Appendix E
Microwave Study

ENGINEERING REPORT
CONCERNING THE EFFECTS UPON
FCC-LICENSED MICROWAVE FACILITIES
DUE TO CONSTRUCTION OF THE
WEST STEVENS WIND PROJECT
IN STEVENS COUNTY, MINNESOTA

Prepared for:
Mnioka Construction, LLC
Chokio, Minnesota

July 27, 2009

By: B. Benjamin Evans, P.E.
Evans Associates
216 N. Green Bay Road, #205
Thiensville, WI 53092
262-242-6000 PHONE
262-242-6045 FAX
www.evansassoc.com

**ENGINEERING REPORT
CONCERNING THE EFFECTS UPON
FCC-LICENSED MICROWAVE FACILITIES
DUE TO CONSTRUCTION OF THE
WEST STEVENS WIND PROJECT
IN STEVENS COUNTY, MINNESOTA**

Mnioka Construction, LLC

I. INTRODUCTION

This engineering report describes the results of a study and analysis to determine the locations of federally licensed (FCC) point-to-point microwave paths that may be adversely impacted as a result of the construction of the West Stevens Wind Turbine Project. The project involves an area just northwest of the city of Chokio in Stevens County, Minnesota. This document describes impact zones and any necessary mitigation procedures, along with recommendations concerning individual wind turbine siting. All illustrations, calculations and conclusions contained in this document are subject to on-site verification[1].

Wind turbines located on land parcels near federally licensed radio frequency facilities can cause one or more modes of RF impact, due to aperture blockage and/or re-radiation. An iterative procedure is frequently necessary to minimize adverse effects. Information provided in this document will minimize the chances that disruption of the studied facilities either does not occur or, in the alternative, that mitigation procedures will be effective. The purpose of this study is to facilitate the siting of turbines to avoid unacceptable impact.

The West Stevens Wind project involves the construction of thirteen (13) new turbines. The wind turbines will have a hub height of 80 meters above ground and a blade radius of 40 meters. Thus, the total height will be about 120 meters above ground level to the tip of one blade at the 12:00 position.

Using industry standard procedures and FCC databases, a search was conducted to determine the presence of any existing microwave paths crossing the subject property. A specific turbine layout has been submitted for analysis. The rough outline of the general area of the wind project is shown in the following Figure 1.

[1] The databases used in creating the attached tables and maps are generally accurate, but anomalies have been known to occur. An on-site verification survey is suggested as part of the due diligence process.

