

# **Appendix R – Radar and Navigational Aid Screening Study**

**SOUTH DEUEL WIND PROJECT**  
**RADAR AND NAVIGATIONAL AID SCREENING STUDY**  
**JULY 14, 2021**

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## INTRODUCTION

The South Deuel Wind Project consists of approximately 146,804 acres of land (study area) in Deuel County in South Dakota, and Lincoln and Yellow Medicine counties in Minnesota.<sup>1</sup> This report provides the results of a radar and navigational aid screening study conducted by Westslope Consulting, LLC (Westslope) for the study area using blade-tip heights of 551 feet above ground level (AGL), 591 feet AGL, and 640 feet AGL. This study includes the following:

- An initial analysis using the Department of Defense (DoD) Preliminary Screening Tool (PST);
- Research into other radar sites and Very High Frequency Omnidirectional Range (VOR) navigational aid sites near the study area;
- An Air Route Surveillance Radar (ARSR) and Airport Surveillance Radar (ASR) line-of-sight (LOS) analysis;
- A VOR screening analysis; and
- A Next Generation Radar (NEXRAD) weather radar screening analysis.

## ANALYSIS

### DoD Preliminary Screening Tool

Westslope conducted an initial analysis for Long Range Radar (LRR) and NEXRAD using the DoD PST on the Federal Aviation Administration (FAA) Obstruction Evaluation/Airport Airspace Analysis website.<sup>2</sup> This analysis provides a cursory indication of whether wind turbines may be within line-of-sight of one or more radar sites, and likely to affect radar performance.

The PST LRR analysis accounts for ARSR sites and a few select ASR sites used for air defense by the DoD at the North American Aerospace Defense Command (NORAD) and for homeland security by the Customs and Border Protection Air and Marine Operations Center.<sup>3</sup> Further, the PST NEXRAD analysis accounts for DoD, FAA, and National Oceanic and Atmospheric Administration (NOAA) Weather Surveillance Radar model-88 Doppler (WSR-88D) sites.<sup>4</sup> The PST does not account for all DoD, Department of Homeland Security (DHS), or FAA ground-based radar sites, including Relocatable Over-the-Horizon Radar sites, tethered aerostat radar sites, or FAA Terminal Doppler Weather Radar sites.

The PST is helpful for identifying potential impacts to LRR and NEXRAD; however, the results are preliminary, as suggested by the title of the PST, and do not provide an official decision as to whether impacts are acceptable to operations.

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<sup>1</sup> S Deuel Airspace AOI.kmz.

<sup>2</sup> See <http://oeaaa.faa.gov>.

<sup>3</sup> For LRR, the PST uses a buffered line-of-sight analysis at a blade-tip height of 750 feet AGL.

<sup>4</sup> For NEXRAD, the PST uses a blade-tip height of 160 meters AGL (525 feet AGL).

Please note that the PST NEXRAD analysis does not account for blade-tip heights greater than 525 feet AGL, does not account for WSR-88D sites authorized to scan at elevation angles below 0.5 degrees, and does not reflect the wind farm impact zone scheme updated in 2018 by the NOAA WSR-88D Radar Operations Center (ROC). The updated scheme expands the red area, or “No Build Zone,” from three to four kilometers (km) and to areas where wind turbines penetrate the third elevation angle scanned by a WSR-88D.

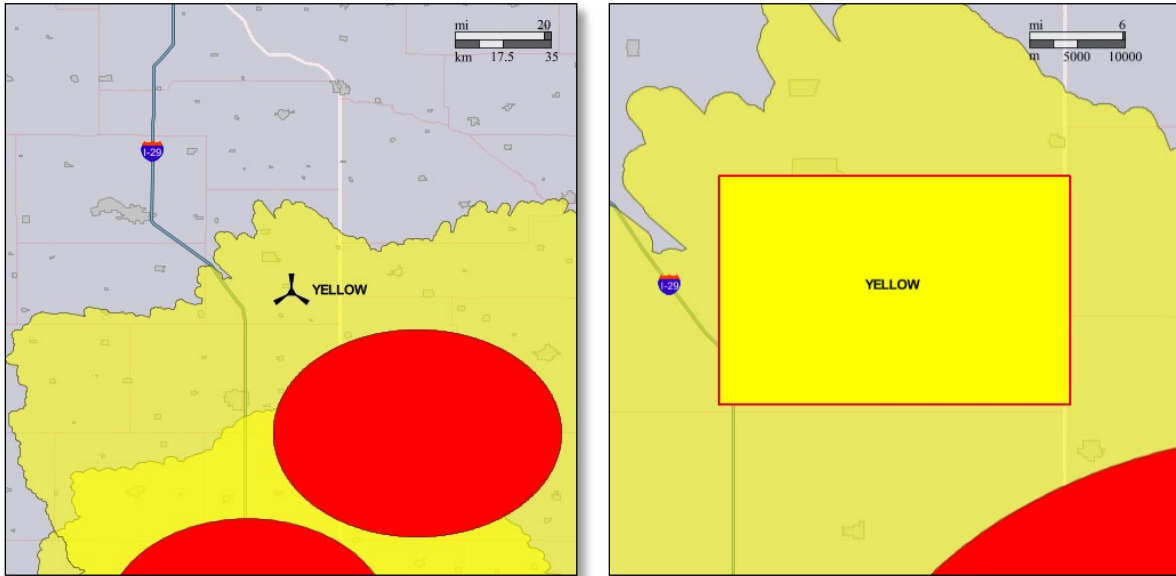
Based on the study area, Westslope created a single point and a four-point polygon for PST analysis purposes.

The PST single point and polygon analysis results for LRR show that the study area falls within a yellow area. A yellow area indicates that impacts are likely to air defense and homeland security radar. See Figure 1, where the black rotor represents the single point, and the red line represents the polygon and the study area.

