Appendix H

Noise Reports for Single Circuit Transmission Lines

- **Transmission Line Audible Noise Report – Single Circuit - 414 MW**
- **Transmission Line Audible Noise Report – Single Circuit – 207 MW**

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Transmission Line

Audible Noise Report – Single Circuit

PLUM CREEK WIND PROJECT 414 MW

GERONIMO® ENERGY

PREPARED BY

ULTEIG ENGINEERS, INC.

PROJECT NO. 19.00499

REV. C

DATE: 10/11/19

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Executive Summary

An audible noise study was performed on the Plum Creek Wind Farm 345kV Transmission Line. The purpose of the audible noise analysis is to predict the maximum audible noise that can be heard from the transmission line at the edge of the right of way and nearest residence. Audible noise results are determined for a single circuit transmission line configuration. The results of the analysis show that the audible noise levels at the edge of the right of way will be a maximum of 45.70 dB(A) using 2-bundle 954 kcmil 54/7 "Cardinal" ACSR conductor or 2-bundle 1272 kcmil 45/7 "Bittern". For the route options being evaluated the nearest residences are located at 185 feet and 192 feet from the transmission line centerline. The maximum audible noise at these locations is estimated at 41.37 dB(A) for "Cardinal" conductor and 39.14 dB(A) for "Bittern" Conductor.

Study Criteria

Software Used

The software used to predict audible noise was developed by Bonneville Power Administration (BPA), called AN CALC. The BPA method for calculating the audible noise is an empirical method developed from long-term measurements on a number of full-scale operating or test lines. It is specifically designed to calculate audible noise based on phase configuration, typical operating voltage, height above mean sea level, number of conductors in a bundle (if applicable), conductor diameter, and height above ground at maximum conductor sag.

Assumptions

- Conductor is 954 kcmil 54/7 "Cardinal" ACSR with two conductors per phase (Diameter is 1.196") OR 1272 45/7 "Bittern" ACSR (Diameter is 1.345") with two conductors per phase.
- Minimum ground clearance of 27'-3" when conductor is at max sag conditions
- Typical single circuit direct-embed steel poles in delta configuration:
    - 15'-0" vertical spacing between phases with braced post insulators extending 12'-0" horizontally from structure centerline
- Minimum ground clearance of 27'-3" when conductor is at max sag conditions
- Right-of-way width is 150 feet (75' each side of centerline)

Results

Single Circuit

Table 1.B shows the predicted audible noise of the conductors at the edge of the transmission right of way for the single circuit route configuration. The result is produced from calculating the combined audible noise from all phases of conductor. For this analysis, 954 kcmil 54/7 "Cardinal" ACSR conductor and 1272 kcmil 45/7 "Bittern" ACSR Conductor were both reviewed.

The sound level is calculated at "L_{50}" which refers to a sound level exceeded 50% of the time and corresponds to the median sound level. For example, during a 1-hour measurement, an L_{50} of 50 dB(A) means the sound level was at or below 50 dB(A) for 30 minutes. L_{50} is the typical noise level measurement criterion for new transmission lines.

Table 1.A: Single Circuit Audible Noise Input Data – "Cardinal"

Bundle	Bundle Description	X-Position [ft]	Y-Position [ft]	# Cond.	Cond. Dia [in]	Cond. Spacing [in]	Line to Neutral Voltage [kV]	Phase Orientation Angle
1	"Cardinal"	12.0	27.25	2	1.196	18	209.15	0
2	"Cardinal"	-12.0	42.25	2	1.196	18	209.15	120
3	"Cardinal"	12.0	57.25	2	1.196	18	209.15	240

Table 1.B: Audible Noise Level Results – Single Circuit – "Cardinal"

Conductor loading at maximum wind farm output (414 MW)* [amps]	Distance to edge of Right-of-way from centerline [ft]	Predicted audible noise level, L_{50} [dB(A)]
815.1	+300	38.97
815.1	+192**	41.19
815.1	+185**	41.37
815.1	+150	42.40
815.1	+75	45.70
815.1	10	50.33
815.1	-75	45.13
815.1	-150	42.10
815.1	-300	38.82

*For reference only. It is not used in the calculation for audible noise.
**Nearest residence

