

**Appendix G – Crocker Wind Farm
Telecommunications Studies (Comsearch)**

Wind Power GeoPlanner™

Communication Tower Study

Crocker Wind Farm



Prepared on Behalf of
Crocker Wind Farm, LLC

April 28, 2016



COMSEARCH
A CommScope Company



Table of Contents

1. Introduction	- 1 -
2. Summary of Results	- 1 -
3. Discussion of Separation Distances	- 4 -
4. Conclusions	- 4 -
5. Contact Us	- 5 -

1. Introduction

This Communication Tower Study was performed for the Crocker Wind Farm in Clark County, South Dakota to identify the tower structures as well as FCC-licensed communication antennas that exist in and around the project area. This information is useful in the planning stages of the wind energy facilities to identify turbine setbacks and to prevent disruption to the services provided by the tenants on the towers. This data can be used in support of the wind energy facilities communications needs in addition to avoiding any potential impact to the current communications services provided in the region.

2. Summary of Results

The communication towers and antennas in the study area were derived from a variety of sources including the FCC's Antenna Structure Registration (ASR) database, Universal Licensing System (ULS), national and regional tower owner databases, and the local planning and zoning boards. The data¹ was imported into GIS software and the structures mapped in the wind energy area of interest. Each tower location is identified with a unique ID number associated with detailed structure and contact information provided in a spreadsheet attachment.

Three tower structures and seven communication antennas were identified within or near the Crocker Wind Farm project area using the data sources described in our methodology above.. These three tower structures contain four of the seven communication antennas. The remaining antennas may be located on a variety of structure types such as guyed towers, monopoles, silos, rooftops or portable structures. The specific type of structure would normally need to be determined by an on-site visit.

Detailed information about the tower structures and communication antennas is provided in Table 1 and Table 2 including location coordinates, structure height above ground level, and owner-operator name².

A discussion of turbine setback distances is provided in section three.

¹ Comsearch makes no warranty as to the accuracy of the data included in this report beyond the date of the report. The data provided in this report is governed by Comsearch's data license notification and agreement located at http://www.comsearch.com/files/data_license.pdf.

² Please note that this report analyzes all known operators on the towers from data sources available to Comsearch. Unidentified operators may exist on the towers due to unlicensed or federal government systems, mobile phone operators with proprietary locations, erroneous data on the FCC license, and other factors beyond our control.

Tower ID	ASR Number	Owner	Structure Height AGL (m)	Latitude (NAD83)	Longitude (NAD83)
Tower001	1037201	Northern Border Pipeline Company	73.0	45.06611111	-97.79861111
Tower002	N/A	Gray Television Group, Inc.	Unknown	45.10638889	-97.89944444
Tower003	1048745	Midcontinent Communications	98.4	45.11055556	-97.86380556

