Appendix G
Aviation Constraints Study

Engie
North Bend Wind Project
20-N-0619.003

Prepared by:
Nicholas Albert
Airspace Analyst

10/16/2020

2510 West 237th Street. • Suite 210 • Torrance, CA 90505
Tel: 310.530.3188 • Fax: 310.530.3850 • email: asi@aviationsystems.com • www.aviationsystems.com

Common Acronyms and Abbreviations

1A Survey	A survey with horizontal +20 ft (6 m) and vertical +3 ft (1 m) accuracy
2C Survey	A survey with horizontal +50 ft (15 m) and vertical +20 ft (6 m) accuracy
AGL	Above Ground Level
AMSL	Above Mean Sea Level
ATC	Air Traffic Control
ARP	Airport Reference Point
ARSR	Air Route Surveillance Radar
ATRCC	Air Route Traffic Control Center (Center)
ASI	Aviation Systems, Inc.
ASR	Airport Surveillance Radar
CAT	Category
CFR	Code of Federal Regulations
DA	Decision Altitude
DHS	Department of Homeland Security
DME	Distance Measuring Equipment
DNH	Determination of No Hazard
DoD	Department of Defense
DOH	Determination of Hazard
EMI	Electromagnetic Interference
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
HP	Holding Pattern
IAP	Instrument Approach Procedures
ICA	Initial Climb Area
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Procedures
LNAV	Lateral Navigation
LPV	Localizer Performance with Vertical Guidance
LOC	Localizer Directional Aid
LoS	Line of Sight
LRR	Long Range Radar
MAH	Missed Approach Hold
MAP	Missed Approach Procedure
MDA	Minimum Descent Altitude
MEA	Minimum Enroute Altitude
MOA	Military Operations Areas
MOCA	Minimum Obstacle Clearance Altitude
MSA	Minimum Safe/Sector Altitude
MTR	Military Training Route
MVA	Minimum Vectoring Altitude
NAS	National Airspace System
NAVAID	Navigational Aid

NDB	Non-directional Beacon
NEXRAD	Next-Generation Radar (WSR-88D)
NM	Nautical Miles
NOAA	National Oceanic and Atmospheric Administration
NPH	Notice of Presumed Hazard
OEA	Obstacle Evaluation Area
OCS	Obstacle Clearance Surface
PRI	Private Instrument Approach
PT	Procedure Turn
RAPCON	Radar Approach Control (for military operations)
RNAV	Area Navigation (GPS)
ROC	Required Obstacle Clearance
ROFA	Runway Object Free Area
RPZ	Runway Protection Zone
RWY	Runway
SFC	Surface
SID	Standard Instrument Departure
SM	Statute Mile
SR	Slow Speed Route
TAA	Terminal Arrival Area
TACAN	Tactical Air Navigation System
TPA	Traffic Pattern Airspace
TRACON	Terminal Radar Approach Control Facility
VFR	Visual Flight Rules
VNAV	Vertical Navigation
VOR	Very High Frequency Omnidirectional Range
WTG	Wind Turbine Generator

Executive Summary

As requested, ASI, has evaluated the feasibility of the North Bend Wind Project hereinafter referred to as the "Project," from an aviation and airspace point of view.

The goal of this analysis was to evaluate the regulatory compliance and potential impacts of WTGs at heights up to 650 feet AGL. The FARs (14 CFR 77) requires structures that exceed 200 feet AGL to be submitted to the FAA for an aeronautical study to determine whether the structures may be a hazard (or not) to air navigation per 14 CFR §77.9.

Vertical limits overlying the Project area could limit WTG construction to heights ranging from 2,700 feet to 2,899 feet AMSL. WTGs that exceed these limits, may receive Notice of Presumed Hazards (NPHs) from the FAA requiring significant revisions to the airspace to allow construction.

