Appendix B

Noise Analysis Report

Noise Study Technical Report

I-29 Exit 130 (20th Street South) Interchange

Brookings, South Dakota

SDDOT Project Number: EM 0295(45)130

PCN: 020V

September 2020

I-29 Exit 130 (20th Street South) Interchange

Noise Study Technical Report

EXECUTIVE SUMMARY

The City of Brookings, in conjunction with South Dakota Department of Transportation (SDDOT) and Federal Highway Administration (FHWA) are initiating a study to evaluate alternatives for a new interchange on Interstate 29 at 20th Street South.

On behalf of SDDOT, and as part of the environmental documentation, HDR Engineering, Inc. (HDR) performed a traffic noise analysis for the proposed improvements. The analysis included traffic noise monitoring and modeling. HDR used the FHWA Traffic Noise Model (TNM), Version 2.5, to evaluate projected traffic noise levels under the Build alternative. The potential for noise impacts was evaluated in accordance with SDDOT Noise Analysis and Abatement Guidance (July 13, 2011).

Traffic noise levels were calculated for the existing condition and future Build Alternative 5 at 46 receptors in the Project area. Six traffic noise impacts were identified in the Project area and five receptors are anticipated to be acquired or relocated. A feasible and reasonable traffic noise barrier was unable to be modeled to shield the impacted receptors; therefore, noise abatement is not proposed.

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1. Introduction

The City of Brookings (the City), in conjunction with South Dakota Department of Transportation (SDDOT) and Federal Highway Administration (FHWA) are initiating a study to evaluate alternatives for a new interchange on Interstate 29 (I-29) at 20th Street South (20th St S) (the Project). The purpose of the Project is to relieve congestion on major north/south and east/west arterials, to better connect workers and places of employment, and to provide access for planned economic development.

HDR Engineering, Inc. (HDR) performed a highway traffic noise analysis for SDDOT in support of the Project, as part of the environmental documentation. The analysis is based on the SDDOT Noise Analysis and Abatement Guidance (July 13, 2011). Results of the analysis are presented in this report.

Traffic noise levels were evaluated for the existing condition and future Build Alternative 5 at 46 receptors in the Project area. Figure 1 shows the noise study area and receptors.

Figure 1: Noise Study Area

2. Nature of Noise

Noise is defined as unwanted or excessive sound. Sound becomes unwanted when it interferes with normal activities, such as sleep, work, speech, or recreation. Vehicle noise is a combination of the noise produced by the engine, exhaust, and tires. Noise levels from highway traffic are affected by three factors: (1) the volume of the traffic, (2) the speed of the traffic, and (3) the number of trucks in the flow of traffic. Generally, traffic noise increases commensurate with these three factors.

Noise is measured in decibels (dB) – a logarithmic scale. Because human hearing is not equally sensitive to all frequencies of sound, certain frequencies are given more "weight." The A-weighted scale corresponds to the sensitivity for human hearing. Therefore, noise levels are measured in dBA, the A-weighted sound level in decibels. When noise levels change 3-dBA, the change is considered barely perceptible to human hearing. However, a 5-dBA change in noise level is clearly noticeable. A 10-dBA change in noise levels is perceived as a doubling or halving of noise loudness, while a 20-dBA change is considered a dramatic change in loudness. Table 1 shows noise levels associated with common, everyday sources and helps the reader more fully understand the magnitude of noise levels discussed in this report.

Table 1: Common Noise Sources and Levels

Sound Pressure Level, dBA	Typical Sources
120	Jet aircraft takeoff at 100 feet
110	Same aircraft at 400 feet
90	Motorcycle at 400 feet
80	Garbage disposal
70	City street corner
60	Conversational speech
50	Typical office
40	Living room (without TV)
30	Quiet bedroom at night

Source: Environmental Impact Assessment Handbook, ed. by Rau and Wooten, 1980

3. SDDOT Noise Guidance

The updated (July 13, 2011) SDDOT Noise Analysis and Abatement Guidance (Guidance), upon which this analysis is based, is intended to supplement FHWA traffic noise and abatement regulations and guidance. The Guidance provides procedures for noise studies and noise abatement measures to help protect the public health and welfare, to supply Noise Abatement Criteria (NAC), and to establish requirements for traffic noise information to be given to those officials who have planning and zoning authority.

The Guidance contains NAC that are based on the Leq(h), which is used to analyze traffic noise levels and identify noise impacts. The Leq is defined as the equivalent, steady-state sound level that, in a stated period of time, contains the same acoustic energy as the time-varying sound level

during the same period. Therefore, for the purposes of this analysis, Leq can be considered the average sound level and Leq(h) can be considered the average sound level occurring over a one-hour time period. It is representative of the overall (average) traffic-generated noise level expressed on an hourly basis.

Land uses are assigned to an activity category based on the type of activities occurring in each area (i.e. picnic areas, churches, commercial land, and undeveloped land). Activity Categories are then ordered based on their sensitivity to traffic noise levels. NAC are assigned to each Activity Category. These NAC represent the maximum traffic noise levels that allow uninterrupted land use within each Activity Category. Table 2 summarizes the NAC corresponding to various land use activity categories. Activity categories and related traffic noise impacts are determined based on the actual land use in a given area.

Table 2: Noise Abatement Criteria

Activity Category	Leq(h), dBA	Evaluation Location	Activity Description
A	57	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve as an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67	Exterior	Residential
C	67	Exterior	Active sports areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools television studios, trails and trail crossings
D	52	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recordings studios, schools, and television studios.
E	72	Exterior	Hotels, motels, office, restaurant/bars, and other developed lands, properties or activities not included in A-D or F.
F	--	--	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical) and warehousing
G	--	--	Undeveloped lands that are not permitted

Source: 23 CFR 772

Highway traffic noise impacts occur when the predicted traffic noise levels for the design year approach (reach 1 decibel less than) or equal/exceed the NAC contained in 23 CFR 772 (Table 2), or when the predicted traffic noise levels substantially exceed the existing noise levels by 15 dBA, even though the predicted levels may not exceed the NAC.

4. Noise Prediction Method

Traffic noise levels were determined by using the FHWA Traffic Noise Model (TNM), Version 2.5. Basic model inputs are:

- Project design and geometry.
- Existing and 2045 Build traffic volumes in the Project Area (Appendix A). Traffic Variables for Design based on the Interchange Justification Report.
- Operational posted speeds:
  - I-29: 75 miles per hour (mph) for heavy trucks due to TNM limitations and 80 mph for all other vehicles
  - I-29 ramps and 34th Avenue: 45 mph
  - 20th Street South and 22nd Avenue: 35 mph

The traffic volumes used for this analysis are the PM Peak Hourly Volume (PHV) traffic. Existing and Build vehicle classifications were only available for autos and heavy trucks.

