Appendix H

Noise Supplement

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Noise Overview and Noise Standards

Noise is generally defined as unwanted sound. Sound travels in mechanical wave motion and produces a sound pressure level. Sound pressure level is commonly measured in decibels (dB), representing the logarithmic increase in sound energy relative to a reference energy level. Sound measurement is further refined by using an A-weighted decibel scale (dBA) to emphasize the range of sound frequencies that are most audible to the human ear (i.e., between 1,000 and 8,000 cycles per second). Decibel measurements discussed in this environmental impact statement (EIS) are presented using the dBA scale (MPCA 2008, reference H1).

A noise level change of three dBA is barely discernible to average human hearing. A five dBA change in noise level, however, is clearly noticeable. A ten 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. Cumulative noise increases occur on a logarithmic scale. If a noise source is doubled, there is a three dBA increase in noise, which is barely discernible to the human ear. For cumulative increases in noise resulting from sources of different magnitudes, the rule of thumb is that if there is a difference of greater than ten dBA between noise sources, there will be no additive effect to the overall noise level. Figure H-1 shows noise levels associated with common, everyday sources and provides a context for the magnitude of noise levels discussed here.

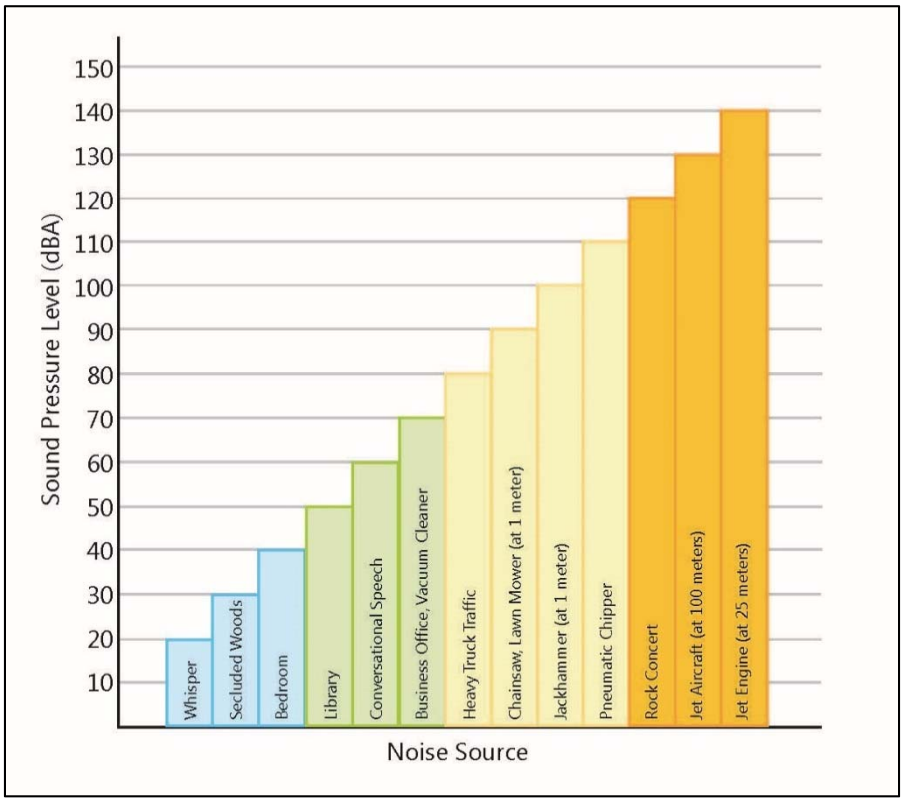

Figure H-1 Noise levels associated with common, everyday sources

Typically, noise is evaluated according to two general criteria: the extent to which noise levels exceed federal, state, or (where applicable) local noise regulations; and the estimated degree of disturbance to people.

The Minnesota Pollution Control Agency (MPCA) has established standards for the regulation of noise levels. Land use activities associated with residential, commercial and industrial land have been grouped together into Noise Area Classifications (NAC;Minn. R. 7030.0050). Each NAC is then assigned both daytime (7 a.m.to 10 p.m.) and nighttime (10 p.m. to 7 a.m.) limits for land use activities within the NAC (Minn. R. 7030.0040).

