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November 30, 2016

Via Electronic Filing

Ms. Barcy McNeal
Public Utilities Commission of Ohio
Administration/Docketing
180 East Broad Street, 11th Floor
Columbus, OH 43215-3793

Re: Trishe Wind Ohio, LLC, Case No. 13-197-EL-BGN

Dear Ms. McNeal:

The December 16, 2013 Opinion, Order, and Certificate approving Northwest Ohio Wind Energy, LLC's [now known as Trishe Wind Ohio, LLC ("Trishe")] Certificate of Environmental Compatibility and Public Need ("Certificate") and the October 1, 2013 Supplement to Amended Application ("Supplement") established a set of conditions and supplemental commitments as part of the Certificate.

Condition No. 24 of the Board's Order requires the following:

The Applicant shall monitor the microwave paths to ensure there are no adverse impacts. At least 30 days prior to the preconstruction conference, the Applicant shall conduct a microwave path study that identifies all existing microwave paths that intersect the selected route, and a worst-case Fresnel zone analysis for each path. A copy of this study shall be provided to the path licensee for review and to Staff for review and confirmation that the Applicant is complying with this condition.

On November 14, 2016, Trishe filed a Microwave Study dated November 1, 2016 that focused on the potential impact of 50 wind turbines on licensed, proposed and applied microwave systems. In compliance with Condition No. 24, attached is a copy of the updated Microwave Study dated November 23, 2016, which focuses on the potential impact of 60 wind turbines. A copy of the study was previously sent to OPSB Staff on November 29, 2016, and was also mailed to the licensees.

If you have any questions please call at the number listed above.

Sincerely,

Sally W. Bloomfield

Attachment

cc: Grant Zeto (w/Attachment)
Andrew Conway (w/Attachment)

Wind Power GeoPlanner™

Microwave Study

Trishe Wind Ohio



Prepared on Behalf of
Starwood Energy Group
Global

November 23, 2016



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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: Trishe Wind Ohio

County: Paulding

State: Ohio

Number of Turbines: 60

Max Blade Diameter¹: 126 meters

Hub Height: 80 - 96 meters

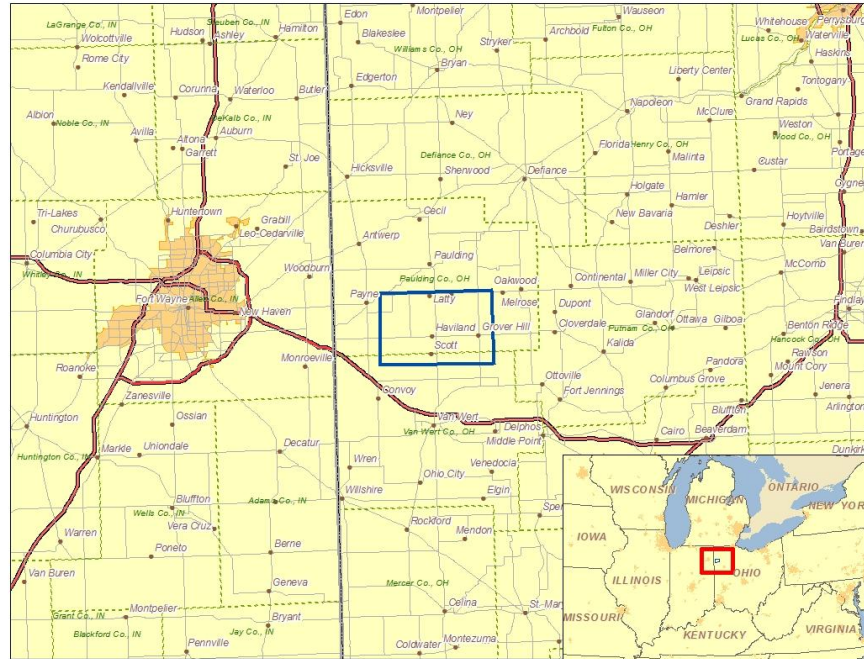


Figure 1: Area of Interest

¹ The turbine model is TBD. This study is based on the worst case scenario except for turbine 55 which was given specific dimensions.