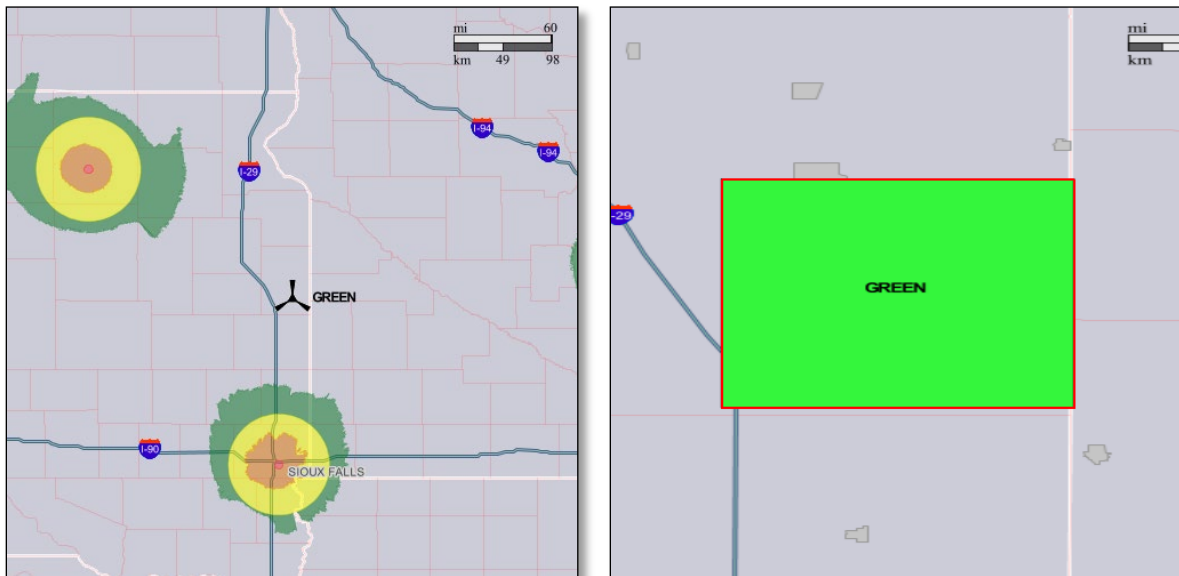
Westslope identified the two radar sites in the PST LRR results as the Sioux Falls Airport Surveillance Radar model-11 (ASR-11) and the Tyler Common Air Route Surveillance Radar (CARSR). In addition to the DoD and DHS using these radar sites for air defense and homeland security, the FAA uses these radar sites for air traffic control at multiple facilities, including the Sioux Falls Terminal Radar Approach Control and the Minneapolis Air Route Traffic Control Center.

For NEXRAD, the PST analysis results for the single point and the polygon show that the study area falls within a green area. A green area, or “No Impact Zone,” indicates that impacts are not likely to WSR-88D operations. Please note that grey areas also represent green areas in the PST NEXRAD analysis results. See Figure 2. Westslope identified the two radar sites in the PST NEXRAD analysis as the Aberdeen WSR-88D and the Sioux Falls WSR-88D.

Research conducted by Westslope shows that the lowest elevation angle scanned by the Aberdeen WSR-88D and the Sioux Falls WSR-88D is 0.5 degrees.



**Figure 1 Long Range Radar Results for the Single Point (left) and for the Polygon (right)**



**Figure 2 NEXRAD Results for the Single Point (left) and for the Polygon (right)**

### **Other ARSR and ASR Sites**

Research conducted by Westslope identified no additional ARSR or ASR sites near the study area.

### **Co-Located Secondary Surveillance Radar**

Research conducted by Westslope identified the following secondary surveillance radar systems co-located with the ARSR and ASR systems:

- A Mode S is co-located with the Tyler CARSR; and
- A Monopulse Secondary Surveillance Radar is co-located with the Sioux Falls ASR-11.

In general, secondary surveillance radar systems are less susceptible to interference from wind turbines than primary surveillance radar systems, such as the ARSR and ASR systems.

### **VOR Sites**

Research conducted by Westslope identified the following two navigational aid sites near the study area:

- Marshall VOR and co-located Distance Measuring Equipment (VOR/DME); and
- Watertown VOR and co-located Tactical Air Navigation system (VORTAC).

Correspondence with the FAA indicates that all of these VORs are conventional VORs. In general, conventional VORs are more susceptible than Doppler VORs to interference from wind turbines.

### **ARSR and ASR LOS Analysis**

Westslope conducted an ARSR and ASR LOS analysis using the United States Geological Survey (USGS) 10-meter National Elevation Dataset (NED). This analysis shows whether wind turbines at blade-tip heights of 551 feet AGL, 591 feet AGL, or 640 feet AGL will be within line-of-sight of one or more ARSR or ASR sites.

Westslope conducted the LOS analysis for the following four ARSR and ASR sites:

- Sioux Falls ASR-11; and
- Tyler CARSR.

#### Sioux Falls ASR-11

The LOS analysis results show that wind turbines in the study area will not be within line-of-sight of and will not interfere with the Sioux Falls ASR-11 at blade-tip heights of 551 feet AGL, 591 feet AGL, or 640 feet AGL. As a result, Westslope does not expect any radar effects at or below these blade-tip heights.

#### Tyler CARSR

The LOS analysis results show that wind turbines in the majority of the study area will be within line-of-sight of and will interfere with the Tyler CARSR at blade-tip heights of 551 feet AGL and 591 feet AGL. At a blade-tip height of 640 feet AGL, wind turbines in the entire study area will be within line-of-sight of and will interfere with this radar site. See Figure 3. The radar effects will include unwanted radar returns (clutter) resulting in a partial loss of primary target detection and a number of false primary targets over and in the immediate vicinity of wind turbines within line-of-sight in the study area.

