Appendix I

Noise Study

NOISE STUDY REPORT

January, 2012

PROJECT NO. 385-3(118), C.N. 51432
Junction L-62A/US-385 to Alliance
Morrill and Box Butte Counties, Nebraska

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PROJECT BACKGROUND

This report documents the noise analysis completed in support of the Nebraska Department of Roads (NDOR) Junction L-62A/US-385 to Alliance Project. The proposed 27 mile long project consists of widening the roadway from an existing 2-lane highway to a 4-lane highway with the new lanes generally constructed along the west side of the existing lanes. The project begins on L-62A, 2.19 miles west of the junction with US-385 in Morrill County and continues north along US-385 into the city of Alliance in Box Butte County, ending just north of the intersection with Nebraska Highway 2. North of rock road and upon entering Alliance the roadway changes to 5 lanes by removing the median and adding a center turn lane. These portions of L-62A and US-385 are part of the "Heartland Expressway" project in western Nebraska.

The purpose of this noise report is to:

- Provide a discussion of the fundamentals of noise and traffic noise analysis.
- Evaluate existing traffic noise levels in the corridor.
- Predict the future traffic noise levels (2035) of sensitive receivers. Sensitive receivers are used adjacent to the studied corridor (such as houses, businesses, parks and schools) that might be affected by traffic noise.
- Identify the typical distance from the roadway at which noise levels would be predicted to approach the Federal Noise Abatement Criteria (NAC) noise levels of L_{eq} 67 dBA and 72 dBA. "Approaching" this level is defined by NDOR policy as a noise level within one decibel of the NAC.
- Quantify the number of properties that are predicted to experience roadway noise levels that exceed the applicable standards.
- Evaluate potential mitigation measures for sensitive receivers adjacent to the new alignment that approach or exceed the NAC.

NATURE OF NOISE

Noise may be defined as unwanted sound. Sound is the sensation produced when the movement of an object creates vibrations, or waves, that pass through the ears. The relative impact of sound waves depends on the amount of pressure they generate. The unit of measure for sound pressure is the decibel (dB). Decibels are based on a logarithmic scale because the range of sound pressures is too great to be accommodated on a linear scale. The range of sound pressure levels most frequently encountered in evaluating traffic-generated noise on highways is 50 to 95 dB.

The measured noise level from a given source does not necessarily correspond to our perception of "loudness." For instance, a three (3) decibel increase from a noise source represents a doubling of the noise level (as measured in sound pressure) on the logarithmic scale. However, this change is barely perceptible for human beings. Furthermore, an increase in 10 decibels from a noise source is a tenfold increase in noise pressure, but is only perceived as a doubling in the loudness by the human ear.

For highway traffic noise analysis, the Federal Highway Administration (FHWA) has specified that noise be predicted and evaluated in decibels weighted with the A-level frequency response; this unit of measure is referred to as dBA. Measurements in dBA incorporate a human's reduced sensitivity to both low frequency and very high frequency noises to better correlate with our subjective impression of loudness.

Table 1 displays noise levels common to everyday activities.

TABLE 1. Common Exterior Noise Levels (dBA)

Common Noise Levels	Noise Level (dBA)
Rock Band at 16 ft	110
Jet Flyover at 985 ft	105
Gas Lawn Mower at 3 ft	95
Diesel Truck at 50 ft	85
Same Truck at 110 ft	80
Gas Lawn Mower at 100 ft	70
Normal Speech at 3 ft	65
Birds Chirping	50
Leaves Rustling	40
Very Quiet Soft Whisper	30
Threshold of Hearing	0

23 CFR Part 772 Standards

23 Code of Federal Regulations (CFR) Part 772 was written by the Federal Highway Administration (FHWA). Its purpose is to provide procedures for noise studies, and noise abatement measures to help protect the public health and welfare, to supply noise abatement criteria, and to establish requirements for traffic noise information to be given to those officials who have planning and zoning authority in the project area. 23 CFR 772 contains noise abatement criteria, which are based on the equivalent level (L_{eq}), noise descriptor. L_{eq} (h) is the equivalent steady state sound level, which during the hour under consideration contains the same acoustic energy as the time-varying traffic sound level during that same hour. The following table contains the upper limits of hourly L_{eq} desirable noise levels that are part of the noise abatement criteria established by 23 CFR 772. Any noise levels that approach or exceed these criteria would not be desirable and would be referred to as a noise impact.