The Project area could be in the LoS of FAA/DoD radar, particularly the Air Route Surveillance Radar (ARSR) at Gettysburg (QJB). An in-depth radar impact study after filing may be required. See section on Radar Systems Interference for more detail.

Victor Airways V26 and V120 overlie the Project area and have Minimum Enroute Altitudes (MEAs) with Obstacle Clearance Surfaces (OCSs) of 3,049 and 2,949 feet AMSL respectively, which are above the Target Height, hence, the Project will not impact MEAs. However, V10 has a Minimum Obstacle Clearance Altitude (MOCA) with an OCS of 2,449 feet AMSL, which is below the Target Height. A MOCA is an Obstruction Standard of FAR Part 77, §77.17(a)(4). For any structures exceeding an Obstruction Standard, the FAA may initially issue NPHs. Please note that as a measure of impact severity, Obstruction Standards are not considered ultimate operational limitations, in the absence of any other limiting factor, and the FAA should issue DNHs after conducting a more in-depth impact study. See section on Enroute Airways for more detail.

Instrument Approach Procedures (IAPs) into Pierre Regional Airport (PIR) overlie the Project area and will limit construction to 2,700 feet AMSL near the northwestern boundary. Although this limit is below the Target Height, ground elevation does not exceed 2,050 feet AMSL beneath it, therefore, the Project will not impact IAPs. See section on IAPs for more detail.

The Project will not impact any Imaginary Surfaces, TPA, MVAs, Military Airspace, NAVAIDs, MSAs, Approach Circling Airspace, Instrument Departures or Private Airports.

All WTGs greater than 499 feet AGL will receive an NPH and be circulated for public notice, which will delay the process. The FAA will have to conduct further aeronautical study to determine their effect on navigable airspace and ensure they do not pose a hazard. This includes Potential VFR Flyways, which may overlie the Project but is unlikely. See section on VFR Flyways for more detail.

This analysis did not consider EMI on communications or navigation systems.

Currently, notwithstanding radar interference or potential VFR Flyways (See attached Figure 12 and Table 5):

According to ASI topography,

Ground elevation does not exceed 2,050 feet AMSL in Sector A or 2,249 feet AMSL in Sector B, therefore, 650-foot AGL WTGs should be approvable anywhere in the Project area.

Basic Project Information

We reviewed the Project against Federal aviation and airspace criteria set forth in:

- FAR Part 77 (14 CFR 77), the *Safe, Efficient Use and Preservation of the Navigable Airspace;*
- FAA Order 8260.3D, the *United States Standard for Terminal Instrument Procedures* (referred to as TERPs);
- FAA Order 8260.58A Change 1, the *United States Standard for Performance Based Navigation (PBN) Instrument Procedure Design;*
- FAA Order JO 7400.2M, the *Procedures for Handling Airspace Matters;*
- FAA Order 7610.4, *Special Military Operations;*
- DoD Flight Information Publication AP/IB, *Military Training Routes, North and South America*; and
- FAR Part 95 (14 CFR Part 95), Subpart B, *Designated Mountainous Areas.*
- *AC 150/5300-13A, Airport Design*

The criteria in these documents comprise the factors the FAA will use in evaluating the aeronautical compatibility and regulatory compliance of the Project when it is submitted for their official regulatory review under FAR Part 77 as specified in Title 49 U.S. Code Section 44718.

Our task was to apply those criteria and determine the airspace regulatory feasibility of WTGs at up to 650 feet AGL proposed in an area of approximately 123 NM^2 or about 104,181 acres in Hughes and Hyde Counties, South Dakota. Please see Figure 1 depicting the Project boundaries and surrounding area in the regional setting.

