Albany County Wind Project

ConnectGen Operating, LLC

Albany County, Wyoming

Microwave Path Analysis

March 25, 2019

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Summary

Capitol Airspace conducted a microwave path analysis for the Albany County wind project in Albany County, Wyoming. The purpose for this analysis was to identify licensed and applied coordinated non-federal microwave paths that could limit the placement of wind turbines. At the time of this analysis, individual wind turbine locations had not been identified. As a result, this analysis assessed microwave paths overlying an approximately 46 square mile study area (red outline, ***Figure 1***) to aid in identifying optimal wind turbine locations.

Point-to-point microwave transmission is a critical component of the national communications infrastructure. Microwave paths enable broadband data transmission that supports telephone, cellular, and personal communication service (PCS) networks, wireless internet providers, audio and video transmission from television studios to transmitter sites, as well as many other industry and utility applications. In order to ensure signal reliability, these paths are sited to avoid any line-of-sight obstructions. Proposed structures that create a line-of-sight obstruction can degrade signal reliability and could require revisions to the microwave system.

Eight unique microwave links overlie the Albany County wind project (blue, ***Figure 1***). Wind turbines within the associated Fresnel zones could cause signal blockage that degrades link performance. However, due to the narrow widths of most Fresnel zones, micrositing wind turbines outside of these zones is often a feasible mitigation option.

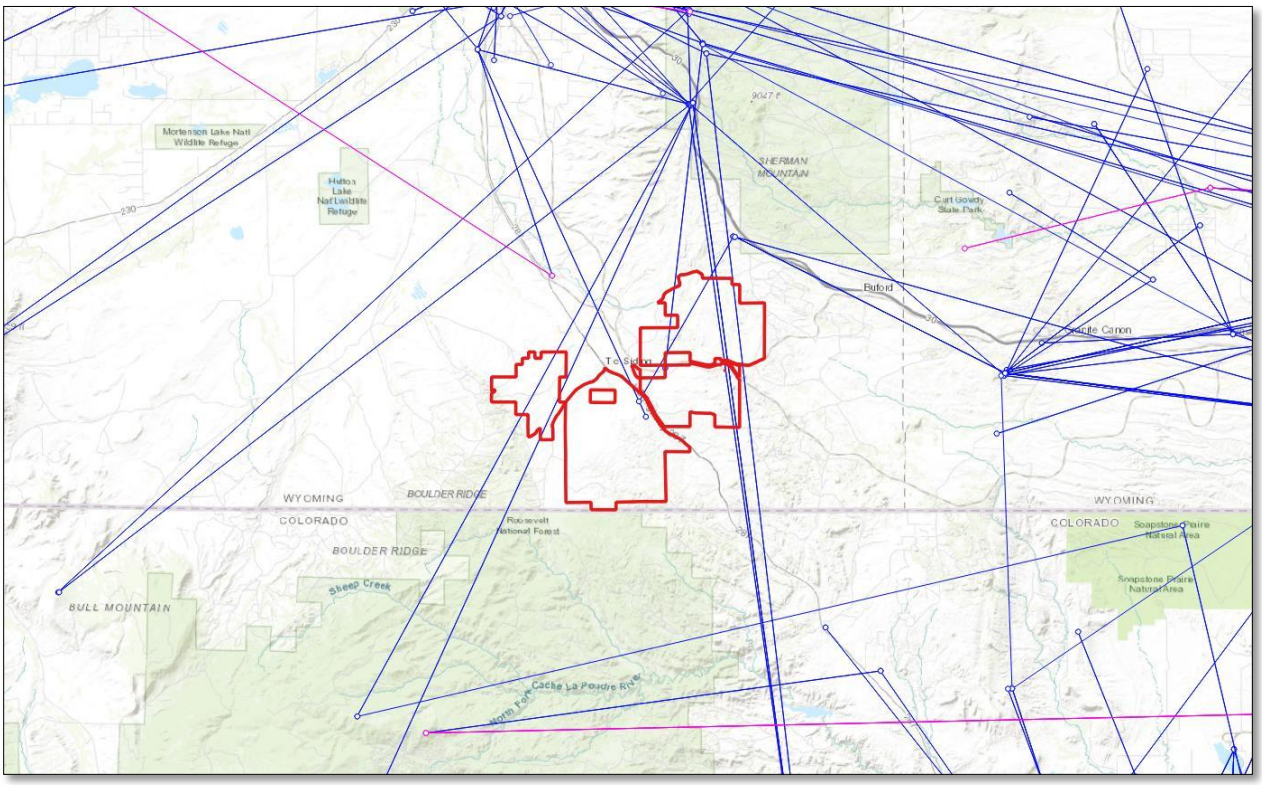

Figure 1: Licensed (blue) and applied (pink) microwave paths in proximity to the Albany County wind project

Capitol Airspace maintains a database obtained from the FCC which is updated on a daily basis. The results of this analysis are based on FCC data available as of the date of this report.

