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XCEL ENERGY

May Valley Switching Station 345 kV & Longhorn Switching Station 345 kV May Valley-Longhorn Extension of Colorado's Power Pathway Project

Magnetic Field and Audible Noise Study

Final

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MAGNETIC FIELD AND AUDIBLE NOISE STUDY

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- "Prelim" means this document is issued for preliminary review, not for implementation
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EXECUTIVE SUMMARY

Public Service Company of Colorado (Public Service or the Company) contracted POWER Engineers, Inc. (POWER) to investigate magnetic field and audible noise effects for the construction of Longhorn and May Valley substations as part of the May Valley-Longhorn Extension of Colorado's Power Pathway Project (Pathway Project), which includes a new double circuit 345 kV transmission line connecting the two substations in eastern Colorado. The purpose of this report is to set forth the expected maximum level of magnetic fields that could be experienced at substation boundaries and the projected level of audible noise at 25 feet beyond substation property lines. This is consistent with Colorado Public Utilities Commission (PUC) Rule 3206 – Construction or Extension of Transmission Facilities (4 CCR 723-3-3206), in support of Public Service's application for a Certificate of Public Convenience and Necessity (CPCN) for construction of these new substations and the related transmission line. This report will be submitted to the PUC with the CPCN application.

Table 1 shows the maximum magnetic field strengths calculated at substation boundaries and the maximum audible noise levels calculated at 25 feet from substation property lines. For magnetic field strengths, the maximum value at the fence line or property line of each substation is shown. As detailed in the report, the calculated magnetic field strengths at the fence line of the May Valley Substation is expected to be below the 150 mG level deemed reasonable by PUC Rule 3206(e). For the Longhorn Substation, although the magnetic field strength at one fence line is projected to be above the level deemed reasonable by Rule 3206(e), the magnetic field strength at that property line is below the level deemed reasonable by Rule 3206(e). For audible noise levels, the maximum value 25 feet from the property line is shown in accordance with PUC Rule 3206(f).

TABLE 1 – STATION MAGNETIC FIELD AND AUDIBLE NOISE RESULTS SUMMARY

CASE	LOCATION OF APPLICABLE MAXIMUM VALUE	DEEMED REASONABLE LEVEL (PUC RULE 3206)	RESULTS
Magnetic Field	Station Boundary	150 mG	—
Longhorn	Maximum at southern property line	150 mG	63 mG
May Valley	Maximum at western fence line	150 mG	42 mG
Audible Noise	25 feet from Station Property Line	Deemed reasonable level (Zoning-dependent per Rule 3206)	—
Longhorn	Maximum 25 feet from eastern property line	No 3206(f) defined ruling limit[b]	63 dB(A)
May Valley	Maximum 25 feet from eastern property line	No 3206(f) defined ruling limit[b]	64 dB(A)

* For these substations, the substation parcels and surrounding land are zoned agricultural and/or a mix of other zoning designations. Rule 3206(f) does not identify an audible noise level that is deemed reasonable for land zoned agricultural, and POWER does not draw any conclusions about the zoning-dependent audible noise levels that would be deemed reasonable by PUC Rule 3206(f). Additional information about zoning and land use can be found in the "Zoning Designations and Land Use" section below.

Table 2 shows the maximum magnetic field strengths calculated at the edge of the transmission line right-of-way (ROW) and the maximum audible noise levels calculated at 25 feet from the edge of the ROW, consistent with Colorado Public Utilities Commission (PUC) Rule 3206(e) and (f), respectively.

Table 2 - TRANSMISSION MAGNETIC FIELD AND AUDIBLE NOISE RESULTS SUMMARY

Case	Location	Deemed Reasonable Level (PUC Rule 3206)	Results
Audible Noise	25 Feet Outside Edge of ROW	50 dB(A) (Residential – most stringent level)	49.8 dB(A)
Magnetic Field	Edge of ROW	150 mG	54.7 mG

PROJECT NEED

In 2018, Public Service announced the Company's vision to reduce carbon dioxide emissions 80 percent company-wide from 2005 levels by 2030 and to provide 100 percent carbon-free electricity by 2050. In order to achieve an 80 percent reduction by 2030, extra high voltage transmission infrastructure will need to be constructed to assist bringing renewable generation from northeastern, eastern and/or southern parts of Colorado to the Denver Metro area and the Company's existing transmission system.

PROJECT DESCRIPTION

Colorado's Power Pathway project will consist of a double circuit 345 kV transmission line that will connect with seven existing and new stations: Fort St. Vrain, Canal Crossing, Pawnee, Goose Creek, May Valley, Tundra, and Harvest Mile. Figure 1 shows the larger project area with the double circuit 345 kV transmission line. This analysis covers an extension option consisting of a 345 kV transmission line that will connect the May Valley Substation to a new Longhorn Substation.

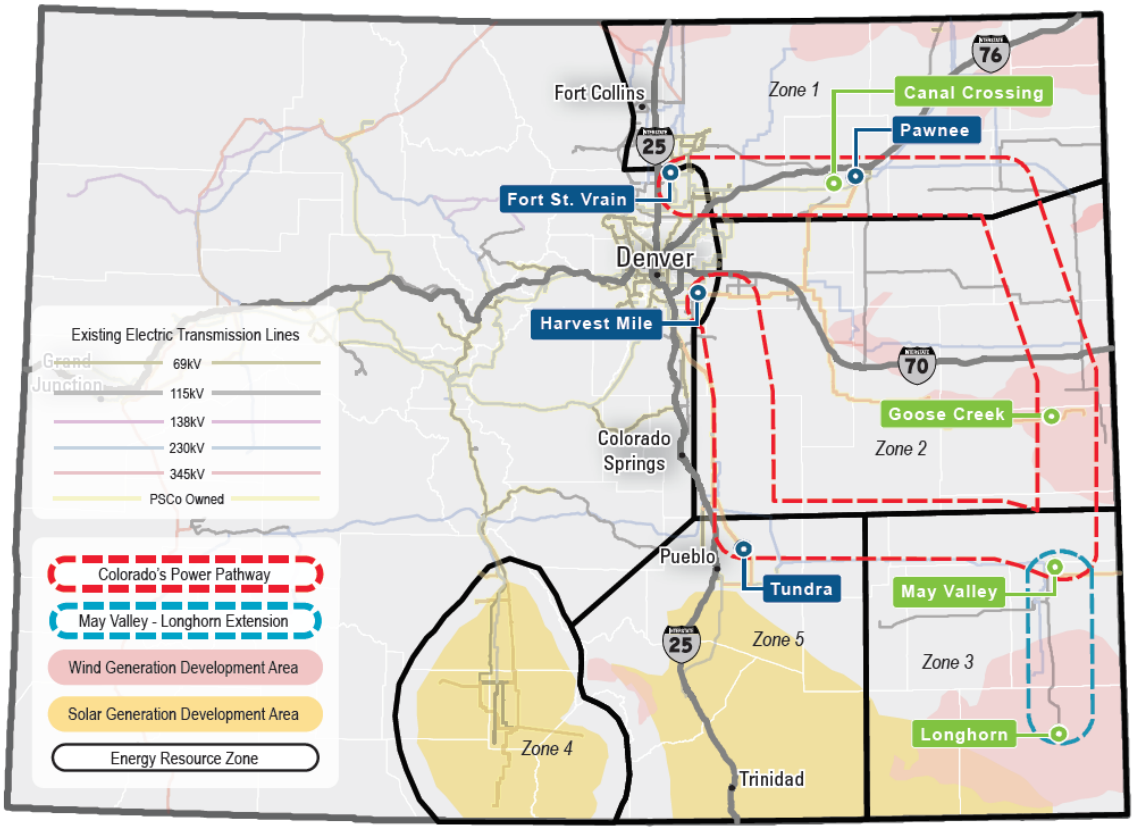

Figure 1: Pathway Project General Area Overview

PUC RULES AND STUDY METHODOLOGY

Applicable Rules for Magnetic Fields and Audible Noise

PUC Rule 3206 – Construction or Extension of Transmission Facilities (4 CCR 723-3-3206) requires new transmission facilities comply with Rule 3206(e) for magnetic field strengths and 3206(f) for audible noise.

Magnetic field levels are detailed in Rule 3206(e), which states the following:

> The filing shall include the expected maximum level of magnetic fields that could be experienced under design conditions at the edge of the transmission line right-of-way or substation boundary, at a location of one meter above ground.