Table H-1 shows the MPCA daytime and nighttime limits in dBA for each NAC. The limits are expressed as a range of permissible dBA within a one hour period. L_{50} is the dBA that may be exceeded 50 percent of the time within an hour, while L_{10} is the dBA that may be exceeded ten percent of the time within one hour. Residences, which are typically considered sensitive to noise, are classified as NAC-1 (MPCA 2008, reference H1).

Table H-1 Applicable Noise Standards for Different Land Uses in Minnesota

Noise Area Classification (NAC)	Noise Standard dB(A)			
	Daytime (7 a.m. to 10 p.m.)		Nighttime (10 p.m. to 7 a.m.)	
	L_{50}	L_{10}	L_{50}	L_{10}
Residential (NAC-1)	60	65	50	55
Commercial (NAC-2)	65	70	65	70
Industrial (NAC-3)	75	80	75	80
Undeveloped (NAC-4)	None	None	None	None

Minnesota's state noise level standards are more stringent than the U.S. Department of Housing and Urban Development standards; therefore, noise levels in the project area can conservatively be compared to state standards.

In addition to local, state, and federal standards, the degree of disturbance becomes a key factor in evaluating noise conditions. Typically this includes a focus on residents in the vicinity of the area under evaluation. The concept of human disturbance varies with a number of interrelated factors, including changes in noise levels;, the presence of other, non-project-related noise sources in the vicinity, people's attitudes toward the project, the number of people exposed, and the type of human activity affected (e.g., sleep or quiet conversation as compared to physical work or active recreation).

Project Noise

Noise associated with the project would be produced by construction of the transmission lines and substations, and by its operation.

As discussed in the Section 6.1.3 of this EIS, noise levels associated with construction will be highly localized and intermittent. Table H-2 and Table H-3 provides additional detail regarding typical noise

levels associated with a variety of types of construction equipment that may be used during construction of the proposed project. Receptors (people/residences), though perhaps nearby, would be located outside of the immediate construction area, so sound levels associated with construction equipment shown in Tables H-2 and Table H-3 are not necessarily indicative of noise levels experienced by sensitive receptors.

Table H-2 Typical Noise Levels of Transmission Line Construction Equipment

Equipment Type	Maximum Noise Level (Lmax, dBA)	Utilization Factor	Estimated Noise Level (dBA) at 50 feet
Pickup Truck	55	0.4	51
Crew Cab	55	0.4	51
Compressor Trailer	80	0.4	76
Crane	85	0.16	77
Backhoe/Frontend loader	80	0.4	76
Auger Truck	85	0.2	78
Water Truck	84	0.4	80
Dump Truck	84	0.4	80
Concrete Truck	85	0.4	81
Fork Lift	86	0.4	82
Vibratory Pile Driver	95	0.2	88
Estimated Transmission Line Construction Noise Level (at 50 feet)			**91**

Sources: (FHWA 2006, Reference H2)
Notes: Noise emission levels and utilization factors are based on FHWA guidelines.

Table H-3 Typical Noise Levels of Substation Construction Equipment

Equipment Type	Maximum Noise Level (dBA)	Distance (feet)	Utilization Factor	Estimated Noise Level (dBA) at 50 feet
Backhoe	80	50	0.4	76
Bobcat	82	50	0.8	81
Flatbed Truck	84	50	0.4	80
Excavator	85	50	0.4	81
Foundation Auger	85	50	0.2	78
Dump Truck	84	50	0.4	80
Concrete Truck	85	50	0.4	81
Loader	80	50	0.4	76
Forklift	86	50	0.4	82
Crane	85	50	0.16	77
Water Truck	84	50	0.4	80
Crew Vehicle	55	50	0.4	51
Manlift	85	50	0.2	78
Paving Roller	85	50	0.2	78
Asphalt Paver	85	50	0.5	82
Tractor	84	50	0.4	80
Compressor	80	50	0.4	76
Generator	82	50	0.5	79
Estimated Substation Construction Noise Level (at 50 feet)				**92**

Sources: (FHWA 2006, Reference H2)

Notes: Noise emission levels and utilization factors are based on FHWA guidelines.

Construction of the proposed compensation station and regeneration stations is assumed to require similar equipment as those necessary to build the proposed Blackberry 500 kV substation, resulting in similar levels of construction noise

Noise from the operation of transmission lines is primarily associated with the "corona effect," small electrical discharges which ionize surrounding air molecules, causing a cracking or hissing noise that may be audible from directly below the transmission line, especially during damp conditions. The Applicant has modeled Audible Noise (AN) from the proposed 500 kV transmission lines under rainy conditions (worst case scenario for noise generated from corona effect), considering two configurations: standalone 500 kV transmission line and collocation of the proposed Project with existing transmission lines. The Applicant's calculations for the audible noise results are provided in Table H-4.