TABLE 2. Noise Abatement Criteria, Hourly A-Weighted Sound Level

Activity Category	Activity[1] Leq(h)	Activity Description
A	57 (exterior)	Lands on which serenity and quiet are of extraordinary significance and serve and important public need where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B[2]	67 (exterior)	Residential
C[2]	67 (exterior)	Active sport 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 structure, radio stations, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, trail crossings.
D	52 (Interior)	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structure, radio studios, recording studios, schools, television studios.
E[2]	72 (exterior)	Hotels, motels, offices, restaurants/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

[1]The Leq(h) Activity Criteria values are for impacted determination only, and are not design standards for noise abatement.

[2] Includes undeveloped lands permitted for this activity category.

The selection and analysis of all individual noise sensitive receptors are based on the data included in the above table. Most areas come under Activity Category "B" or "C" and “E”. Activity "E" typically consists of commercial land use or business offices. Category “F” sites are not considered to be noise sensitive areas. Primary consideration is to be given to exterior areas; therefore, all noise levels referred to in this study are exterior noise levels unless otherwise stated. Activity Category "D" is not normally used since interior noise depends on the type of windows, doors or wall structures of each building; however, sometimes a specific receptor might warrant its use. Category “A” sites are extremely rare as only a few exist in the entire nation.

NOISE PREDICTION METHOD

Traffic noise levels associated with existing conditions, no-build and build scenarios were predicted for this noise study:

> ***The Existing Conditions Scenario*** assumed current (2012) traffic volumes, vehicle mix (broken down by autos, medium trucks and heavy trucks) and roadway characteristics.
>
> ***The 2035 No-Build Scenario*** assumed that future (2035) forecasted traffic would be traveling on the existing alignment without a physical change to the road.
>
> ***The 2035 Build Scenario*** assumed that future (2035) forecasted traffic would be traveling on the constructed 4-lane roadway with an earth median. North of rock road upon entering Alliance the roadway changes to 5 lanes by removing the median and adding a center turn lane.

Traffic noise levels shown in this study resemble “peak hour” noise levels and are predicted in hourly L_{eq} dBA. The L_{eq} descriptor is reliable for low volume as well as high volume roadways, is simpler in most instances for highway designers to work with, and is more flexible in terms of permitting noise levels from different sources to be included in the analysis of the total ambient noise.

The "FHWA Highway Traffic Noise Prediction Model" is the method used in this report to predict L_{eq} dBA noise levels. This method was developed and approved for use by the U.S. Department of Transportation Federal Highway Administration. The procedures included in the FHWA Model permit an analysis of variations in traffic noises in terms of traffic parameters, roadway and observer characteristics. These parameters are then identified for a particular traffic situation and transformed into noise level estimates through the use of this prediction method, which has been set up on a computer, using the FHWA Traffic Noise Model (TNM) Version 2.5.

NOISE MODEL PARAMETERS

The following parameters were considered when applying the traffic noise prediction methodology:

- Traffic levels, vehicle composition (whether auto, medium truck or heavy truck)
- Posted speed: 65 mph on US-385, 65 mph on L62A, 45 mph approaching 3rd St.
- Design Speed: 65 mph on US-385, 65 mph on L62A, 45 mph approaching 3rd St.
- Plan and profile information for roadways
- Location and elevation of sensitive noise receivers by activity category
- Location of terrain and man-made features that act to shield traffic noise
- Ground cover type

TRAFFIC PARAMETERS

The traffic volume used for this hour time period is the Design Hourly Volume (DHV) traffic. If the DHV is not that predictable, a peak hour volume that occurs on a regular basis during design year might be used. Heavy trucks include vehicles having three or more axles, generally having a gross vehicle weight greater than 26,000 lbs. Medium trucks include all vehicles having two axles and six wheels, generally having a gross vehicle weight greater than 10,000 lbs but less than 26,000 lbs. The following diagram shows traffic volumes used on this project.

