

Wind Turbine Siting and Point-to-Point Microwave

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Potential Telecommunications Issues with Wind Turbines

- Wind turbines create potential blockage problems with point-to-point microwave links
- Turbines potentially alter propagation characteristics of nearby telecommunications facilities
- Turbines potentially affect the electromagnetic characteristics of surrounding telecommunications facilities

Wind power developers are pro-active in the early planning stages of facilities to quantify and minimize any disruption to existing telecommunications networks

Potential Telecommunications Issues Involving Wind Turbines

- Microwave point-to-point communications
- Off-air television reception
- Radar
- Land mobile radio (LMR)
- Cellular and PCS mobile telephone
- AM/FM radio coverage
- Amateur radio operations



Prediction of Microwave—Point-to-Point Interference

Based on

Microwave Station Database GeoPlanner™

and

Fresnel Zone Blockage Analysis

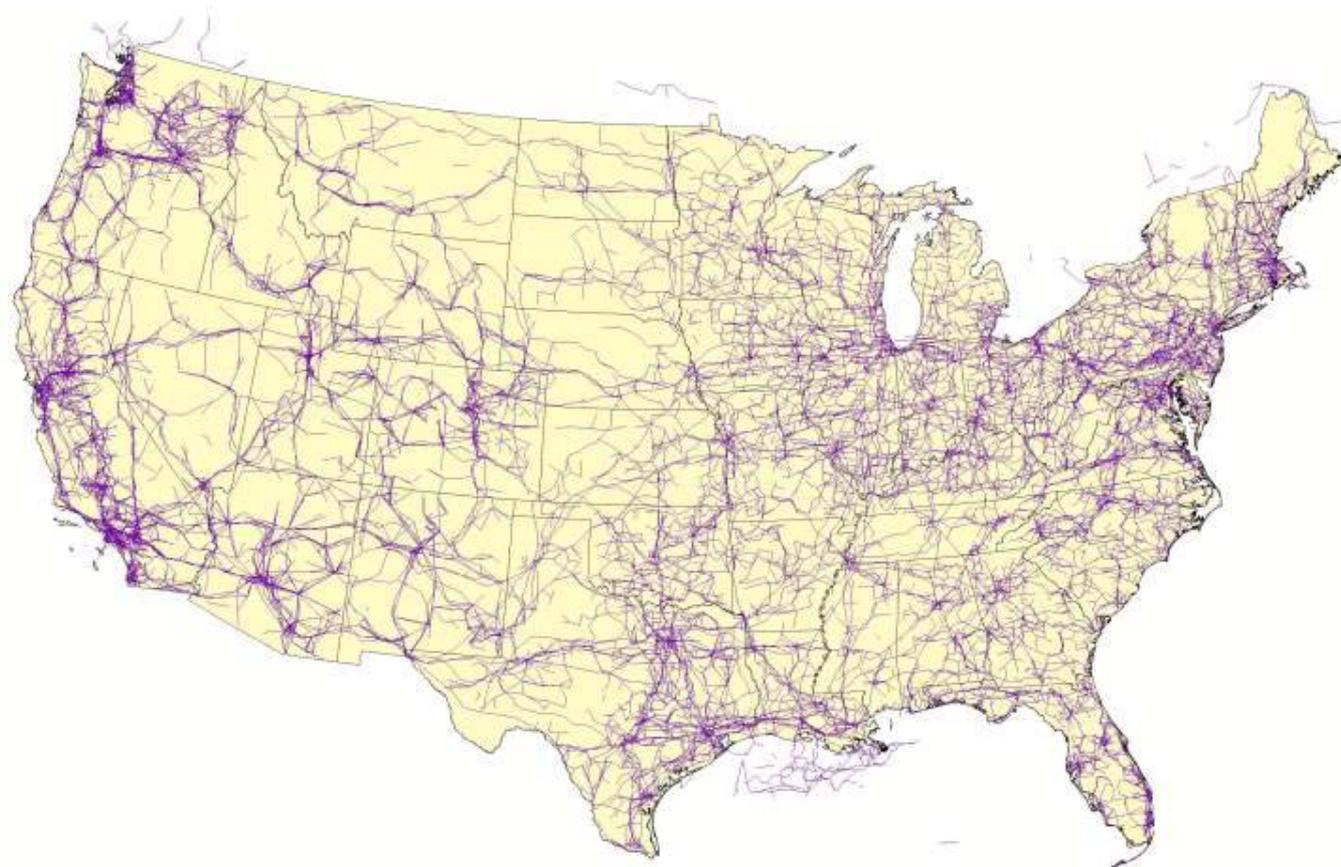
Microwave Point-to-Point Communications



Point-to-Point Microwave Analysis Requirements

- Database containing technical characteristics of all licensed and coordinated microwave paths
- Location of wind turbines (area of interest or specific proposed turbine locations)
- Dimensions of turbines (hub height and blade diameter)
- Fresnel zones of microwave paths (calculated)