Table 1: Summary of Tower Structures

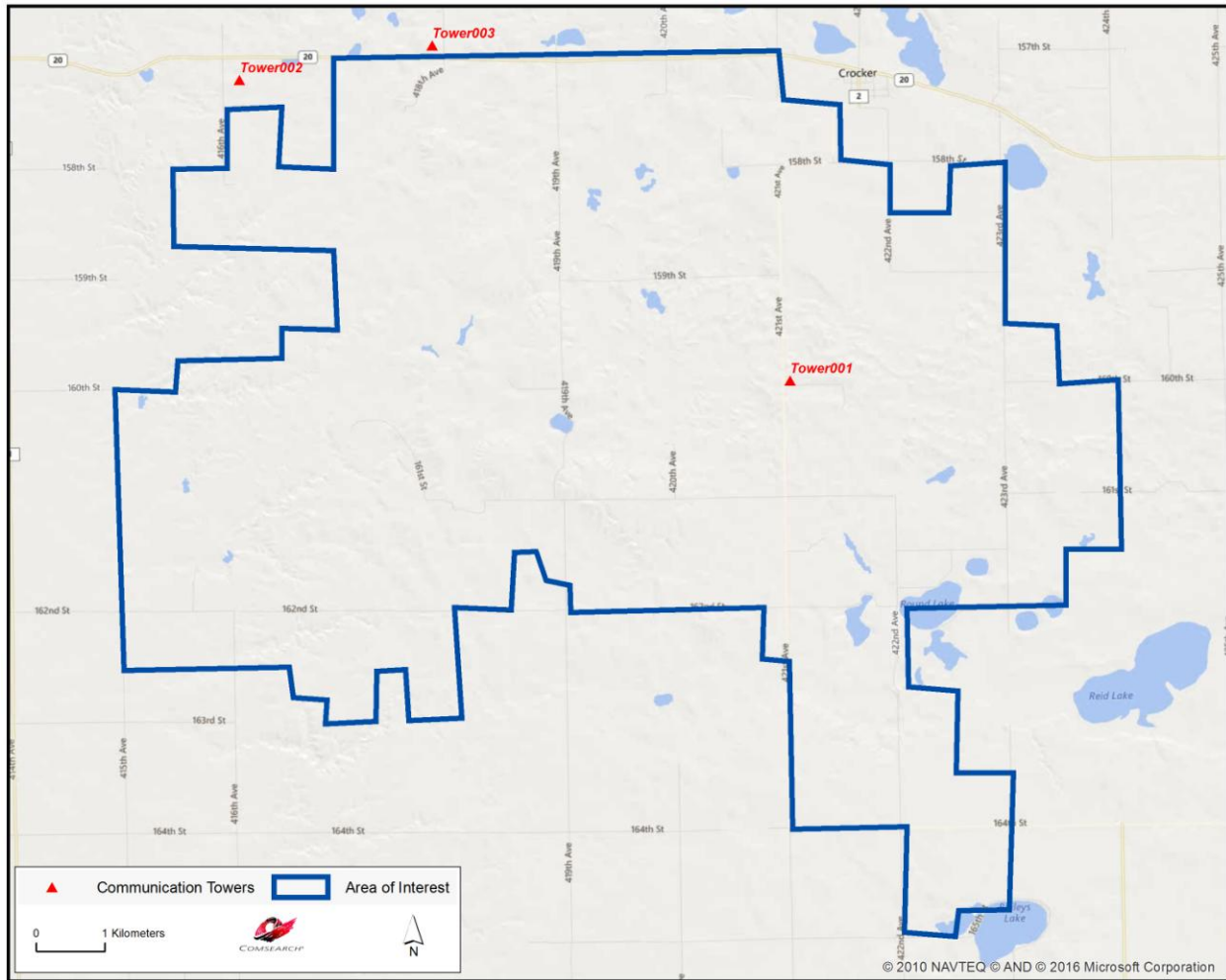


Figure 1: Towers within or near the Area of Interest

ID	Tower ID	Callsign	Service Type	Licensee	Antenna Height AGL (m)	Latitude (NAD83)	Longitude (NAD83)
1		WPRL543	Land Mobile	CLARK RURAL WATER SYSTEM INC	5	45.05052778	-97.90508333
2	Tower001	WPJX963	Land Mobile	NORTHERN BORDER PIPELINE COMPANY	73	45.06608333	-97.79869444
3	Tower001	WQDT284	Microwave	Northern Border Pipeline Company	56.7/71.93	45.06611111	-97.79861111
4		WNWR458	Land Mobile	HUBER, DAVID	9	45.06663889	-97.85175000
5		WQWC905	Land Mobile	ORMAT NEVADA INC.	6	45.06733333	-97.79808333
6	Tower002	KABY-TV	TV	GRAY TELEVISION LICENSEE, LLC	427	45.10638889	-97.89944444
7	Tower003	WMV705	Microwave	RED RIVER BROADCAST CO., LLC	30.48	45.11055556	-97.86380556