In addition, Rule 3206(e)(III) provides that "[p]roposed magnetic field levels of 150 mG (milliGauss) and below are deemed reasonable by rule and need not be mitigated to a lower level."

Audible noise compliance limits are detailed in Rule 3206(f), which states the following:

> The filing shall include the projected level of noise radiating beyond the property line or right-of-way (as applicable) at a distance of 25 feet.

Rule 3206(f)(II) provides that proposed levels of noise at or below the values listed in Figure 2, by land use zoning designation, are deemed reasonable by rule and need not be mitigated to a lower level:

(A)	Residential	50 db(A)
(B)	Commercial	55 db(A)
(C)	Light industrial	65 db(A)
(D)	Industrial	75 db(A)

Figure 2: Audible Noise Levels Deemed Reasonable By Rule 3206(f) by Zoning Designation

Rule 3206(f)(III) further provides that for land that has a zoning designation other than one of the four designations enumerated above, proposed noise levels will not be subject to further review if the proposed noise threshold is 50 dB(A) or below regardless of use of land.

Zoning Designations and Land Use

Table 3 summarizes the zoning designations of the Pathway Project station parcels and details zoning and uses of the surrounding land.

TABLE 3 – STATION ZONING AND SURROUNDING LAND USES

STATION	STATION ZONING*	ZONING OF SURROUNDING LAND	SURROUNDING LAND USES
May Valley	Non-irrigated Agriculture (A-2)	• Non-irrigated Agriculture (A-2)	• Agriculture • Oil and gas infrastructure
Longhorn	No Zoning	• County does not have any zoning	• Agriculture • Oil and gas infrastructure • Industrial operations

* Zoning information in this table was provided by Public Service.

The transmission line will likely cross through multiple different zoning districts with different zoning designations.

Transmission Line Magnetic Fields and Audible Noise Analysis Methodology and Assumptions

The audible noise and magnetic field analysis was performed using the Bonneville Power Administration's (BPA) Corona and Field Effects Program (CAFEP) software version 3, which is a utility standard program for noise and magnetic field modeling. CAFEP uses the electrical and physical characteristics of the transmission line to calculate resulting fields and interference effects from the transmission lines.

The audible noise is primarily a function of the maximum operating voltage of conductors but is also impacted by the diameter of the conductors, distance of the conductors from each other, and elevation of the line above sea level. Audible noise was analyzed at the average conductor height along a span, as is standard in the industry.

Magnetic fields were primarily a function of the line current loading, which varies over time. The magnetic fields calculations were performed at 25%, 50% and 100% conductor current carrying capacity, as defined for each conductor in Table 4. For the analysis, magnetic fields were analyzed at a minimum conductor height (near mid-span, at maximum sag), as this location will produce the worst-case scenario (*i.e.* the highest magnetic field values).

Audible Noise (AN)

Audible noise is measured as an equivalent A-weighted sound-pressure level in decibels [dB(A)]. The L50 audible noise values represent the predicted average noise levels. The actual value is expected to be at or below this calculated L50 value 50% of the time, and above the value the other 50% of the time. Values are calculated at a height of five feet above the ground per IEEE Std 656-2018, using an estimated average conductor height of two-thirds the MOT (Maximum Operating Temperature) sag to approximate the average values along the entire line. In general, audible noise is highest during foul weather conditions (rain) as can be seen in the Results section for Audible Noise.

A single pole structure was modeled for audible noise. The new 345 kV lines are generally anticipated to be located in the center of a 150-foot-wide ROW.

Magnetic Fields

The reported magnetic field values are the magnetic flux density at a given point in space. Magnetic flux density is measured in gauss or milligauss (mG). Magnetic fields were analyzed at minimum conductor height above ground. Magnetic fields are analyzed at the edge of right-of-way for transmission lines and at a height of one meter (3.28 ft) above ground per IEEE Std 644-2019 and consistent with PUC Rule 3206(e).

A transmission line was modeled using a single pole structure. The new 345 kV lines are generally anticipated to be located in the center of a 150-foot-wide ROW.

TRANSMISSION LINE DATA

The two conductor types analyzed were 1272 ACSR Bittern and 556 twisted pair (T2) ACSR Dove. Table 4 provides the loading of each conductor (in percentage as a function of the conductor current carrying capacity) as provided by Public Service, to be used in this study and the equivalent conductor diameter. Both conductors are two-conductor bundle with a horizontal spacing of 18 inches.

Table 4 – Conductor Loading and Sizes

Conductor	Loading (amperes)			Diameter (inches)
	25%	50%	100%	
1272 ACSR Bittern	723	1,445	2,890	1.345
556 T2 ACSR Dove	786	1,571	3,142	1.517

The double circuit structure reviewed is provided in Appendix A. Dimensions shown for the double circuit structure in Appendix A were used in calculations to obtain audible noise and magnetic field results. Figure 3 shows the phasing for the double circuit structure.

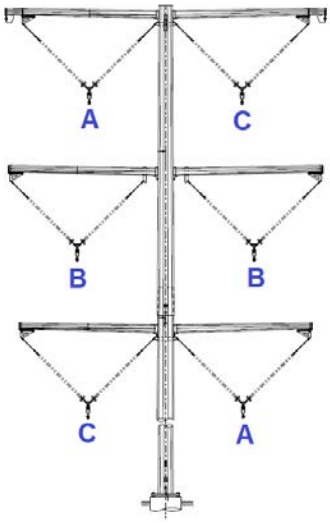

Figure 3: Double Circuit Phasing

Additional data used in the audible noise and magnetic field calculations are listed below.

- Average line altitude: 7,000 feet
- Right-of-Way (ROW) width: 150 feet
- Operating voltage: 345 kV
- Conductor minimum height: 30.5 feet
- Lower conductor average height: 51.5 feet
- Shield Wires: Two AFL DNO-10723 OPGW, 0.555-inch diameter

The shield wires were assumed to have 10-foot less sag than the phase conductors.

Any changes to the conductors, dimensions, or the phase arrangement could affect the results of the study.

TRANSMISSION LINE RESULTS

Results for audible noise and magnetic field calculations are shown as to allow a comparison of results by conductor types.

Magnetic Fields

The calculated magnetic field results are shown in Table 5. Magnetic field results are analyzed within the right-of-way for maximum value and at the edge of right-of-way for each 25%, 50%, and 100% of the conductor current carrying capacity.

Table 5 – Magnetic Field Results

Conductor	Edge of ROW Magnetic Field (mG)		
	25% Capacity	50% Capacity	100% Capacity
Deemed reasonable level (PUC Rule 3206)	*150*	*150*	*150*
Bittern	13.7	27.4	54.7
T2 Dove	14.9	29.7	59.5

Figure 4, Figure 5, and Figure 6 show plots of the magnetic field results at 25%, 50% and 100% capacity, respectively, by conductor type.