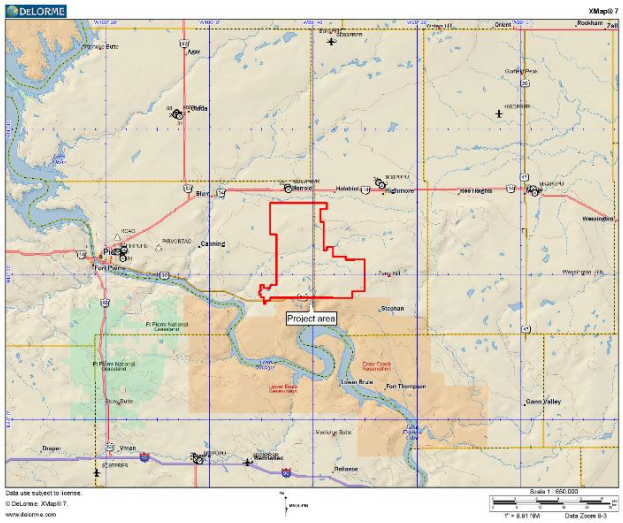

Figure 1: Regional Setting

Terrain within the Project area varies from approximately 1,560 feet AMSL to 2,200 feet AMSL. With a proposed overall WTG height up to 650 feet AGL, the highest point of the Project could theoretically be 2,850 feet AMSL. A 49-foot buffer is added for terrain variations and to establish the "Target Height[1]" of 2,899 feet AMSL.

The nearest public-use facility subject to the Federal regulatory criteria above is Highmore Municipal Airport (FAA Identifier: 9D0), which is located approximately eight NM northeast of the Project boundary. 9D0 is an IFR airport with two IAPs: RNAV (GPS) RWYs 13 & 31, one paved runway (13/31); 13 based aircraft; and approximately 5,616 annual operations.

There are four other regional public-use facilities subject to the Federal regulatory criteria, which were also evaluated for effect (See Table 1).

Table 1: Regional Public-Use Facilities

Airport	Distance to center (NM)	Direction	Approaches
Presho Municipal Airport (5P5)	32.63	SW	VFR
Onida Municipal Airport (98D)	26.06	NE	RNAV (GPS) RWYs 13 & 31
Miller Municipal Airport (MKA)	31.76	E	RNAV (GPS) RWYs 15 & 33
Pierre Regional Airport (PIR)	25.79	W	ILS OR LOC RWY 31; RNAV (GPS) RWYs 07, 13, 25 & 31; VOR/DME OR TACAN RWY 07; VOR OR TACAN RWY 25

[1] *The "Target Height" is not an official FAA vertical limitation but, rather, an in-house artificial convention used to limit the analysis to only relevant and material factors which might influence building heights and FAA approvability. In simple terms, if you do not exceed the "Target Height" your structures should have no FAA FAR Part 77 operational airspace issues.*

Analytical Findings

Part 77 Imaginary Surfaces

In 14 CFR §77.19 Imaginary Surfaces are defined as those which have a relationship to an airport and to each of its runways. The dimensions of each category of Imaginary Surface are based on the type of approach available or planned. Exceeding an Imaginary Surface does not automatically mean a DOH will be issued from the FAA. That outcome depends on other airspace factors as well, but it does trigger more in-depth scrutiny.

The Project will not impact Imaginary Surfaces.

TPA

TPA is used for VFR maneuvering by pilots in the area surrounding an airport. The dimensions of the TPA are based on the category of aircraft operating at the field and their approach speeds to the runways. In addition to approach speed, other factors such as: weight bearing capacity, runway surface type, and runway length are also considered.

The Project will not impact any TPA.

Enroute Airways

In the NAS, there are both High Altitude Enroute Airways and Low Altitude Enroute Airways separated at 18,000 feet AMSL and are eight NM wide. In this evaluation, we are only concerned with Low Altitude Enroute Airways (known as Victor Airways). These airways are used by pilots to navigate between VOR NAVAIDs. The FAA publishes minimum altitudes for the airways to ensure clearance from obstacles and terrain. The FAA requires that each airway have a minimum of 1,000 feet of obstacle clearance in non-mountainous terrain areas and normally 2,000 feet in mountainous areas. These areas are delineated in 14 CFR Part 95, Subpart B. The Project falls within the non-mountainous area.