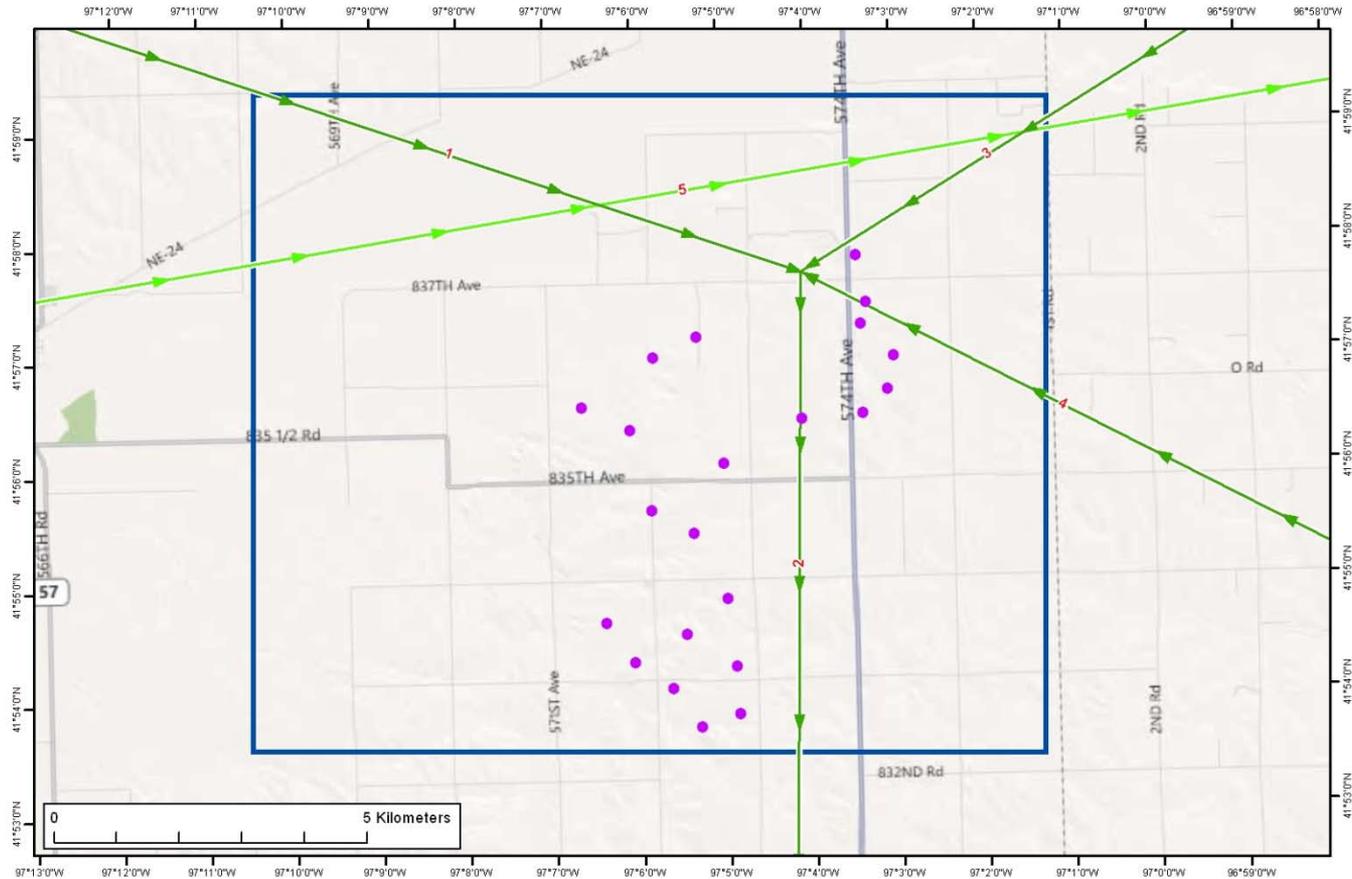
Microwave Communications at 6 GHz



Comsearch GeoPlanner Microwave Links
6 GHz Band



Microwave Path Overlay



- Turbines
- Area of Interest

Client
Wind Power GeoPlanner™
Project

- Microwave GeoPlanner Bands (labeled with Link ID)**
- | | | |
|-------------|---------|--------|
| 940-960 MHz | 4 GHz | 10 GHz |
| 950 MHz | 6 GHz | 11 GHz |