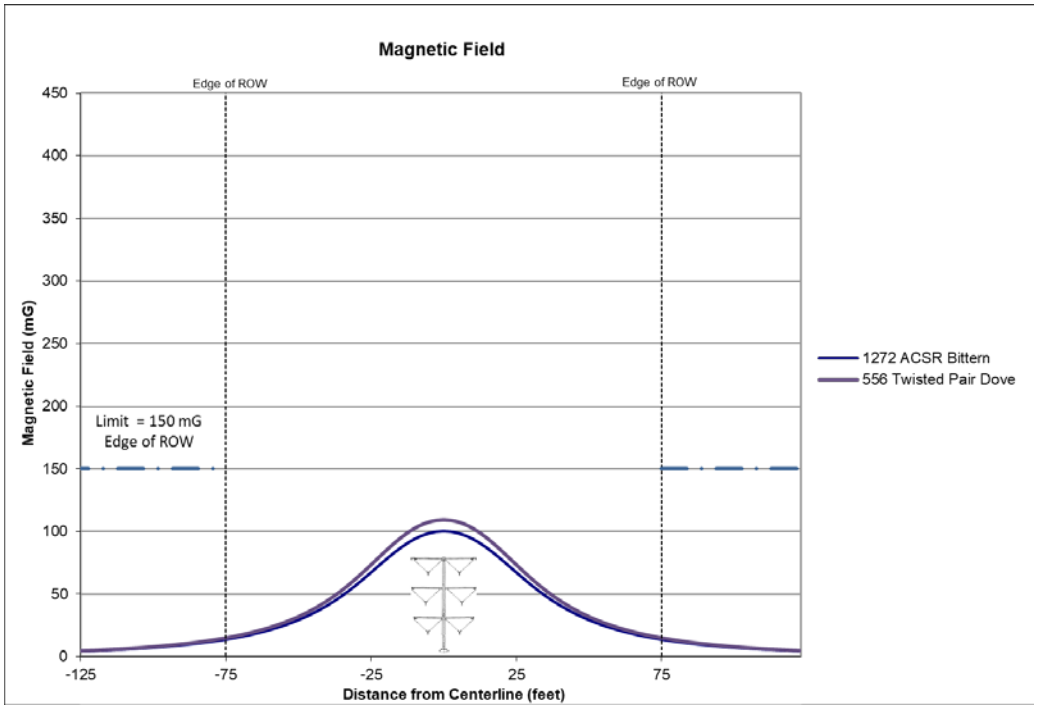

Figure 4: Magnetic Field (MF) – 25% Capacity

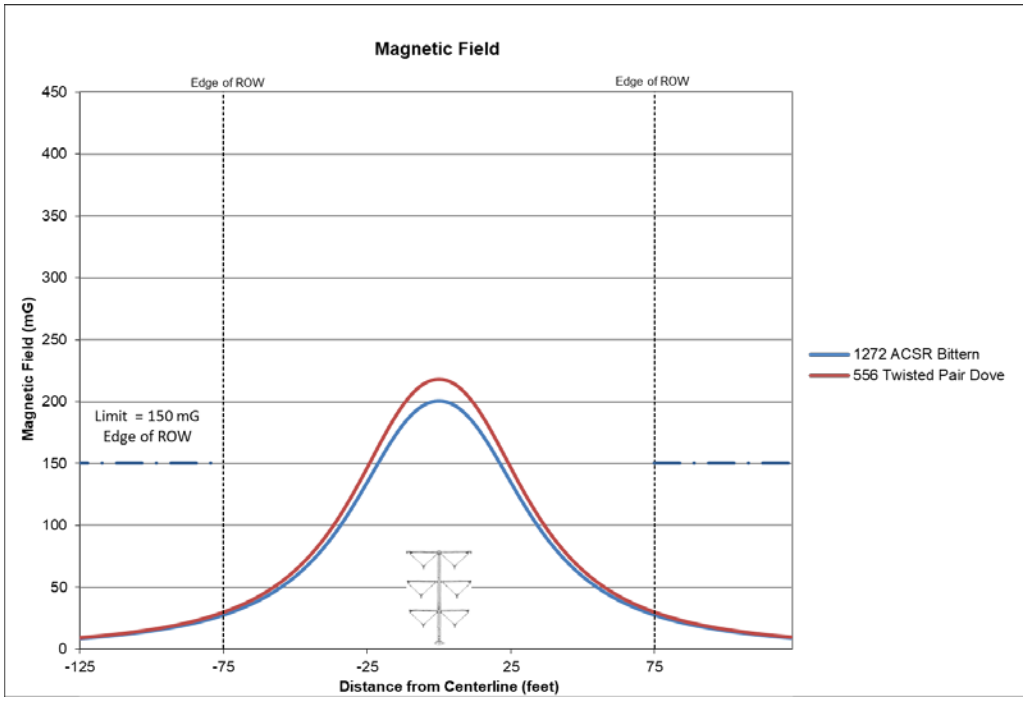

Figure 5: Magnetic Field (MF) – 50% Capacity

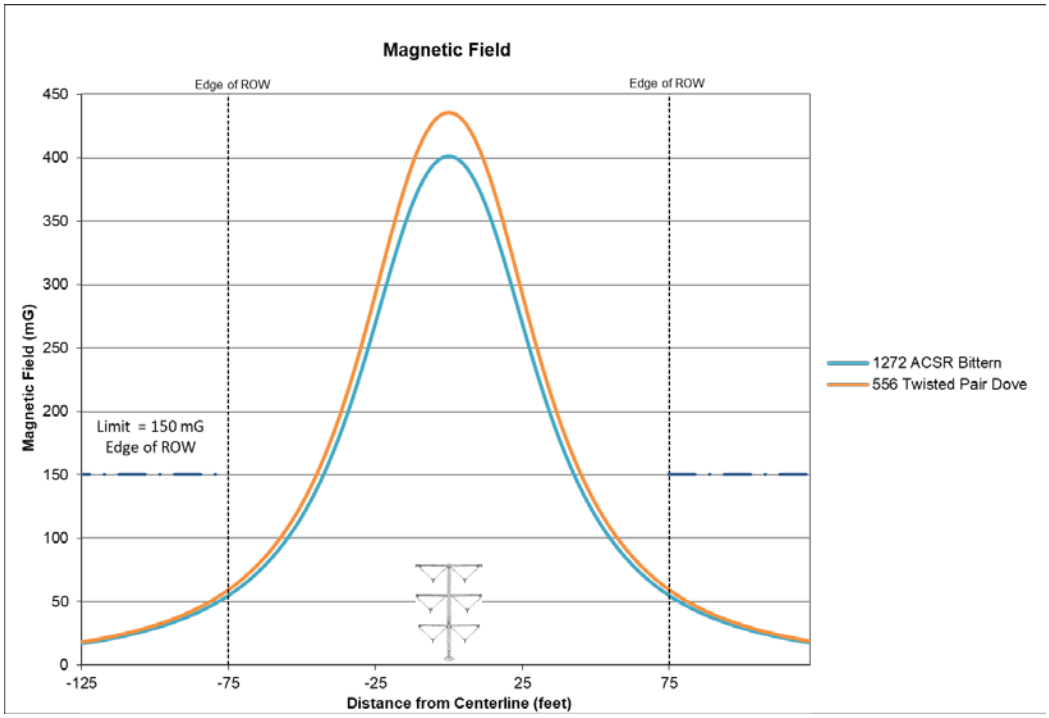

Figure 6: Magnetic Field (MF) – 100% Capacity

The magnetic field results for all conductor current carrying capacity are well below the 150 mG deemed reasonable at the edge of the ROW by PUC Rule 3206(e).

Audible Noise (AN) Results

The calculated results of the audible noise (AN) for each specified conductor type are shown in Table 6. Audible noise results are analyzed at the centerline, at the edge of right-of-way, and at 25 feet beyond the edge of right-of-way.

Table 6 – Audible Noise Results

Conductor	Audible Noise (dB(A)) Per Location					
	Rain			Fair		
	25 Feet Beyond ROW	Edge of ROW	Centerline	25 Feet Beyond ROW	Edge of ROW	Centerline
Most stringent deemed reasonable level [Residential] (PUC Rule 3206)	*50*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
Bittern	49.8	50.7	52.9	24.8	25.7	27.9
T2 Dove	47.6	48.5	50.7	22.6	23.5	25.7

Figure 7 and Figure 8 show plots of the audible noise results for foul weather (rain) conditions and fair weather (dry) conditions, respectively, by conductor type.

