# AM/FM Radio & Television Interference Analysis

## Scioto Ridge Transmission Line Project


Prepared on Behalf of
Hardin Wind, LLC

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# 1. Introduction

Comsearch performed this study to determine if there would be electromagnetic interference from the proposed Scioto Ridge 345 kVolt transmission line to the AM/FM radio and television broadcast signals at seven specific home locations. Figure 1 shows a map of the preferred and alternate transmission line paths as well as the location of the seven home locations with respect to the paths. Table 1 lists the homes along with their respective IDs, coordinates, and shortest separation distances from the preferred transmission line path. The separation distances were key parameters in the calculation of the radiated emission levels at the homes from the preferred transmission line.

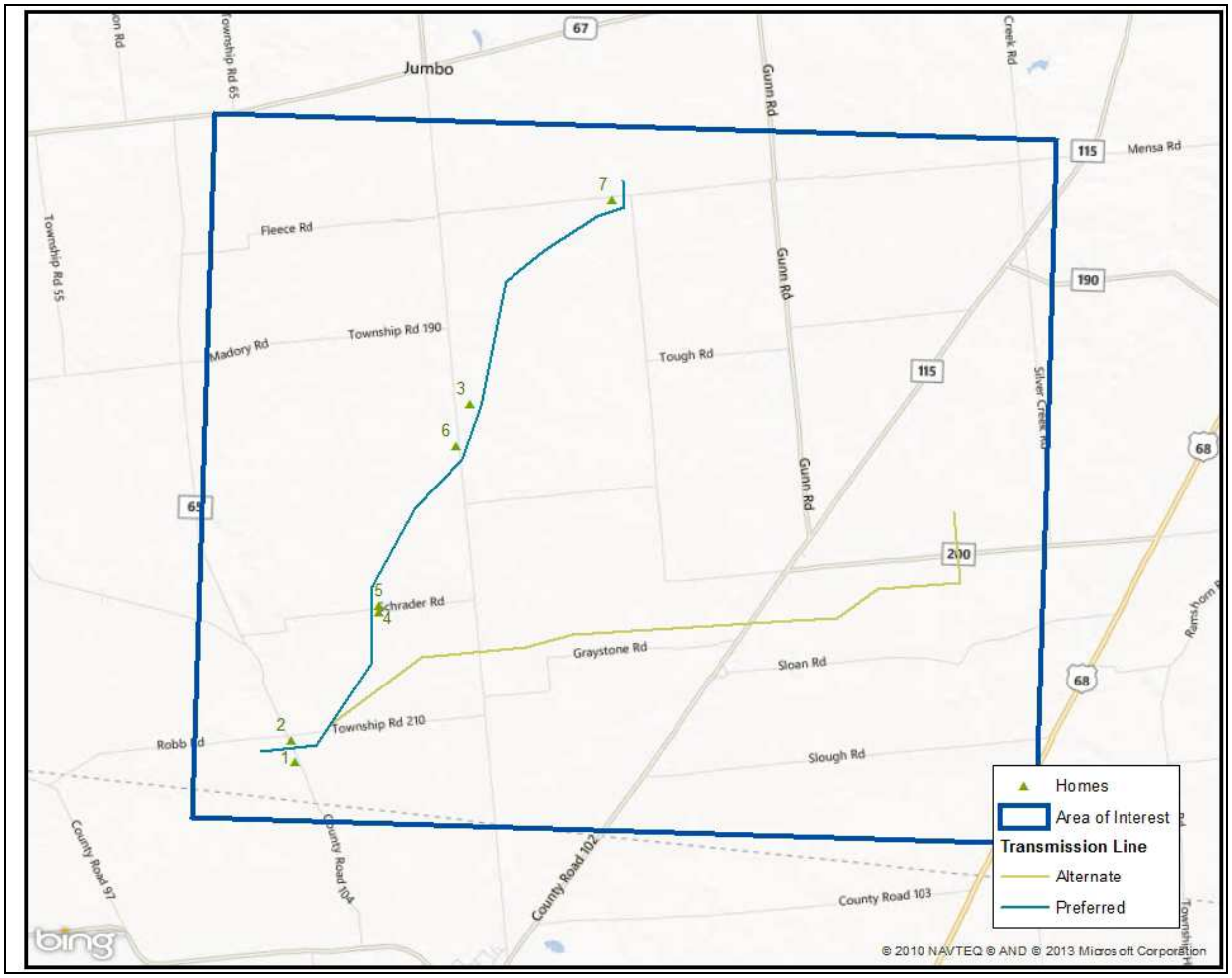


***Figure 1: Map of Scioto Transmission Lines and Homes in the Vicinity***

| Home ID | Owner Status | latitude | longitude | Closest Distance to TX Line (meters) |
|---|---|---|---|---|
| 1 | Signed | 40.52918390190 | -83.77171977280 | 147.6 |
| 2 | Non Participating | 40.53119326890 | -83.77227034420 | 91.7 |
| 3 | Non Participating | 40.56350716630 | -83.75134829740 | 117.1 |
| 4 | Non Participating | 40.54359367010 | -83.76175689360 | 92.7 |
| 5 | Non Participating | 40.54416374070 | -83.76182608270 | 89.5 |
| 6 | Non Participating | 40.55954303140 | -83.75296282030 | 112.1 |
| 7 | Pending | 40.58324537710 | -83.73450277610 | 122.5 |

***Table 1: Homes Analyzed Near Transmission Line***

## 2. Analysis Approach

To determine whether there will be interference, the electric field emitted from the transmission line was modeled across a wide range of frequencies that includes the AM, FM, and television broadcast signal bands. The modeling was based on a 345 kVolts transmission line at 60 Hz. Table 2 shows the electric field emissions from the transmission line.

| Frequency [Hz] | Transmission Line Level at Frequency [Volts] | Radiated Emission [Volts/meter] | Radiated Emission @3meters [Volts/meter] | Reception Band |
|---|---|---|---|---|