5. Adjacent Land Use

The Project corridor is east of Brookings, and includes the proposed 20th Street South alignment and a section of I-29. The noise study area is defined as the area within 500 feet of the edge of pavement along the Project corridor. Within the noise study area, land use with exterior areas of frequent human use includes residential properties, a golf course, and two trails. Figure 1 in Section 1 provides an aerial view of the noise study area.

6. Model Validation

Existing traffic noise levels were measured in the field and then compared against computer modeling results to verify the accuracy of the computer model. When modeled and measured levels are within +/- 3 dBA of one another, this indicates that the model is within the accepted level of accuracy.

6.1. Field Testing Procedure

On June 4, 2020, HDR staff measured traffic noise levels at representative sites throughout the project corridor. Traffic noise measurements were conducted in accordance with the FHWA-PD-96-046 Measurement of Highway Related Noise (May 1996). Table 3 contains the observed meteorological conditions during the measurements.

Table 3: Meteorological Conditions

Temperature	≈ 73 to 84°F
Humidity	≈ 39 to 78%
Wind	< 5 mph
Conditions	Cloudy
Barometric Pressure	≈ 28.3 inches

6.2. Field Instrumentation

Traffic noise monitoring was conducted using a Larson Davis 824 Sound Level Meter (SLM). Table 4 summarizes the instruments used to collect the data for this noise analysis report.

Table 4: Instrumentation Summary

Instrument	Make	Model	Serial Number
Sound Level Meter (type 1)	Larson Davis	824	824A2636
Microphone	Larson Davis	2541	7490
Calibrator	Larson Davis	CAL200	4467

6.3. Field Measurement Methods

The SLM was programmed to compute the Leq(h). The following procedures were used for noise monitoring:

- The duration of the Leq(h) measurements was 15 to 20 minutes.
- The SLM was calibrated before and after monitoring. No significant calibration drifts were detected.
- The microphone was mounted on a tripod about 5 feet above the ground.
- The microphone was covered with a windscreen.

6.4. Field Measurement Locations

Table 5 describes the location of the measurement and validation sites in the Project corridor.

Table 5: Noise Validation Location Summary

Measurement Location	Description
MLA	Near 2228/2230 20th Street
MLB	Near 314 Horseshoe Bend
MLC	Edgebrook Golf Course
MLD	Along 20th Street E
MLE	Near 907 Tumbleweed Road

Figure 1 in Section 1 shows these noise validation locations. Appendix B contains the Field Data Sheets.

6.5. Model Validation Results

Table 6 contains the measured and modeled noise levels for each of the monitoring sites selected along the Project corridor. Each set of predicted and measured data was found to be within the acceptable +/- 3 dBA tolerance; therefore, the model is considered to be validated.

Table 6: Model Validation Results

Measurement Location	Leq(h), dBA		
	Measured	Modeled	Difference
MLA	50.6	48.4	-2.2
MLB	48.1	49.9	+1.8
MLC	66.3	66.8	+0.5
MLD	52.7	53.8	+1.1
MLE	58.7	60.3	+1.6

7. Traffic Noise Prediction

HDR used the FHWA TNM, Version 2.5, to evaluate existing and Build traffic noise levels at noise sensitive receptors within the limits of the Project. The TNM model accounts for the elevation differences and the proposed roadway alignment in relation to the noise-sensitive sites. Table 7 lists the NAC, the existing modeled Leq(h), and the Build (2045) modeled Leq(h).

Table 7: Predicted Noise Levels at Receptors

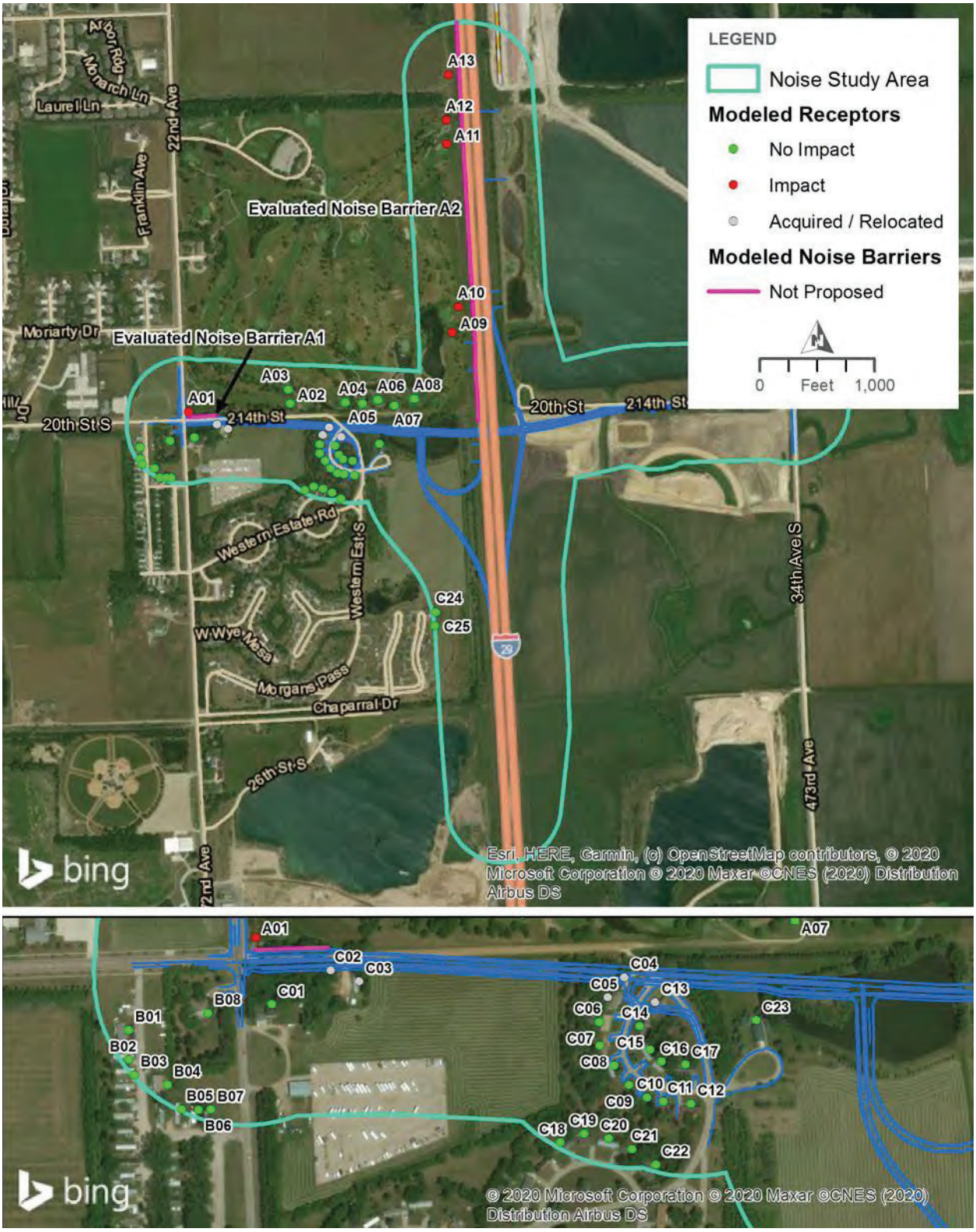
Noise Receptor ID	Noise Receptor (Receptors Represented)	Activity Category	NAC, dBA	Leq(h), dBA			Impact?
				Existing	2045 Build	Difference between Existing/ Build	
A01	Trail – North of Edgebrook Golf Course (1)	C	66	63.8	67.7	+3.9	Yes
A02	Edgebrook Golf Course – Hole 4 Fairway (1)	C	66	48.6	58.4	+9.8	No
A03	Edgebrook Golf Course – Hole 5 Tee Box (1)	C	66	48.6	54.9	+6.3	No
A04	Edgebrook Golf Course – Hold 8 Green (1)	C	66	50.9	57.9	+7.0	No
A05	Edgebrook Golf Course – Hole 9 Tee Box (1)	C	66	52.2	58.4	+6.2	No
A06	Edgebrook Golf Course – Hole 11 Green (1)	C	66	53.5	58.3	+4.8	No
A07	Edgebrook Golf Course – Hole 12 Tee Box (1)	C	66	55.1	59.8	+4.7	No
A08	Edgebrook Golf Course – Hole 14 Green (1)	C	66	57.1	59.8	+2.7	No
A09	Edgebrook Golf Course – Hole 15 Fairway (1)	C	66	65.7	67.2	+1.5	Yes
A10	Edgebrook Golf Course – Hole 16 Tee Box (1)	C	66	68.8	70.3	+1.5	Yes
A11	Edgebrook Golf Course – Hole 17 Green (1)	C	66	67.4	68.9	+1.5	Yes
A12	Edgebrook Golf Course – Hole 18 Tee Box (1)	C	66	68.0	69.5	+1.5	Yes
A13	Trail – At Intersection of 20th St S and 22nd Ave S (1)	C	66	70.2	71.6	+1.4	Yes
B01	Single-Family Residence (1)	B	66	50.3	53.5	+3.2	No
B02	Single-Family Residence (1)	B	66	50.2	53.1	+2.9	No
B03	Single-Family Residence (1)	B	66	50.3	53.1	+2.8	No
B04	Single-Family Residence (1)	B	66	52.5	55.2	+2.7	No