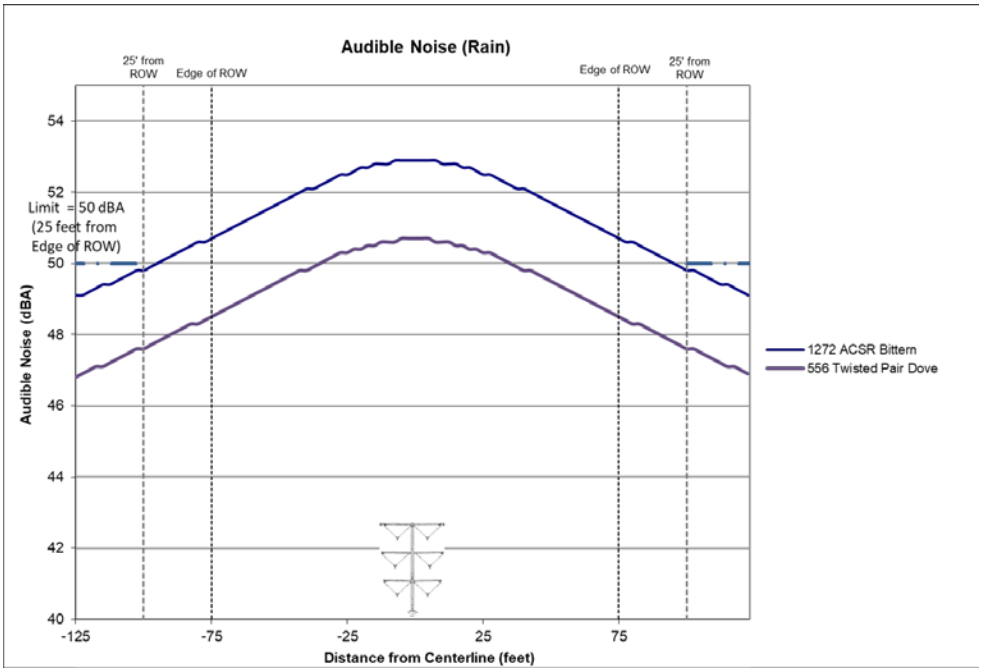

Figure 7: Audible Noise (AN) - Rain

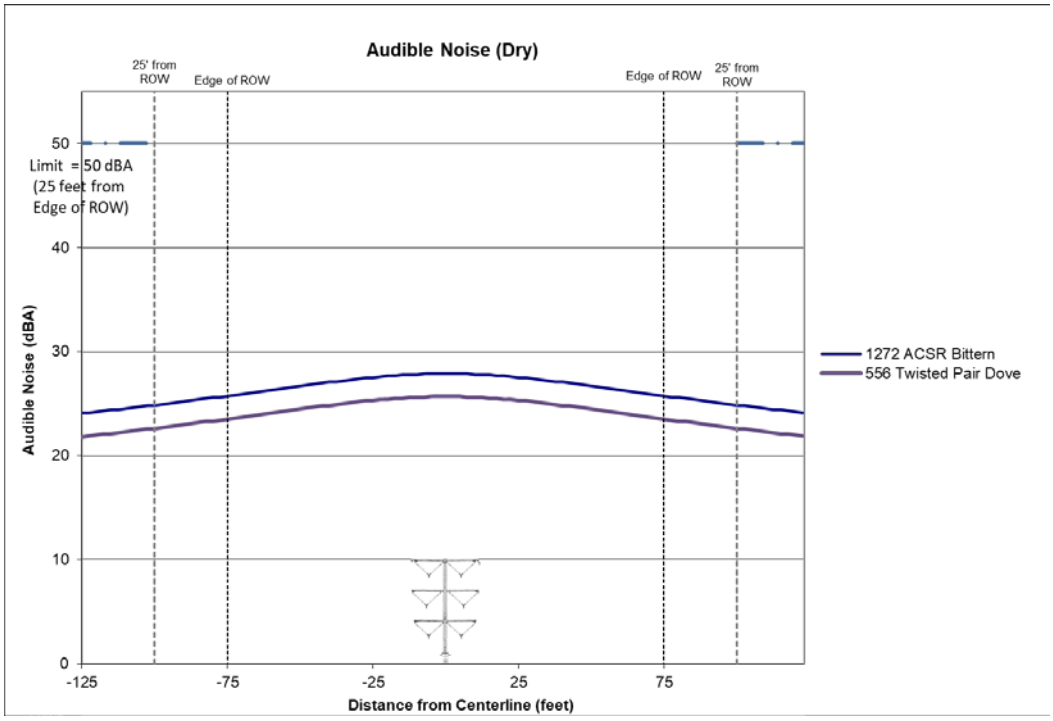

Figure 8: Audible Noise (AN) – Fair Weather (Dry)

The audible noise results for both foul weather (rain) conditions and fair conditions are below 50 dBA at 25 feet from both sides of the edge of the ROW. The audible noise levels are below all levels deemed reasonable by Commission rule, including the Commission's most stringent 50 dBA residential noise limit set forth in Rule 3206(f).

Substation Magnetic Field and Audible Noise Analysis Methodology and Assumptions

Magnetic Fields

The magnetic field effects were modeled using SES (Safe Engineering Services and technologies ltd.) CDEGS (Current Distribution, Electromagnetic fields, Grounding and Soil structure analysis) software, version 16.2. The CDEGS software allows for modeling of the bus work (typically horizontal conductors and vertical conductors) in three dimensions, which allows the physical system to be accurately represented within the model and field effects to be analyzed.

The analysis was performed by energizing the buses to the maximum rating. To this end, vertical and horizontal buses were energized to carry the maximum steady state current rating of 3,000 amperes in the same directions. It is worth mentioning that this energization scheme may not be physically feasible given that currents will split at bus nodes. Therefore, this energization represents the worst-case magnetic field strengths (i.e. the highest EMF values) that can be produced outside of the bus zone if all the bus conductors carry their maximum current rating. Consistent with PUC Rule 3206(e), the magnetic field is analyzed and reported at a height of one meter above the ground.

The values of these effects were calculated at the substation fence line. Results include, for reference, plots of the values for the entire substation.

Audible Noise

The audible noise effects were analyzed through acoustic modeling of the substation using the DataKustik GmbH, CadnaA (Computer Aided Noise Abatement) software package (version 4.5.151 or version 2021 MR 1), which is a utility standard program. Noise propagation characteristics in this software package are based upon *ISO 9613 "Acoustics – Attenuation of sound during propagation outdoors –Part 1: Calculation of the absorption of sound by the atmosphere and Part 2: General method of calculation."*

The audible noise effects for this project are driven by the maximum sound pressure of the transformers and reactors. The values of these effects were calculated at points 25 feet from the substation property line. The receptor height placement is modeled at 1.5 meters (4.9 feet) to approximate the height of an individual's ear. Results include, for reference, plots of the values for the entire substation and at least 25 feet beyond the substation property line.

STATION DATA

Magnetic field and audible noise performance are based on the electrical and physical characteristics of the substation. Specifically, these factors are driven by the voltage and current loading of the bus, the heights of the conductors and buses from the ground, and transformer and reactor ratings. As a result, there are a number of variable factors that will affect results. The data listed in Table 7 was used for the analysis. Should any of this data change, the results will also change.

Table 7 – Summary of Input Data

MEASUREMENT CATEGORY	DATA
345 kV Bus Rating*	3,000 A
345 kV Low Bus Height**	19.0 feet
345 kV High Bus Height**	33.5 feet
40 MVAR Reactor Maximum Sound Pressure Level***	65 dB(A)

* Bus ratings are per Public Service design standards.

** Bus heights listed in Table 2 are per Public Service design standards.

*** Measurement locations per IEEE Std C57.21-2008 and IEEE Std C57.12.90-2010. 40 MVAR reactor level per NEMA.

Appendix A includes substation general arrangement drawings from which dimensions were obtained. Note, all buses shown horizontally on the drawings were assumed to be low buses, and all shown vertically were assumed to be high buses.

STATION RESULTS

Magnetic Field

The reported magnetic field strength values are the magnetic flux densities at given points in space. Magnetic flux density is calculated in gauss or milligauss (mG). For these studies, magnetic field strengths were calculated with the maximum ampacity flowing in the substation based upon the bus rating.

Longhorn

Table 8 shows a summary of the magnetic field strength values at hypothetical fence lines and property lines for the new Longhorn Substation based on a conceptual substation general arrangement provided by the Company and the assumed land acquisition for the substation. Values are calculated at a height of one meter above the ground per IEEE Std 644-2019 and consistent with PUC Rule 3206(e). The magnetic field strength levels at each of the hypothetical property lines for the substation are below the 150 mG magnetic field strength levels deemed reasonable by PUC Rule 3206(e).

Table 8 – Longhorn Magnetic Field Strength		
STATION FENCE LINE LOCATION	MAGNETIC FIELD AT EDGE OF FENCE LINE [mG]	MAGNETIC FIELD AT EDGE OF PROPERTY LINE [mG]
Magnetic Field Deemed Reasonable Level (PUC Rule 3206)	*150*	*150*
Maximum Northern Fence Line	81	8
Maximum Eastern Fence Line	124	51
Maximum Southern Fence Line	152	63
Maximum Western Fence Line	81	39

Figure 9 and Figure 10 show plots of the magnetic field strengths along the fence line and property line, respectively. Figure 11 shows magnetic field strengths that exceed 150 mG.