ID	Status	Callsign 1	Callsign 2	Band	Path Length (km)	Licensee
1	Proposed	1029441	1225294	Upper 6 GHz	77.87	Torellco LLC
2	Proposed	1034986	1013766	Lower 6 GHz	59.90	Webline Holdings LLC
3	Proposed	ADA	WETSEL	Upper 6 GHz	60.24	ECW Wireless, LLC
4	Removed ⁴	ATC42132	FCC12661	Lower 6 GHz	34.68	Fort Wayne Communications Group Company
5	Proposed	CCI87269	ATC50782	Lower 6 GHz	49.37	Fundamental Broadcasting LLC
6	Removed ⁴	FCC12164	FCC12661	Lower 6 GHz	35.92	Fort Wayne Communications Group Company
7	Removed ⁴	FCC12661	FCC12887	Lower 6 GHz	39.99	Fort Wayne Communications Group Company
8	Proposed	FCC12661	SITA2235	Upper 6 GHz	30.64	Fort Wayne Communications Group Company
9	Proposed	FTJENNIN	FORTWAYN	Upper 6 GHz	76.99	ECW Wireless, LLC
10	Proposed	FTJENNIN	TOWNLEY	Upper 6 GHz	49.32	ECW Wireless, LLC
11	Proposed	GTPIN-52	OH03415-	Lower 6 GHz	54.80	Wireless Internetwork LLC
12	Proposed	OH03415-	CCI87204	Lower 6 GHz	56.25	Wireless Internetwork LLC
13	Proposed	VANWERT	FTWAYNE	Lower 6 GHz	57.94	ECW Wireless, LLC
14	Proposed	VANWERT	WQPF726	Upper 6 GHz	57.94	ECW Wireless, LLC
15	Licensed	WAZ563	WAZ596	Lower 6 GHz	31.42	Norfolk Southern Railway
16	Removed ⁴	WAZ563	WAZ596	Upper 6 GHz	31.42	Norfolk Southern Railway
17	Licensed	WAZ596	WBB735	Lower 6 GHz	38.51	Norfolk Southern Railway
18	Licensed	WAZ596	WBB735	Upper 6 GHz	38.51	Norfolk Southern Railway
19	Licensed	WLD621	RXONLY	950 MHz	21.00	First Family Broadcasting, Inc.
20	Licensed	WQON426	WQON427	Upper 6 GHz	51.69	Fort Wayne Communications Group Company
21	Licensed	WQON427	WQON424	Upper 6 GHz	39.37	Fort Wayne Communications Group Company
22	Licensed	WQOV246	WQOV248	Upper 6 GHz	60.24	World Class Wireless, LLC
23	Proposed	WQOV248	EDGERTON	Lower 6 GHz	31.09	ECW Wireless, LLC
24	Licensed	WQOV248	WQOS750	11 GHz	35.35	World Class Wireless, LLC
25	Licensed	WQPA629	WQOV248	11 GHz	16.31	World Class Wireless, LLC
26	Licensed	WQRX775	WQRY695	11 GHz	15.85	Sprint Spectrum L.P.
27	Licensed	WQRY696	WQRY695	11 GHz	12.61	Sprintcom, Inc
28	Licensed	WQSA894	WQSA779	Lower 6 GHz	49.37	Argos Engineering, LLC
29	Licensed	WQSD967	WQSD966	Lower 6 GHz	49.79	Torellco LLC
30	Licensed	WQTB516	WQRX775	11 GHz	16.56	Sprint Spectrum L.P.
31	Licensed	WQTX715	WQTX717	11 GHz	21.79	MetaLINK Technologies, Inc.
32	Licensed	WQTX717	WQWF235	11 GHz	8.85	MetaLINK Technologies, Inc.
33	Licensed	WQUL511	WQUL808	Lower 6 GHz	57.94	Torellco LLC
34	Licensed	WQUU748	WQUT739	11 GHz	30.27	Agile Network Builders LLC
35	Licensed	WQWD687	RXONLY	2.4 GHz	84.41	Waterleaf International LLC
36	Licensed	WQWF483	WQWF484	4 GHz	84.41	Waterleaf International LLC
37	Licensed	WQXC632	WQUL808	Lower 6 GHz	59.99	Torellco LLC
38	Licensed	WQUL511	WQUL808	Lower 6 GHz	57.94	Torellco LLC
39	Licensed	WQYJ953	WQYI235	11 GHz	20.45	Paulding-Putnam Electric Cooperative

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)

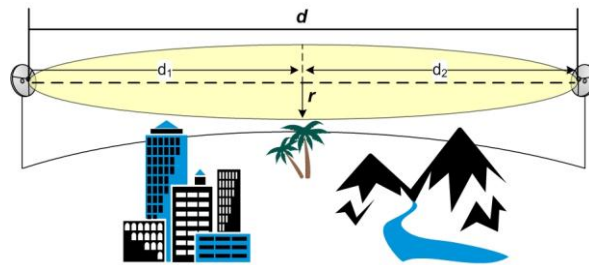
⁴ IDs 4, 6, and 7 were proposed microwave paths evaluated in the August 2006 Microwave Study. They have not been converted into licenses or renewed their proposed status and therefore were removed for this study. ID 16 has also been canceled and isn't included in this report.