Noise Receptor ID	Noise Receptor (Receptors Represented)	Activity Category	NAC, dBA	Leq(h), dBA			Impact?
				Existing	2045 Build	Difference between Existing/ Build	
B05	Single-Family Residence (1)	B	66	53.6	56.2	+2.6	No
B06	Single-Family Residence (1)	B	66	55.7	58.2	+2.5	No
B07	Single-Family Residence (1)	B	66	57.8	60.4	+2.6	No
B08	Single-Family Residence (1)	B	66	58.6	61.5	+2.9	No
C01	Single-Family Residence (1)	B	66	58.7	62.6	+3.9	No
C02	Single-Family Residence (1)	B	66	51.6	Note a	-	-
C03	Single-Family Residence (1)	B	66	50.3	Note a	-	-
C04	Single-Family Residence (1)	B	66	49.9	Note a	-	-
C05	Single-Family Residence (1)	B	66	49.6	Note a	-	-
C06	Single-Family Residence (1)	B	66	49.4	58.6	+9.2	No
C07	Single-Family Residence (1)	B	66	49.4	56.3	+6.9	No
C08	Single-Family Residence (1)	B	66	49.6	55.5	+5.9	No
C09	Single-Family Residence (1)	B	66	49.9	55.2	+5.3	No
C10	Single-Family Residence (1)	B	66	50.2	55.3	+5.1	No
C11	Single-Family Residence (1)	B	66	50.5	55.6	+5.1	No
C12	Single-Family Residence (1)	B	66	51.2	56.2	+5.0	No
C13	Single-Family Residence (1)	B	66	50.5	Note a	-	-
C14	Single-Family Residence (1)	B	66	50.1	58.6	+8.5	No
C15	Single-Family Residence (1)	B	66	50.3	56.7	+6.4	No
C16	Single-Family Residence (1)	B	66	50.5	56.6	+6.1	No
C17	Single-Family Residence (1)	B	66	51.1	57.0	+5.9	No
C18	Single-Family Residence (1)	B	66	48.8	53.4	+4.6	No
C19	Single-Family Residence (1)	B	66	49.1	53.8	+4.7	No
C20	Single-Family Residence (1)	B	66	49.4	54.0	+4.6	No
C21	Single-Family Residence (1)	B	66	49.8	54.4	+4.6	No
C22	Single-Family Residence (1)	B	66	50.3	54.6	+4.3	No
C23	Single-Family Residence (1)	B	66	53.5	61.6	+8.1	No
C24	Single-Family Residence (1)	B	66	58.3	60.6	+2.3	No
C25	Single-Family Residence (1)	B	66	58.1	60.3	+2.2	No

Note a: Residence would be acquired or relocated as part of Build Alternative 5.

Under the existing condition noise levels exceed the NAC at four receptors. All four receptors are activity category C: three are located at Edgebrook Golf Course and one is located at a trail. Under the Build condition, impacts are predicted at six receptors and five receptors are anticipated to be acquired or relocated as part of Build Alternative 5. All six impacted receptors are activity category C: four are located at Edgebrook Golf Course and two are located at trails. All impacts are the result of approaching or exceeding the NAC. Predicted noise levels would increase 1.4 to 9.8 dBA over the existing condition, which is below the impact threshold for a substantial increase (15 dBA or more). Figure 2 shows these noise receptors and locations with predicted impacts.

Figure 2: Predicted Noise Impacts



8. Noise Impact Analysis

In accordance with the SDDOT noise policy, noise-abatement measures must be evaluated for noise receptors predicted to approach or exceed the FHWA NAC as a result of the Build Alternative, or which are predicted to experience a substantial (15 dBA) noise level increase over existing noise levels.

Six impacts are predicted as a result of the Build Alternative. Potential traffic noise abatement measures that could be considered are listed below, along with reasons why some are considered infeasible.

1. Modifying the proposed horizontal and/or vertical alignments of the roadway
   - *Impacted receptor A01 is a trail that crosses 20th Street South and extends north and south along 22nd Avenue. Therefore, relocating the proposed intersection of 20th Street South and 22nd Avenue would not mitigate this impact.*
   - *The remaining five impacted receptors are located along I-29 and are due to existing traffic noise or increased traffic noise due to future growth. Project alignment adjustments would not mitigate these impacts.*
2. Traffic management measures (e.g. modify speed limits and restrict truck traffic)
   - *Impractical given the type of road causing the majority of impacts.*
3. Construction of noise barriers along or within the ROW
   - *Potentially possible; options include walls and berms. To be investigated further.*
4. Acquisition of property to serve as a buffer zone
   - *Impacted receptor A01 is a trail that crosses 20th Street South; it is impossible to add a buffer zone.*
   - *Prohibitively expensive for remaining impacted receptors.*

8.1. Discussion of Noise Barriers (SDDOT Noise Guidance)

When a traffic noise impact is identified, noise abatement measures will be considered and evaluated for feasibility and reasonableness by comparing the cost and effect of the abatement measure against the amount of benefit. All of the following conditions must be met in order for noise abatement to be justified and incorporated into Project design. Failure to achieve any single element of feasibility or reasonableness will result in the noise abatement measure being deemed not feasible or not reasonable, whichever applies.