Enroute Airways V26 and V120 are eight NM wide and overlie the Project area. They have MEAs of 4,000 and 3,900 feet AMSL respectively and a 1,000-foot ROC. This leaves OCSs of 3,000 and 2,900 feet AMSL. However, the FAA can round down to the nearest 100-foot increment, which may allow for a 49-foot ROC reduction. This raises the OCS by 49 feet and thus leaves OCSs of 3,049 and 2,949 feet AMSL, which are above the Target Height, hence, the Project will not impact MEAs (See Table 2 and Figure 2).

Table 2: Enroute Airways

Enroute Airway	MEA (ft AMSL)	MOCA (ft AMSL	ROC (ft)	ROC Reduction (ft)	OCS for MEA (ft AMSL)	OCS for MOCA (ft AMSL)
V26	4,000	N/A	1,000	49	3,049	N/A
V120	3,900	3,400	1,000	49	2,949	2,449

Note: V120 has a MOCA of 3,400 feet AMSL. After applying the ROC (with reduction), the OCS is 2,449 feet AMSL, which is below the Target Height. However, an MEA is an Operational Limitation whilst a MOCA is an Obstruction Standard of FAR Part 77, §77.17(a)(4). For any structures exceeding an Obstruction Standard, the FAA may initially issue NPHs. Please note that as a measure of impact severity, Obstruction Standards are not considered ultimate operational limitations, in the absence of any other limiting factor, and the FAA should issue DNHs after conducting a more in-depth impact study.