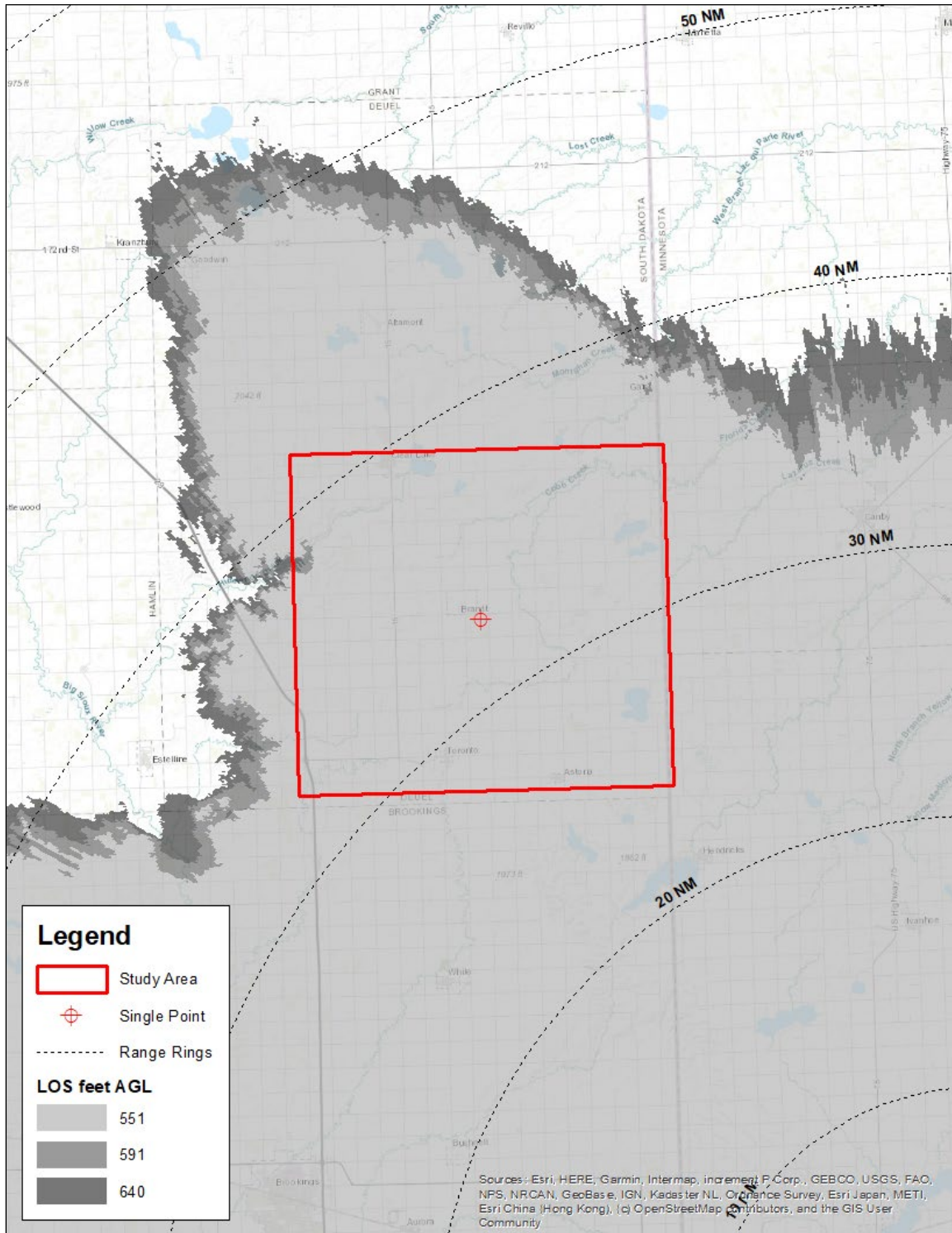


Figure 3 LOS Analysis Results for the Tyler CARSR using 10-meter NED



### **VOR Screening Analysis**

Westslope conducted a VOR screening analysis using USGS 10-meter NED. This analysis shows whether wind turbines in the study area (1) will be located less than or equal to 8 nautical miles (NM) from a VOR site; (2) will subtend elevation angles greater than 0.60 degrees from the base elevation of a conventional VOR at blade-tip heights of 551 feet AGL, 591 feet AGL, or 640 feet AGL, or 0.75 degrees for a Doppler VOR; and (3) will fall within line-of-sight of a VOR site. This screening analysis provides a cursory indication of whether wind turbines in the study area may affect VOR performance and is similar to the FAA's analysis approach for VOR sites. The same criteria will also protect for DMEs and Tactical Air Navigation Systems.

Westslope conducted a VOR screening analysis for the following two navigational aid sites:

- Marshall VOR/DME; and
- Watertown VORTAC.

The study area is greater than 8 NM from the Marshall VOR/DME and the Watertown VORTAC. As such, no additional analysis was considered necessary for these navigational aid sites.

### **NEXRAD Weather Radar Screening Analysis**

The PST NEXRAD analysis does not account for blade-tip heights greater than 525 feet AGL, does not account for WSR-88D sites authorized to scan at elevation angles below 0.5 degrees, and does not reflect the wind farm impact zone scheme updated in 2018 by the NOAA WSR-88D ROC. The updated scheme expands the red area, or “No Build Zone,” from three to four kilometers and to areas where wind turbines penetrate the third elevation angle scanned by a WSR-88D.

Westslope conducted a NEXRAD weather radar screening analysis using USGS 10-meter NED. This analysis shows whether wind turbines at blade-tip heights of 551 feet AGL, 591 feet AGL, or 640 feet AGL will be within line-of-sight of one or more WSR-88D sites and incorporates the updated wind farm impact zone scheme.

Westslope conducted the NEXRAD weather radar screening analysis for the following two radar sites:

- Aberdeen WSR-88D; and
- Sioux Falls WSR-88D.