TABLE 3. Existing (2012) Traffic Data

Location	ADT	DHV	Cars	%HCV*	Medium Trucks	Heavy trucks
US-385 South of Rock Rd	3515	373	322	13	14	35
US-385 South of Kansas St.	4240	458	403	12	16	39
US-385 South of 3rd St. (HWY-2)	3967	428	377	12	14	37
US-385 North of 3rd St. (HWY-2)	4210	455	405	11	14	36
3rd st (HWY-2)	4365	476	452	5	7	17
Kansas St.	1220	162	141	13	6	15

*percent heavy commercial vehicles

TABLE 4. Build Condition (2035) Traffic Data

Location	ADT	DHV	Cars	%HCV*	Medium Trucks	Heavy trucks
US-385 South of Rock Rd	4895	515	448	13	19	48
US-385 South of Kansas St.	5600	605	532	12	20	53
US-385 South of 3rd St. (HWY-2)	5420	590	519	12	20	51
US-385 North of 3rd St. (HWY-2)	5700	615	547	11	19	49
3rd st (HWY-2)	4880	535	508	5	8	19
Kansas St.	1660	220	191	13	8	21

*percent heavy commercial vehicles

Table 5 documents the field measurements used to verify TNM. The model reasonably reflected the measured noise levels deviating by less than 3 dB(A).

Table 5. Monitored Noise Levels

	Time	Distance to pavement	Measured Leq	Predicted Leq (TNM)
Reading 1	4:15 PM	60	63.7	66
Reading 2	5:45 PM	80	62.4	63.7
Reading 3	6:30 PM	75	61.8	63

Locations of field noise measurements are illustrated on the aerials beginning on page 15.

Table 6 lists all those noise sensitive receptors within the limits of this project. The table details the following: distance of each receptor from the existing and proposed project centerline, computed noise levels in hourly L_{eq} dBA for the existing system (2012 traffic volumes), and computed noise levels in hourly L_{eq} dBA for future design year 2035 (no-build and build alternatives). Also shown are the hourly L_{eq} dBA noise abatement criteria (NAC) that are part of the 23 CFR Part 772 guidelines used in determining a noise impact. The asterisk indicates properties that have been acquired or planned for re-location.

TABLE 6. Noise Levels at Project Receptors

Receiver ID R-residential C-commercial	Distance from edge of pavement (ft) (existing/build)	Noise Levels [dB(A)]			Impacted (NAC)
		Existing (2012)	No-Build (2035)	Build (2035)	
R1	85/ 85	58	59	60	within NAC
R2	138/138	58	59	58	within NAC
R3	150/ 150	57	58	58	within NAC
R4	205/205	58	60	61	within NAC
R5	300/300	59	60	62	within NAC
R6	233/218	60	62	62	within NAC
R7	250/235	60	61	61	within NAC
R8	262/258	57	58	61	within NAC
R9	273/258	56	57	60	within NAC
R10	155/140	61	62	65	within NAC
R11	145/130	61	62	65	within NAC
R12	153/138	61	62	65	within NAC
R13	148/133	62	63	65	within NAC
R14	154/139	62	63	65	within NAC
R15	220/205	60	61	62	within NAC
R16	205/190	61	62	63	within NAC
R17	195/180	61	62	63	within NAC
R18	395/380	54	55	58	within NAC
R19	150/ -	63	64	–	*
R20	110/ -	65	67	–	*
R21	1045	43	44	46	within NAC
R22	238/178	58	60	62	within NAC
R23	120/ -	64	65	–	*
R24	175/125	60	61	65	within NAC