Table H-4 Predicted Audible Noise Levels from the proposed Project Transmission Line in Rainy Weather Conditions

Proposed Transmission Line Configuration	Maximum Audible Noise Level (dBA)		
	Within ROW	At edge of ROW	At 300 feet from centerline
500 kV Transmission Line (Stand-alone, not paralleling existing lines)	51	48	43
500 kV Transmission Line paralleling existing 500 kV Transmission Line(1)	51	48	43
500 kV Transmission Line paralleling existing 230 kV Transmission Line(2)	51	50	46
500 kv Transmission Line paralleling existing 115 kV Transmission Line(3)	51	48	43
500 kV paralleling two existing 115 kV Transmission Lines(4)	52	52	51
500 kV paralleling existing 115 kV and 230 kV Transmission Lines(5)	51	48	44

Source: (Power Engineer 2013, Reference H3); (Power Engineer 2014, Reference H4).
Notes:
(1) Existing 500 kV D602F transmission line (self-supporting tower structures). For this analysis the applicant calculated audible noise up to 400 feet from the centerline. Results are reported at 300 feet for comparison purposes.
(2) Existing 230 kV 83L transmission line (H-Frame structures).
(3) Existing 115 kV 28L tap (H-Frame structures).
(4) Existing 115 kV 62L and 63L transmission lines (H-Frame structures).
(5) Existing 115 kV 28L and 230 kV 83L transmission lines (H-Frame structures).

Noise from operation of the proposed Project does not solely emanate from the transmission line; it also includes noise from the proposed Blackberry Substation. Operating noise results from vibrations associated with magnetic forces inside substation transformers and from cooling fans and pumps that control transformer temperature. Most of the other equipment at a substation is either silent or generates minimal noise in comparison to the transformers. It is anticipated that the substation transformers installed at the proposed Blackberry 500 kV Substation would not exceed the values specified by the National Electrical Manufacturers Association (NEMA) Standards. The NEMA Standards maximum sound

levels applicable to the proposed Project oil-immersed transformers are 91 dB at 1 foot (NEMA 2000, reference H5). Based on these assumptions, the predicted noise operational level perceived at 100 feet from the proposed Blackberry 500 kV Substation would be 41 dBA. No residences have been identified in the vicinity of the substation site. The closest non-residential area identified is the Trout Lake Cemetery, located approximately 8,000 feet west from the existing Blackberry 230/115 kV Substation. Noise associated with capacitor banks and other electrical equipment commonly used in compensation stations would be lower than levels associated with substations, since they do not require the use of transformers.

Table H-5 provides the predicted noise levels associated with the proposed Project construction, transmission line operation, and substation operation and how they attenuate over distance.

Table H-5 Predicted Noise Levels for the Proposed Project

Proposed Project Noise Source/ Distance to Receiver (feet)	Predicted Noise Level (dBA)					
	50	100	250	500	1,000	1,500
500 kV Transmission Line Construction	91	85	77	71	65	62
Blackberry 500 kV Substation Construction	92	86	78	72	66	62
500 kV Transmission Line Operation	52	46	38	32	26	22
Blackberry 500 kV Substation Operation	47	41	33	27	21	17

Operational noise levels are below the Minnesota standards and because construction noise is intermittent and levels decrease by 6 dBA with a doubling of distance, noise levels at residences along the route are generally not expected to exceed Minnesota's daytime noise standards during construction (Table H-1).

References

H1. Minnesota Pollution Control Agency (MPCA). 2008. A Guide to Noise Control In Minnesota: Acoustical Properties, Measurement, Analysis and Regulation.

H2. Federal Highway Administration (FHWA). 2006. FHWA Roadway Construction Noise Model User's Guide. FHWA-HEP-05-054. January.

H3. Power Engineer 2013. Memorandum: Great Northern Transmission Line Project – EMF and Corona Effects Calculations (includes appendices). August 8, 2013.

H4. Power Engineer 2014. Memorandum: Great Northern Transmission Line Project – EMF and Corona Effects Calculations with Adjacent Lines. January 27. 2014.

H5. National Electrical Manufacturers Association (NEMA). 2000. NEMA Standards Publication TR-1-1993 (R2000) Transformers, Regulators and Reactors. Rosslyn, VA.