Table 2: Summary of Communication Antennas

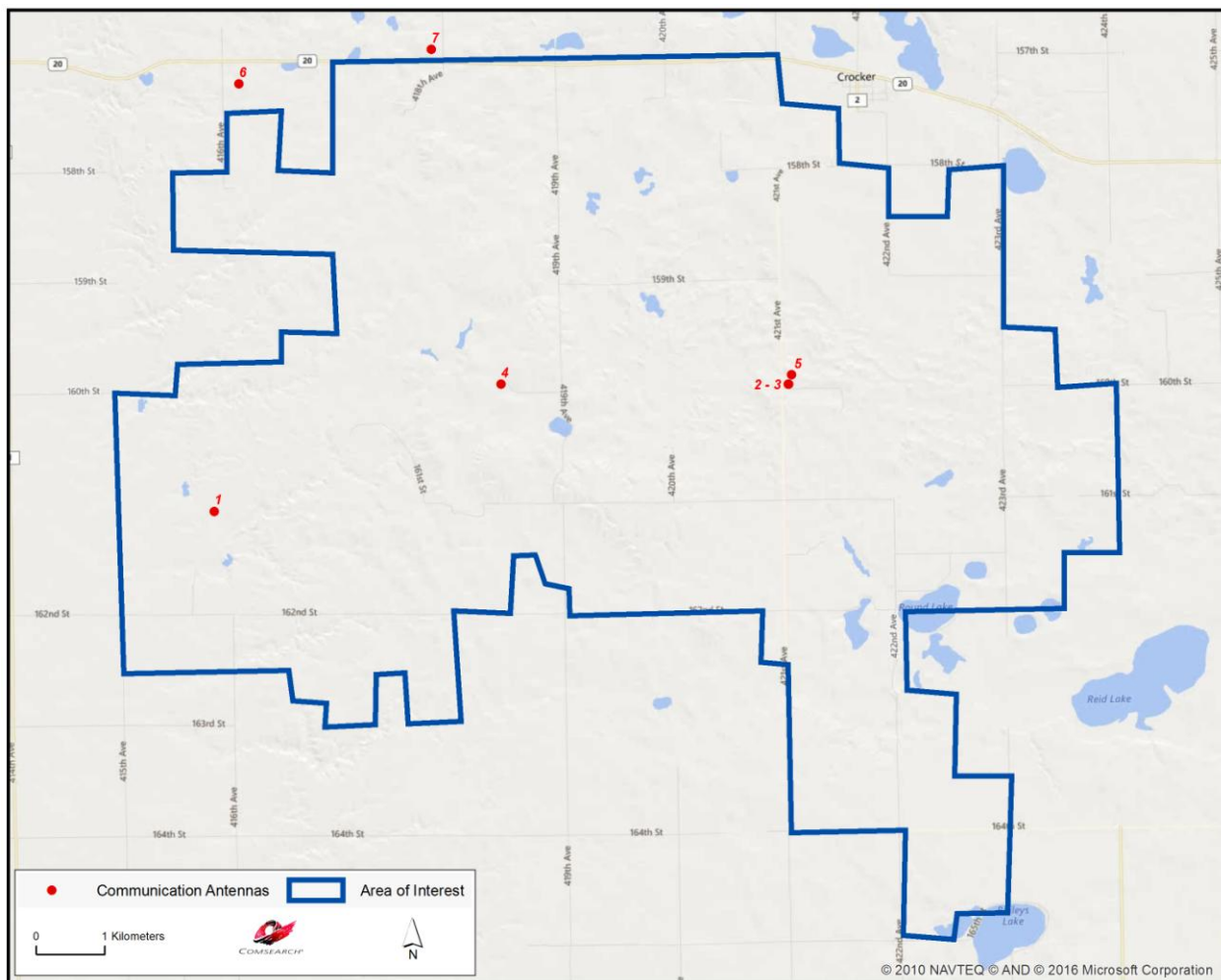


Figure 2: Communication Antennas within or near the Area of Interest

3. Discussion of Separation Distances

In planning the wind energy turbine locations, a conservative approach would dictate not locating any turbines in close proximity to existing tower structures to avoid any possible impact to the communications services provided by the structures. Reasonable distance between communication towers and wind turbine towers is a function of two things: (1) the physical turning radius of the wind turbine blades and (2) the characteristics of the communication systems on the communication tower.

Since wind turbine blades can rotate 360°, the first consideration of separation distance to other structures is clearance of the blades. If the blade radius is 50 meters, then a separation distance greater than 50 meters is necessary. From a practical standpoint, a setback distance greater than the maximum height of the turbine is necessary to insure a “fall” safety zone in the unlikely event of a turbine tower failure. Setback requirements for “fall” safety are typically specified by the local zoning ordinances.

The required separation distance based on the characteristics of the communication systems will vary depending on the type of communication antennas that are installed on the tower. For example, AM broadcast antennas should be separated by distances that allow for normal coverage which can extend up to 3 kilometers. For land mobile and mobile phone systems, setback distances are based on FCC interference emission limits from electrical devices in the land mobile and mobile phone frequency bands.