Research conducted by Westslope shows that the lowest elevation angle scanned by the Aberdeen WSR-88D and the Sioux Falls WSR-88D is 0.5 degrees.

#### Aberdeen WSR-88D

Westslope’s NEXRAD weather radar screening analysis shows that wind turbines in the study area will not be within line-of-sight of and will not interfere with the Aberdeen WSR-88D at blade-tip heights of 551 feet AGL, 591 feet AGL, or 640 feet AGL. The results also show that wind turbines in the study area at blade-tip heights of 551 feet AGL, 591 feet AGL, and 640 feet AGL will fall within a NOAA green area for this radar site. A green area, or “No Impact Zone,” indicates that impacts are not likely to WSR-88D operations. See Figures 4, 5, and 6.

#### Sioux Falls WSR-88D

Westslope’s NEXRAD weather radar screening analysis shows that wind turbines in the study area will not be within line-of-sight of and will not interfere with the Sioux Falls WSR-88D at blade-tip heights of 551 feet AGL, 591 feet AGL, or 640 feet AGL. The results also show that wind turbines in the study area at blade-tip heights of 551 feet AGL, 591 feet AGL, and 640 feet AGL will fall within a NOAA green No Impact Zone for this radar site. See Figures 7, 8, and 9.

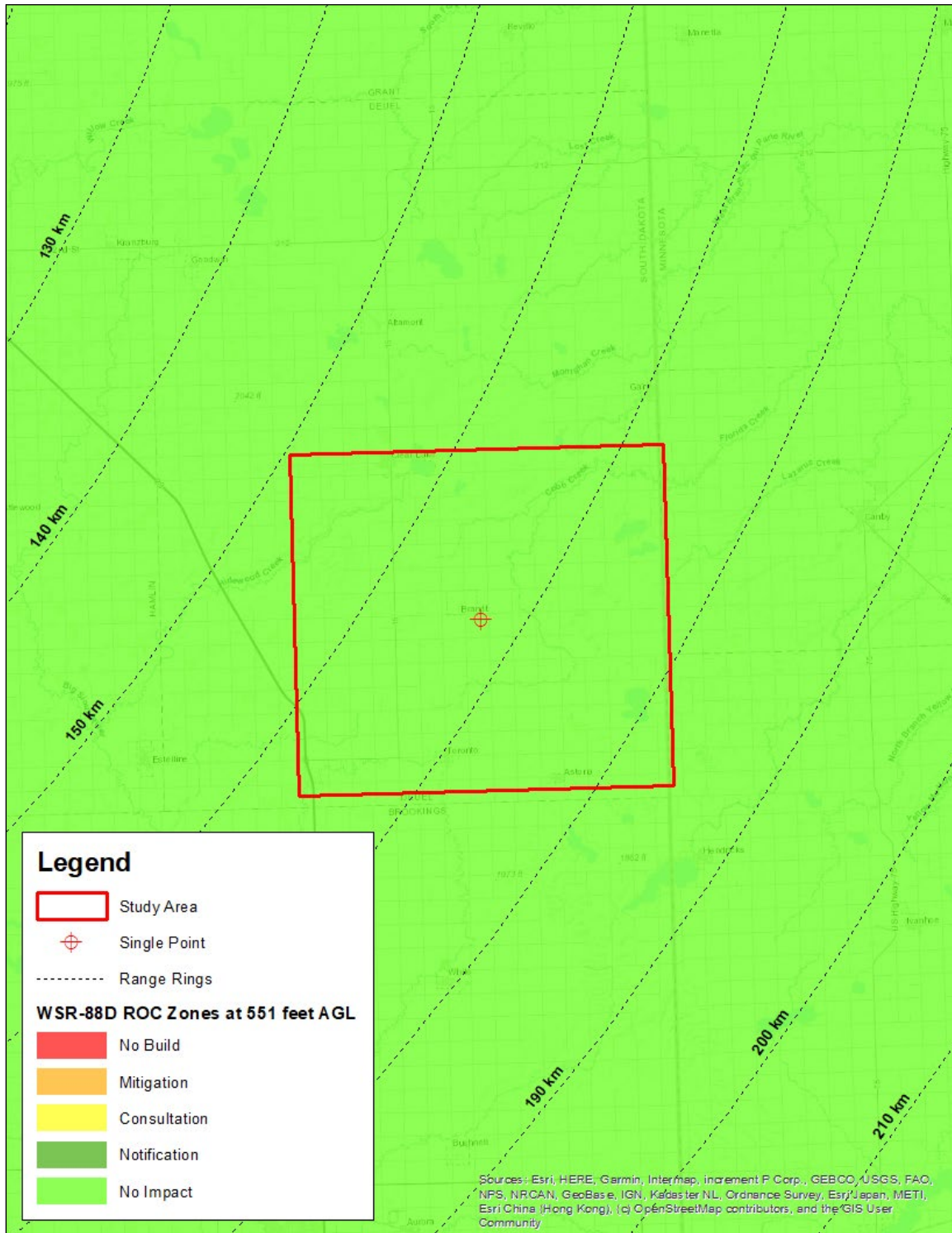


Figure 4 WSR-88D ROC Zone Results at 551 feet AGL for the Aberdeen WSR-88D using 10-meter NED