Verification of Coordinate Accuracy

It is possible that as-built coordinates may differ from those on the FCC license. For this project, path IDs 20, 26, 29, 31 and 34 cross within close proximity of the proposed turbines and the tower locations for these paths will have a critical impact on the result. Therefore, we verified these locations using aerial photography. Some of the towers were found to be slightly off and were moved to their locations based on the aerial photos⁵.

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

$$r \cong 17.3 \sqrt{\frac{n}{F_{\text{GHz}}} \left(\frac{d_1 d_2}{d_1 + d_2} \right)}$$



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
- d_1 = Distance from antenna 1 to a specific point in the microwave path, kilometers
- d_2 = Distance from antenna 2 to a specific point in the microwave path, kilometers

In general, this is the area where the planned wind turbines should be avoided, if possible. A depiction of the Fresnel Zones for each microwave path listed can be found in Figure 3, and is also included in the enclosed shapefiles^{6,7}.

⁵ See enclosed mw_geopl.shp and mw_geopl_fcc.shp for details.

⁶ The ESRI® shapefiles enclosed are in NAD 83 UTM Zone 16 projected coordinate system.

⁷ 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.

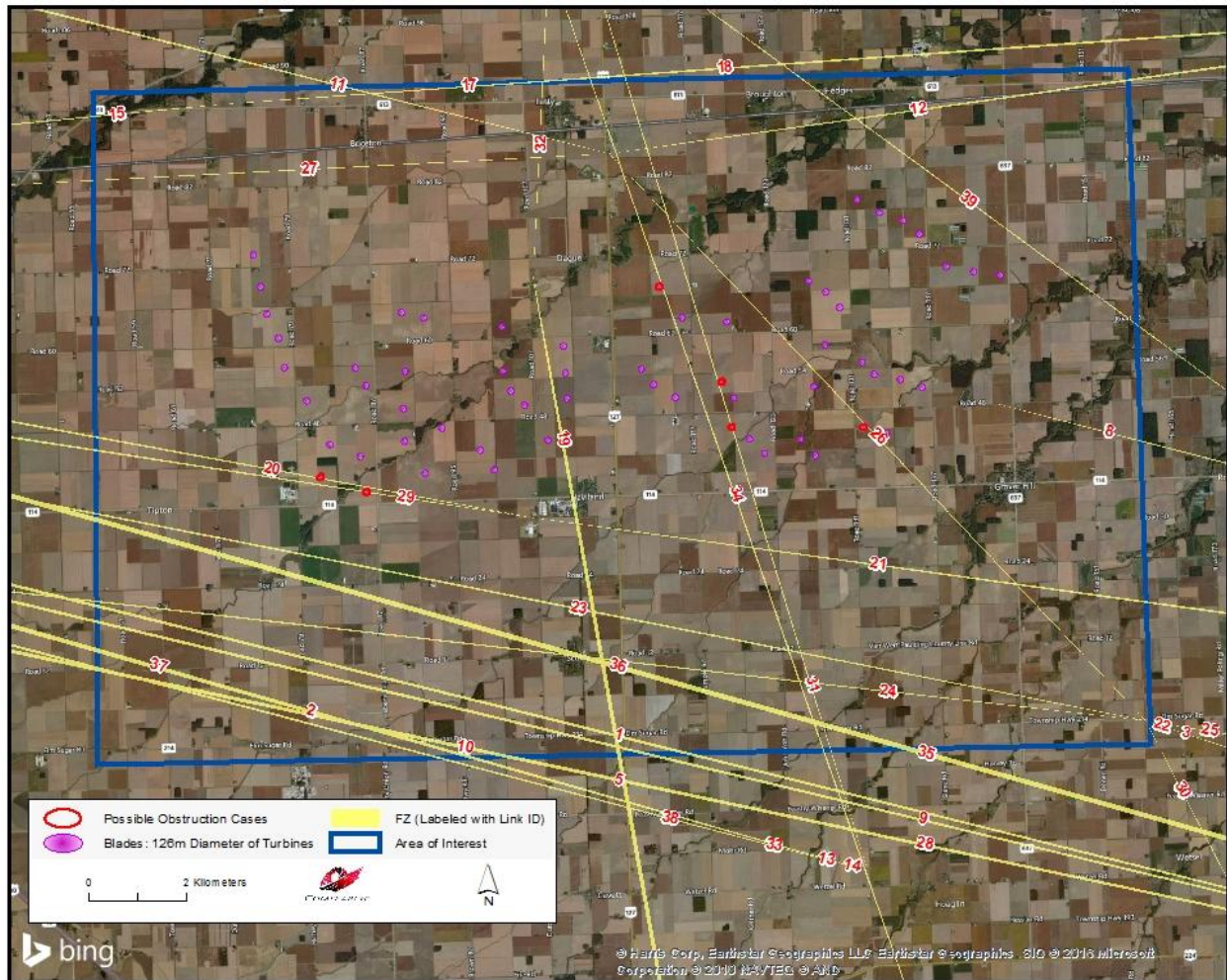


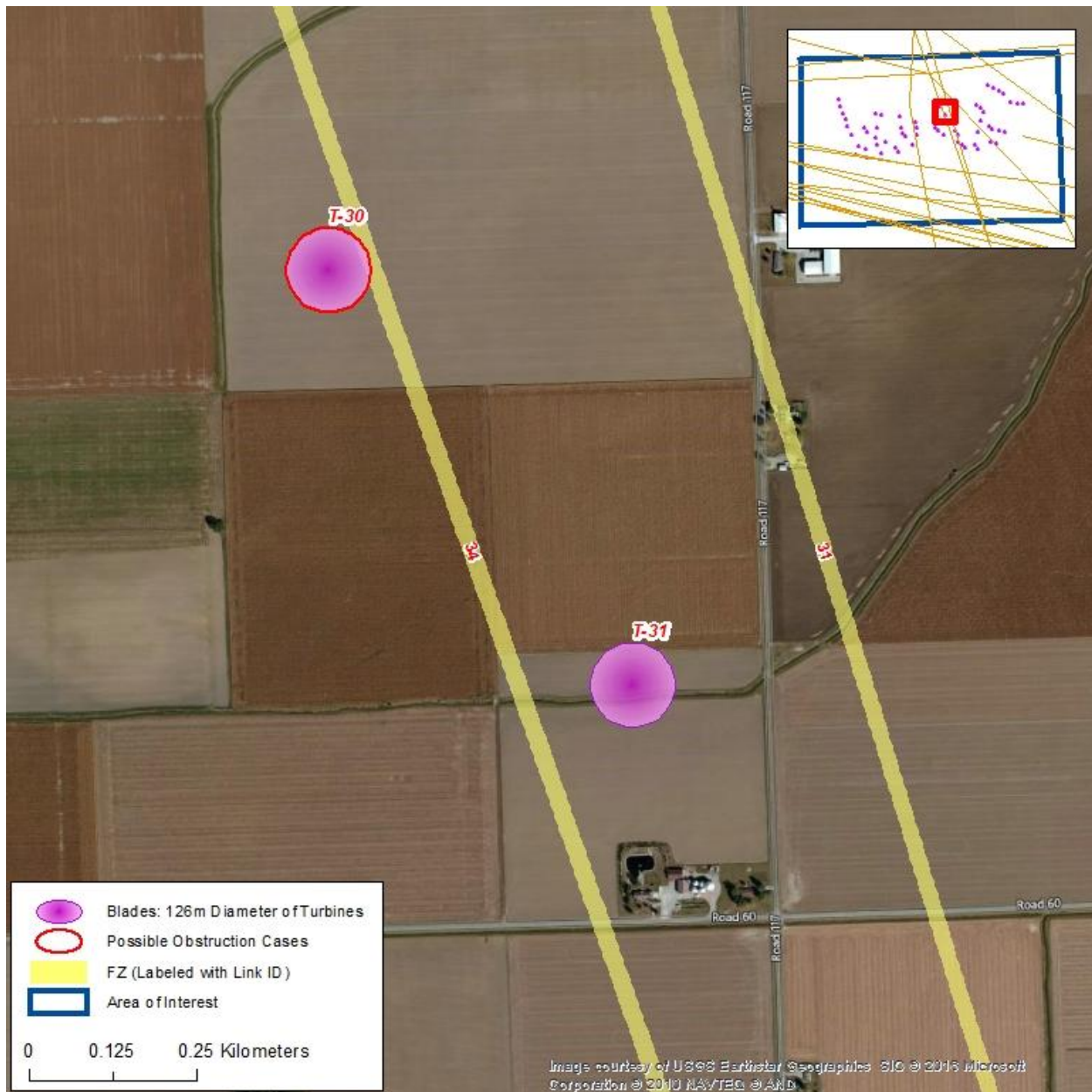
Figure 3: Fresnel Zones in the Area of Interest

Discussion of Potential Two Dimensional Obstructions

Total Microwave Paths	Paths with Affected Fresnel Zones	Total Turbines	Turbines intersecting the Fresnel Zones
35	5	60	6

Table 2: Two Dimensional Fresnel Zone Analysis Result

For this project, 60 turbines were considered in the analysis, each with a maximum blade diameter of 126 meters and turbine hub height of 80 to 96 meters. Of those turbines, six were found to intersect the Fresnel Zones of five microwave paths. Figures 4 through 7 contain a detailed depiction of the potential obstruction scenarios and Table 3 contains a summary of the affected turbines. A cross sectional analysis was performed in Section 4 to determine the diagonal clearance value for these cases.