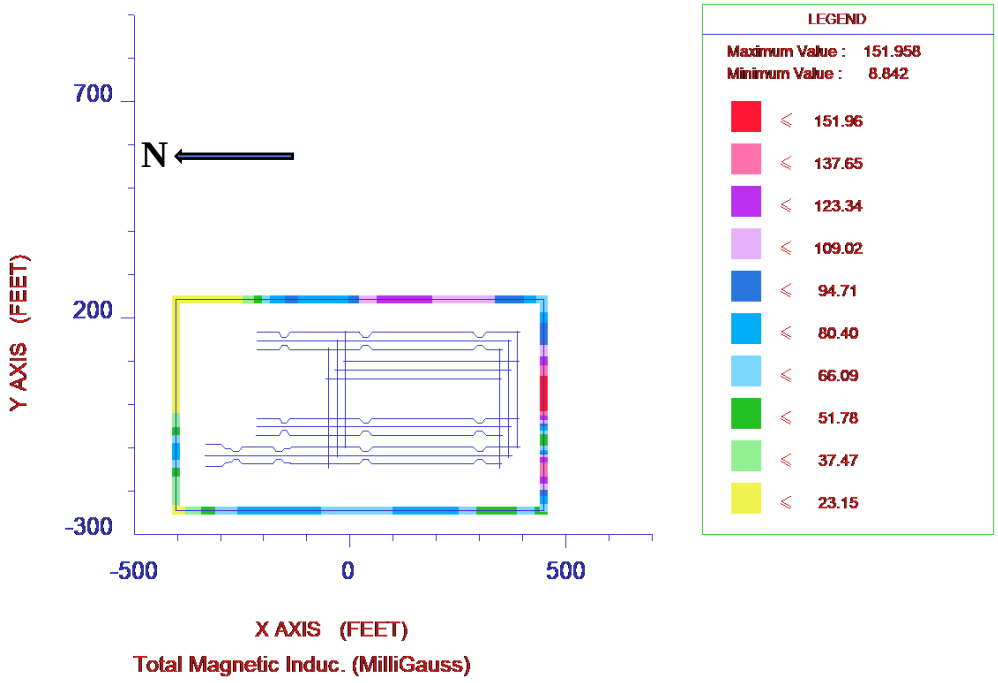

Figure 9: Longhorn Magnetic Field Strength Values at the Fence Line

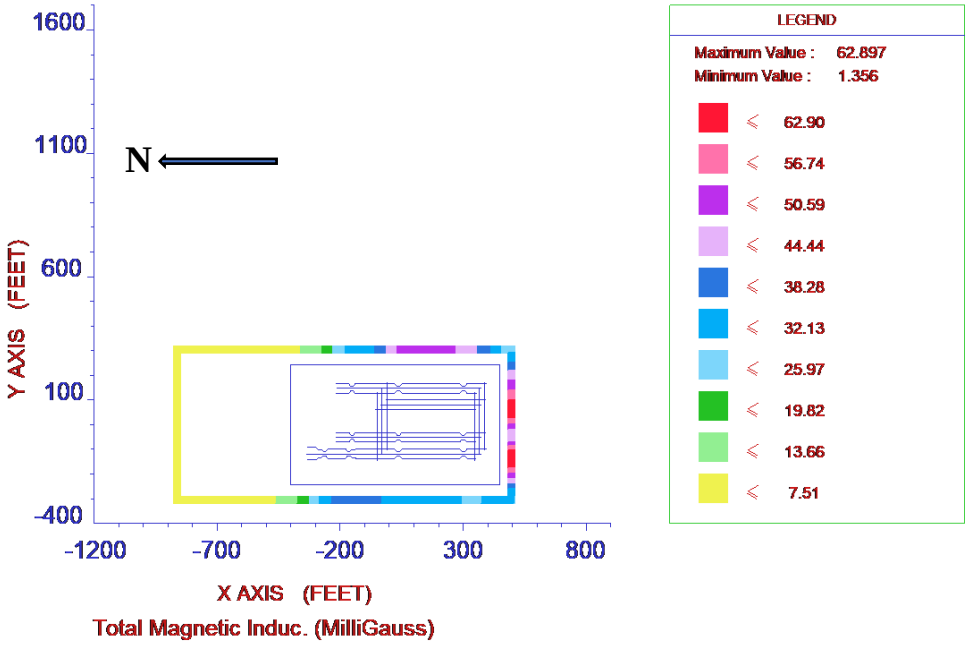

Figure 10: Longhorn Magnetic Field Strength Values at the Property Line

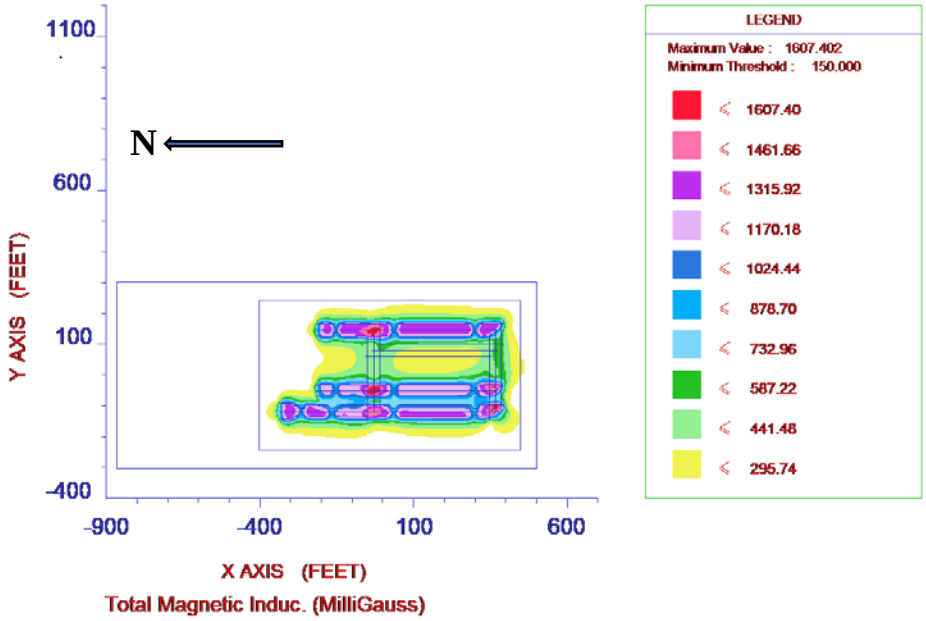

Figure 11: Longhorn Magnetic Field Strength Values Exceeding 150 mG

May Valley

Table 9 shows a summary of the magnetic field strength values at the hypothetical fence line for the new May Valley Substation based on a conceptual substation general arrangement provided by the Company and the assumed land acquisition for the substation. The May Valley Substation that is planned for the Pathway Project would be enlarged to accommodate the May Valley-Longhorn Extension. Values are calculated at a height of one meter above the ground per IEEE Std 644-2019 and consistent with PUC Rule 3206(e). The magnetic field strength levels at each of the hypothetical fence lines for the substation are below the 150 mG magnetic field level deemed reasonable by PUC Rule 3206(e).

Table 9 – May Valley Magnetic Field Strength

STATION FENCE LINE LOCATION	MAGNETIC FIELD AT EDGE OF FENCE LINE [mG]
Magnetic Field Deemed Reasonable Level (PUC Rule 3206)	*150*
Maximum Northern Fence Line	14
Maximum Eastern Fence Line	31
Maximum Southern Fence Line	24
Maximum Western Fence Line	42

Figure 12 shows magnetic field strengths along the fence line, while Figure 13 shows magnetic field strength values throughout the substation that exceed 150 mG.