R25	1500/1500	40	41	43	within NAC
R26	1460/1460	40	41	42	within NAC
R27	1020/950	43	45	47	within NAC
R28	735/645	46	47	52	within NAC
R29	1310/1235	41	42	44	within NAC
R30	120/120	59	60	64	within NAC
R31	255/255	55	56	59	within NAC
R32	1080/1005	43	44	46	within NAC
R33	250/ -	57	59	–	*
R34	430/360	52	53	55	within NAC
R35	290/ -	56	57	–	*
R36	210/ -	59	61	–	*
R37	475/400	51	53	54	within NAC
R38	575/595	44	46	49	within NAC
R39	830/830	46	47	48	within NAC
R40	1620/1550	40	41	41	within NAC
R41	990/990	43	45	45	within NAC
R42	1025	43	45	46	within NAC
R43	1220/1170	42	44	45	within NAC
R44	2630/2580	36	37	38	within NAC
R45	1080/1095	43	44	45	within NAC
R46	1175/1100	42	43	45	within NAC
C1	128/128	60	62	61	within NAC
C2	250/235	59	60	61	within NAC
C3	155/140	65	66	65	within NAC
C4	360/345	53	55	58	within NAC
C5	170/155	61	62	64	within NAC
C6	150/135	64	65	65	within NAC
C7	267/252	59	61	59	within NAC
C8	145/130	62	64	66	within NAC

*property acquisition/relocation

TRAFFIC NOISE ANALYSIS

In analyzing the preceding traffic noise table, emphasis will be given to the two main noise criteria of a traffic noise impact as set forth in 23 CFR 772. A comparison will be made between the predicted traffic noise levels and the noise abatement criteria (NAC) to determine if a traffic noise impact exists due to the noise levels approaching or exceeding the criteria. Also, a comparison will be made between existing noise levels and future predicted traffic noise levels to determine if a noise impact occurs due to a substantial increase in noise. Nebraska Department of Roads generally considers that an impact occurs and abatement measures will be considered for receptors if:

1. The predicted design year noise levels approach or exceed the noise abatement criteria (NAC). NDOR has established that a noise level of one decibel less than the NAC in the FHWA Noise Standards, or 66 dB(A), constitutes “approaching” the NAC.

2. Predicted future noise levels are 15 dBA or more above existing levels. For purposes of interpreting the FHWA noise standards, this would be considered “substantially exceeding” existing levels.

PREDICTED NOISE LEVELS

The primary tasks for the noise study were to identify receivers that approached or exceeded the NAC and to determine the relative change in traffic noise levels anticipated due to the changed in alignment. Noise levels were predicted for existing conditions (2012), 2035 no-build conditions, and 2035 build conditions. TNM was applied using the appropriate roadway, traffic and sensitive receiver information to predict the noise levels for each of the scenarios.
The predicted noise levels are summarized as follows:

- There are no instances of build condition noise levels substantially exceeding no-build condition noise levels in the study area (increase of 15 dBA over the existing levels).
- There are no receivers that experienced noise levels approaching or exceeding the NAC for the future build scenario.
- 2035 no-build noise levels increased between one (1) and two (2) dBA compared to existing levels (2015).
- Noise levels typically increased by 1 or 2 decibels when comparing the 2035 no-build and build scenarios.

Typical 2035 build scenario noise impact contours of L_{eq} 66 dBA and L_{eq} 71 dBA were generated for this analysis. The uses that fall within these contours represent a noise level approaching (within one decibel) the NAC for Activity Category B, C and E uses. The typical distance to the edge of the noise impact contour may vary significantly throughout the corridor due to changes in terrain, some variation in traffic levels and changes in vehicle speed. The typical noise contours were generated to represent conditions where the roadway and receiver are at the same elevation with a direct line-of-sight between the roadway and receiver. For this reason, in some locations the actual width of the noise impact contour may differ from those documented in Table 6.