| 60 | 345,000 | 38333.33333 | 12777.78 | Fundamental |
| 120 | 3.45E+02 | 38.33333333 | 12.77778 | Second Harmonic |
| 245760 | 1.73E-01 | 0.019212177 | 0.006404 | Third Harmonic |
| 491520 | 8.67E-02 | 0.009628898 | 0.00321 | AM |
| 983040 | 4.34E-02 | 0.004825881 | 0.001609 | AM |
| 1966080 | 2.18E-02 | 0.00241867 | 0.000806 | AM |
| 3932160 | 1.09E-02 | 0.001212206 | 0.000404 | Amateur |
| 7864320 | 5.47E-03 | 0.000607542 | 0.000203 | Amateur |
| 15728640 | 2.74E-03 | 0.000304492 | 0.000101 | Amateur |
| 31457280 | 1.37E-03 | 0.000152608 | 5.09E-05 | VHF-TV |
| 62914560 | 6.88E-04 | 7.64851E-05 | 2.55E-05 | VHF-TV & FM |
| 1.26E+08 | 3.45E-04 | 3.83333E-05 | 1.28E-05 | VHF-TV |
| 2.52E+08 | 1.73E-04 | 1.92122E-05 | 6.4E-06 | VHF-TV |
| 5.03E+08 | 8.67E-05 | 9.6289E-06 | 3.21E-06 | UHF-TV |
| 1.01E+09 | 4.34E-05 | 4.82588E-06 | 1.61E-06 | Microwave |

***Table 2: Emission Levels from Transmission Line at Various Frequency Bands***

Electromagnetic interference from a transmission line is the result of the induction field created by the 60 Hz electrical voltage and by the harmonics of the 60 Hz fundamental signal. The interference can also be the results of arcing that can occur at high voltage interconnect points on the transmission line. In either case, the interfering signal is amplitude modulated (AM), and

the propagation of the interference occurs over very short distances. These distances are generally less than 500 feet. Also, the frequency of the interference does not normally extend above 50 MHz. Therefore, the interference signals generated by the transmission line will not affect most communication devices including microwave systems, FM radio, television, wireless telephones, and other personal communication devices because they operate at higher frequencies. Furthermore, their modulation schemes prevent their susceptibility to amplitude-modulated interference. The reception devices that may be affected will be AM radios, which operate between 0.5 and 1.6 MHz The degree of degradation to AM reception will be a function of the separation distance of the AM radio from the transmission line as well as the strength of the received signal from the broadcast station.