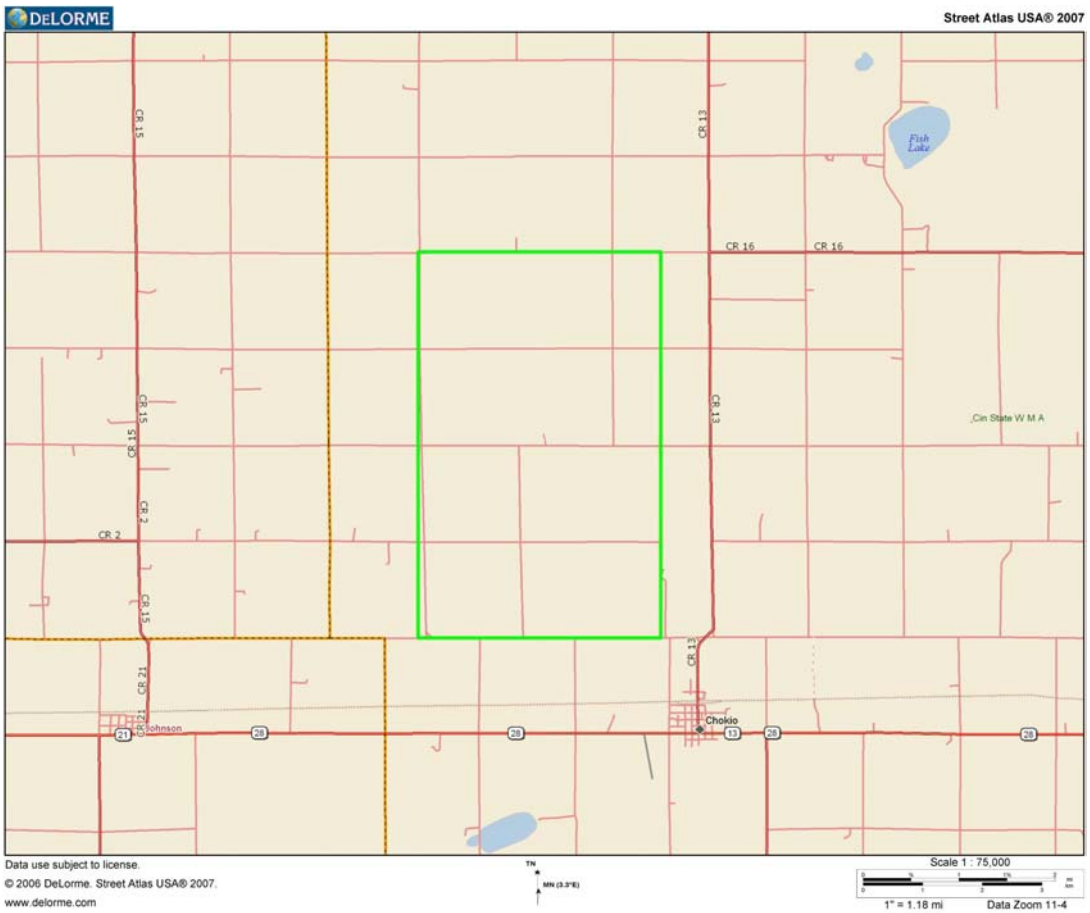

Figure 1 – West Stevens Wind Project Area

<u>This report addresses the impact of known microwave point-to-point paths only.</u>

The attached maps were generated based upon the operating parameters of the FCC-licensed microwave stations as contained in FCC databases.

The analysis included herein examines the pertinent FCC licensed services in the area for potential impact according to generally accepted engineering standards. This analysis assumes that all licensed services have been designed and constructed according to FCC requirements and good engineering practice. If this is not the case, the impacted facility must share responsibility with the wind turbine company for the costs of any mitigation measures[2].

[2] For instance, some microwave paths may have insufficient ground clearances as they are presently configured.

II. ANALYSIS OF MICROWAVE LINKS

An extensive analysis was undertaken to determine the likely effect of the new wind turbine farm upon the existing microwave paths, consisting of a Fresnel x/y axis study and a z-axis (height) evaluation. The microwave paths have been overlaid on Google Earth™ maps, and the images of the microwave paths and the proposed turbines also available as KMZ and GIS shape files.

Important Note: Microwave path studies are based upon third party and FCC databases that normally exhibit a high degree of accuracy and reliability. Although Evans performs due diligence to ensure that all existing microwave facilities are represented, we cannot be responsible for errors that may lead to incomplete results. However, should such situations occur, Evans would perform an engineering analysis to determine how the additional facilities can be accommodated or, if wind turbine structures are already built, determine a method to re-direct the offending beam path. It is recommended that a consultant visit the site to visually check for anomalies.

For this microwave study, *Worse Case Fresnel Zones* (WCFZ) were calculated for each microwave path. The mid-point of a microwave path is the location where the widest (or worst case) Fresnel zone occurs. Possible geographic coordinate errors must be added to the Fresnel zone clearance numbers[3]. The radius R of the Worst Case Fresnel Zone, in meters, is calculated for each path using the following formula:

$$R \cong 8.65\sqrt{\frac{D}{F_{GHz}}}$$

where D is the microwave path length in kilometers and F_{GHz} is the frequency in gigahertz.

In general, the WCFZ is defined by the cylindrical area whose axis is the direct line between the microwave link endpoints and whose radius is R as calculated above. This is the zone where the siting of obstructions should be avoided. Evans Associates has identified two microwave links transmitting over one unique path existing in the FCC database that come close to the project area. These paths are tabulated below in Table 1 and are shown in Figure 2.

ID	Call Sign	Status	Name Xmit	Dist/Bear (km/°T))	Ant. Elevation (m AMSL)	Freq. (MHz)	Licensee	WCFZ (m)
1	WNTV962	A	STATION	38.0@317.1	406.9	954.4	Great River Energy	54.6
2	WNTV965	A	STATION	38.0@136.9	434.3	958.0	Great River Energy	54.5

Table 1 – Microwave Links Near Wind Project Area

[3] Many microwave facilities were built before accurate methods were available to establish exact geographic coordinates (such as GPS). It is not unusual for database errors of up to 4 or 5 seconds to occur, which can effect the positioning of critical turbines located near Fresnel paths.

Neither of the above paths create blackout zones through the project area. In fact, neither approach the 10-square mile turbine area to within 700 meters. Therefore, as of this date, there are no FCC-licensed microwave paths that would impede the construction of the planned West Stevens wind turbines.

The Google Earth™ map below shows all known active FCC-licensed microwave facilities near the turbines. The turbines are shown as blue dots with yellow "pushpins".