FEASIBILITY

When a traffic noise impact is identified on a project, noise abatement will be considered and evaluated for engineering and acoustical feasibility.

- **Engineering feasibility:**
  - Safety: An abatement measure will be deemed not feasible if it causes an excessive restriction of sight distance, continuous shadow resulting in icing or snow accumulation on driving lanes, or severe drainage problems associated either with the barrier or flood-prone areas.
  - Barrier height: The design of each proposed barrier will be considered on an individual basis when determining barrier height. The designed height of any proposed barrier may be adjusted based on feasibility and reasonableness

considerations. Due to safety concerns, SDDOT will generally not construct barriers higher than 20 feet.
  - Topography: If the topography is such that an abatement measure cannot be built, then it will be deemed not feasible.
  - Drainage and utilities: A noise abatement measure is not feasible if access to drainage and utilities cannot be maintained.
  - Maintenance of the abatement measure, maintenance access to adjacent properties, and access to adjacent properties: A noise abatement measure is not feasible if access to the abatement measure, side streets, driveways, ramps, etc., cannot be maintained.
- **Acoustic Feasibility:**
  A noise abatement measure is considered acoustically feasible when a minimum of 60 percent of front-row receptors directly behind the noise wall (noise wall must extent entirely across receptor's property line) achieve a 5 dBA noise reduction.

REASONABLENESS

Reasonableness is a more subjective criterion than feasibility. It implies that common sense and good judgment were applied in arriving at a decision when noise abatement measures are considered. The following three reasonableness criteria must be collectively achieved for an abatement measure to be considered reasonable:

- **Viewpoints of the Property Owners and Residents of all Benefited Receptors:**
  For Activity Category B, a public information meeting and vote is held to consider the opinion of benefited property owners and residents. No impacts are predicted at Activity Category B receptors for this Project. For Activity Categories A, C, D, and E, the views of the property owner or authority having jurisdiction over the property will be considered.
- **Cost Effectiveness:**
  Noise barriers that are determined to be feasible to design and construct must also be evaluated for reasonable cost. SDDOT defines cost effectiveness as dollars per benefited receiver. Based on 2010 construction cost estimates, SDDOT will use $44/ft^2$ for barrier costs. The abatement cost guidance will be reevaluated every 5 years, or sooner if updated costs become available. If the cost per benefited receptor is more than $21,000, the abatement measure will be considered not reasonable.
- **Noise Reduction Goal:**
  A minimum of 40 percent of benefited receptors must achieve a 7 dBA noise reduction in order for noise abatement to be reasonable.

NOISE BARRIER A1

Noise Barrier A1 was modeled north of 20th Street South and east of 22nd Avenue in an attempt to shield impacted receptor A01. The modeled wall is about 225 feet long (see Figure 2). The trail represented by receptor A01 crosses 20th Street South. As summarized in Table 8, a 20-foot high wall was evaluated.

Table 8. Noise Abatement Analysis for Noise Barrier A1

Barrier Height	Feasibility		Reasonableness					Is Barrier Feasible & Reasonable?
	% Front-row with 5-dBA Reduction	Acoustically Feasible?[a]	% Benefited with 7-dBA Reduction	Noise Abatement Design Goal?[b]	Anticipated Cost	Allowable Cost[c]	Cost-Effective?[d]	
20	0	No	0	No	N/A	N/A	N/A	No

[a] 5-dBA reduction for at least 60% of front-row receptors.
[b] 7-dBA reduction for at least 40% of benefited receptors.
[c] Allowable cost is $21,000 per benefited receptor.
[d] Anticipated cost is less than allowable cost.

Minimal noise reduction is predicted because receptor A01 cannot be fully shielded from the roadway due to the trail crossing. Noise Barrier A1 was not found to be feasible or reasonable. Therefore, a wall at this location is not proposed.

NOISE BARRIER A2

Noise Barrier A2 was modeled west of I-29 in an attempt to shield impacted receptors A09, A10, A11, A12, and A13. The modeled wall is about 3,383 feet long to extend across the entire property per the Guidance (see Figure 2). As summarized in Table 9, walls with heights from 10 to 20 feet were evaluated.

Table 9. Noise Abatement Analysis for Noise Barrier A2

Barrier Height	Feasibility		Reasonableness					Is Barrier Feasible & Reasonable?
	% Front-row with 5-dBA Reduction	Acoustically Feasible?[a]	% Benefited with 7-dBA Reduction	Noise Abatement Design Goal?[b]	Anticipated Cost	Allowable Cost[c]	Cost-Effective?[d]	
10	60	Yes	0	No	N/A	N/A	N/A	No
12	100	Yes	80	Yes	$1,786,224	$105,000	No	No
14	100	Yes	100	Yes	$2,083,928	$105,000	No	No
16	100	Yes	100	Yes	$2,381,632	$105,000	No	No
18	100	Yes	100	Yes	$2,679,336	$105,000	No	No
20	100	Yes	100	Yes	$2,977,040	$105,000	No	No

[a] 5-dBA reduction for at least 60% of front-row receptors.
[b] 7-dBA reduction for at least 40% of benefited receptors.
[c] Allowable cost is $21,000 per benefited receptor.
[d] Anticipated cost is less than allowable cost.

Noise Barrier A2 was not found to be feasible and reasonable. Therefore, a wall at this location is not proposed.

9. Construction Noise and Vibration

Construction of the Project would result in temporary noise and vibration increases within the Project area. The evaluation and control of construction noise and vibration must be considered along with traffic noise. This Project is bordered by various receptors for which impacts from construction noise and vibration are a concern.

The following are basic categories for mitigation measures for construction noise. Due to the interrelatedness of construction noise and vibration, some of these measures will also apply for vibration resulting from construction activities.

Design Considerations: Design considerations include measures in the plans and specifications to minimize or eliminate adverse impacts. The proposed changes and their proximity to noise sensitive receptors were considered during design.

Community Awareness: It is important for people to be made aware of the possible inconvenience construction can cause, and to know its approximate duration so they can plan their activities accordingly. It is SDDOT's policy to submit such Project information to all local news media.

Source Control: Source control involves reducing noise impacts from construction by controlling the noise emissions at their source. This can be accomplished by specifying proper muffler systems, either as a requirement in the plans and specifications on this Project or through an established local noise ordinance requiring mufflers. Contractors generally maintain proper muffler systems on their equipment to ensure efficient operation and to minimize noise for the benefit of their own personnel as well as the adjacent receptors.