TABLE 7. Typical Noise Impact Contour Widths

Location	2035	
	66 dBA contour (ft)	71 dBA contour (ft)
US-385 L-62A to Rock Rd	125	40
US-385 Rock Rd to N-2 (3rd St.)	130	50
US-385 North of N2 (3rd St.)	70	NA
Kansas Street	30	NA
N-2 (3rd St.)	40	NA

While the noise contours illustrated in Table 7 and the Aerials do not illustrate any variation in impact width due to locations of noise shielding, the estimated noise levels at each receiver (Table 6) do account for location-specific shielding where appropriate.

NOISE ABATEMENT MEASURES

According to NDOR Policy, noise abatement measures should be considered where predicted traffic noise levels approach or exceed the noise abatement criteria, or when the predicted traffic noise levels substantially exceed the existing noise levels. In this case, abatement measures were not considered because no future build noise levels along the construction approach or exceed the NAC.

DETOUR NOISE

The project will utilize the existing alignment as a detour for any future build scenarios. Noise levels would remain the same as traffic numbers and flow will not be significantly changed.

CONSTRUCTION NOISE

The evaluation and control of construction noise must be considered as well as the traffic noise. The noise sensitive receptors that are located directly adjacent to this project are those that are of major concern in this study of construction noise. These same receptors were also of concern in the traffic noise study.

The following are some basic categories of mitigation measures for construction noise.

Design Considerations: This includes measures in the plans and specifications to minimize or eliminate adverse impacts. Because the existing noise sensitive receptors are on both sides of the roadway, nothing can be done to minimize or eliminate construction noise through changes in design.

Community Awareness: It is important for people to be made aware of the possible inconvenience and to know its approximate duration so they can plan their activities accordingly. It is the policy of the Nebraska Department of Roads that information concerning the upcoming project construction be submitted to all local news media.

Source Control: This 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 impact 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 is a more personal approach to work out ways to minimize construction noise impacts in the more noise-sensitive areas. No specific construction-noise, site-control specifications will be included in the plans.

Time and Activity Constraints: Limiting work 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 a time-related phase of construction work could occur. No specific constraints will be incorporated in the plans of this improvement. Enforcement of these constraints could be handled through a general city or county ordinance, either listing the exceptions or granting them on a case-by-case basis.

SUMMARY

Land use adjacent to this project is primarily agricultural along most of the corridor. Upon entering Alliance north of Rock Road the land use is a mix of residential and commercial. The noise levels table on page 8 of this report shows that NO receptors analyzed have a noise impact in the year 2035 build scenario due to noise levels approaching or exceeding the NAC. Although receiver 20 and 23 would experience a noise impact in the build scenario, these residences are being acquired or relocated.

The noise impact contours of 66 dBA and 71 dBA were generated for this analysis, because they represent a noise level approaching (within one decibel) the NAC for Activity Category B, C and E uses. The contours are a general reference and do not take into consideration shielding factors from buildings or terrain. Noise levels for specific areas or receivers are shown in Table 6 on page 8 and 9.

In the event that any changes in the nature, design, or location of the project are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing.

REFERENCES

23 Code of Federal Regulations (CFR) Part 772 was used throughout the study.

Predicted noise levels were based upon the method presented in FHWA-RD-77-108 "FHWA HIGHWAY TRAFFIC NOISE PREDICTION MODEL."

Nebraska Department of Roads “Noise Analysis and Abatement Policy,” July, 2011.

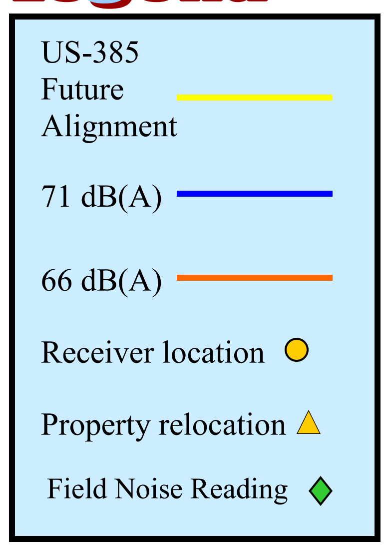
The introductory section of this study was taken in part from "Guide on Evaluation and Attenuation of Traffic Noise" prepared by American Association of State Highway and Transportation Officials. It is included to familiarize the reader with some of the basic technical terminology and to discuss the guidelines and standards used in the development of the report.