**Figure 4: Potential Obstruction Case
(Turbine T-30)**

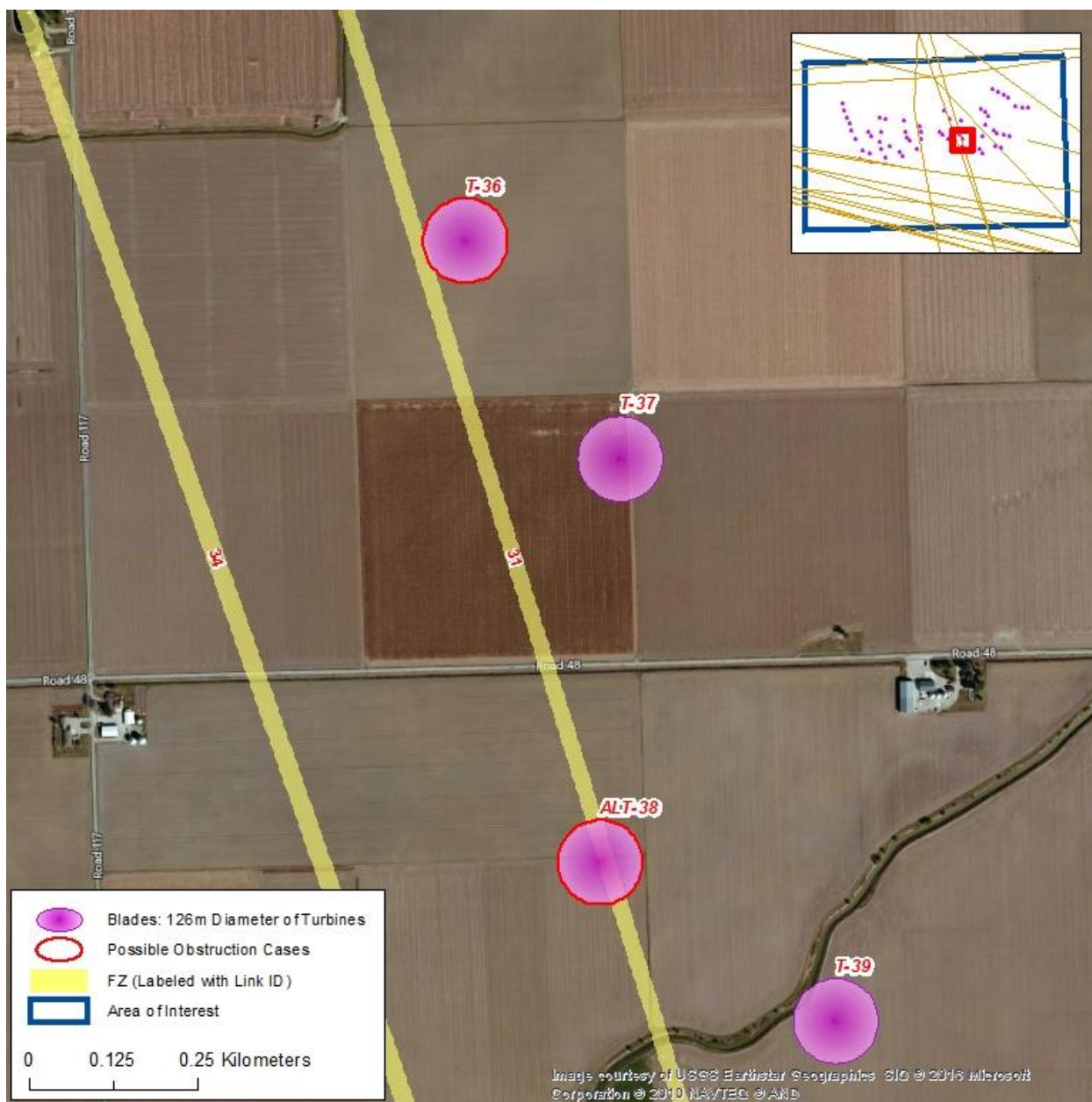


Figure 5: Potential Obstruction Cases
(Turbine T-36 and ALT-38)