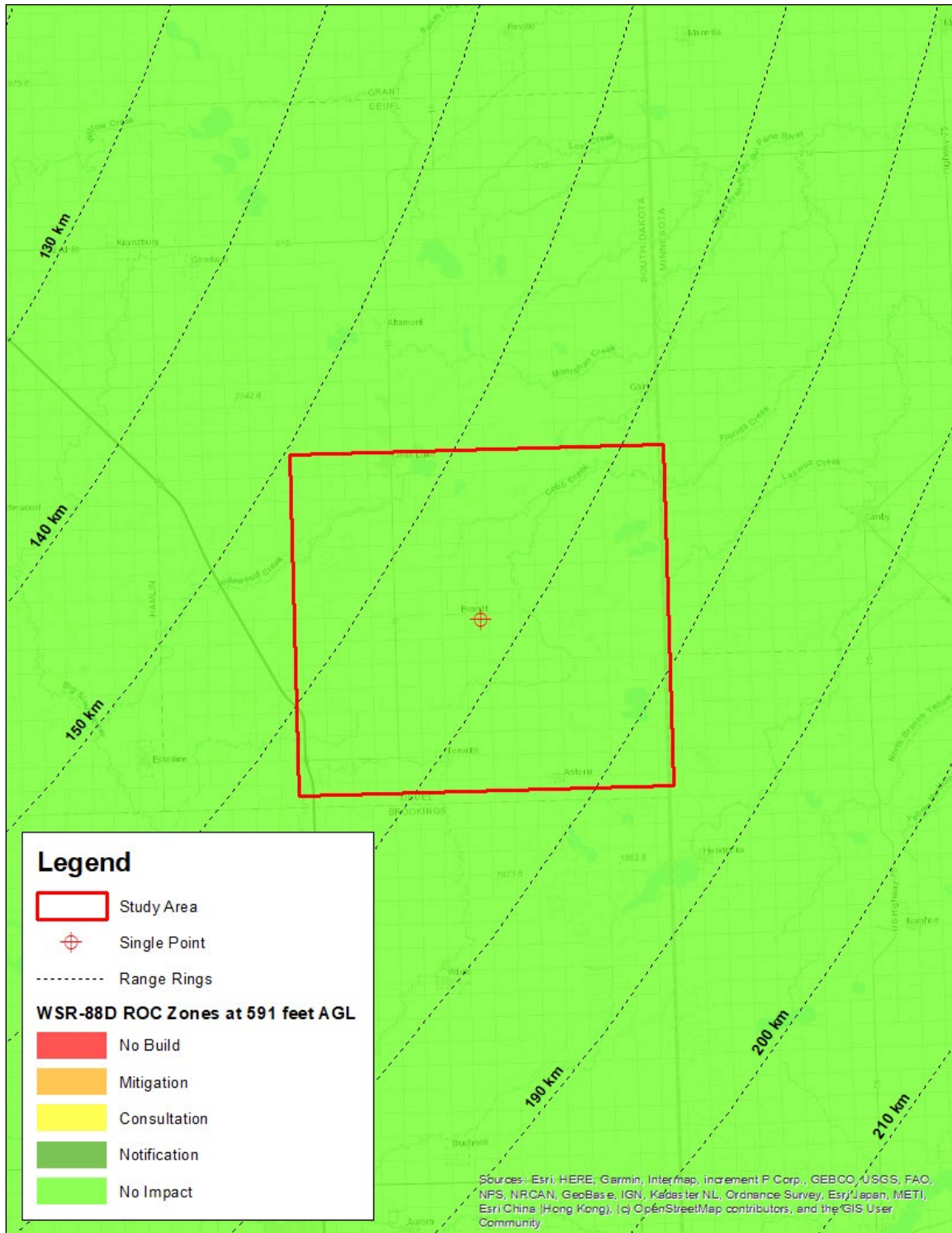


Figure 5 WSR-88D ROC Zone Results at 591 feet AGL for the Aberdeen WSR-88D using 10-meter NED