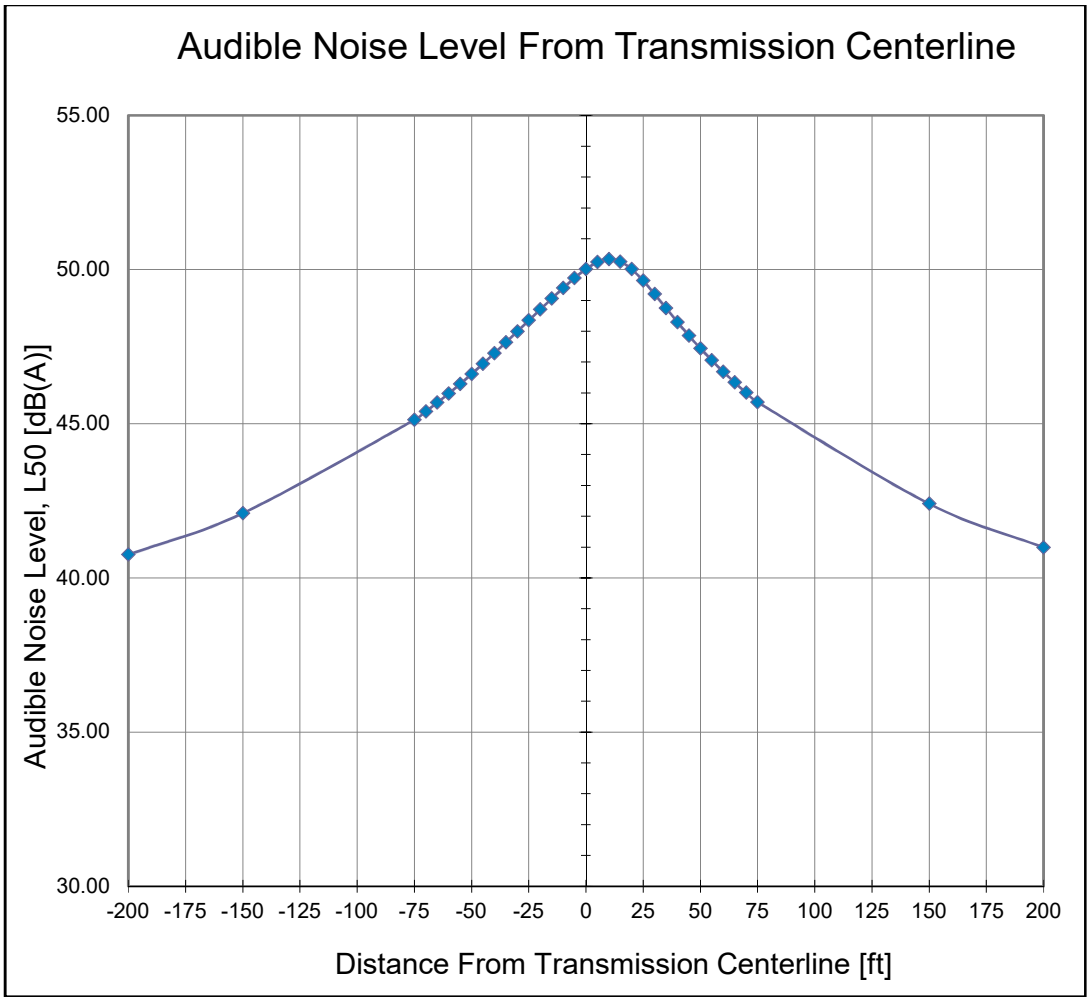

Figure 1: Audible Noise Level Plot – Single Circuit "Cardinal"

Table 2.A: Single Circuit Audible Noise Input Data – "Bittern"								
Bundle	**Bundle Description**	**X-Position [ft]**	**Y-Position [ft]**	**# Cond.**	**Cond. Dia [in]**	**Cond. Spacing [in]**	**Line to Neutral Voltage [kV]**	**Phase Orientation Angle**
1	"Bittern"	12.0	27.25	2	1.345	18	209.15	0
2	"Bittern"	-12.0	42.25	2	1.345	18	209.15	120
3	"Bittern"	12.0	57.25	2	1.345	18	209.15	240

Table 2.B: Audible Noise Level Results – Single Circuit – "Bittern"		
Conductor loading at maximum wind farm output (414 MW)* [amps]	Distance to edge of Right-of-way from centerline [ft]	Predicted audible noise level, L_{50} [dB(A)]
815.1	+300	36.74
815.1	+192	38.95
815.1	+185	39.14
815.1	+150	40.17
815.1	+75	43.47
815.1	10	48.10
815.1	-75	42.89
815.1	-150	39.87
815.1	-300	36.59