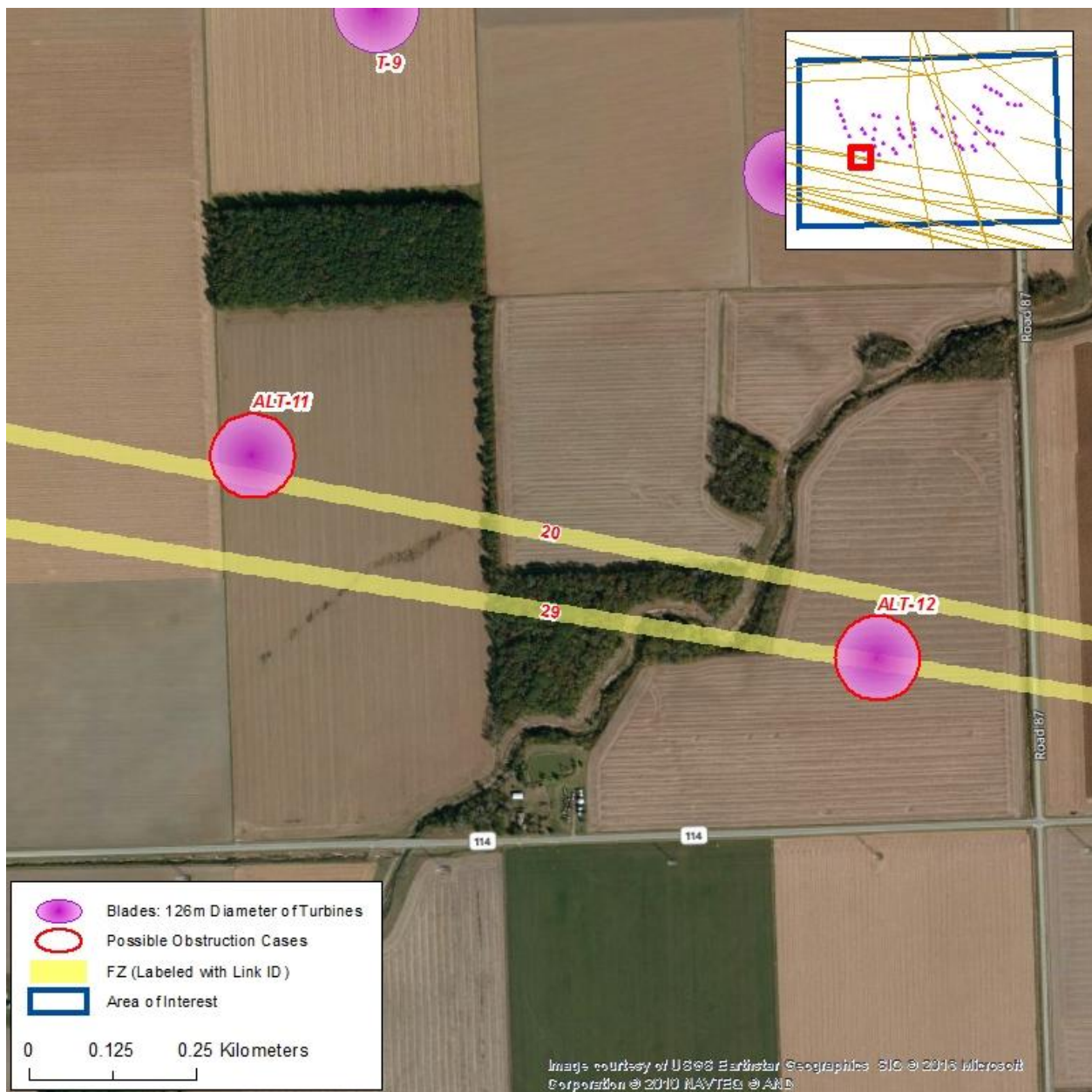


Figure 6: Potential Obstruction Cases
(Turbine ALT-11 and ALT-12)