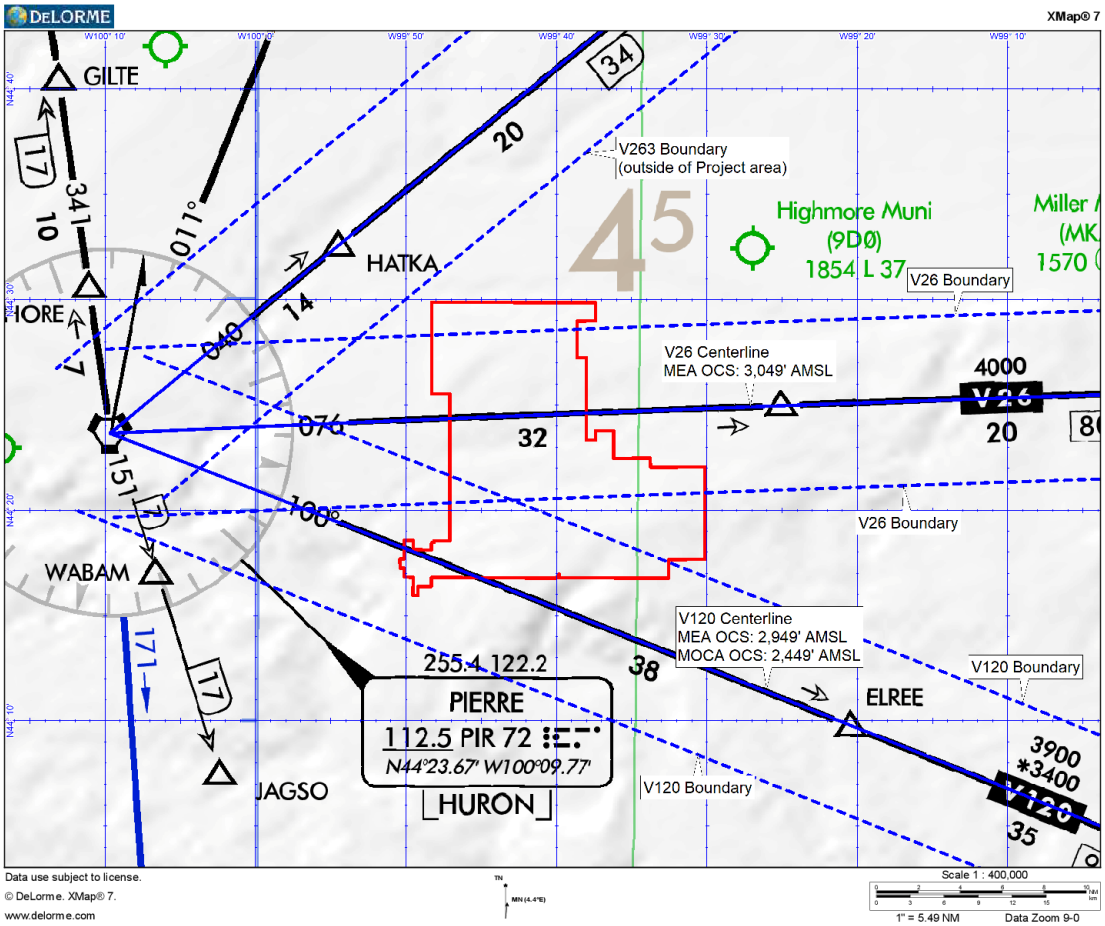

Figure 2: Enroute Chart

MVAs

MVAs are the lowest altitude clearances that may be assigned by ATC to pilots during vectoring or direct routing. These altitudes in an MVA chart depiction are broken up into sectors and encompass a 60 NM radial area around a radar station.

The Project will not impact any MVAs.

Radar Systems Interference

The DoD Screening Tool indicates that the Project appears to be in the LoS of FAA/DoD LRR, Gettysburg (QJB) ARSR, which is located approximately 41.47 NM northwest of the Project's center. There are no ASRs within 65 NM of the Project and one ARSRs within 105 NM of the Project (See Table 3). An in-depth radar impact study after filing may be required (See Table 3 and Figures 3 and 4).

The Project will not impact NEXRAD weather radar. Further weather study will not be necessary (See Figure 5).