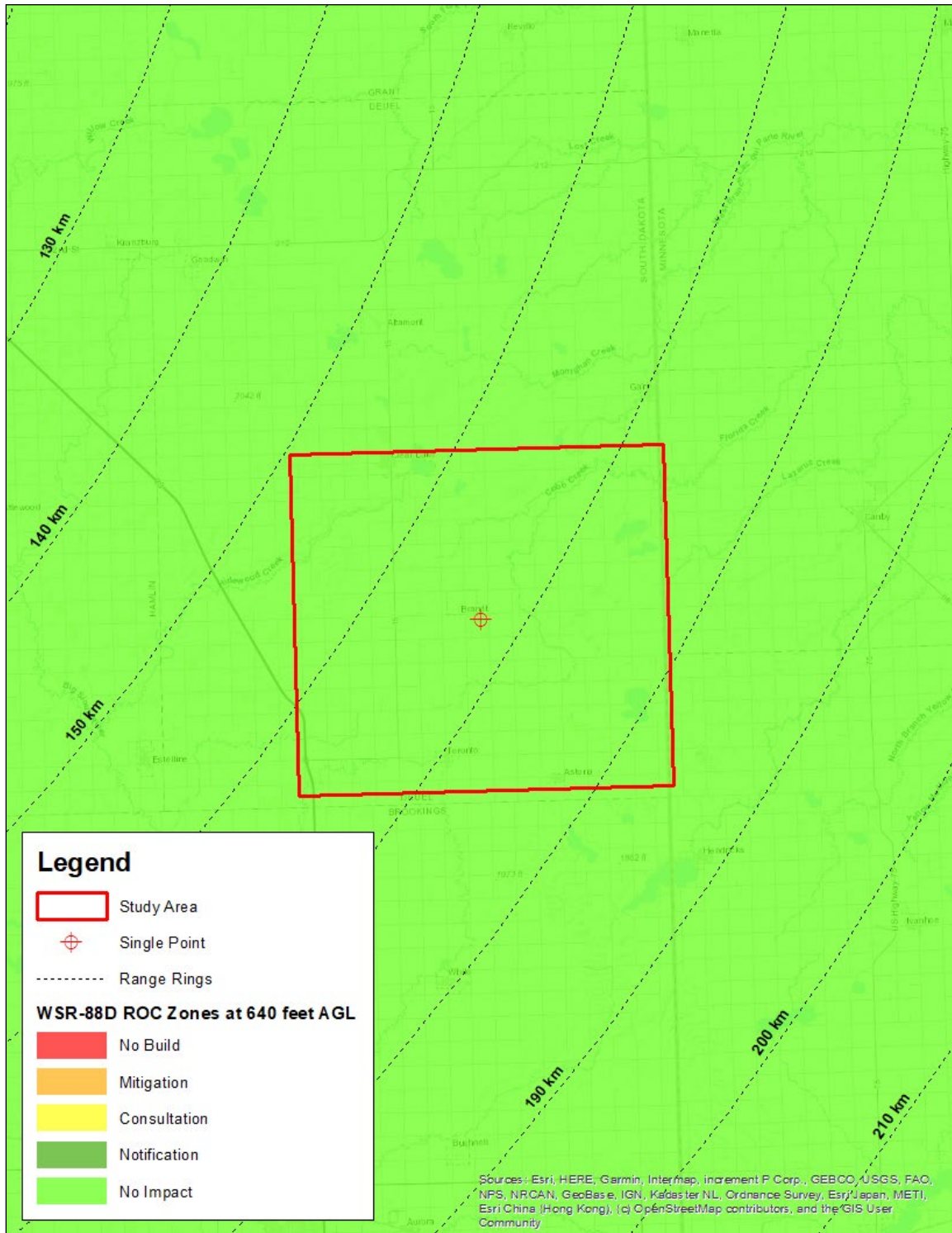


Figure 6 WSR-88D ROC Zone Results at 640 feet AGL for the Aberdeen WSR-88D using 10-meter NED

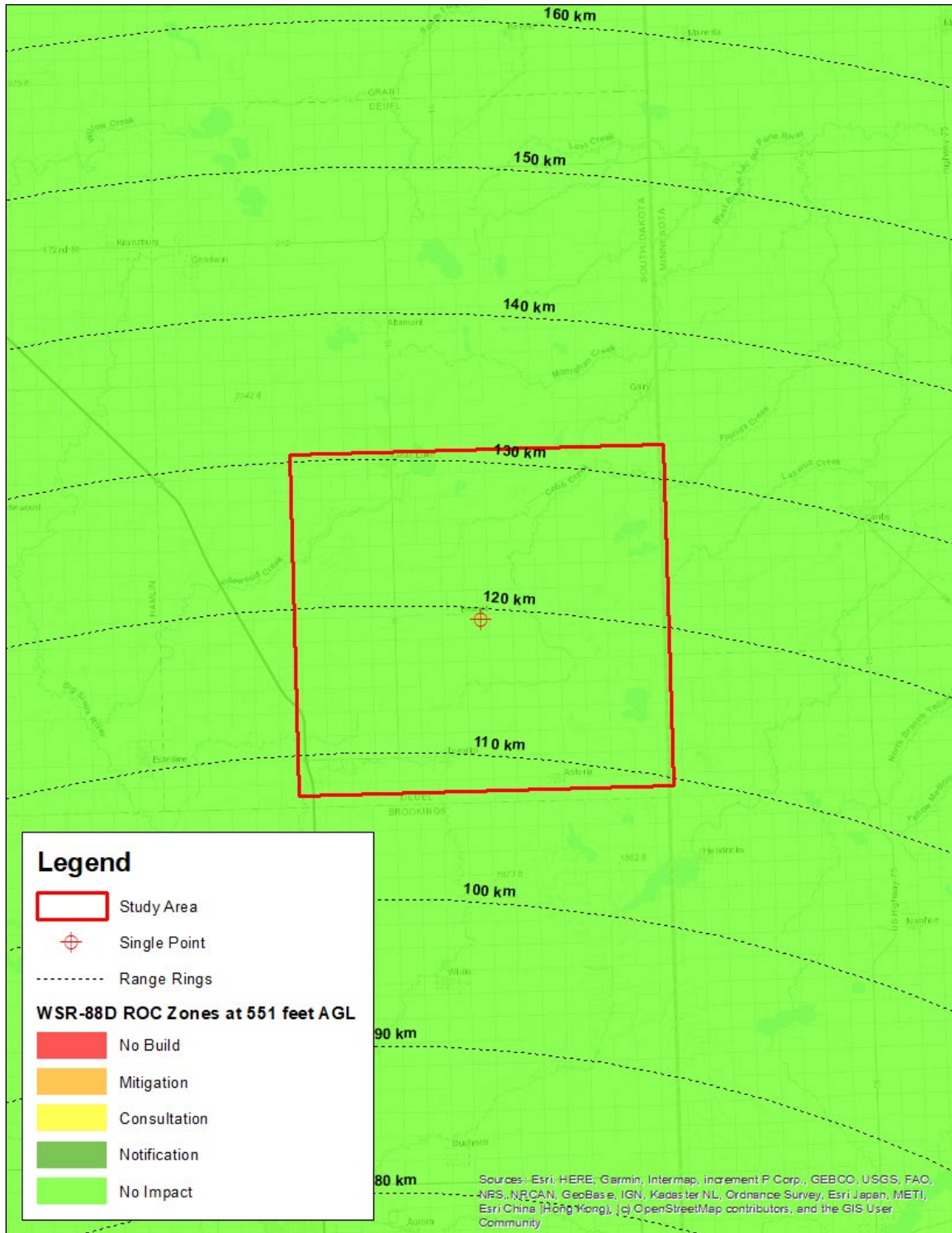


Figure 7 WSR-88D ROC Zone Results at 551 feet AGL for the Sioux Falls WSR-88D using 10-meter NED