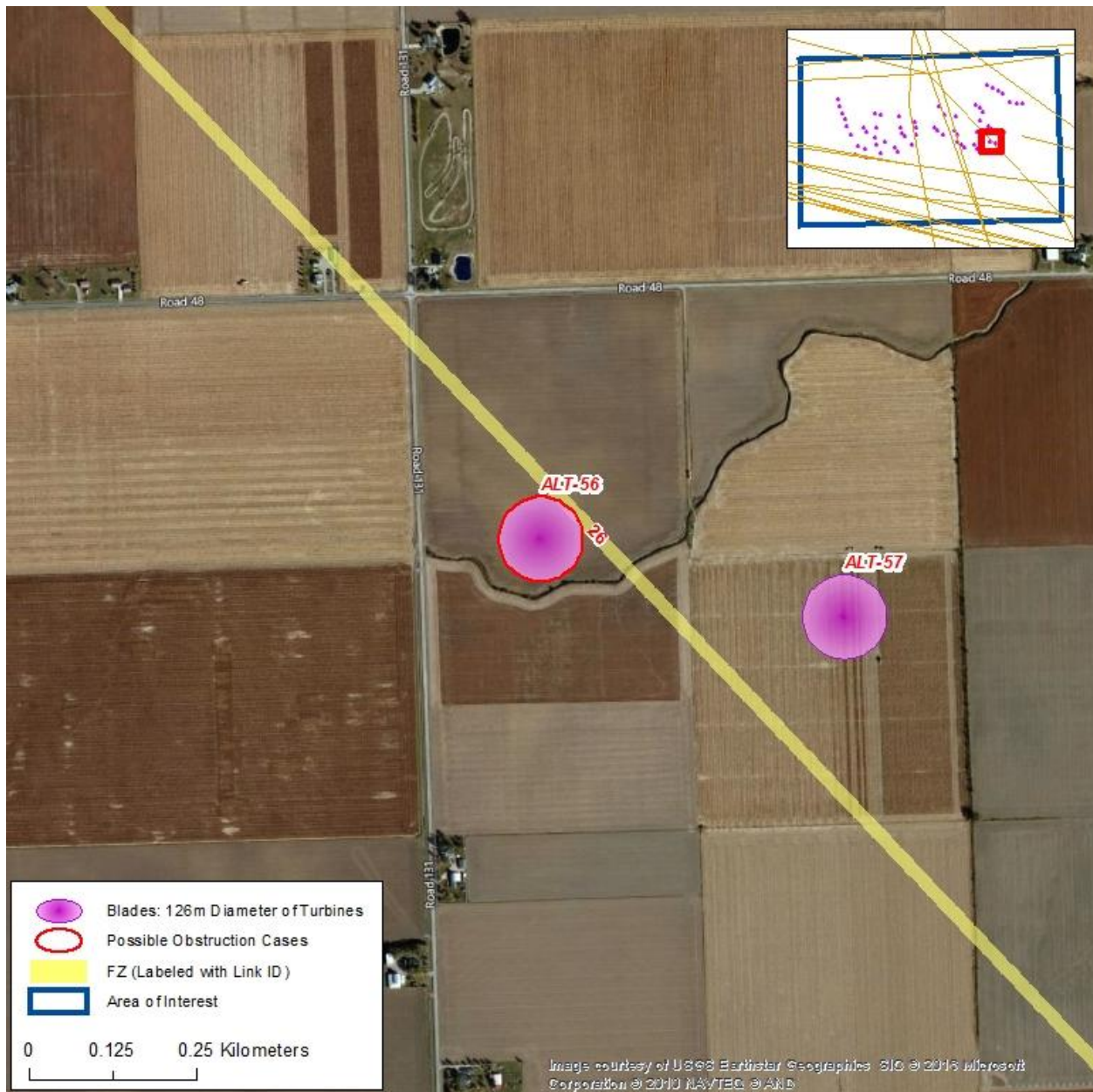


Figure 7: Potential Obstruction Case
(Turbine ALT-56)