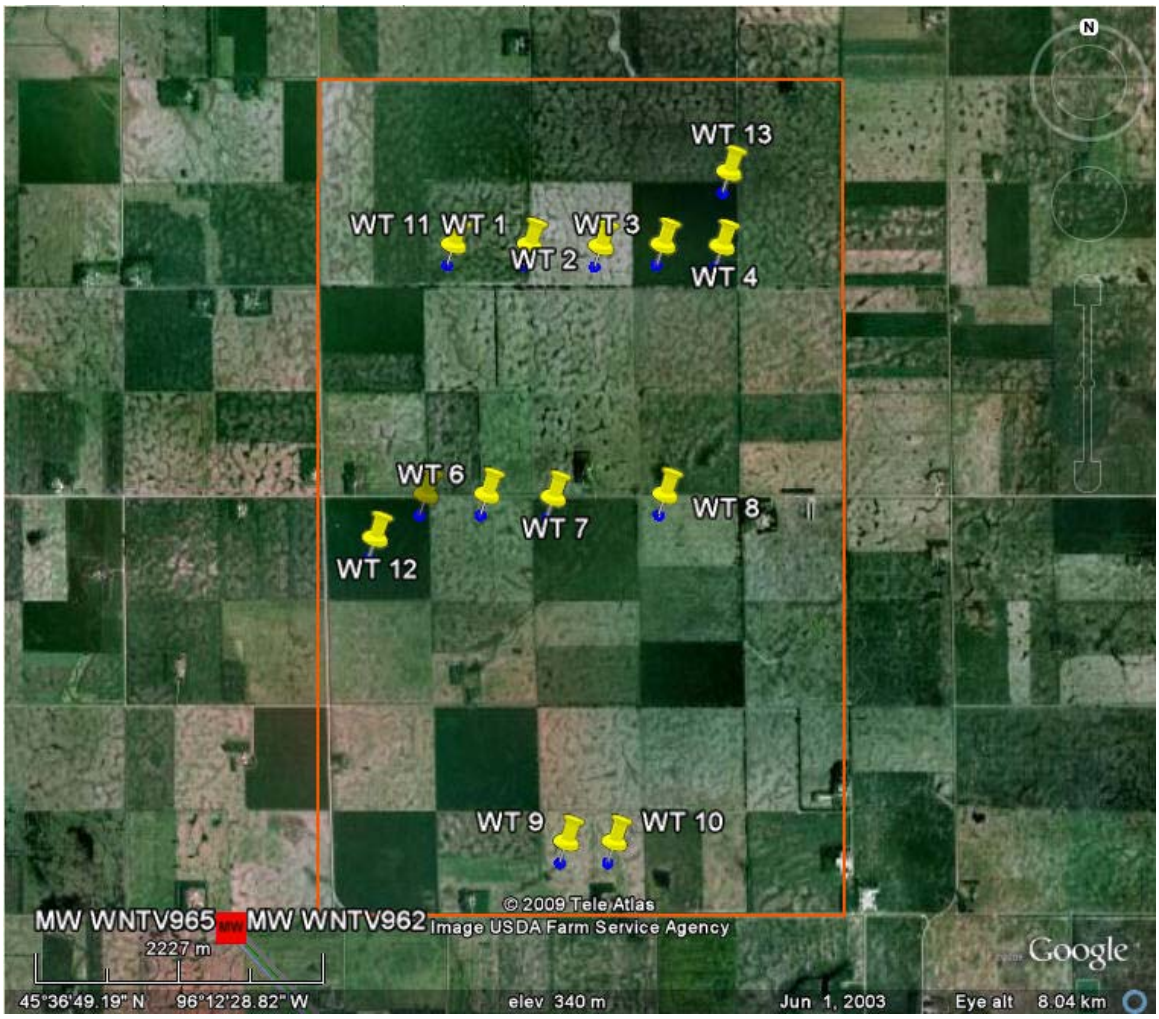

Figure 2 – West Stevens Wind Turbine Project Area Showing Active Facilities

If an excessive amount of time goes by before the turbines are to be constructed, it is recommended that this study be updated in case new paths have been added to the FCC's database.

The reader is referred to the provided KMZ and GIS shape files for more magnification and closer inspection. A spreadsheet is also provided tabulating additional information concerning each microwave facility found in the study. The spreadsheet contains additional microwave paths found during the search which are much farther from the project area than the two paths shown in this report.

III. CONCLUSIONS

1. The proposed turbines, including the blades, are located so as to not penetrate the WCFZs (Worst-Case Fresnel Zones) of any known microwave path. Two microwave links transmitted over one unique path were found in the FCC databases that are near the West Stevens Wind project area, but neither has been determined to create a blackout zone in the area.

2. An on-site inspection of the West Stevens Wind project area should be done to determine the existence of any undocumented communications towers.

Respectfully Submitted,

B. Benjamin Evans, P.E.
RF Impact Consultant

July 27, 2009

E:\EA\Client Services\Windmills\Mnioka Construction\RFImpactStudyReportWestStevensWind,Chokio,MN61009.doc