| 2 GHz | 6.1 GHz | 13 GHz |
| 2.1 GHz | 6.7 GHz | 18 GHz |
| 2.4 GHz | 7 GHz | 23 GHz |



Fresnel Zones

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

Where,

R_n = Fresnel Zone radius at a specific point in the microwave path, meters

n = Fresnel Zone number, 1

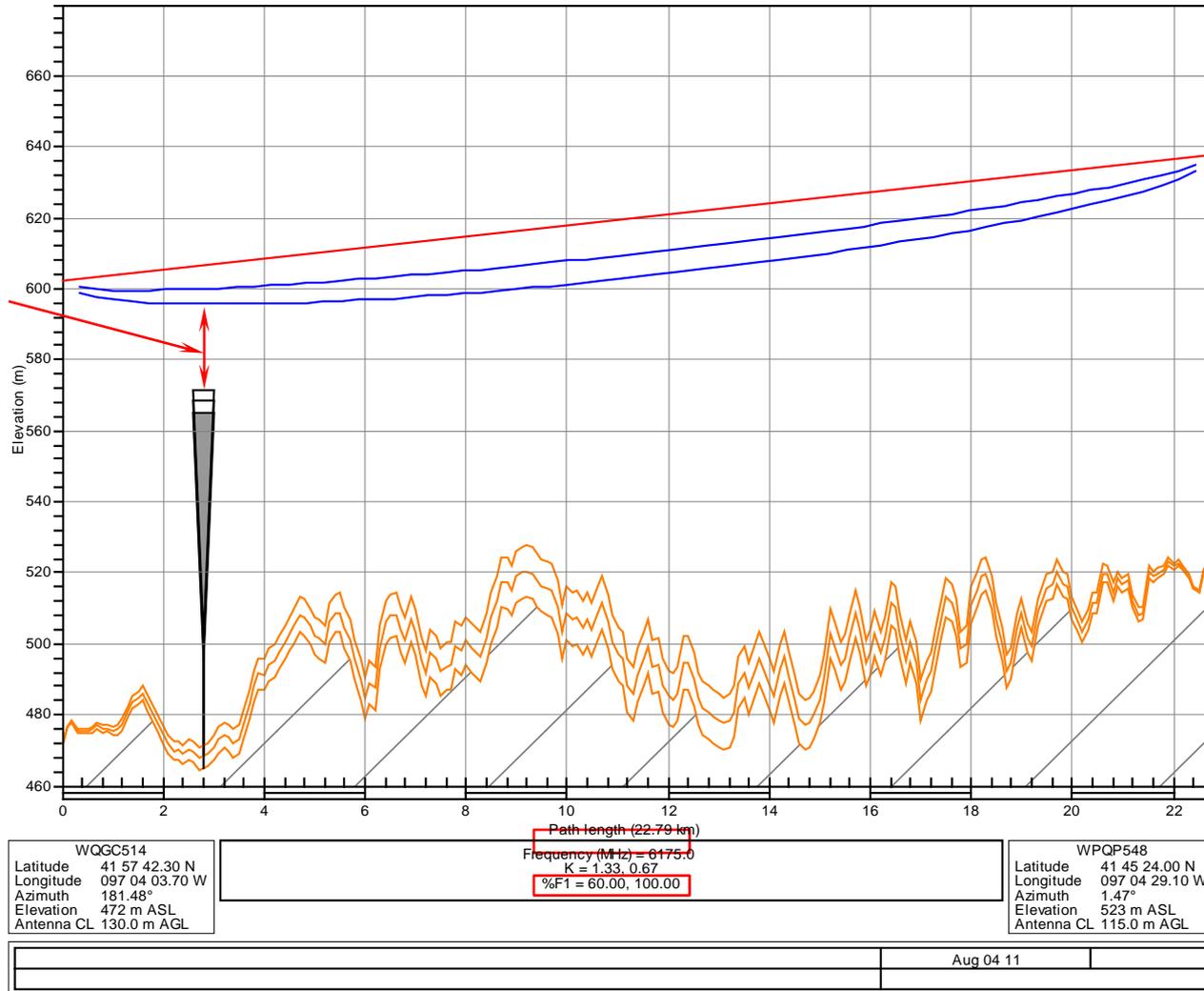
F_{GHz} = Frequency of microwave system, GHz