*For reference only. It is not used in the calculation for audible noise.
**Nearest residence

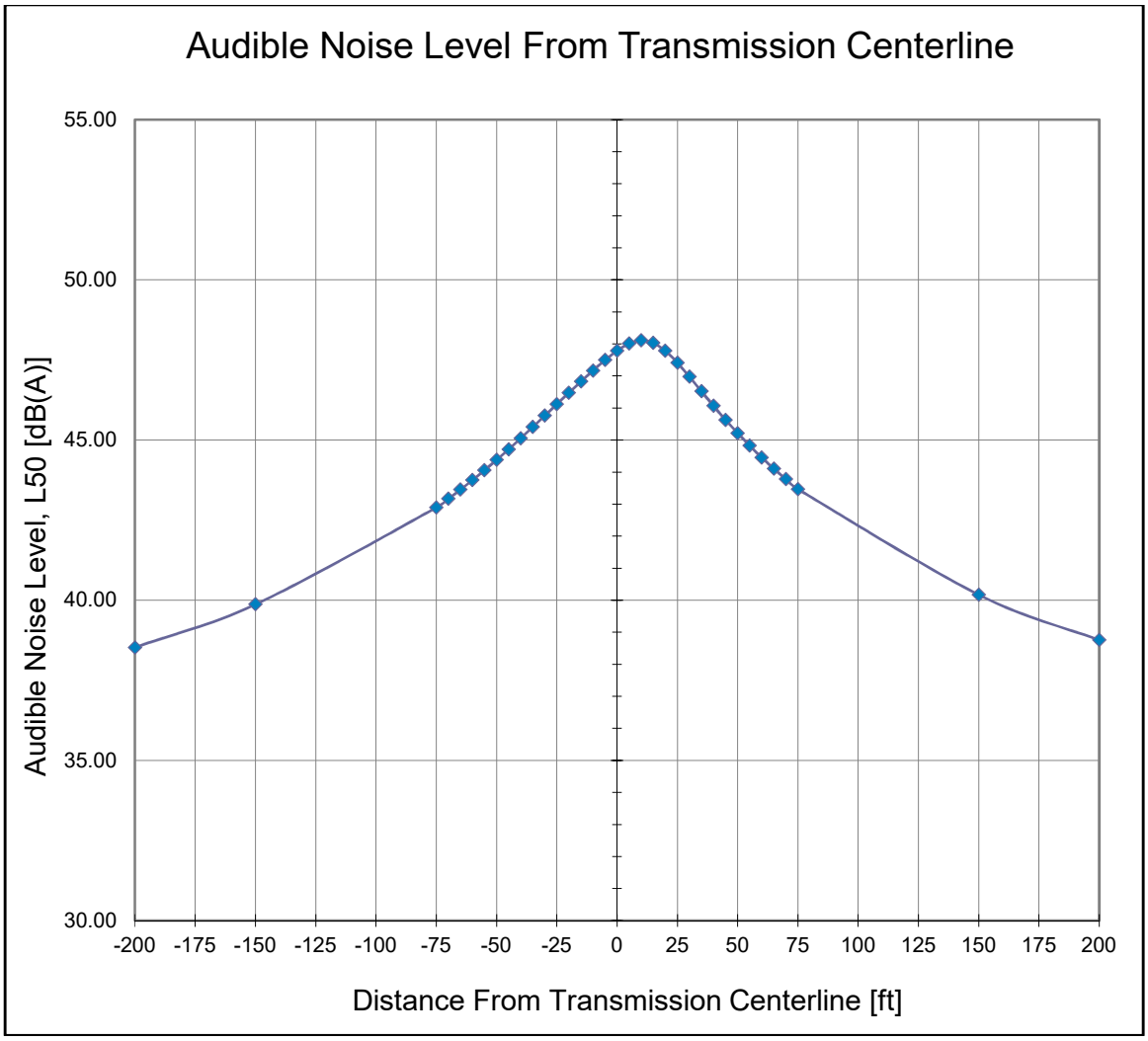

Figure 2: Audible Noise Level Plot – Single Circuit "Bittern"

Conclusions

Based on the results in Section 3, the EPA suggested maximum L_{50} audible noise level of 55 dB(A) at the edge of the transmission line right of way will not be exceeded by the proposed transmission line for a single circuit configuration if 954 kcmil 54/7 "Cardinal" ACSR conductor or 1272 45/7 "Bittern ACSR conductor is used.

