APPENDIX H

ELLENDALE 345-KV SUBSTATION CALCULATED NOISE ANALYSIS

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TECHNICAL MEMORANDUM: ELLENDALE 345-KV SUBSTATION CALCULATED NOISE ANALYSIS

Noise emissions from the Ellendale 345-kV Substation were evaluated using the Cadna-A acoustical modeling software. Cadna-A was used to evaluate potential substation noise levels at nearby residences. The primary sound source of interest is the transformer, but consideration was also given to corona noise generated within the substation. The nearest receiver is a residence located approximately 1,600 feet from the substation.

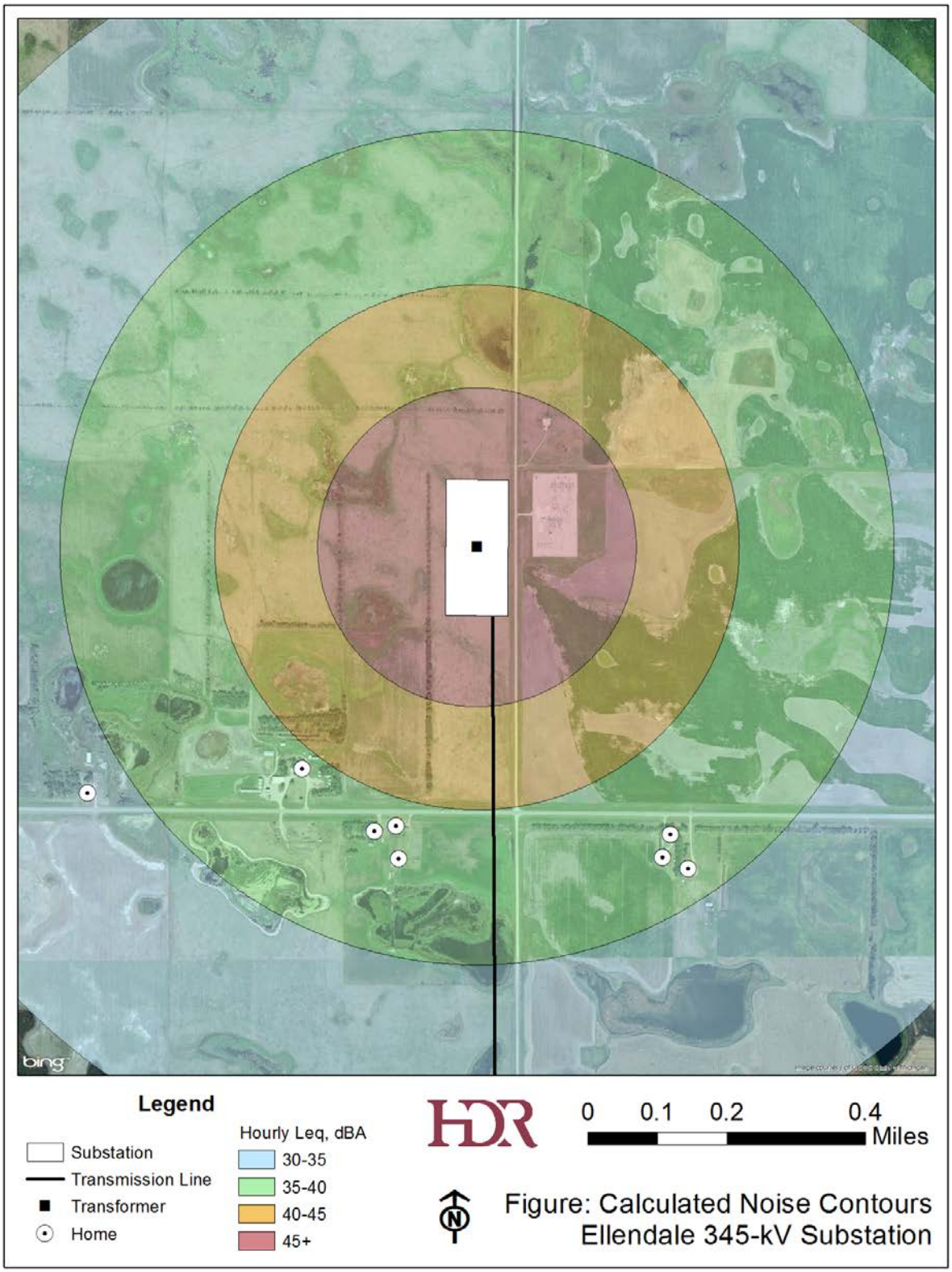
Cadna-A is an acoustical analysis software based upon International Standards Organization standard number 9613, "Attenuation of Sound during Propagation Outdoors." Sound power levels for the transformer were calculated using the Edison Electric Institute's Electric Power Plan Environmental Noise Guide, Volume 1. Table 1 contains the calculated sound power levels, based upon a 500 MVA standard (un-quieted) transformer.

Table 1. Calculated Transformer Sound Power Levels

Octave Band, Hz	31	63	125	250	500	1000	2000	4000	8000
Sound Power Level, dB	105	111	113	108	108	102	97	92	85

The Cadna-A modeling parameters were selected to produce conservative estimates of transformer sound levels. A ground coefficient of 0.5 was used, which considers the ground to be 50 percent absorptive and 50 percent reflective. This takes into consideration more reflective conditions (which can result in higher sound levels) that can be created by snow-covered ground. Site-specific meteorology and terrain were not included, resulting in conservatively high sound levels. Figure 1 illustrates the modeled results as noise contours.

Figure 1. Substation Noise Contours



The transformer is modeled in the approximate center of the substation, and the eight nearest residences are shown. Noise contours represent sound pressure levels over areas of equal loudness; areas with the same color are predicted to experience similar sound levels. Analysis results show that the calculated equivalent sound level (Leq) at the nearest residence was found to be 39 dBA. This level only represents sound produced by the transformer, and does not consider ambient background noise which may be higher. Transformer noise has somewhat of a tonal characteristic to it, generally centered around frequencies that are harmonics (multiples) of 60 Hz which corresponds to the current alternating at 60 cycles per second (60 Hz). The nearest acoustical octave band centers are 63 and 125 Hz. Tonal noise emitted from the alternating current inside the substation's transformer is included in and reported using the acoustical octave band centers of 63 and 125 Hz. As shown in Table 1, transformer noise levels are expected to peak in the 125 Hz octave band.

Corona noise is produced by transmission lines and bus bars found in substations. According to the Electric Power Research Institute's Transmission Line Reference Book, corona noise is characterized by crackling, frying, and hissing noises. Due to the proximity of the bus from the perimeter of the substation, and the additional distance to the nearest receiver, corona noise is not considered to be a significant source of noise at the residences near the substation. There do not appear to be any widely accepted and verified methods for estimating corona noise from substations.