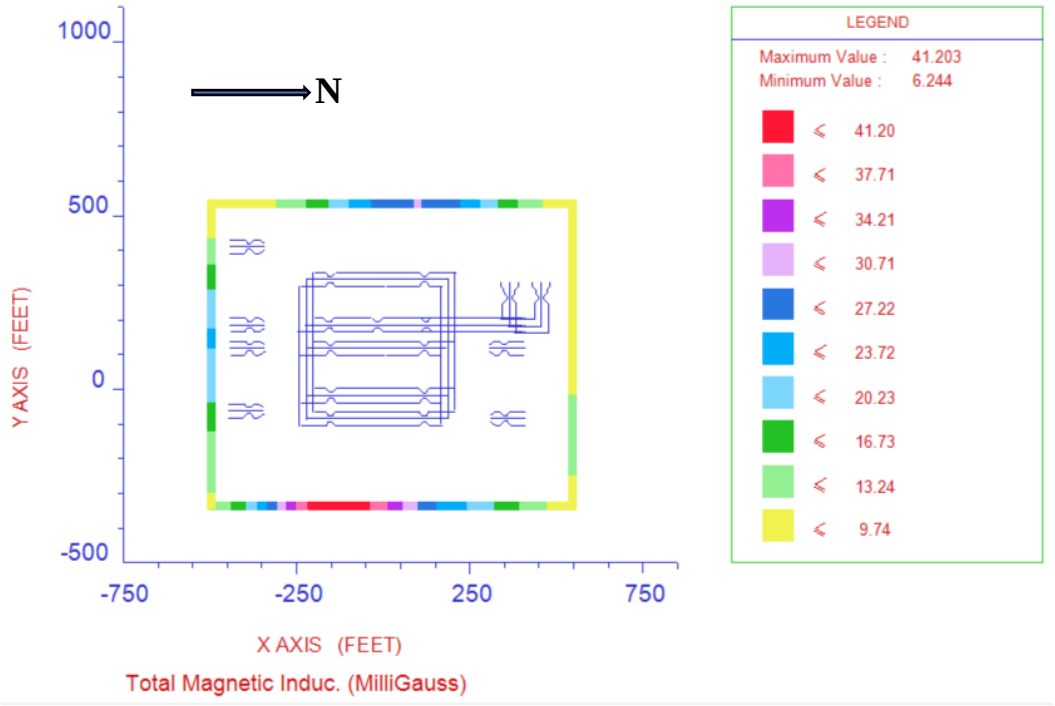

Figure 12: May Valley Magnetic Field Strength Values at the Fence Line

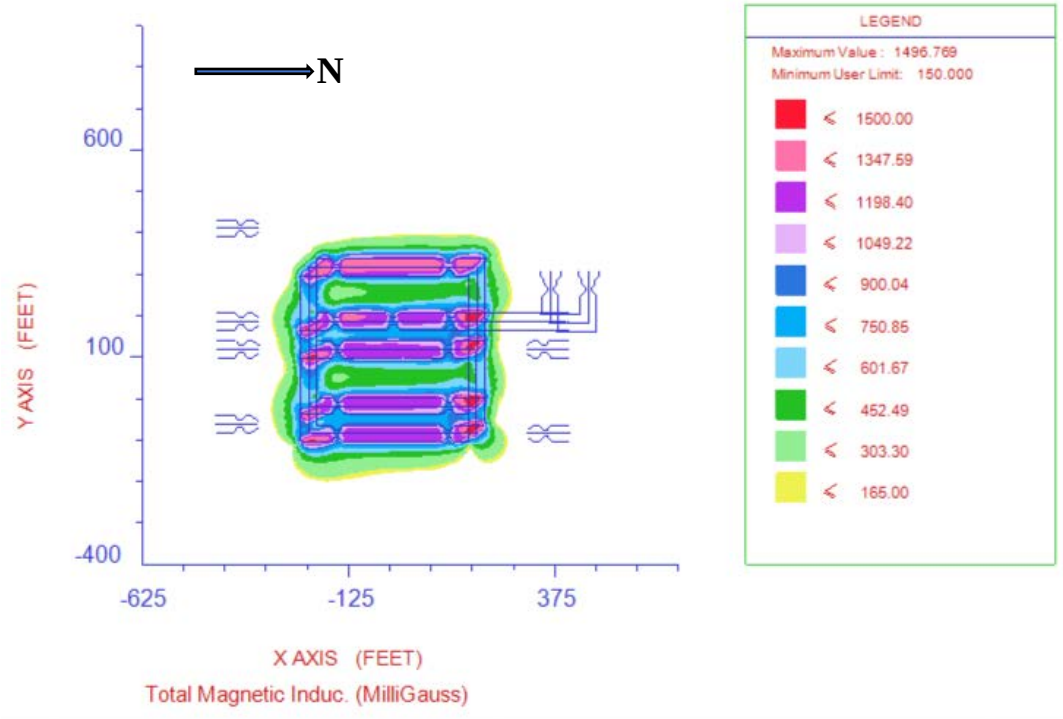

Figure 13: May Valley Magnetic Field Strength Values Exceeding 150 mG

Audible Noise

Within the scope of the Pathway Project, the new and expanded substations will contain reactors and transformers that are considered as continuous noise generating equipment. Each noise source was modeled as a point source. Additionally, the models included walls or barriers that might block sound, such as control houses, for their impact at mitigating noise outside the stations.

Audible noise is measured and calculated as an equivalent A-weighted sound pressure level in decibels (dB(A)). Values are calculated at a height of 1.5 meters (~4.9 feet) to approximate the height of an individual's ear.

This preliminary study assumes a flat surface at the site and does not account for possible elevation changes. Additionally, the analysis does not consider possible attenuation due to the properties of ground surfaces. No structures outside of substation fence lines, including buildings that would be expected to absorb, reflect, or shield audible noise, were modeled for these studies.

Longhorn

The new Longhorn Substation will contain two reactors (assumed rating of 60 MVAR) that are considered as continuous noise generating equipment on the site. Figure 14 shows the color-shaded plot of the sound pressure levels produced by the reactors around the substation.

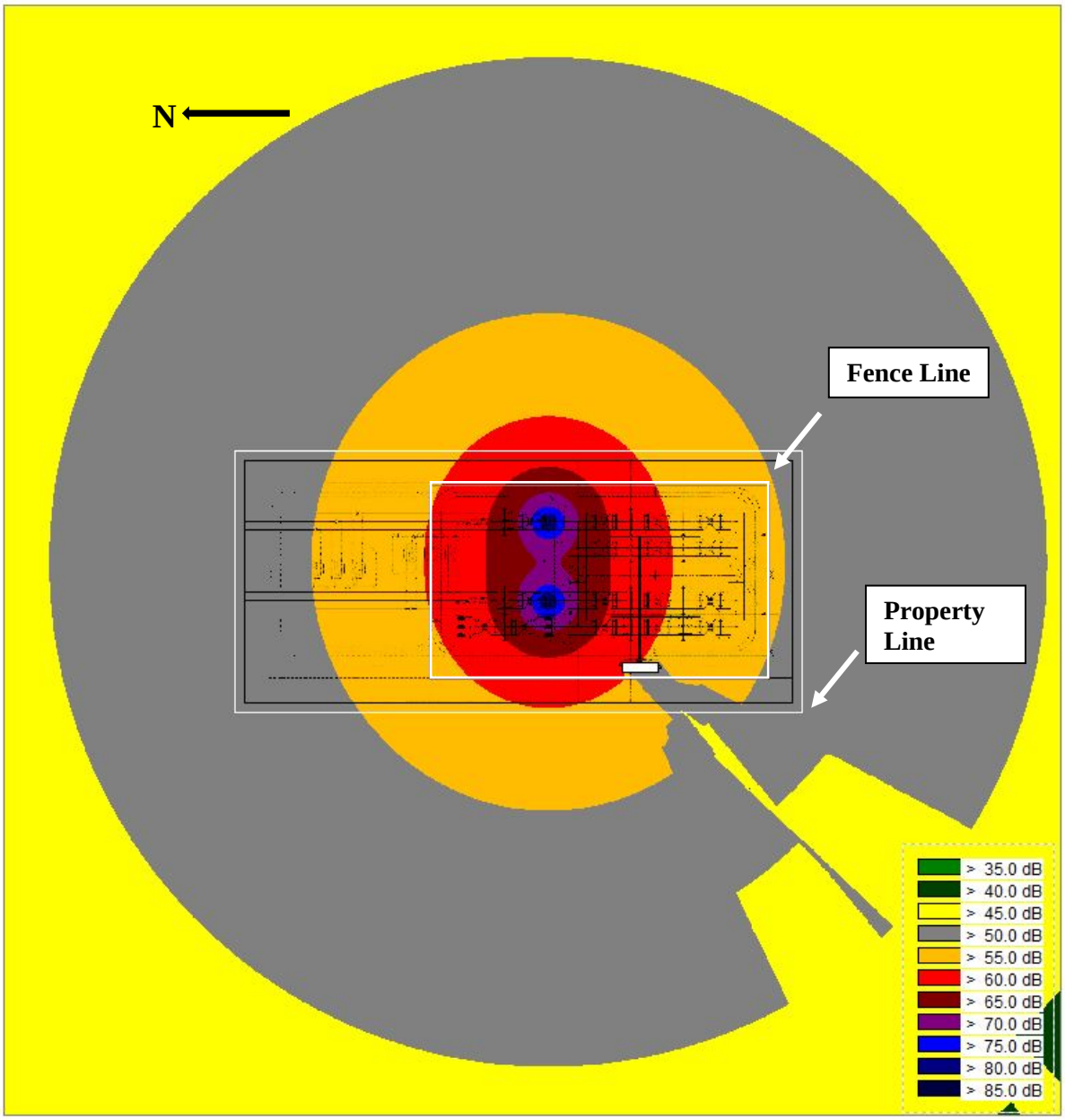

Figure 14: Longhorn Audible Noise Levels

Table 10 shows the projected audible noise levels 25 feet from hypothetical substation's property lines based on a conceptual substation general arrangement provided by the Company and the assumed land acquisition for the substation. The audible noise produced by the substation is expected to be 63 dB(A) or less at a distance of 25 feet from the property lines.