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Transmission Line

Audible Noise Report – Single Circuit

PLUM CREEK WIND

207 MW

GERONIMO® ENERGY

PREPARED BY

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REV. B

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Executive Summary

An audible noise study was performed on the Plum Creek Wind Farm 345kV Transmission Line. The purpose of the audible noise analysis is to predict the maximum audible noise that can be heard from the transmission line at the edge of the right of way and nearest residence. Audible noise results are determined for a single circuit transmission line configuration. The results of the analysis show that the audible noise levels at the edge of the right of way will be a maximum of 45.70 dB(A) using 2-bundle 954 kcmil 54/7 "Cardinal" ACSR conductor or 2-bundle 1272 kcmil 45/7 "Bittern". For the route options being evaluated the nearest residences are located at 140 feet and 173 feet from the transmission line centerline. The maximum audible noise at these locations is estimated at 42.74 dB(A) for "Cardinal" conductor and 40.52 dB(A) for "Bittern" Conductor.

Study Criteria

Software Used

The software used to predict audible noise was developed by Bonneville Power Administration (BPA), called AN CALC. The BPA method for calculating the audible noise is an empirical method developed from long-term measurements on a number of full-scale operating or test lines. It is specifically designed to calculate audible noise based on phase configuration, typical operating voltage, height above mean sea level, number of conductors in a bundle (if applicable), conductor diameter, and height above ground at maximum conductor sag.

Assumptions

- Conductor is 954 kcmil 54/7 "Cardinal" ACSR with two conductors per phase (Diameter is 1.196") OR 1272 45/7 "Bittern" ACSR (Diameter is 1.345") with two conductors per phase.
- Minimum ground clearance of 27'-3" when conductor is at max sag conditions
- Typical single circuit direct-embed steel poles in delta configuration:
    - 15'-0" vertical spacing between phases with braced post insulators extending 12'-0" horizontally from structure centerline
- Minimum ground clearance of 27'-3" when conductor is at max sag conditions
- Right-of-way width is 150 feet (75' each side of centerline)

Results

Single Circuit

Table 1.B shows the predicted audible noise of the conductors at the edge of the transmission right of way for the single circuit route configuration. The result is produced from calculating the combined audible noise from all phases of conductor. For this analysis, 954 kcmil 54/7 "Cardinal" ACSR conductor and 1272 kcmil 45/7 "Bittern" ACSR Conductor were both reviewed.

The sound level is calculated at "L_{50}" which refers to a sound level exceeded 50% of the time and corresponds to the median sound level. For example, during a 1-hour measurement, an L_{50} of 50 dB(A) means the sound level was at or below 50 dB(A) for 30 minutes. L_{50} is the typical noise level measurement criterion for new transmission lines.

Table 1.A: Single Circuit Audible Noise Input Data – "Cardinal"

Bundle	Bundle Description	X-Position [ft]	Y-Position [ft]	# Cond.	Cond. Dia [in]	Cond. Spacing [in]	Line to Neutral Voltage [kV]	Phase Orientation Angle
1	"Cardinal"	12.0	27.25	2	1.196	18	209.15	0
2	"Cardinal"	-12.0	42.25	2	1.196	18	209.15	120
3	"Cardinal"	12.0	57.25	2	1.196	18	209.15	240

Table 1.B: Audible Noise Level Results – Single Circuit – "Cardinal"

Conductor loading at maximum wind farm output (207 MW)* [amps]	Distance to edge of Right-of-way from centerline [ft]	Predicted audible noise level, L_{50} [dB(A)]
407.5	+300	38.97
407.5	+173**	41.70
407.5	+150	42.40
407.5	+140**	42.74
407.5	+75	45.70
407.5	10	50.33
407.5	-75	45.13
407.5	-150	42.10
407.5	-300	38.82

*For reference only. It is not used in the calculation for audible noise.
**Nearest residence