Methodology

Capitol Airspace studied the proposed project based upon location information provided by ConnectGen Operating, LLC. Using this information, Capitol Airspace used a Geographic Information System (GIS) to determine proximity to both licensed and applied coordinated non-federal microwave paths contained in the Federal Communication Commission (FCC) Universal Licensing System (ULS) database.

This analysis considers impact on microwave paths resulting from the physical blockage of the first Fresnel zone (***Figure 2***). The first Fresnel zone is a three dimensional volume whose radius at a given point is calculated using the path frequency and distance from the transmitting and receiving antennas. The Fresnel zone radius is largest at the path midpoint (where $d_1 = d_2$). Lower frequencies result in larger Fresnel zone radii for a given path and are typically associated with longer paths. Higher frequencies result in smaller Fresnel zone radii for a given path and are typically associated with shorter paths.

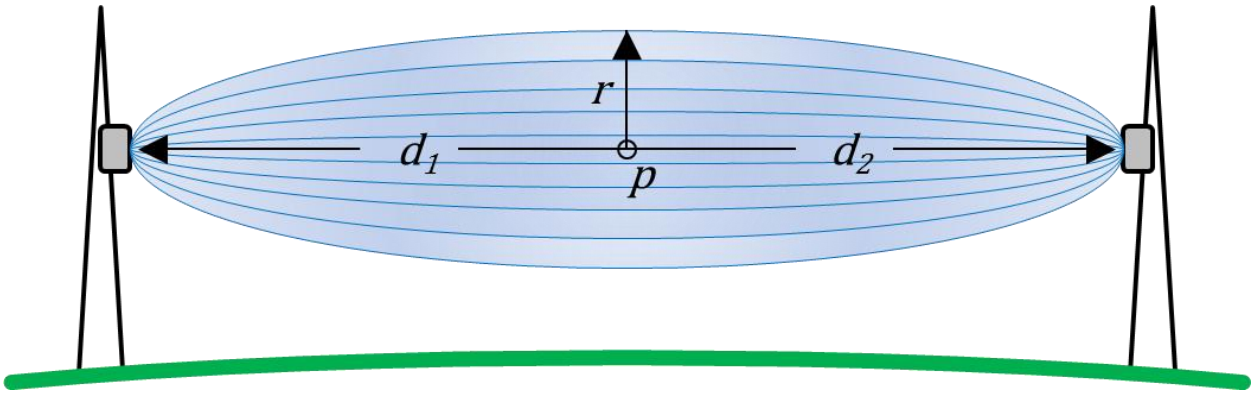

Figure 2: Fresnel zone example

In many cases, ULS database microwave transmitter and receiver antenna locations are inaccurate (e.g. ***Figure 3***). Available satellite and aerial imagery was used to improve the coordinates for locations associated with microwave paths in proximity to the defined study area.

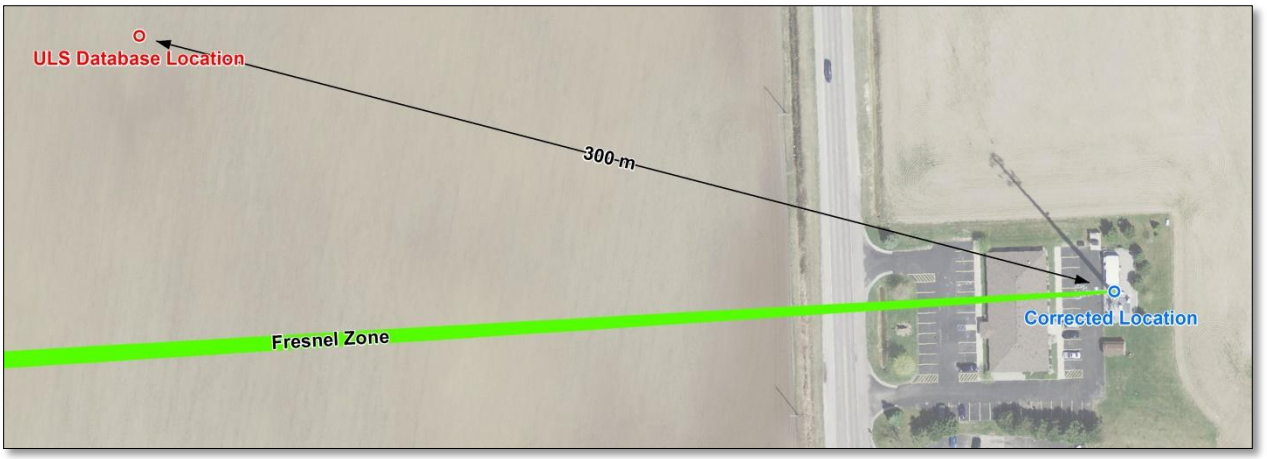

Figure 3: Example of using aerial imagery to correct erroneous ULS database antenna location

Findings

17 paths associated with eight microwave links overlie the Albany County wind project (***Table 1*** & ***Figure 4***).