Finally, the tower structures identified could be a potential benefit in support of communications network needs for the wind energy facility. An example would be the implementation of a Supervisory Control and Data Acquisition (SCADA) system that monitors and provides communications access to the wind energy facility.

4. Conclusions

Our study identified three tower structures and seven communication antennas within or near the project area. They are used for microwave, TV and land mobile services in the area. Detailed impact assessments should be performed for each service type.



5. Contact Us

For questions or information regarding the Communication Tower Study, please contact:

Contact person: Denise Finney
Title: Account Manager
Company: Comsearch
Address: 197 Janelia Farm Blvd., Ashburn, VA 2147
Telephone: 73-726-565
Fax: 73-726-5595
Email: dfinney@comsearch.com
Web site: www.comsearch.com

Wind Power GeoPlanner™

Microwave Study

Crocker Wind Farm



Prepared on Behalf of
Crocker Wind Farm, LLC

April 25, 2016



COMSEARCH
A CommScope Company



Table of Contents

1. Introduction	- 1 -
2. Project Overview	- 1 -
3. Fresnel Zone Analysis	- 2 -
4. Conclusion	- 5 -
5. Contact	- 5 -

1. Introduction

Microwave bands that may be affected by the installation of wind turbine facilities operate over a wide frequency range (900 MHz – 23 GHz). Comsearch has developed and maintains comprehensive technical databases containing information on licensed microwave networks throughout the United States. These systems are the telecommunication backbone of the country, providing long-distance and local telephone service, backhaul for cellular and personal communication service, data interconnects for mainframe computers and the Internet, network controls for utilities and railroads, and various video services. This report focuses on the potential impact of wind turbines on licensed, proposed and applied non-federal government microwave systems.