Site Control: Site control involves the specification of certain areas where extra precautions should be taken to minimize construction noise. One way to reduce construction noise impacts at sensitive receptors is to operate stationary equipment, such as air compressors or generators, as far away from the sensitive receptors as possible. Another method might be placing a temporary noise barrier in front of the equipment. As a general rule, good coordination between the Project engineer, the contractor, and the affected receptors is less confusing, less likely to increase the cost of the Project, and provides a more personal approach to work out ways to minimize construction noise impacts in the more noise-sensitive areas.

Time and Activity Constraints: Limiting working hours on a construction site can be very beneficial during the hours of sleep or on Sundays and holidays. However, most construction activities do not occur at night and usually not on Sundays. Exceptions due to weather, schedule, and time-related phases of construction could occur. Enforcement of such constraints could be handled through a general city or county ordinance, either listing the exceptions or granting them on a case-by-case basis.

10. Information for Local Officials

Local officials will be provided with information on noise compatible planning techniques that can be used to prevent future highway traffic noise impacts. To assist local officials within whose jurisdiction a Type I highway project is located, SDDOT will provide information on future noise levels for each Activity Category located along the Project. This is accomplished by providing a

copy of the noise analysis report to the local official. The local official will also be provided with an estimation of future noise levels at various distances from the highway.

Table 10 provides the FHWA NAC noise contour distances. These contour distances represent the individual roadways, so higher noise levels could occur at intersections.

Table 10: FHWA NAC Noise Contour Distances

Roadway Segment	Activity Category	Leq(h), dBA	Approximate Width of FHWA NAC for 2045 Build Alternative (Distance in Feet from Edge of Proposed Roadway)
I-29	B & C	66	≈ 240
	E	71	≈ 135
20th Street South (22nd Avenue to I-29)	B & C	66	≈ 40
	E	71	< 10
20th Street South (I-29 to 34th Avenue)	B & C	66	≈ 50
	E	71	≈ 10
22nd Avenue	B & C	66	≈ 45
	E	71	≈ 10
34th Avenue	B & C	66	≈ 70
	E	71	≈ 35

Local officials can use this information as a guide to ensure that noise impacts are minimized in the event of land use changes and to assist in the development of compatible land use criteria. The contour distances were determined using lines of receptors perpendicular to the roadway in TNM. Because the contour distances would vary with terrain, the roadway segments and receptors were modeled on flat ground to provide approximate distances that could be applied more universally.

11. Conclusion

Traffic noise levels were evaluated for the existing condition and future Build Alternative 5 at 46 receptors in the Project area. Six traffic noise impacts have been identified in the Project area as well as five receptors that will be acquired or relocated as part of the Build alternative. A feasible and reasonable traffic noise barrier was unable to be modeled to shield the impacted receptors; therefore, noise abatement is not proposed as part of the Project.

12. References

South Dakota Department of Transportation, “Noise Analysis and Abatement Guidance,” July 13, 2011.

Federal Highway Administration (FHWA), “Procedures for Abatement of Highway Traffic Noise and Construction Noise,” July 13, 2011.

Methods for evaluation and control of construction noise were taken from the FHWA Special Report – “Highway Construction Noise: Measurement, Prediction and Mitigation.”

Appendix A
Traffic Data

Project:	SDDOT 20th St
Task:	Noise
Subject:	Traffic Data
Job:	10220242

Traffic Data

	I-29 NB	I-29 SB	I-29 NB Off-Ramp	I-29 NB On-Ramp	I-29 SB Off-Ramp	I-29 SB On-Ramp	20th St S (22nd Ave to I-29)	20th St S (I-29 to 34th Ave)	22nd Ave	34th Ave
AADT (Existing)	7100	7100	0	0	0	0	0	0	9200	1700
AADT (2022)	7500	7500	500	500	500	500	2500	2500	10000	3500
AADT (2045)	10000	10000	1500	1500	1500	1500	11500	9500	16000	11500
D (PM Peak)	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
DHV (2045)	1000	1000	150	150	150	150	1150	950	1600	1150
T DHV	16%	16%	10%	10%	10%	10%	4%	10%	3%	10%
T ADT	16%	16%	10%	10%	10%	10%	4%	10%	3%	10%
V	85	85	50	50	50	50	40	40	40	40

Posted speed limits will be 5 mph less than the design speeds (V) listed.
Due to the type of traffic in the area, we will not generate vehicular splits beside the heavy truck volumes (T DHV and T ADT in the table).

AADT = annual average daily traffic
DHV = design hour volume

Existing and Build Data by Vehicle Class

	I-29 NB	I-29 SB	I-29 NB Off-Ramp	I-29 NB On-Ramp	I-29 SB Off-Ramp	I-29 SB On-Ramp	20th St S (22nd Ave to I-29)	20th St S (I-29 to 34th Ave)	22nd Ave	34th Ave
EX DHV Autos	596	596	0	0	0	0	0	0	892	153
EX DHV HT	114	114	0	0	0	0	0	0	28	17
BLD DHV Autos	840	840	135	135	135	135	1104	855	1552	1035
BLD DHV HT	160	160	15	15	15	15	46	95	48	115
Posted speed	80	80	45	45	45	45	35	35	35	45

Based on speed limit signs visible on Google Maps street view

Project:	SDDOT 20th St
Task:	Noise
Subject:	Existing Traffic Data
Job:	10220242

Existing Traffic Data

	I-29 NB	I-29 SB	I-29 NB Off-Ramp	I-29 NB On-Ramp	I-29 SB Off-Ramp	I-29 SB On-Ramp	20th St S (22nd Ave to I-29)	20th St S (I-29 to 34th Ave)	22nd Ave	34th Ave
EX DHV Autos	596	596	0	0	0	0	0	0	892	153
EX DHV HT	114	114	0	0	0	0	0	0	28	17
Posted speed	80	80	45	45	45	45	35	35	35	45

Existing Traffic Inputs for TNM

Roadway:	I-29 NB		I-29 SB		
# of Lanes/Dir:	2		2		
# of Directions:	1		1		
Vehicle Type	Veh/hr	mph	Veh/hr	mph	
Auto	298	80	298	80	
Medium	0	0	0	0	
Heavy Truck	57	75	57	75	Heavy truck speed limited to 75 mph by TNM
Buses	0	0	0	0	
Motorcycle	0	0	0	0	

Roadway:	22nd Ave		22nd Ave		34th Ave	
# of Lanes/Dir:	1	(S of 20th)	2	(N of 20th)	1	
# of Directions:	2		2		2	
Vehicle Type	Veh/hr	mph	Veh/hr	mph	Veh/hr	mph
Auto	446	35	223	35	77	45
Medium	0	0	0	0	0	0
Heavy Truck	14	35	7	35	9	45
Buses	0	0	0	0	0	0
Motorcycle	0	0	0	0	0	0