Licensee	Call Sign	Path	Status	Transmitter	Receiver	Frequency (MHz)[1]
Colorado Interstate Gas	WQV71	2	Licensed	CROW CREEK HILL[2]	1717[2]	6565.00
	WQW47	2	Licensed	Buckhorn[2]	Crow Creek[2]	6735.00
LARIMER COUNTY	WQET320	1	Licensed	BUCKHORN MT[2]	POLE MTN[2]	6750.63
	WQEW974	2	Licensed	POLE MTN[2]	BUCKHORN MT[2]	6590.63
	WQEW974	3	Licensed	POLE MTN[2]	BEAR GULCH	6630.63
	WQEW974	4	Licensed	POLE MTN[2]	BUCKHORN MT[2]	6595.00
	WQEW974	5	Licensed	POLE MTN[2]	KILPECKER	6650.63
	WQHT454	1	Licensed	BEAR GULCH	POLE MTN[2]	6790.63
	WQWT414	1	Licensed	KILPECKER	POLE MTN[2]	6810.63
New Cingular Wireless PCS, LLC	WQHP971	3	Licensed	BUFORD	TIE SIDING	6063.80
	WQPW881	1	Licensed	Tie Siding	Buford	6315.84
State of Colorado	KAQ96	1	Licensed	BUCKHORN MT[2]	BEACON HILL	953.40
	WNTT991	1	Licensed	STATION	1730[2]	957.00
UNION PACIFIC RAILROAD COMPANY	KBA44	4	Licensed	PLTK WY 01	HERM WY 01	957.95
	WNTW359	1	Licensed	HERM WY 01	PLTK WY 01	954.35
Union Telephone Company	WQGL229	2	Licensed	Tie Siding	LARAMIE CEMENT	6226.89
	WQGY260	7	Licensed	LARAMIE CEME	Tie Siding	5974.85

Table 1: Microwave paths with Fresnel zones overlying the Albany County study area

Conclusion

The results of this analysis indicate that 17 paths associated with eight unique microwave links overlie the Albany County wind project. Wind turbines should be sited outside of the lateral boundaries of the Fresnel zones (green, ***Figure 4***) associated with these paths in order to avoid the likelihood of signal blockage. Due to the relatively narrow size of most microwave path Fresnel zones, it is likely that impact on these paths can be avoided through micrositing.

If you have any questions regarding the findings of this study, please contact ***Rick Coles*** or ***Orlando Olivas*** at (703) 256-2485.

[1] Microwave paths may be licensed to operate using more than one frequency. For the purposes of calculating Fresnel zone radii, the lowest frequency was used to create the largest Fresnel zone.

[2] This microwave link antenna location could not be associated with a single antenna structure due to the multiple antenna structures in close proximity. As a result, Capitol Airspace increased the Fresnel zone radius at this antenna location in order to encompass all of the potential antenna structure candidates.

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Figure 4 - Microwave Path Fresnel Zones

Plot Date: 25 March 2019

Coordinate System: WGS 84 / UTM zone 13N

0 1 2 3 4 5 Kilometers

LARAMIE CEMENT

POLE MTN

POLE MTN

PLTK WY 01

CROW CREEK HILL

POLE MTN

BEACON HILL

STATION

BUFORD

Union Telephone Company
27.79km @ 5.97 - 6.23 GHz

UNION PACIFIC RAILROAD COMPANY
21.19km @ 954 - 958 MHz

New Cingular Wireless PCS, LLC
13.33km @ 6.06 - 6.32 GHz

LARIMER COUNTY
69.8km @ 6.59 - 6.76 GHz

Colorado Interstate Gas
69.8km @ 6.57 - 6.74 GHz

State of Colorado
72.73km @ 953 - 957 MHz

HERM WY 01

TIE SIDING

Tie Siding

LARIMER COUNTY
48.61km @ 6.63 - 6.79 GHz

LARIMER COUNTY
59.78km @ 6.65 - 6.81 GHz

BEAR GULCH

KILPECKER

Buckhorn MT

1717

1730

Antenna Location
Fresnel Zone (2D)
Study Area

Capitol Airspace Group

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