2. Project Overview

Project Information

Name: Crocker Wind Farm

County: Clark

State: South Dakota

Number of Turbines: TBD

Blade Diameter: TBD

Hub Height: TBD

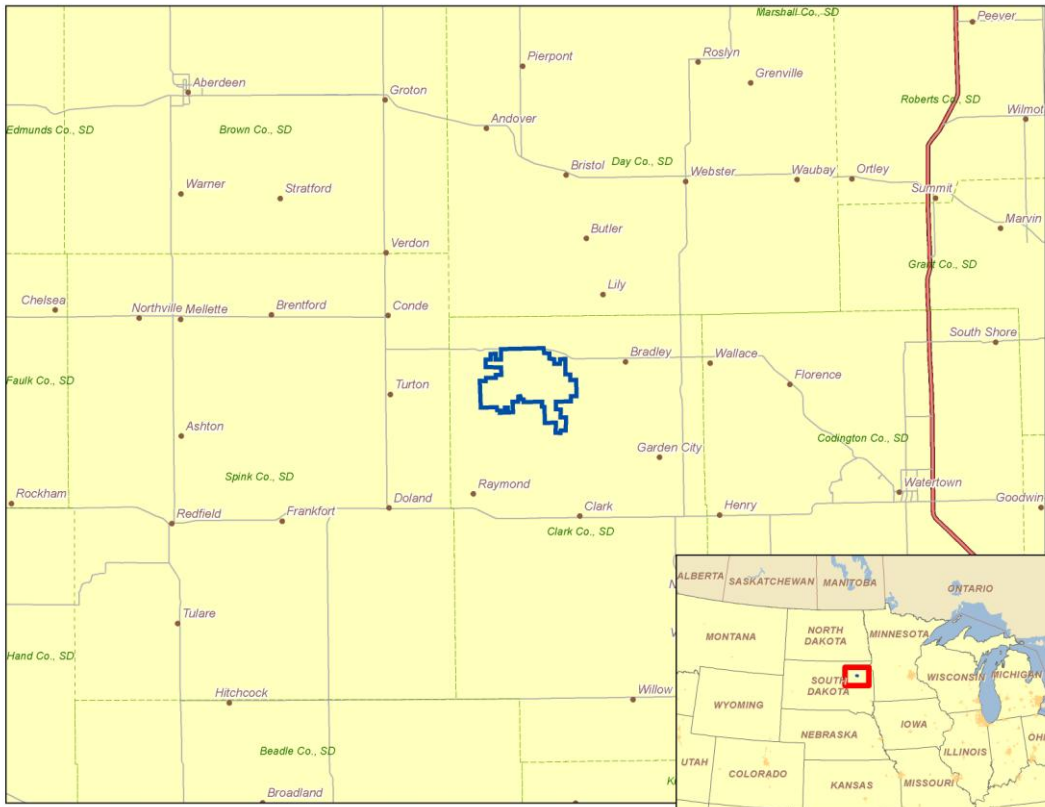


Figure 1: Area of Interest

3. Fresnel Zone Analysis

Methodology

Our obstruction analysis was performed using Comsearch’s proprietary microwave database, which contains all non-government licensed, proposed and applied paths from 0.9 - 23 GHz¹. First, we determined all microwave paths that intersect the area of interest² and listed them in Table 1. These paths and the area of interest that encompasses the planned turbine locations are shown in Figure 2.

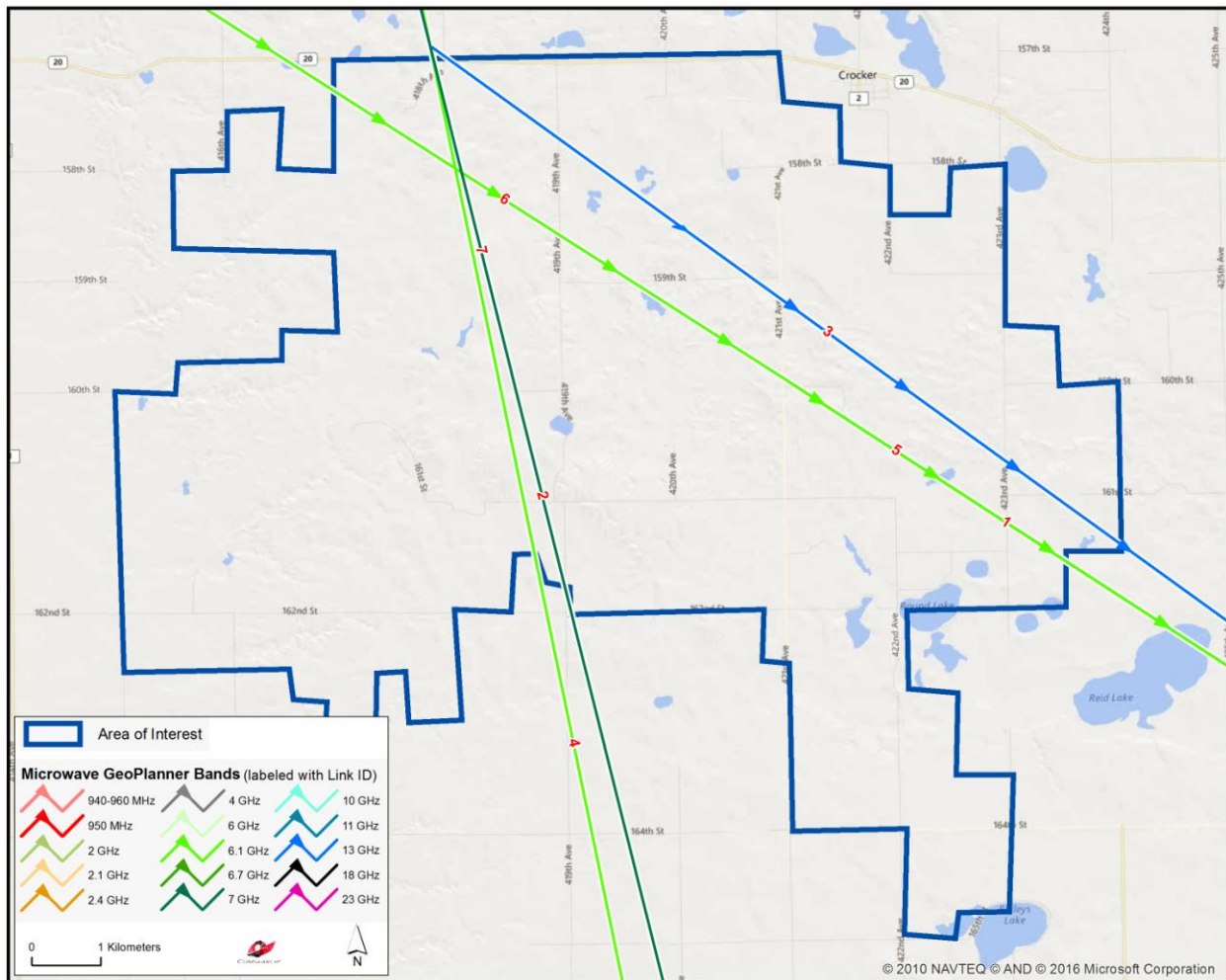


Figure 2: Microwave Paths that Intersect the Area of Interest

¹ Please note that this analysis does not include unlicensed microwave paths or federal government paths that are not registered with the FCC.