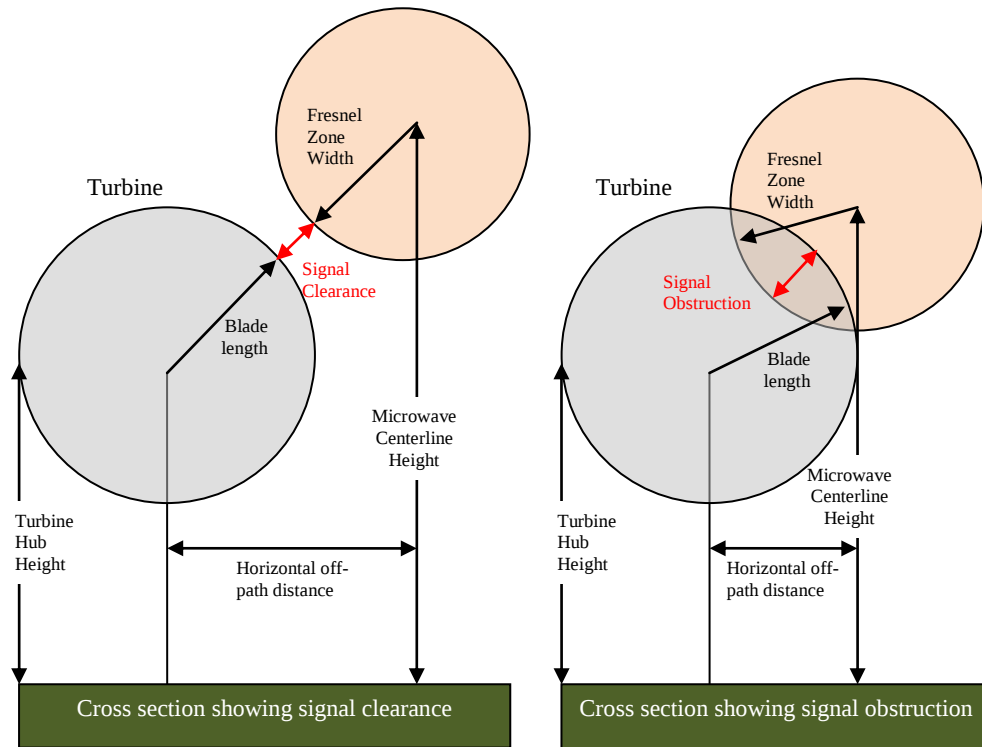
Affected Microwave Path ID	Fresnel Zone Width at Turbine Location (m)	Turbine ID	Latitude (NAD83)	Longitude (NAD83)	Horizontal off-path Distance (m)	Distance along the path from site 1 (km)	Horizontal Clearance (m)
20	13.38	ALT-11	41.02393325	-84.64444141	33.02	47.31	-43.36
26	10.28	ALT-56	41.03032337	-84.51288360	64.46	8.28	-8.82
29	12.40	ALT-12	41.02098480	-84.63343618	5.51	46.38	-69.89
31	11.95	ALT-38	41.03098042	-84.54472177	9.36	9.42	-65.59
31	12.05	T-36	41.03932252	-84.54679397	68.71	10.36	-6.34
34	12.95	T-30	41.05701400	-84.56129243	63.92	8.89	-12.03

Table 3: Turbines that Intersect Fresnel Zones

4. Cross Sectional Analysis

Our Fresnel Zone analysis in the previous section identified six potential obstruction cases that need to be further examined from a cross sectional perspective. The cases that will be analyzed in this section can be found in Table 3.

Our cross sectional analysis calculates the precise height and width of 100% of the first Fresnel Zone at the turbine location based on the antenna heights of the two link endpoints and the earth curvature bulge at the specific turbine location. The horizontal off-path distance was calculated in the previous section and the turbine hub height and blade length were provided by the client. The cross sectional analysis uses these values to calculate the clearance between the blades and the microwave Fresnel Zone as shown in the two diagrams on the next page.



The results of the cross sectional calculations can be seen in Table 4 on the next page. It shows negative clearance values indicating obstruction of the Fresnel zones and positive values indicating clearance of the Fresnel zones.

Microwave Path ID	Fresnel Zone Width at Turbine Location (m)	Microwave Centerline Height at Turbine Location (m)	Turbine ID	Hub Height ⁸ (m)	Blade Length (m)	Cross Sectional Clearance (m)
20	13.38	64.47	ALT-11	80	63	-39.89
26	10.28	74.67	ALT-56	80	63	-8.60
29	12.40	63.71	ALT-12	80	63	-58.20
31	11.95	50.76	ALT-38	80	63	-44.25
31	12.05	47.99	T-36	80	63	0.75
34	12.95	59.66	T-30	80	63	-8.88

Table 4: Cross Sectional Analysis Results

⁸ Because the turbine hubs are higher than the microwave centerlines, the minimum hub height is used to calculate the clearance for the worst case scenario.

5. Conclusion

Our update study identified 35 microwave paths intersecting the Trishe Wind Ohio project area. Four paths (ID 4, 6, 7, and 16) have been removed and two new licensed paths were added (ID 38 and 39) since the previous Microwave Study in August 2016. The Fresnel Zones for these microwave paths were calculated and mapped.

Two turbines and four alternate turbine locations were found to obstruct five microwave beam paths in the two dimensional study and were further analyzed in the three-dimensional cross section. Turbine T-36 was found to clear path 31 in the cross sectional study but turbine T-30 was found to obstruct the Fresnel zone of path 24 by approximately 9 meters. This turbine would need to be moved at least 13 meters west of its current proposed location to avoid the beam path. Other mitigation options would involve using a higher hub height to clear the beam path (at least 101 meters) at its current location. The four alternate turbines that were studied in the cross sectional dimension were found to potentially cause signal degradation in their current locations.

6. Contact

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

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Company:	Comsearch
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Case No(s). 13-0197-EL-BGN

Summary: Correspondence of Trishe Wind Ohio, LLC in Compliance with Condition No. 24 -
Updated Microwave Study electronically filed by Teresa Orahod on behalf of Sally W.
Bloomfield