Project:	SDDOT 20th St
Task:	Noise
Subject:	Build Traffic Data
Job:	10220242

Build Traffic Data

	I-29 NB	I-29 SB	I-29 NB Off-Ramp	I-29 NB On-Ramp	I-29 SB Off-Ramp	I-29 SB On-Ramp	20th St S (22nd Ave to I-29)	20th St S (I-29 to 34th Ave)	22nd Ave	34th Ave
BLD DHV Autos	840	840	135	135	135	135	1104	855	1552	1035
BLD DHV HT	160	160	15	15	15	15	46	95	48	115
Posted speed	80	80	45	45	45	45	35	35	35	45

Build Traffic Inputs for TNM

Roadway: I-29 NB
# of Lanes/Dir: 2
# of Directions: 1

Vehicle Type	Veh/hr	mph
Auto	420	80
Medium	0	0
Heavy Truck	80	75
Buses	0	0
Motorcycle	0	0

Roadway: I-29 SB
# of Lanes/Dir: 2
# of Directions: 1

Veh/hr	mph
420	80
0	0
80	75
0	0
0	0

Heavy truck speed limited to 75 mph by TNM

Roadway: I-29 NB Off-Ramp
# of Lanes/Dir: 1
# of Directions: 1

Vehicle Type	Veh/hr	mph
Auto	135	45
Medium	0	0
Heavy Truck	15	45
Buses	0	0
Motorcycle	0	0

I-29 NB Off-Ramp
2 (turn lanes)
1

Veh/hr	mph
68	45
0	0
8	45
0	0
0	0

I-29 NB On-Ramp
1
1

Veh/hr	mph
135	45
0	0
15	45
0	0
0	0

I-29 NB On-Ramp
2 (turn lanes on 20th)
1

Veh/hr	mph
68	45
0	0
8	45
0	0
0	0

Roadway: I-29 SB Off-Ramp
# of Lanes/Dir: 1
# of Directions: 1

Vehicle Type	Veh/hr	mph
Auto	135	45
Medium	0	0
Heavy Truck	15	45
Buses	0	0
Motorcycle	0	0

I-29 SB Off-Ramp
2 (turn lanes)
1

Veh/hr	mph
68	45
0	0
8	45
0	0
0	0

I-29 SB On-Ramp
1
1

Veh/hr	mph
135	45
0	0
15	45
0	0
0	0

I-29 SB On-Ramp
2 (turn lanes on 20th)
1

Veh/hr	mph
68	45
0	0
8	45
0	0
0	0

Roadway: 20th St S (22nd Ave to I-29)
# of Lanes/Dir: 1
# of Directions: 2

Vehicle Type	Veh/hr	mph
Auto	552	35
Medium	0	0
Heavy Truck	23	35
Buses	0	0
Motorcycle	0	0

20th St S (22nd Ave to I-29)
3 (turn lanes)
2

Veh/hr	mph
184	35
0	0
8	35
0	0
0	0

20th St S (I-29 to 34th Ave)
1
2

Veh/hr	mph
428	35
0	0
48	35
0	0
0	0

20th St S (I-29 to 34th Ave)
2 (turn lanes)
2

Veh/hr	mph
214	35
0	0
24	35
0	0
0	0

Roadway: 22nd Ave
# of Lanes/Dir: 1 (S of 20th)
# of Directions: 2

Vehicle Type	Veh/hr	mph
Auto	776	35
Medium	0	0
Heavy Truck	24	35
Buses	0	0
Motorcycle	0	0

22nd Ave
2 (N of 20th)
2

Veh/hr	mph
388	35
0	0
12	35
0	0
0	0

34th Ave
1
2

Veh/hr	mph
518	45
0	0
58	45
0	0
0	0

Appendix B
Field Data Sheets

HDR

SHORT-TERM TRAFFIC NOISE MONITORING LOG SHEET

Reading: D
Bk 1

Project Description: 10220242; Brookings (20th Street)

Noise Source: I-29, birds, construction Date: 6/4/2020 Personnel: BJC

Equipment	Type	Serial #
Sound Level Meter	LD 824	824A2636
Microphone/Preamp	LD 2541/LD PRM902	7490/2618
Calibrator	LD Cal 200	4467

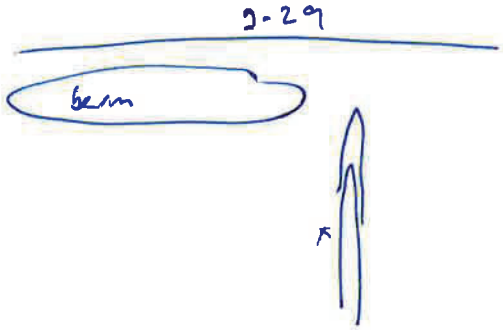
SLM SETTINGS (circle one) **FAST** SLOW

WEIGHTING (circle one) **A** Lin.

Location Description: 20th St E

SITE SKETCH: Including noise source, receptors, reference distances, North arrow, wind direction arrow, terrain and shielding, roadway profile, and direct lines of sight:

44° 16.941 N
96° 45.318 W



Start Time: 9 : 40 (AM) PM

Stop Time: 10 : 00 AM PM

Duration: 20 min

Wind Speed/Direction: 0-2 mph W

Percentiles: L_{10} 55.4 L_{50} 51.7 L_{90} 48.2

Temperature: 73° F

Humidity: 78%

Calibration results before: 114.1 dBA and after 114.0 dBA

Traffic Count Roadway: I-29

	Autos	Medium Trucks	Heavy Trucks	Buses	Motorcycles
NB	80	7	31	0	0
SB	80	4	26	0	0

*Note roadway direction in table

HDR

SHORT-TERM TRAFFIC NOISE MONITORING LOG SHEET

PROJECT: Brookings (20th Street)

JOB NO.: 10220242

SITE/READING NO.: D File 1

PERSONNEL: BJC

LOCATION/ADDRESS: 20th St E

DATE: 6/4/20

#	1 Minute Period Starting	Meas'd Leq (dBA)	√ or X	Other Noise Sources	COMMENTS
1	9:40	50.8			
2	41	49.7			
3	42	51.5			
4	43	53.0			
5	44	51.9			
6	45	52.1			
7	46	52.0			
8	47	50.9			
9	48	52.2			
10	49	54.9			
11	50	54.2			
12	51	52.7			
13	52	53.8			
14	53	52.9			
15	54	52.9			
16	55	54.9			
17	56	49.6			
18	57	50.2			
19	58	54.7			
20	59	53.1			
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

TOTAL Leq = SUBSET Leq =

√ = Other sources contributed to Leq X = Exclude period - contaminated by non-characteristic sources

>> ADD SKETCH AND WEATHER CONDITIONS TO REVERSE OR OTHER SHEET <<

HDR

SHORT-TERM TRAFFIC NOISE MONITORING LOG SHEET

Reading: C
file 2

Project Description: 10220242; Brookings (20th Street)