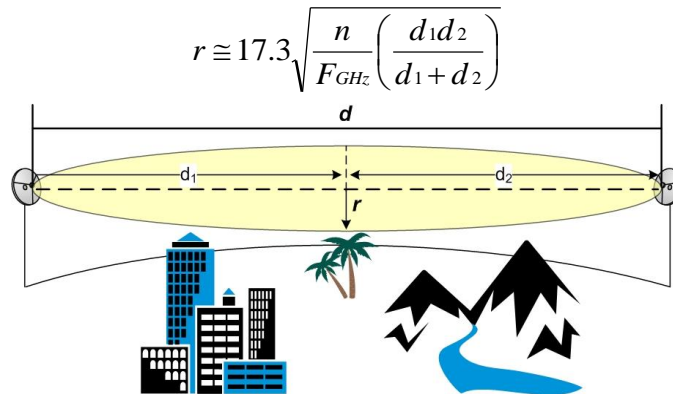
² We use FCC-licensed coordinates to determine which paths intersect the area of interest. It is possible that as-built coordinates may differ slightly from those on the FCC license.

ID	Status	Callsign 1	Callsign 2	Band	Path Length (km)	Licensee
1	Questionable	WEH672	WQDT285	Lower 6 GHz	25.22	Northern Border Pipeline Company
2	Licensed	WIW99	RXONLY	7 GHz	43.08	South Dakota Brd of Dir of ED Telecom
3	Licensed	WMV705	RXONLY	13 GHz	26.93	RED RIVER BROADCAST CO., LLC
4	Licensed	WPSZ826	WQOM534	Lower 6 GHz	39.15	NorthWestern Corporation
5	Licensed	WQDT284	WQDT285	Lower 6 GHz	25.21	Northern Border Pipeline Company
6	Licensed	WQDT323	WQDT284	Lower 6 GHz	53.36	Northern Border Pipeline Company
7	Licensed	WQEJ924	RXONLY	7 GHz	43.08	South Dakota Brd of Dir of ED Telecom

Table 1: Summary of Microwave Paths that Intersect the Area of Interest

(See enclosed mw_geopl.xlsx for more information and GP_dict_matrix_description.xls for detailed field descriptions)

Next, we calculated a Fresnel Zone for each path based on the following formula:



Where,

- r = Fresnel Zone radius at a specific point in the microwave path, meters
- n = Fresnel Zone number, 1
- F_{GHz} = Frequency of microwave system, GHz
- d₁ = Distance from antenna 1 to a specific point in the microwave path, kilometers
- d₂ = Distance from antenna 2 to a specific point in the microwave path, kilometers

The calculated Fresnel Zone shows the narrow area of signal swath and is calculated for each microwave path in the project area. In general, this is the area where the planned wind turbines should be avoided, if possible. A depiction of the individual Fresnel Zones is shown in Figure 3, and is also included in the shapefiles^{3,4}.

³ The ESRI® shapefiles enclosed are in NAD 83 UTM Zone 14 projected coordinate system.

⁴ Comsearch makes no warranty as to the accuracy of the data included in this report beyond the date of the report. The data provided in this report is governed by Comsearch's data license notification and agreement located at http://www.comsearch.com/files/data_license.pdf.