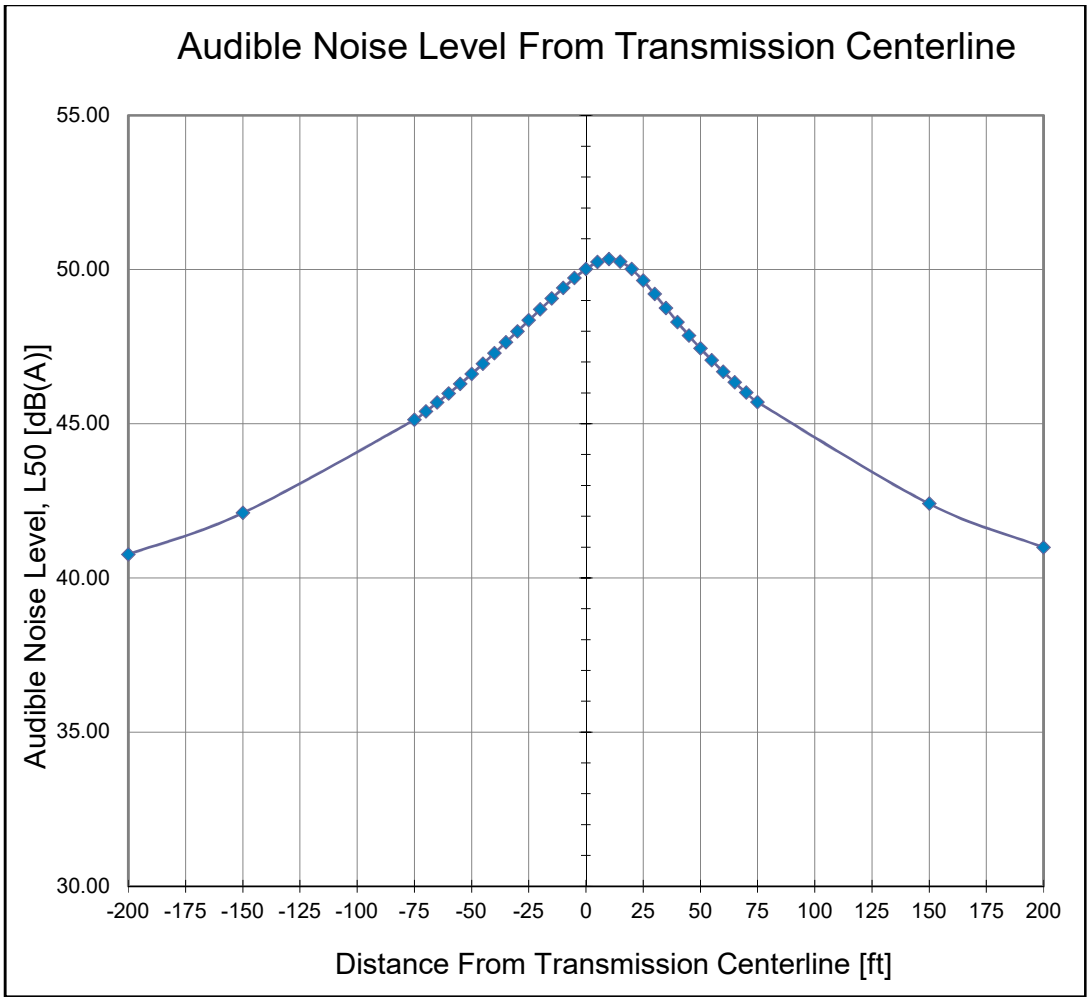

Figure 1: Audible Noise Level Plot – Single Circuit "Cardinal"

Table 2.A: Single Circuit Audible Noise Input Data – "Bittern"								
Bundle	**Bundle Description**	**X-Position [ft]**	**Y-Position [ft]**	**# Cond.**	**Cond. Dia [in]**	**Cond. Spacing [in]**	**Line to Neutral Voltage [kV]**	**Phase Orientation Angle**
1	"Bittern"	12.0	27.25	2	1.345	18	209.15	0
2	"Bittern"	-12.0	42.25	2	1.345	18	209.15	120
3	"Bittern"	12.0	57.25	2	1.345	18	209.15	240

Table 2.B: Audible Noise Level Results – Single Circuit – "Bittern"		
Conductor loading at maximum wind farm output (207 MW)* [amps]	Distance to edge of Right-of-way from centerline [ft]	Predicted audible noise level, L_{50} [dB(A)]
407.5	+300	36.74
407.5	+173**	38.48
407.5	+150	40.17
407.5	+140**	40.52
407.5	+75	43.47
407.5	10	48.10
407.5	-75	42.89
407.5	-150	39.87
407.5	-300	36.59