Noise Source: I-29 Date: 6/4/20 Personnel: BJC

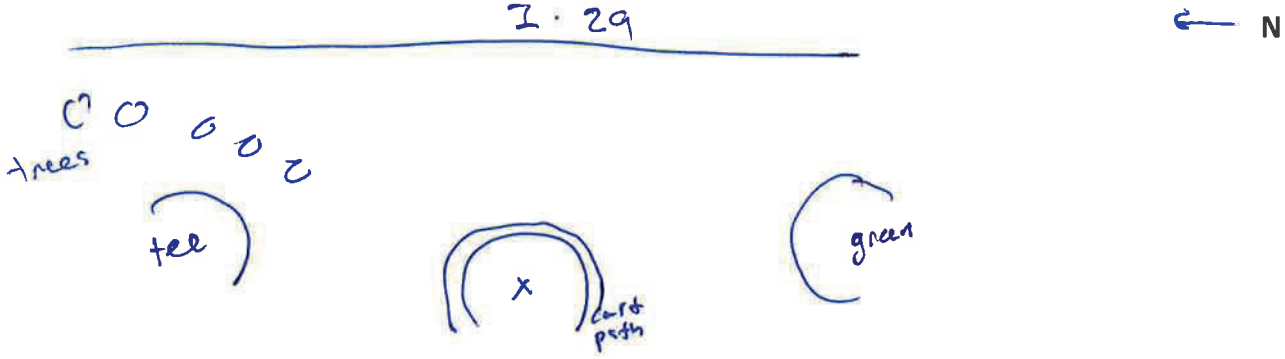
Equipment	Type	Serial #
Sound Level Meter	LD 824	824A2636
Microphone/Preamp	LD 2541/LD PRM902	7490/2618
Calibrator	LD Cal 200	4467

SLM SETTINGS (circle one) **FAST** SLOW

WEIGHTING (circle one) **A** Lin.

Location Description: golf course

SITE SKETCH: Including noise source, receptors, reference distances, North arrow, wind direction arrow, terrain and shielding, roadway profile, and direct lines of sight:



Start Time: 10:46 AM PM

Stop Time: ~~10:59~~ 11:01 AM PM

Duration: ~~15~~ lost power

Wind Speed/Direction: 0-4 mph NE Percentiles: L_{10} 71.1 L_{50} 63.5 L_{90} 51.1

Temperature: 78°F Humidity: 49%

Calibration results before: 114.0 dBA and after 113.9 dBA

Traffic Count Roadway: I-29

	Autos	Medium Trucks	Heavy Trucks	Buses	Motorcycles
NB	96	1	26	0	1
SB	76	2	22	0	0

15 minutes

*Note roadway direction in table

HDR

SHORT-TERM TRAFFIC NOISE MONITORING LOG SHEET

PROJECT: Brookings (20th Street)

JOB NO.: 10220242

SITE/READING NO.: C-File 2

PERSONNEL: BJC

LOCATION/ADDRESS: golf course

DATE: 6/4/20

#	1 Minute Period Starting	Meas'd Leq (dBA)	√ or X	Other Noise Sources	COMMENTS
1	10:46	68.4			
2	47	63.8			
3	48	66.7			
4	49	68.3			
5	50	67.2			
6	51	68.8			
7	52	67.1			
8	53	69.1			golfers
9	54	64.8			
10	55	70.1			
11	56	69.1			mower
12	57	64.7			
13	58	63.9			
14	59	68.8			
15	11:00	65.0			
16	~~01~~	~~60.0~~			
17	02				
18	03				
19	04				
20	05				
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

TOTAL Leq = SUBSET Leq =

√ = Other sources contributed to Leq X = Exclude period - contaminated by non-characteristic sources

>> ADD SKETCH AND WEATHER CONDITIONS TO REVERSE OR OTHER SHEET <<

HDR

SHORT-TERM TRAFFIC NOISE MONITORING LOG SHEET

Reading: A
file 3

Project Description: 10220242; Brookings (20th Street)

Noise Source: I-29, 22nd Ave Date: 6/4/20 Personnel: BJC

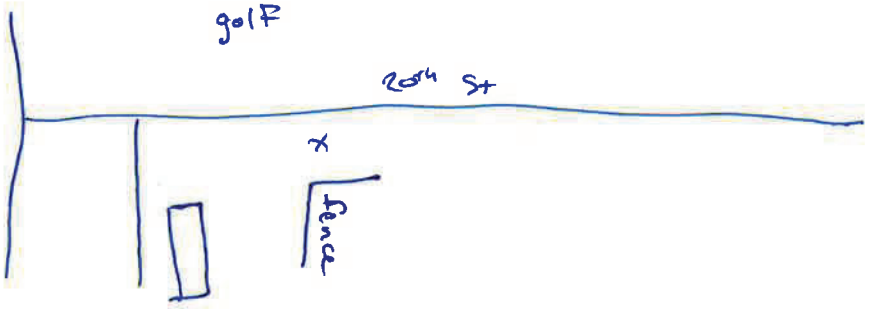
Equipment	Type	Serial #
Sound Level Meter	LD 824	824A2636
Microphone/Preamp	LD 2541/LD PRM902	7490/2618
Calibrator	LD Cal 200	4467

SLM SETTINGS (circle one) (FAST) SLOW

WEIGHTING (circle one) (A) Lin.

Location Description: 2228/2230 20th St

SITE SKETCH: Including noise source, receptors, reference distances, North arrow, wind direction arrow, terrain and shielding, roadway profile, and direct lines of sight:



N

I-29

Start Time: 11:48 (AM) PM Stop Time: 12:08 AM (PM) Duration: 20 min

Wind Speed/Direction: 3 mph NE Percentiles: L_{10} 53.4 L_{50} 45.9 L_{90} 42.4

Temperature: 82°F Humidity: 43%

Calibration results before: 113.9 dBA and after 113.8 dBA

Traffic Count Roadway: I-29, 22nd Ave

	Autos	Medium Trucks	Heavy Trucks	Buses	Motorcycles
NB	75	1	18	0	0
SB	76	0	20	0	0
NB	54	0	4	0	1
SB	73	1	6	0	0

I-29

22nd Ave

20 min

*Note roadway direction in table

HDR

SHORT-TERM TRAFFIC NOISE MONITORING LOG SHEET

PROJECT: Brookings (20th Street)

JOB NO.: 10220242

SITE/READING NO.: A. file 3

PERSONNEL: BJC

LOCATION/ADDRESS: 2228/2230 20th St

DATE: 6/4/20

#	1 Minute Period Starting	Meas'd Leq (dBA)	√ or X	Other Noise Sources	COMMENTS 20th St traffic
1	11:48	46.9			truck turning 20th St
2	49	54.5			car
3	50	45.4			
4	51	57.0			plane low-flying
5	52	48.6			
6	53	46.3			
7	54	56.4			van
8	55	47.7			squealing brakes
9	56	52.4			
10	57	61.0			big [redacted] loader
11	58	45.5			
12	59	46.5			
13	12:00	45.8			
14	01	45.5			
15	02	43.1			
16	03	46.9			car in driveway
17	04	47.9			
18	05	64.9			big loader returns
19	06	58.5			√
20	07	45.7			
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