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

NDOR

Typical Contours (2035) and Receiver Locations

Legend



NDOR

Typical Contours (2035) and Receiver Locations

Legend

Legend	
US-385 Future Alignment	yellow line
71 dB(A)	blue line
66 dB(A)	orange line
Receiver location	○
Property relocation	△
Field Noise Reading	◇

Typical Contours (2035) and Receiver Locations

Legend

US-385 Future Alignment
71 dB(A)
66 dB(A)
Receiver location
Property relocation
Field Noise Reading

NDOR

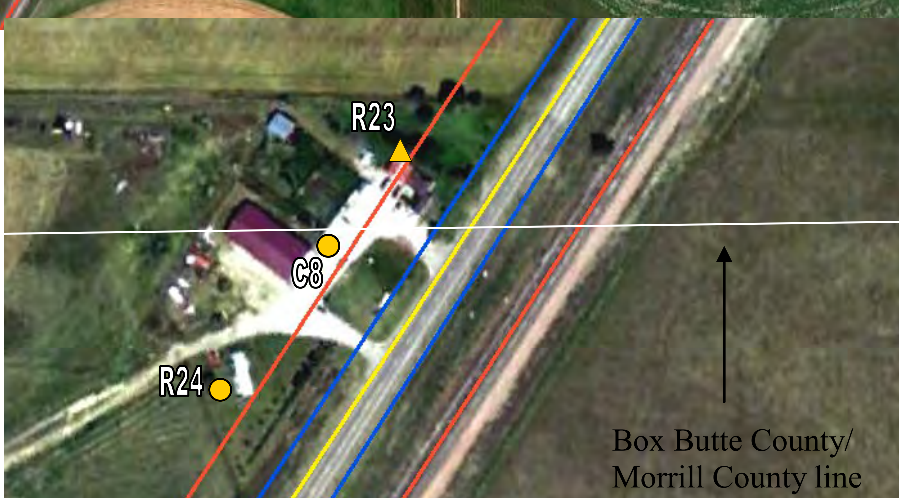
Typical Contours (2035) and Receiver Locations

Legend

US-385 Future Alignment	yellow line
71 dB(A)	blue line
66 dB(A)	orange line
Receiver location	○
Property relocation	△
Field Noise Reading	◇

NDOR

Typical Contours (2035) and Receiver Locations



Legend

US-385 Future Alignment

71 dB(A)

66 dB(A)

Receiver location

Property relocation

Field Noise Reading

NDOR

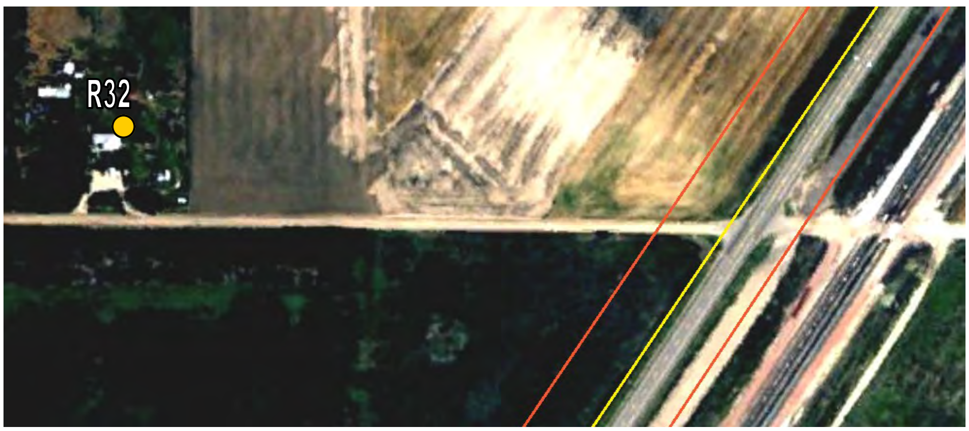
Typical Contours (2035) and Receiver Locations