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

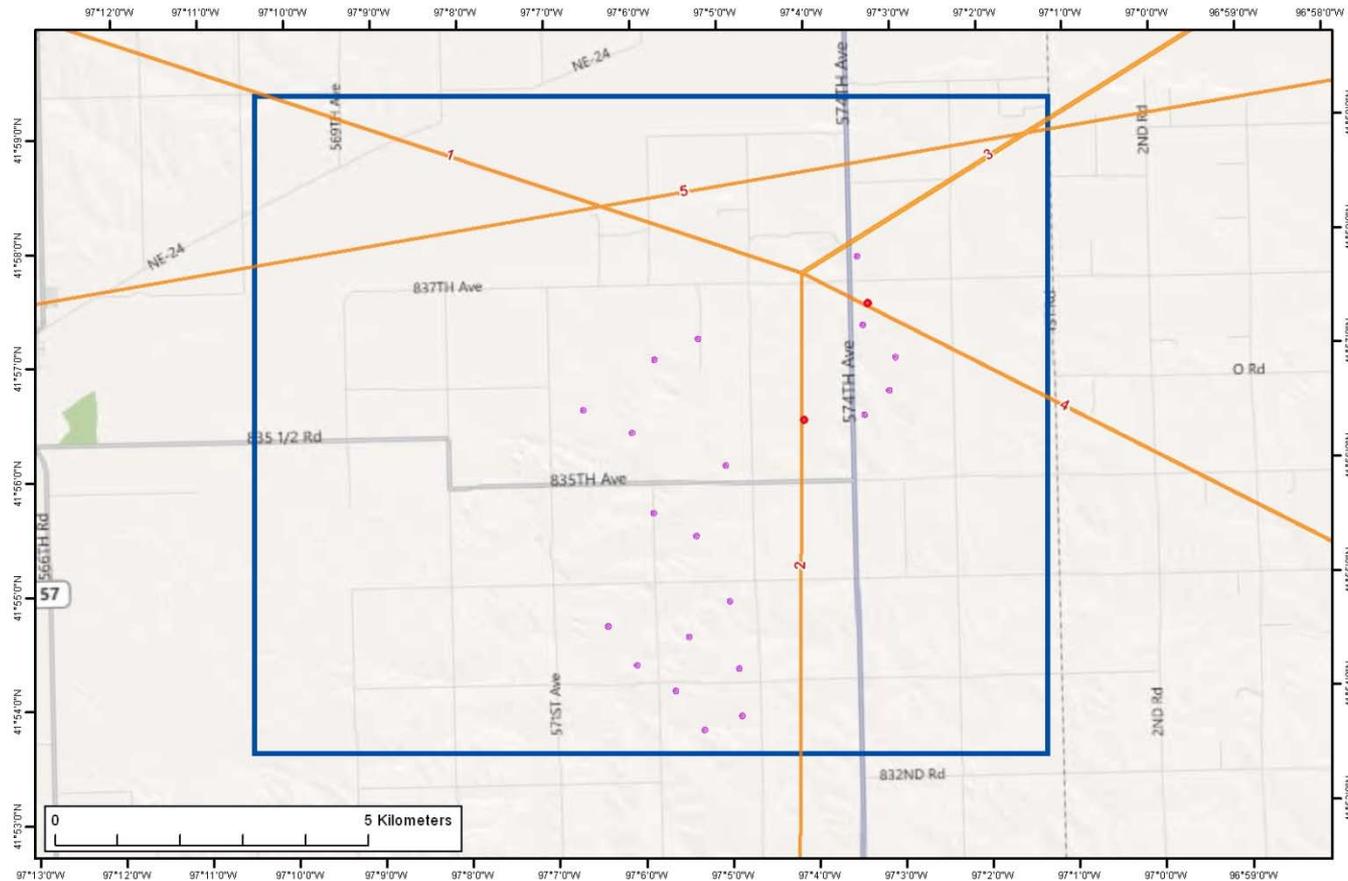
d_2 = Distance from antenna 2 to a specific point in the microwave path, kilometers