TOTAL Leq = SUBSET Leq =

√ = Other sources contributed to Leq X = Exclude period - contaminated by non-characteristic sources

>> ADD SKETCH AND WEATHER CONDITIONS TO REVERSE OR OTHER SHEET <<

HDR

SHORT-TERM TRAFFIC NOISE MONITORING LOG SHEET

Reading: B
file 4

Project Description: 10220242; Brookings (20th Street)

Noise Source: I-29, birds Date: 6/4/20 Personnel: BJC

Equipment	Type	Serial #
Sound Level Meter	LD 824	824A2636
Microphone/Preamp	LD 2541/LD PRM902	7490/2618
Calibrator	LD Cal 200	4467

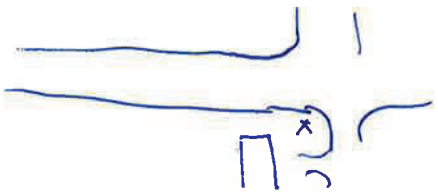
SLM SETTINGS (circle one) **FAST** SLOW

WEIGHTING (circle one) **A** Lin.

Location Description: 314 Horseshoe Bend

SITE SKETCH: Including noise source, receptors, reference distances, North arrow, wind direction arrow, terrain and shielding, roadway profile, and direct lines of sight: I-29

N



Start Time: 12 :30 AM PM

Stop Time: ___:___ AM PM

Duration: 20 min

Wind Speed/Direction: 0 mph Percentiles: ___

Temperature: 84° F Humidity: 39 %

Calibration results before: 113.8 dBA and after 114.0 dBA

Traffic Count Roadway: I-29

	Autos	Medium Trucks	Heavy Trucks	Buses	Motorcycles
NB	81	2	26	0	1
SB	94	2	28	0	1

*Note roadway direction in table

HDR

SHORT-TERM TRAFFIC NOISE MONITORING LOG SHEET

PROJECT: Brookings (20th Street)

JOB NO.: 10220242

SITE/READING NO.: B - File 4 PERSONNEL: BJC

LOCATION/ADDRESS: 314 Horseshoe Bend DATE: 6/4/20

#	1 Minute Period Starting	Meas'd Leq (dBA)	√ or X	Other Noise Sources	COMMENTS
1	12:30	54.2			
2	31	54.3			2 cars
3	32	45.3			
4	33	55.8			car
5	34	47.7			
6	35	45.7			
7	36	44.6			
8	37	47.4			
9	38	46.7			
10	39	49.5			
11	40	49.6			
12	41	46.3			
13	42	47.9			
14	43	46.3			
15	44	48.4			
16	45	51.6			
17	46	48.5			
18	47	50.0			
19	48	48.2			
20	49	52.8			car
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

TOTAL Leq = SUBSET Leq =

√ = Other sources contributed to Leq X = Exclude period - contaminated by non-characteristic sources

>> ADD SKETCH AND WEATHER CONDITIONS TO REVERSE OR OTHER SHEET <<

HDR

SHORT-TERM TRAFFIC NOISE MONITORING LOG SHEET

Reading: E file 5

Project Description: 10220242; Brookings (20th Street)

Noise Source: I-29, birds Date: 6/4/20 Personnel: BJC

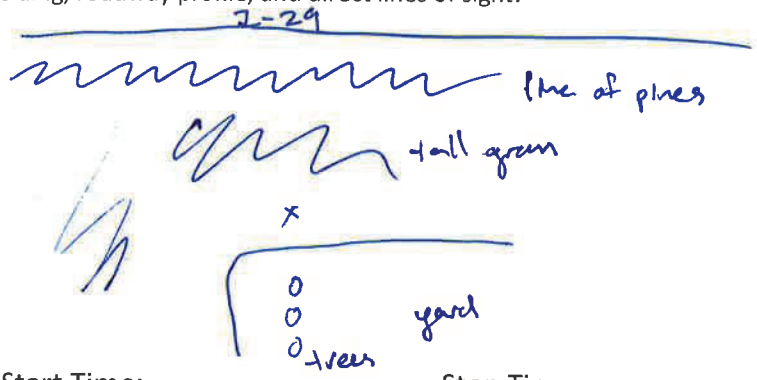
Equipment	Type	Serial #
Sound Level Meter	LD 824	824A2636
Microphone/Preamp	LD 2541/LD PRM902	7490/2618
Calibrator	LD Cal 200	4467

SLM SETTINGS (circle one) (FAST) SLOW

WEIGHTING (circle one) (A) Lin.

Location Description: Tumbleweed Rd 44° 16.678 N 96° 45.580 S

SITE SKETCH: Including noise source, receptors, reference distances, North arrow, wind direction arrow, terrain and shielding, roadway profile, and direct lines of sight:



Start Time: 1:12 AM (PM) Stop Time: 1:32 AM PM Duration: 20 min

Wind Speed/Direction: 0 mph Percentiles:

Temperature: 83°F Humidity: 40%

Calibration results before: 113.8 dBA and after 114.0 dBA

Traffic Count Roadway: I-29

	Autos	Medium Trucks	Heavy Trucks	Buses	Motorcycles
NB	101	1	31	0	0
SB	111	3	32	0	0

*Note roadway direction in table

HDR

SHORT-TERM TRAFFIC NOISE MONITORING LOG SHEET

PROJECT: Brookings (20th Street)

JOB NO.: 10220242

SITE/READING NO.: E - File 5

PERSONNEL: BJC

LOCATION/ADDRESS:

DATE: 6/4/20

#	1 Minute Period Starting	Meas'd Lmax (dBA)	√ or X	Meas'd Leq (dBA)	COMMENTS
1	1:12	63.9		58.6	
2	13	65.5		59.9	
3	14	61.6		56.9	
4	15	63.2		56.9	
5	16	65.0		57.1	
6	17	64.7		58.4	
7	18	64.5		59.1	
8	19	68.2		59.6	
9	20	66.8		60.4	
10	21	69.6		61.4	
11	22	61.8		56.9	
12	23	63.3		55.8	
13	24	64.1		58.3	
14	25	65.5		59.2	
15	26	63.3		55.9	
16	27	65.5		59.7	
17	28	69.0		60.2	plane overhead
18	29	63.0		58.1	
19	30	64.4		58.1	
20	31	67.3		60.6	
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

TOTAL Leq = SUBSET Leq =

√ = Other sources contributed to Leq X = Exclude period - contaminated by non-characteristic sources

>> ADD SKETCH AND WEATHER CONDITIONS TO REVERSE OR OTHER SHEET <<