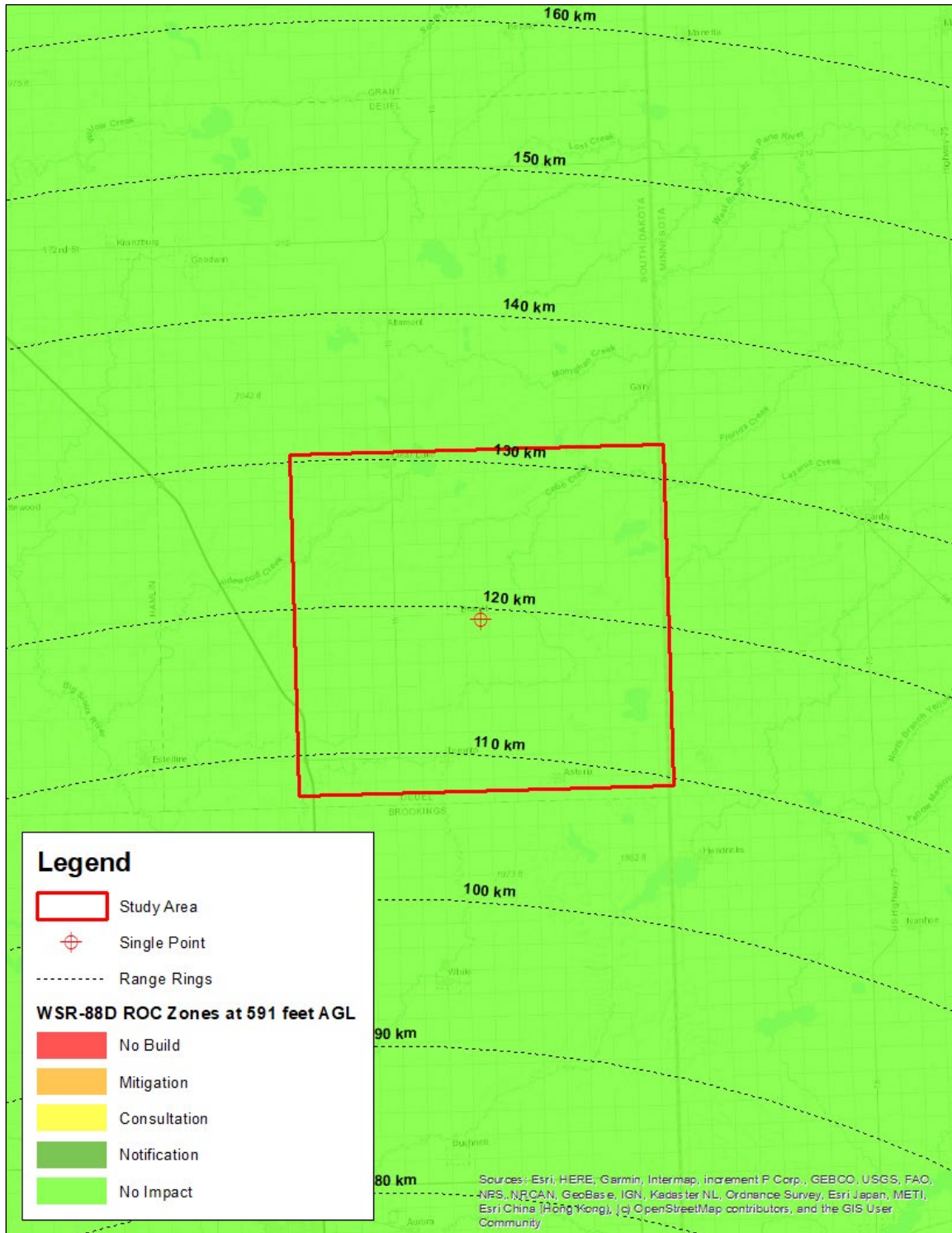


Figure 8 WSR-88D ROC Zone Results at 591 feet AGL for the Sioux Falls WSR-88D using 10-meter NED