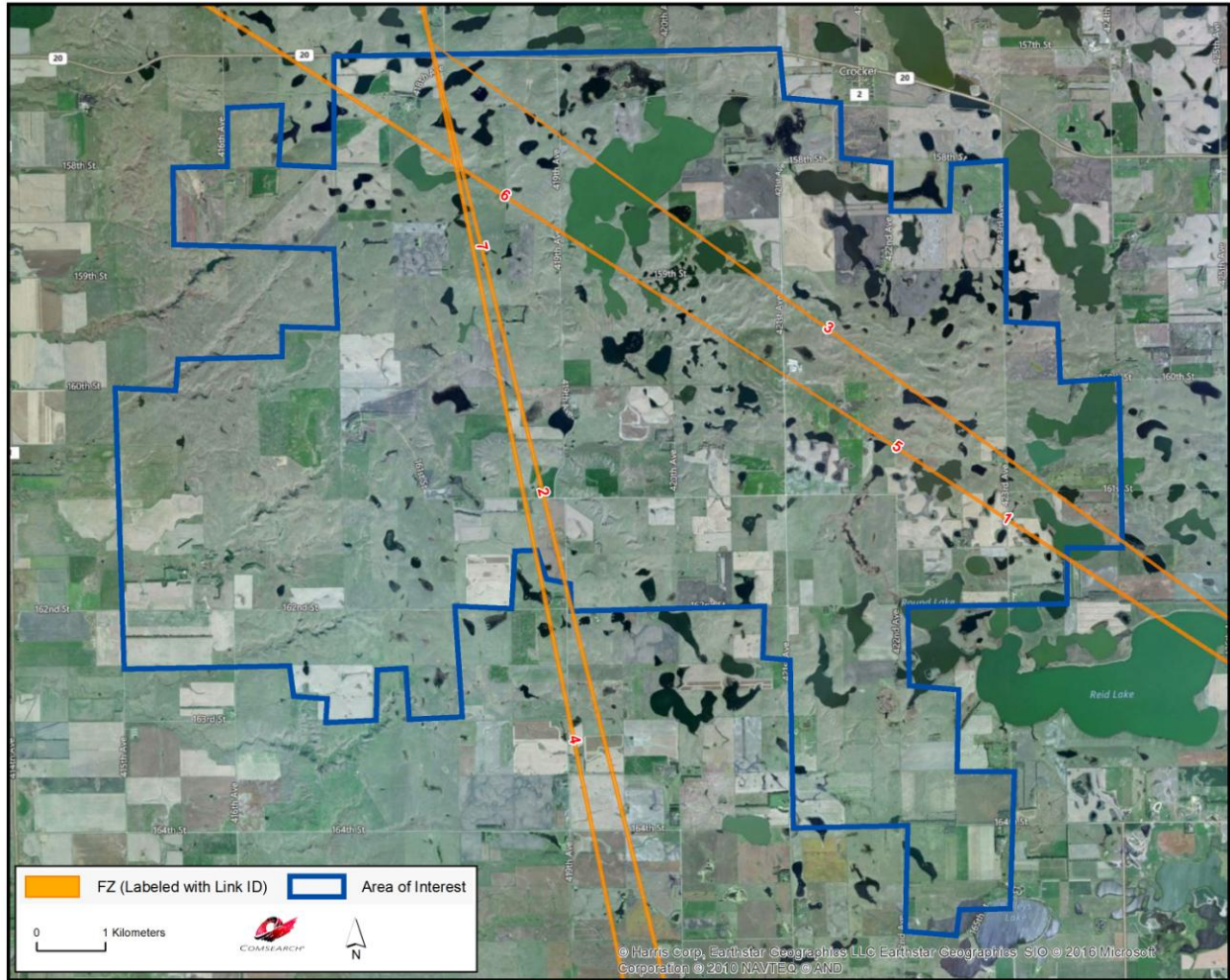


Figure 3: Fresnel Zones in the Area of Interest

Discussion of Potential Obstructions

Total Microwave Paths	Paths with Affected Fresnel Zones	Total Turbines	Turbines intersecting Fresnel Zones
7	N/A	N/A	N/A

For this project, turbine locations were not provided; thus we could not determine if any potential obstructions exist between the planned wind turbines and the incumbent microwave paths. If the latitude and longitude values for turbine locations are provided, Comsearch can identify where a potential conflict might exist.

4. Conclusion

Our study identified seven microwave paths intersecting the Crocker Wind Farm project area. The Fresnel Zones for these microwave paths were calculated and mapped. We recommend that all turbines be sited in locations that will not obstruct the Fresnel Zones.

5. Contact

For questions or information regarding the Microwave Study, please contact:

Contact person:	Denise Finney
Title:	Account Manager
Company:	Comsearch
Address:	19700 Janelia Farm Blvd., Ashburn, VA 20147
Telephone:	703-726-5650
Fax:	703-726-5595
Email:	dfinney@comsearch.com
Web site:	www.comsearch.com