Table 10 – Longhorn Audible Noise Values

STATION PROPERTY LINE LOCATION	AUDIBLE NOISE 25 FEET FROM PROPERTY LINE [DB(A)]
Audible Noise Deemed Reasonable Level (PUC Rule 3206)	*No 3206(f) defined ruling limit**
25 feet from Northern Property Line	53
25 feet from Eastern Property Line	63
25 feet from Southern Property Line	55
25 feet from Western Property Line	60

* For some of the Power Pathway substations, the station parcels and surrounding land are zoned agricultural and/or a mix of other zoning designations. Rule 3206(f) does not identify an audible noise level that is deemed reasonable for land zoned agricultural, and POWER does not draw any conclusions about the zoning-dependent audible noise levels that would be deemed reasonable by PUC Rule 3206(f). Additional information about zoning and land use can be found in the "Zoning Designations and Land Use" section.

May Valley

The new May Valley Switching Station will contain six reactors (assumed rating of 60 MVAR) that are considered as continuous noise generating equipment on the site. Figure 15 shows the color-shaded plot of the sound pressure levels produced by the reactors around the substation.

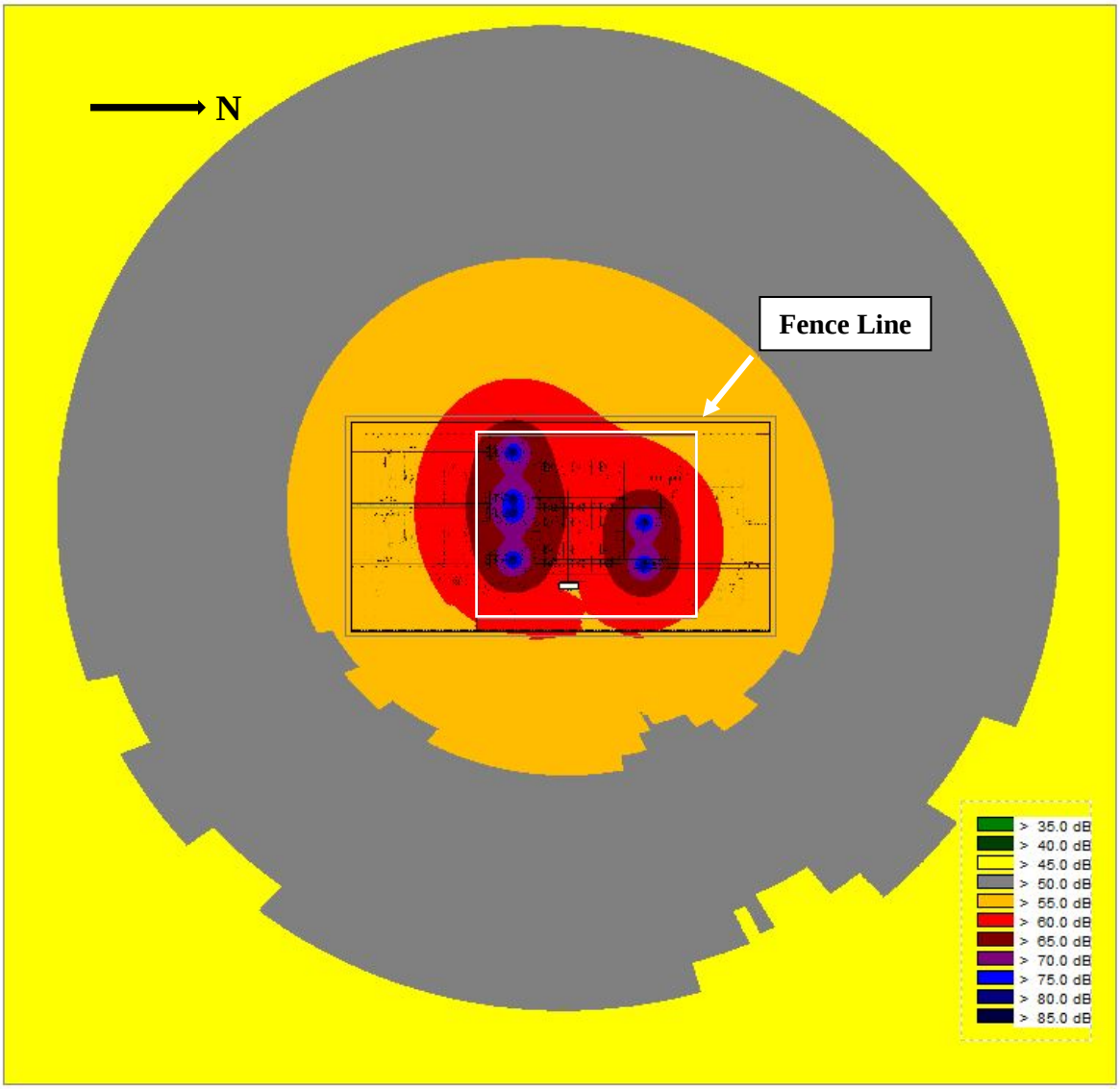

Figure 15: May Valley Audible Noise Levels

Table 11 shows the projected audible noise levels 25 feet from hypothetical substation property lines based on a conceptual substation general arrangement provided by the Company and the assumed land acquisition for the substation. The audible noise produced by the substation is expected to be 64 dB(A) or less at a distance of 25 feet from the property lines.

Table 11 – May Valley Audible Noise Values	
STATION PROPERTY LINE LOCATION	AUDIBLE NOISE 25 FEET FROM PROPERTY LINE [DB(A)]
Audible Noise Deemed Reasonable Level (PUC Rule 3206)	*No 3206(f) defined ruling limit**
25 feet from Northern Property Line	57
25 feet from Eastern Property Line	60
25 feet from Southern Property Line	57
25 feet from Western Property Line	64

* For some of the Power Pathway substations, the substation parcels and surrounding land are zoned agricultural and/or a mix of other zoning designations. Rule 3206(f) does not identify an audible noise level that is deemed reasonable for land zoned agricultural, and POWER does not draw any conclusions about the zoning-dependent audible noise levels that would be deemed reasonable by PUC Rule 3206(f). Additional information about zoning and land use can be found in the "Zoning Designations and Land Use" section.

CONCLUSION

Public Service Company of Colorado contracted POWER to investigate magnetic field and audible noise effects for the construction of Longhorn and May Valley substations as part of the May Valley-Longhorn Extension of Colorado's Power Pathway Project (Pathway Project), which includes a new 345 kV transmission line connecting the two stations in eastern Colorado. The purpose of this analysis is to determine the expected maximum level of magnetic fields that could be experienced at station boundaries and the projected level of audible noise at 25 feet beyond station property lines, consistent with PUC Rule 3206 – Construction or Extension of Transmission Facilities (4 CCR 723-3-3206) requirements.

For magnetic field strengths, the calculated maximum at the May Valley fence line was below the 150 mG level and therefore deemed reasonable by PUC Rule 3206(e). Although the calculated maximum magnetic field strength at one Longhorn fence line is projected to be above the level deemed reasonable by Rule 3206(e), the magnetic field strength at the property line was below the 150 mG level and deemed reasonable by PUC Rule 3206(e). For audible noise levels, the maximum value 25 feet from the substation property lines was calculated in accordance with PUC Rule 3206(f). Neither substation will be located on land for which there is a zoning-dependent noise level deemed reasonable by PUC Rule 3206(f).