In this study, the calculated emission level from the transmission line was compared to the electric field strength of the AM station, WBLL, located in the vicinity of the transmission line project. The WBLL station operates at two transmit power levels: 500 Watts during the day and 81 Watts at night. If the signal strength of the AM broadcast station is 6 dB greater than the emission level of the transmission line at the frequency of station operation, then no problems should exist in the reception of the signal. This same approach and criteria will be applied to the FM and TV Station signals in the area, although no interference is expected for these systems because of the frequency band in which they operate. Also, the modulation schemes for these signals are such that they are generally immune to amplitude-modulated interference from power lines.

## 3. Calculations

To perform the calculations, the distances with respect to the AM, FM, and television broadcast stations in the area are used to determine the signal strengths at each of the seven homes analyzed. The signal strength (S) is derived from FCC database records that list the station antenna location, transmit radiated power, and signal strength contour for each of the stations. If the station signal strength for the broadcast service is found to be 6 dB greater than the emission level from the transmission line at each home, there should be no disruption of service. The first calculation performed is to determine the emission level at each of the seven homes using the following formula:

$$\mathbf{F = V/A}$$

where,

F = The radiated signal strength at the transmission Line, Volts/m
V = Line Voltage at the frequency of interest, Volts
A = Effective length of radiating element, 9 meters

Then to determine the radiated level at each home, the shortest distance to the transmission line is inserted into the following formula:

$$\mathbf{F(d) = F/d}$$

where,

F(d) = Radiated interference signal strength at the homes closest distance (d), V/m
d = Shortest distance to each home from the transmission line, meters

Then to calculate if interference from the transmission line will prevent reception, the ratio in dB of the broadcast stations signal strength to the interference level (F(d)) is calculated.

$$R = 20*\log S/F(d)$$

where,

R = Ratio of broadcast signal to interference emission from transmission line, dB
S = Broadcast signal strength, V/meter

The calculated level of F(d), S and R at each of the seven homes for AM Station WBLL is presented in Table 3.

| Home ID | F(d) Signal Strength at WBLL Frequency [Volts/meter] | WBLL Antenna Distance to Homes [km] | WBLL Signal Strength (S) at Homes [Volts/meter] | Ratio (R) S/F(d) [dB] |
|---|---|---|---|---|
| 1 | 3.27E-05 | 18.2 | 1.69E-04 | 14.3 |
| 2 | 5.26E-05 | 18.4 | 1.67E-04 | 10.0 |
| 3 | 4.12E-05 | 21.8 | 1.41E-04 | 10.7 |
| 4 | 5.21E-05 | 19.6 | 1.57E-04 | 9.6 |
| 5 | 5.39E-05 | 19.7 | 1.56E-04 | 9.2 |
| 6 | 4.30E-05 | 21.3 | 1.44E-04 | 10.5 |
| 7 | 3.94E-05 | 23.1 | 1.33E-04 | 10.6 |

***Table 3: Calculation of F(d), S and R for AM Band***

The calculated level of F(d), S and R at each of the seven homes for the FM band will be performed for station WKTN and is presented in Table 4.

| Home ID | F(d) Signal Strength at WKTN Frequency [Volts/meter] | WKTN Antenna Distance to Homes [km] | WKTN Signal Strength (S) at Homes [Volts/meter] | Ratio (R) S/F(d) [dB] |
|---|---|---|---|---|
| 1 | 3.89E-07 | 21.6 | 1.04E-3 | 68.5 |
| 2 | 6.27E-07 | 21.5 | 1.04E-3 | 64.4 |
| 3 | 4.91E-07 | 18.1 | 1.25E-3 | 68.1 |
| 4 | 6.20E-07 | 20.0 | 1.13E-3 | 65.2 |
| 5 | 6.42E-07 | 20.0 | 1.13E-3 | 64.9 |
| 6 | 5.13E-07 | 18.4 | 1.22E-3 | 67.5 |

| Home ID | F(d) Signal Strength at WKTN Frequency [Volts/meter] | WKTN Antenna Distance to Homes [km] | WKTN Signal Strength (S) at Homes [Volts/meter] | Ratio (R) S/F(d) [dB] |
|---|---|---|---|---|
| 7 | 4.69E-07 | 15.8 | 1.43E-3 | 69.7 |

