01043

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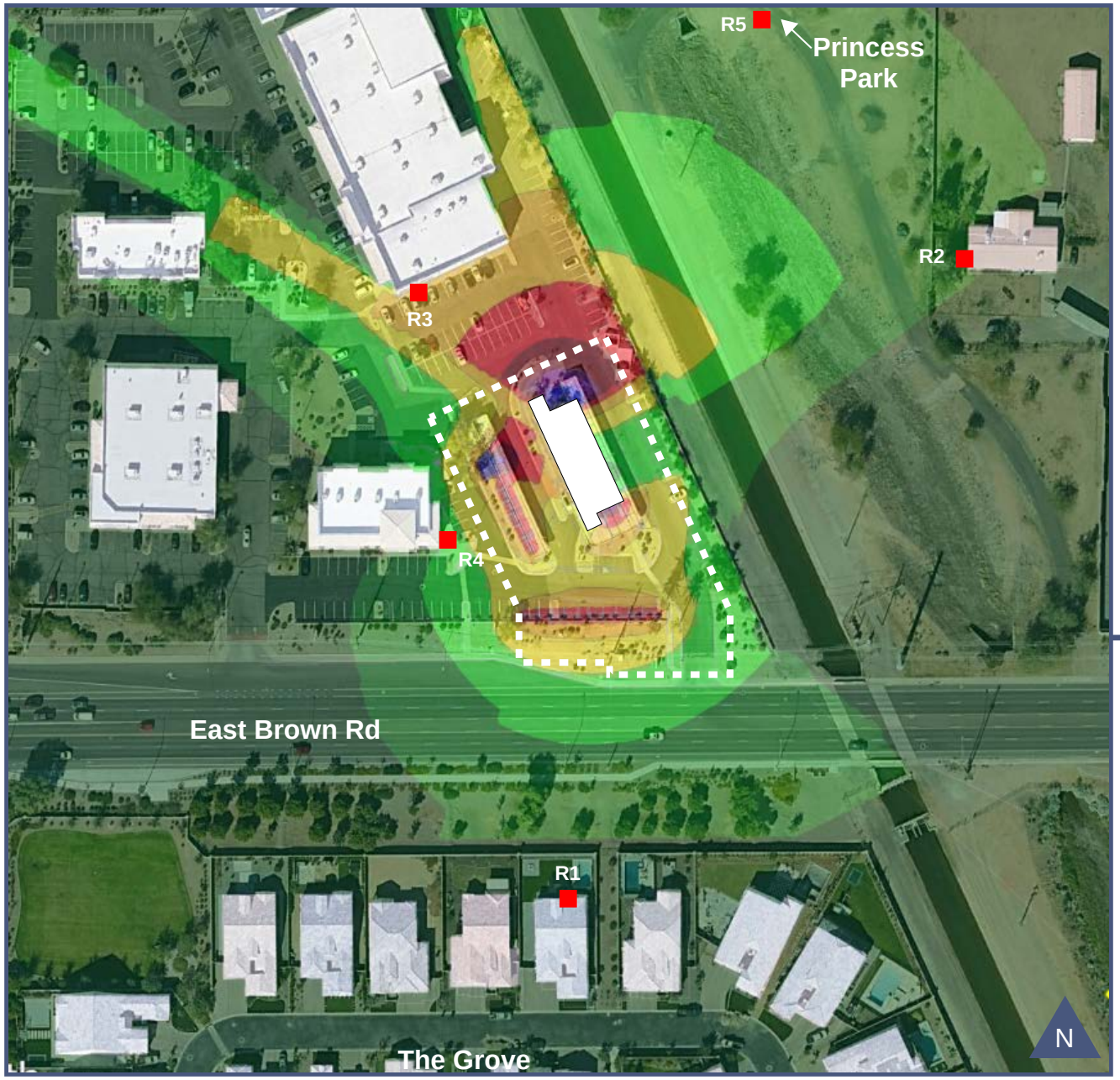

Receiver Location

Site Property Line

LEGEND (dB)

	40 - 45
	45 - 50
	50 - 55
	55 - 60
	60 - 65
	65 - 70
	70 - 75
	75 - 80
	80 - 85

SCALE

0 125 250 500

feet