For the transmission line, audible noise levels [dB(A)] were analyzed at the centerline, at the edge of right-of-way, and at 25 feet beyond the edge of right-of-way. The results indicate that the noise levels in both fair and wet conditions from both potential conductor types reviewed (1272 ACSR Bittern and 556 twisted pair ACSR Dove) would fall below all audible noise levels deemed reasonable by the Rule 3206(f), including the most stringent residential level 50 dB(A) at 25 feet beyond the edge of the ROW.

Magnetic Fields were analyzed at the edge of the ROW and the magnetic fields from both potential conductor types are below the 150 mG magnetic field level that is deemed reasonable by Rule 3206(e).

APPENDIX A – REFERENCE DRAWINGS

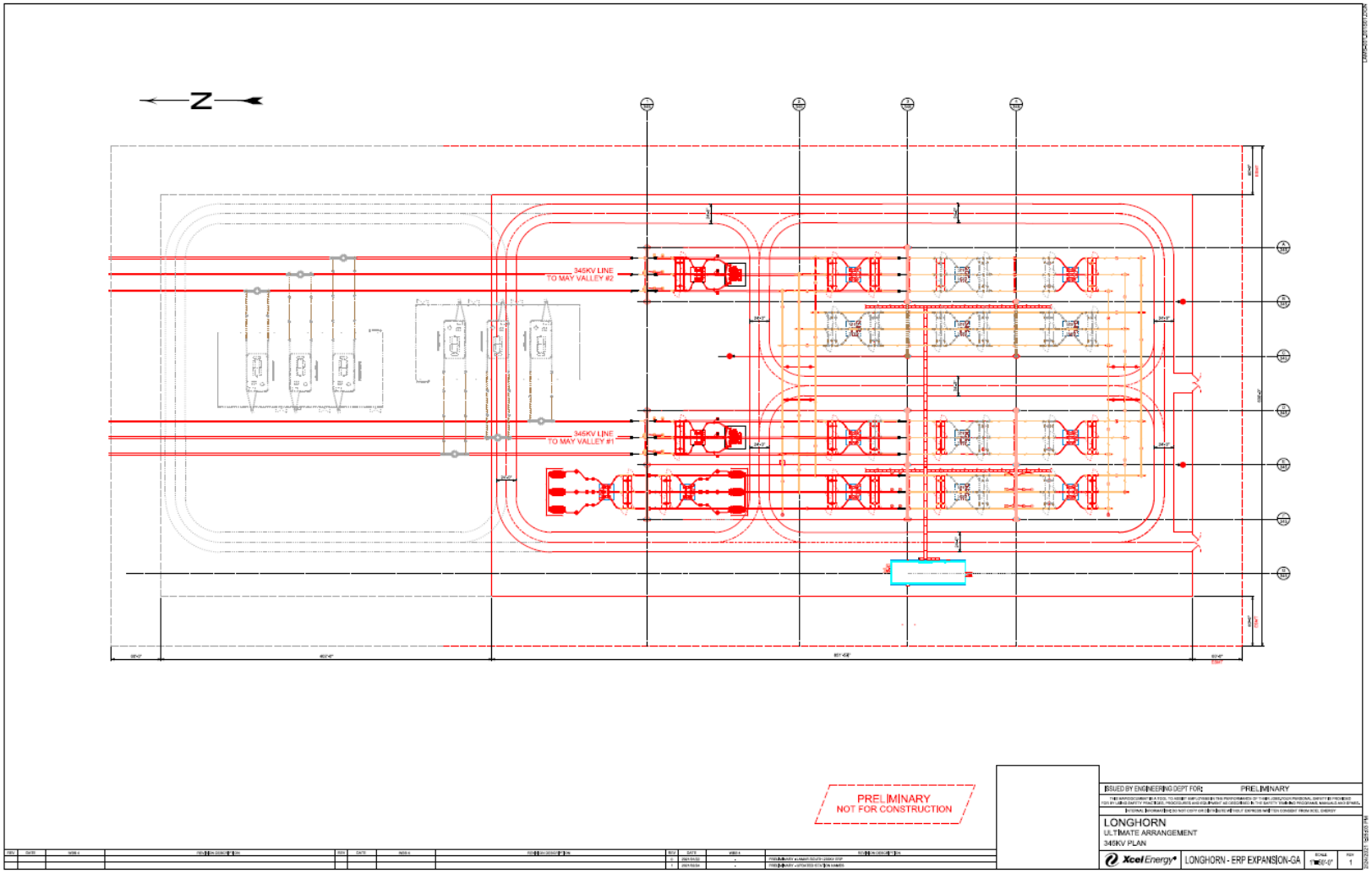

Figure 16: Longhorn General Arrangement Drawing

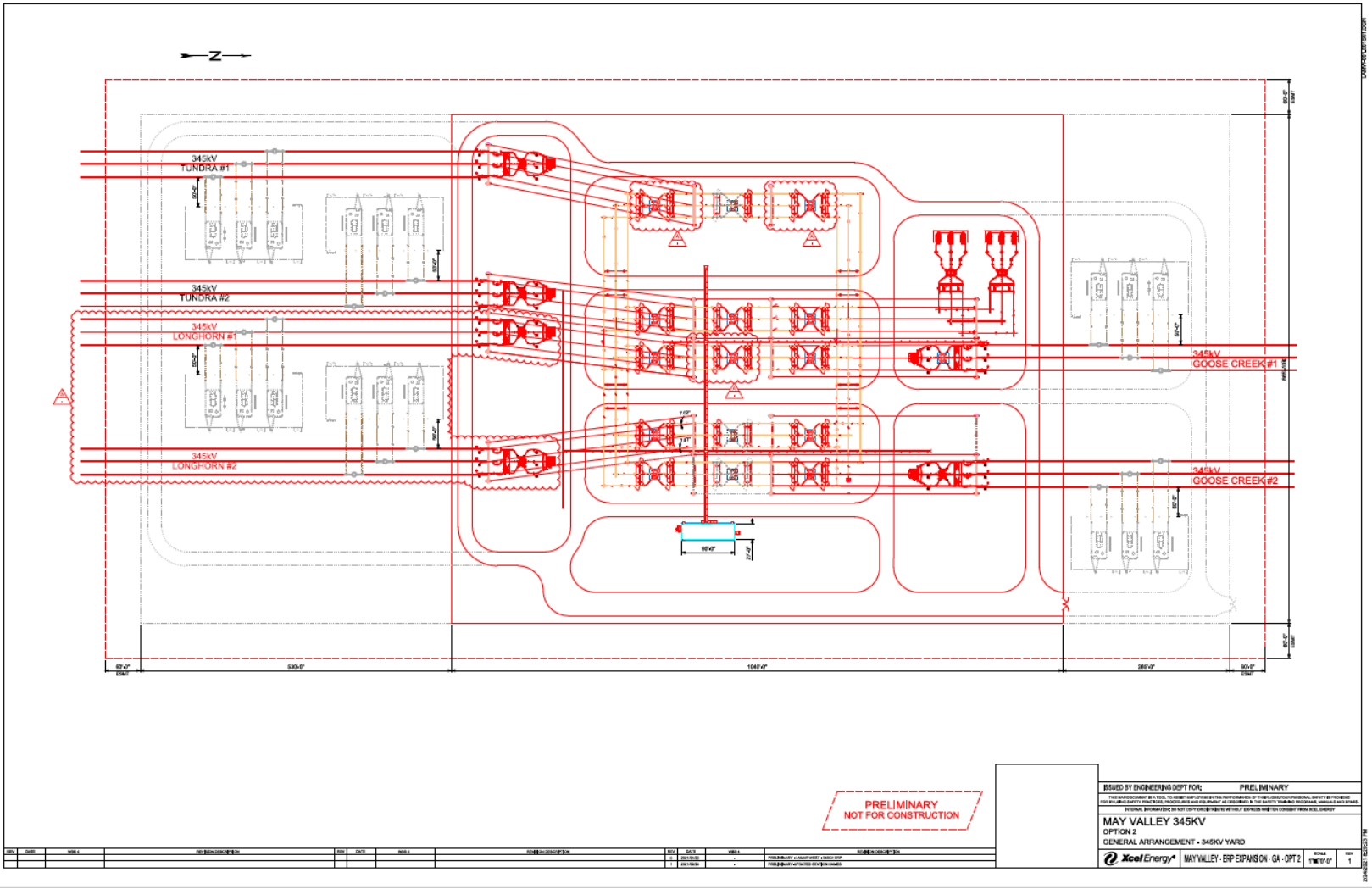

Figure 17: May Valley General Arrangement Drawing