Microwave Path Profile

Vertical Fresnel Zone Clearance



Microwave Path Fresnel Zone Analysis

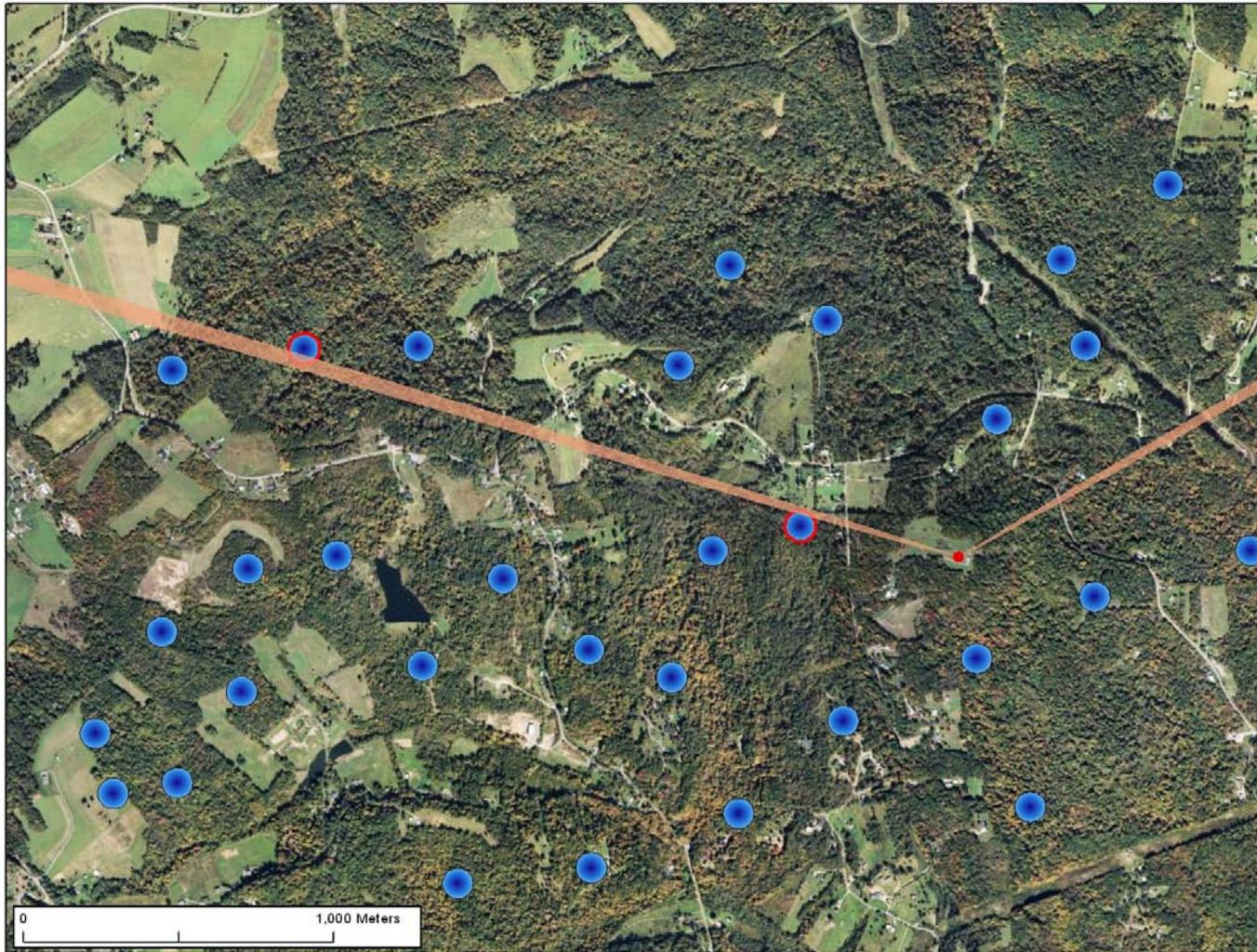


Client
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- Blades: 90m Diameter of Turbines
- Possible Obstruction Cases
- WCFZ (Labeled with Link ID)
- Area of Interest



Microwave Path Fresnel Zone Analysis



Microwave Path Fresnel Zone Analysis



Microwave Path Fresnel Zone Analysis

- Perform full path 3D Fresnel zone analysis to confirm blockage
 - Microwave path may be over the top of turbines or horizontally outside of the actual Fresnel zone requirements

Path ID	Potentially Obstructed by Turbine #	Callsign 1	Callsign 2	Mid-Band Frequency (GHz)	Worst Case (Mid-path) Fresnel Zone Radius (m)	Actual Fresnel Zone Radius at Turbine Location (m)	Horizontal Clearance (m)	Horizontal Clearance?	Vertical Clearance?	Overall Clearance?
2	22	WQGC514	WPQP548	6.700	17.49	7.02	-16.02	NO	YES	YES
4	9	WQGX273	WQGC514	6.700	15.95	9.77	-28.70	NO	NO	NO

Corrective Actions for Microwave Path Blockage

- Relocation or removal of specific wind turbines to avoid the microwave paths
- Relocation or re-engineering of microwave facility



Corrective Actions for Microwave Path Blockage

- No Action – Risk possible blockage, disruption of service and cost/time to resolve after the fact
- Wind power developer can provide details of facility to NTIA / IRAC for analysis
- Provide wind turbine data to NTIA / IRAC as part of a formal, to be defined, coordination process
- Comsearch, or others, to be provided limited access to GMF on an as-needed basis to perform analysis on behalf of operators (results provided to customer and NTIA / IRAC)
- Implement a “blind” automated system fashioned after the 70 - 90 GHz band
- Perform on-site measurements to determine government spectrum usage in the area
- Combinations of above



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