Table 3: ASR and ARSR Regional Radar Stations

Name	Type	Distance to center (NM)	Direction
Gettysburg (QJB)	ARSR	41.47	NW

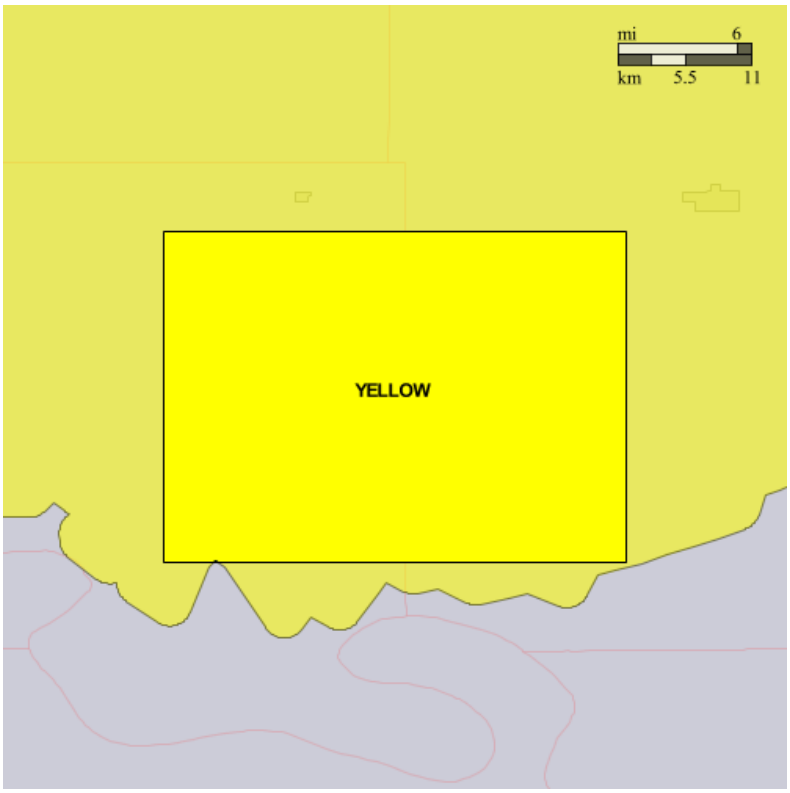

Figure 3: Long Range Radar Screening Tool

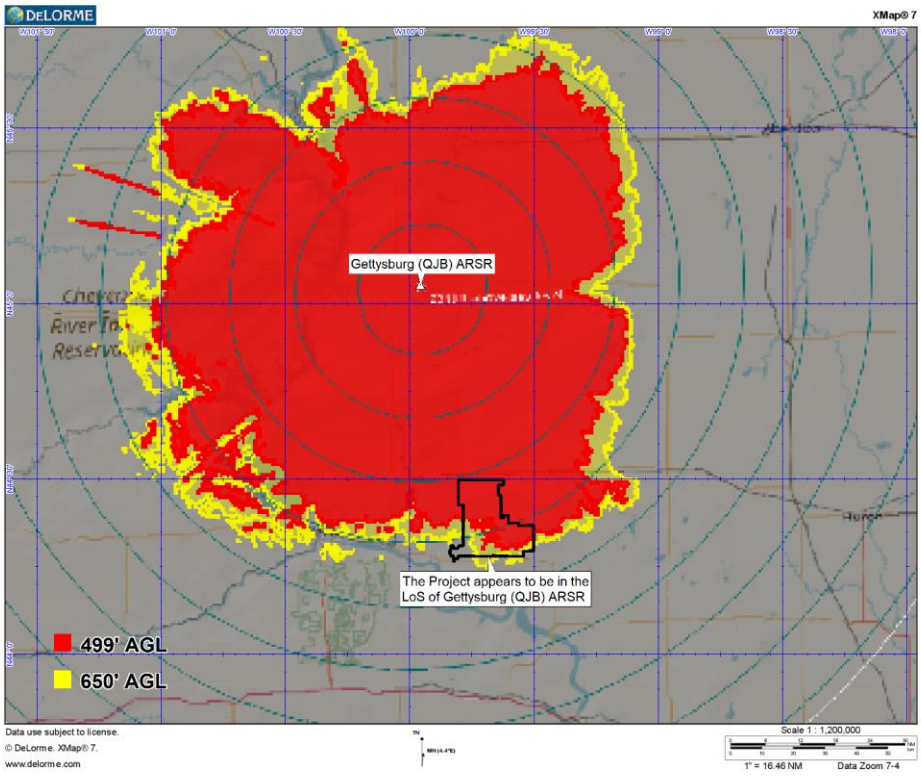

Figure 4: Gettysburg (QJB) ARSR LoS

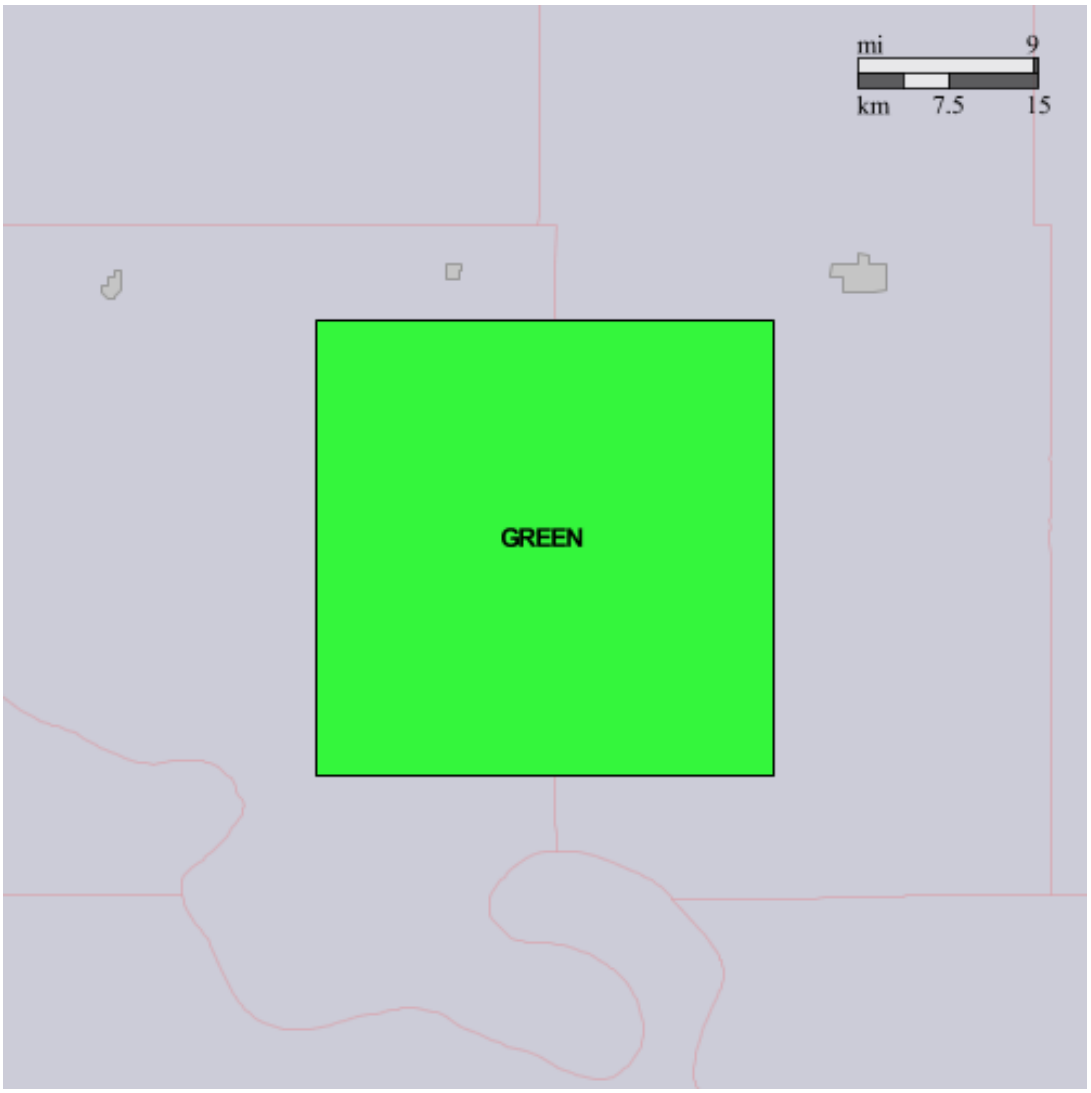

Figure 5: NEXRAD Screening Tool

Military Airspace and Training Routes

The MTR Program is a joint venture by the FAA and the DoD, developed for use by military aircraft to gain and maintain proficiency in tactical “low level” flying. These low-level training routes are generally established below 10,000 feet AMSL for speeds in excess of 250 knots to accommodate both VFR and IFR. Visual MTRs (VRs) are generally designed to be flown below 1,500 feet AGL while Instrument MTRs (IRs) are designed to be flown above 1,500 feet AGL. SR routes, or slow speed routes, are flown at or below 1,500 feet AGL at speeds of 250 knots or less and are commonly used to practice bombing runs.

The Project will not impact military operations such as MOAs, Restricted Airspace, or MTRs (See Figure 6).