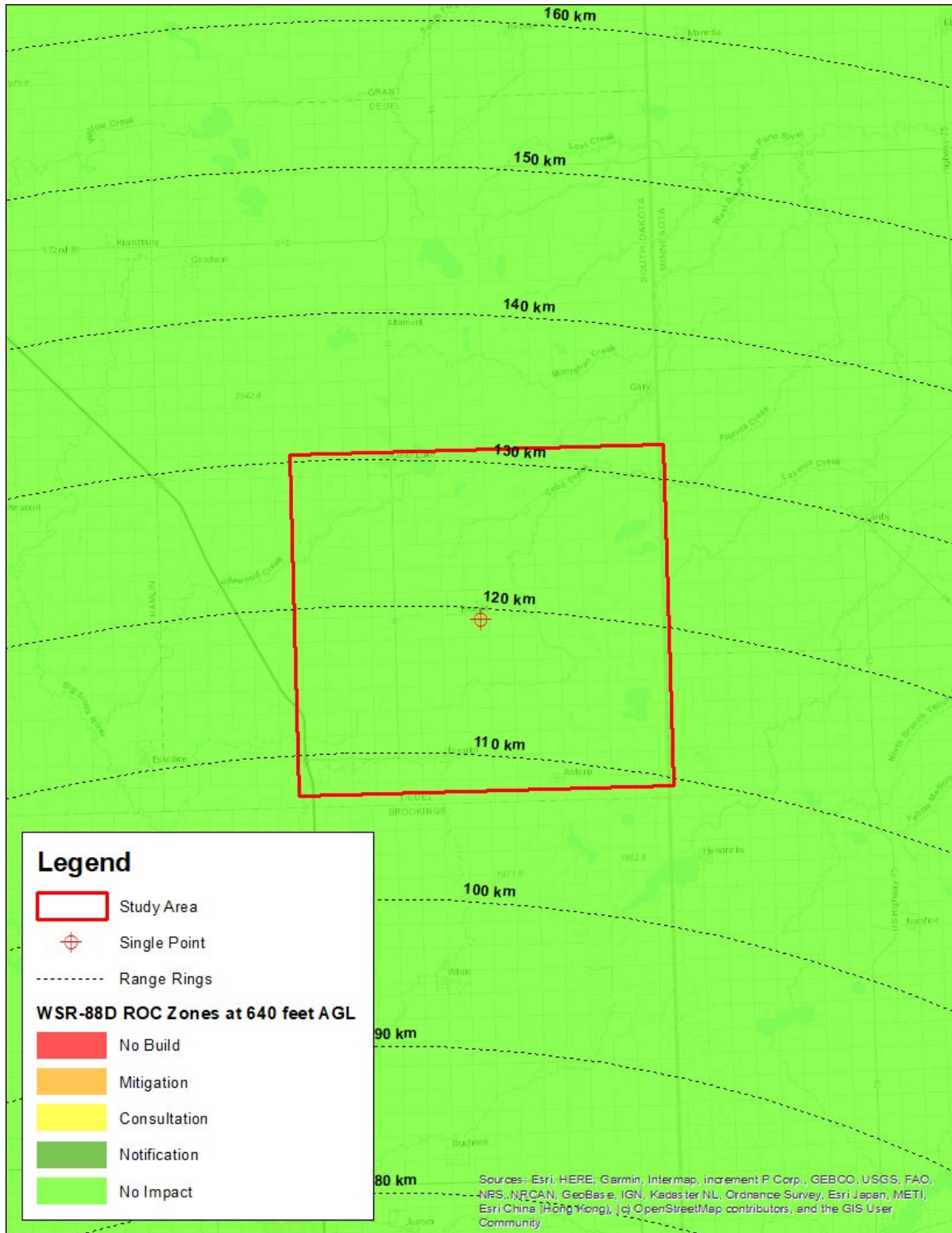


Figure 9 WSR-88D ROC Zone Results at 640 feet AGL for the Sioux Falls WSR-88D using 10-meter NED



## CONCLUSIONS

The DoD PST analysis results for the study area indicate the following:

- Impacts to one air defense and homeland security radar are likely; and
- Impacts to WSR-88D weather radar are not likely.

Westslope identified the two radar sites in the PST analysis results for Long Range Radar as the Sioux Falls ASR-11 and the Tyler CARSR. Further, Westslope identified the closest two radar sites in the PST analysis results for NEXRAD as the Aberdeen WSR-88D and the Sioux Falls WSR-88D.

Research conducted by Westslope identified no additional ARSR or ASR sites near the study area.

Westslope conducted an ARSR and ASR LOS analysis for the following two radar sites:

- Sioux Falls ASR-11; and
- Tyler CARSR.

The ARSR and ASR LOS analyses conducted by Westslope show the following:

- For the Tyler CARSR, wind turbines in the majority of the study area will be within line-of-sight of and will interfere with this radar site at blade-tip heights of 551 feet AGL and 591 feet AGL. At a blade tip height of 640 feet AGL, wind turbines in the entire study area will be within line-of-sight of and will interfere with this radar site.
- For the Sioux Falls ASR-11, wind turbines in the study area will not be within line-of-sight of and will not interfere with this radar site at blade tip heights of 551 feet AGL, 591 feet AGL, or 640 feet AGL.

For the Tyler CARSR, without mitigation, the radar effects due to clutter will include a partial loss of primary target detection and a number of false primary targets over and in the immediate vicinity of wind turbines within line-of-sight in the study area. Please note that radar effects do not always translate into operational impacts. Because wind turbines in the study area will be within line-of-sight of this radar site, Westslope expects that the DoD and FAA will have concerns with wind turbines within line-of-sight in the study area at blade-tip heights of 551 feet AGL, 591 feet AGL, and 640 feet AGL based on electromagnetic interference to an air navigation facility. NORAD has established an “Area of Concern” around the Tyler CARSR as of April 28, 2021. The FAA’s aeronautical study process and the DoD Siting Clearinghouse process will provide an official decision as to whether impacts are acceptable to operations. Although possible, Westslope does not expect that DHS will have concerns with wind turbines within line-of-sight in the study area at blade-tip heights of 551 feet AGL, 591 feet AGL, or 640 feet AGL based on impacts to this radar site.

Westslope does not expect that wind turbines in the study area will affect the secondary surveillance radar co-located with the Tyler CARSR.

Westslope conducted a VOR screening analysis for the following two navigational aid sites:

- Marshall VOR/DME; and
- Watertown VORTAC.

Westslope's VOR screening analysis for the Marshall VOR/DME and the Watertown VORTAC shows that the study area is greater than 8 NM from these navigational aid sites. Although possible, Westslope does not expect that the FAA will have concerns with wind turbines in the study area at blade-tip heights of 551 feet AGL, 591 feet AGL, or 640 feet AGL based on impacts to these navigational aid sites.

Westslope conducted a NEXRAD weather radar screening analysis for the following two radar sites:

- Aberdeen WSR-88D; and
- Sioux Falls WSR-88D.

Westslope's NEXRAD weather radar screening analysis for the Aberdeen WSR-88D and the Sioux Falls WSR-88D shows that wind turbines in the study area will not be within line-of-sight of and will not interfere with these radar sites at blade-tip heights of 551 feet AGL, 591 feet AGL, or 640 feet AGL. The results also show that wind turbines in the study area at blade-tip heights of 551 feet AGL, 591 feet AGL, and 640 feet AGL will fall within a NOAA green No Impact Zone for these radar sites.

Westslope recommends that the study area be submitted to the DoD Siting Clearinghouse for an informal review and to the National Telecommunications Information Administration (NTIA) for a detailed review. The NTIA is essentially a clearinghouse for other federal agencies, including the National Oceanic and Atmospheric Administration.

If you have any questions regarding this analysis, please contact Geoff Blackman at (405) 816-2604 or via email at [gblackman@westslopeconsulting.com](mailto:gblackman@westslopeconsulting.com).