*For reference only. It is not used in the calculation for audible noise.
**Nearest residence

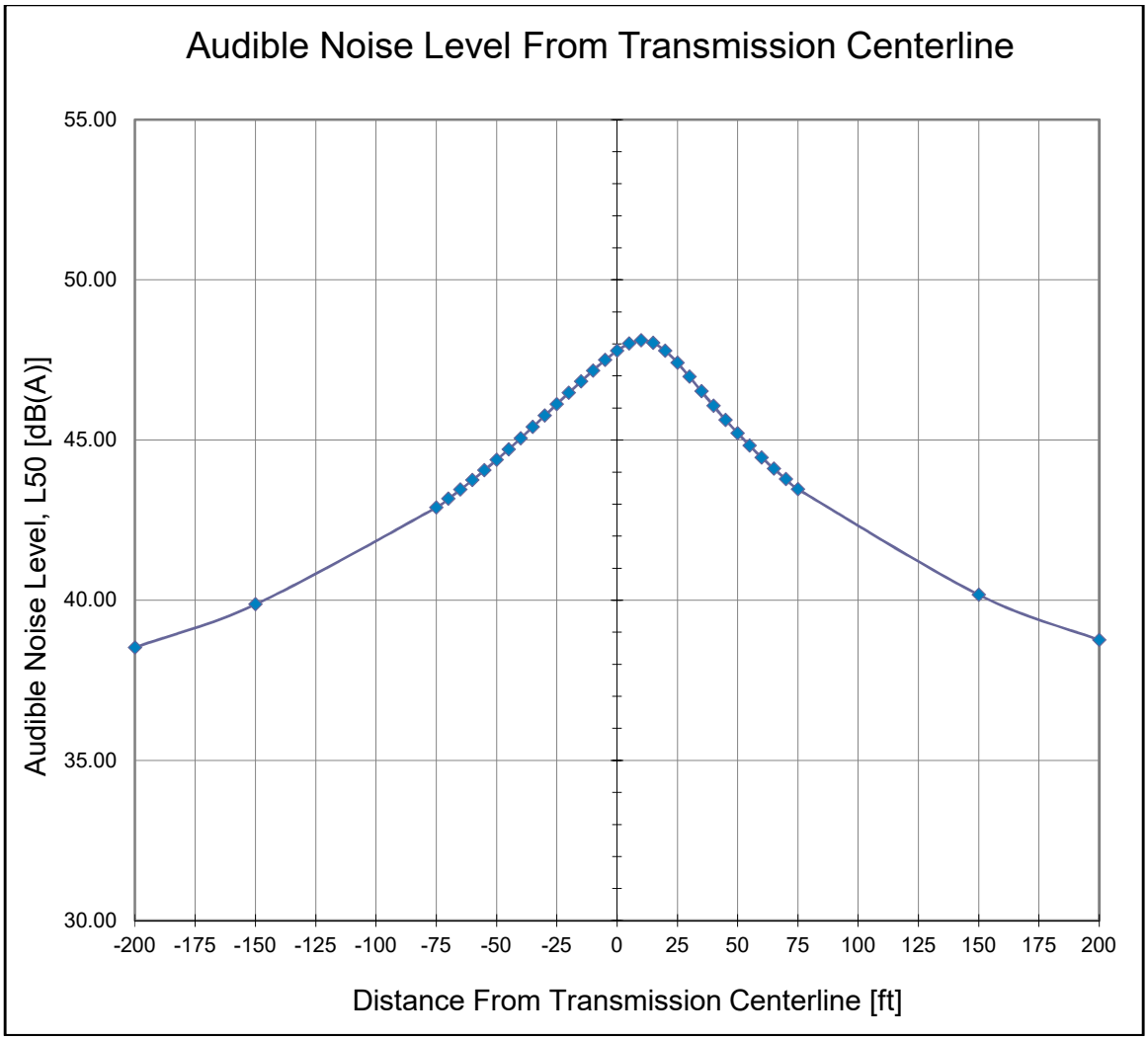

Figure 2: Audible Noise Level Plot – Single Circuit "Bittern"

Conclusions

Based on the results in Section 3, the EPA suggested maximum L_{50} audible noise level of 55 dB(A) at the edge of the transmission line right of way will not be exceeded by the proposed transmission line for a single circuit configuration if 954 kcmil 54/7 "Cardinal" ACSR conductor or 1272 45/7 "Bittern ACSR conductor is used.