***Table 4: Calculation of F(d), S and R for FM Band***

The calculated level of F(d), S and R at each of the seven homes for the VHF television band will be performed for Station WLIO (Channel 9) and is presented in Table 5.

| Home ID | F(d) Signal Strength at WLIO Frequency [Volts/meter] | WLIO Antenna Distance to Homes [km] | WLIO Signal Strength (S) at Homes [Volts/meter] | Ratio (R) S/F(d) [dB] |
|---|---|---|---|---|
| 1 | 1.71E-07 | 38.9 | 8.11E-05 | 53.5 |
| 2 | 2.75E-07 | 38.8 | 8.14E-05 | 49.4 |
| 3 | 2.15E-07 | 38.1 | 8.28E-05 | 51.7 |
| 4 | 2.72E-07 | 38.6 | 8.17E-05 | 49.6 |
| 5 | 2.82E-07 | 38.6 | 8.18E-05 | 49.3 |
| 6 | 2.25E-07 | 38.2 | 8.25E-05 | 51.3 |
| 7 | 2.06E-07 | 38.2 | 8.26E-05 | 52.1 |

***Table 5: Calculation of F(d), S and R for VHF Television Band***

The calculated level of F(d), S and R at each of the seven homes for the UHF television band will be performed for Station WTLW (Channel 44) and is presented in Table 6.

| Home ID | F(d) Signal Strength at WTLW Frequency [Volts/meter] | WTLW Antenna Distance to Homes [km] | WTLW Signal Strength (S) at Homes [Volts/meter] | Ratio (R) S/F(d) [dB] |
|---|---|---|---|---|
| 1 | 4.74E-08 | 43.41 | 1.94E-04 | 72.2 |
| 2 | 7.63E-08 | 43.23 | 1.95E-04 | 68.1 |
| 3 | 5.98E-08 | 38.70 | 2.17E-04 | 71.2 |
| 4 | 7.55E-08 | 43.15 | 1.95E-04 | 68.2 |
| 5 | 7.82E-08 | 43.12 | 1.95E-04 | 67.9 |
| 6 | 6.24E-08 | 42.82 | 1.97E-04 | 70.0 |
| 7 | 5.71E-08 | 42.85 | 1.96E-04 | 70.7 |

***Table 6: Calculation of F(d), S and R for UHF Television Band***

## 4. Results and Conclusions

From the results of the calculations it can be concluded that the reception of AM signals in the area of the 345 kV transmission line are the only ones that are at risk. For the seven home locations analyzed in this project, each one should be able to receive the signal from station WBLL. A further calculation was made to determine the minimum separation distance for an AM receiver to still have adequate reception from WBLL in the area around the preferred and alternate transmission lines. The minimum distance was found to be approximately 75 meters (246 feet). At distances closer to the transmission line it is predicted that the transmission line emission interference will prevent satisfactory reception.

For FM and television signal reception, the emissions from the transmission line are many orders of magnitude below the signal levels of the broadcast stations providing FM radio and television signal service to the area. This is shown in the calculation results for typical stations providing FM radio and television signals to the area. This result applies to both the preferred and alternative path for the transmission line.

No negative effects will occur to cable or satellite service to the area. For those homes to the north of the transmission line, there is a possibility that one of the transmission line support structures could obstruct the look angle to the satellite whether it is the Dish Network or DirecTV. This should not be a problem because each of these carriers has seven satellites in the Geo-stationary orbit and the receiving antenna can be realigned to one of the satellites away from the obstructions. The wires of the transmission line do not obstruct the signal from the satellites. Only the support structures can obstruct the signal. Cable television and radio service will be unaffected by the presence of the transmission line.

## 5. Contact

For questions or information regarding this report, please contact:

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Summary: Application Exhibit C AM/FM Radio & TV Interference Analysis electronically filed by Ms. Miranda R Leppla on behalf of Hardin Wind LLC