Legend

- US-385 Future Alignment (yellow line)
- 71 dB(A) (blue line)
- 66 dB(A) (orange line)
- Receiver location (yellow circle)
- Property relocation (yellow triangle)
- Field Noise Reading (green diamond)

NDOR

Typical Contours (2035) and Receiver Locations

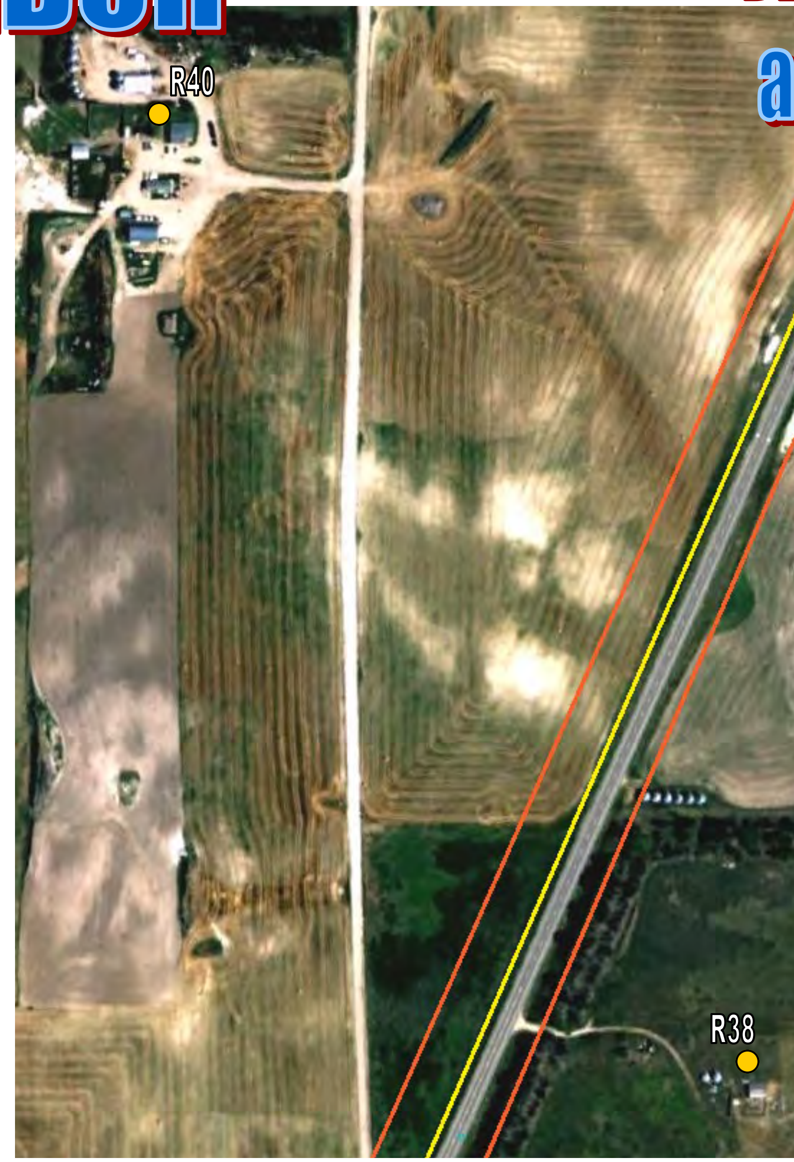


Legend

- US-385 Future Alignment (yellow line)
- 71 dB(A) (blue line)
- 66 dB(A) (orange line)
- Receiver location ○
- Property re-location △
- Field Noise Reading ◇

NDOR

Typical Contours (2035) and Receiver Locations



Legend

US-385 Future Alignment	yellow line
71 dB(A)	blue line
66 dB(A)	orange line
Receiver location	circle
Property re-location	triangle
Field Noise Reading	diamond