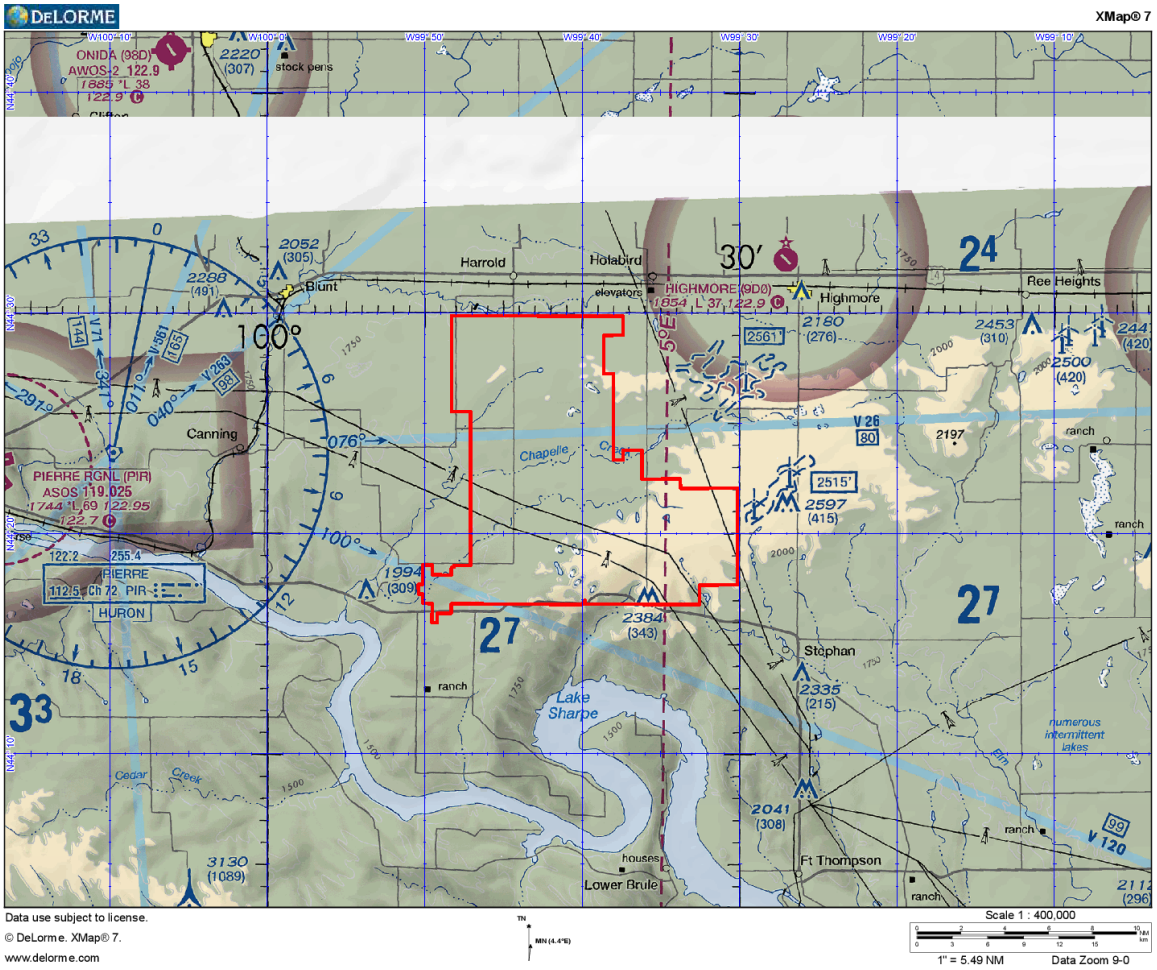

Figure 6: VFR Sectional Chart

Navigational Aids (NAVAIDs)

NAVAIDs provide signals that assist aircraft by guiding and navigating it to its destination. ASI analyzed one NAVAID as part of this evaluation.

The Project will not impact any NAVAIDs.

IAPs

IAPs are used by pilots to land at airports during periods of IMC, i.e., when there is reduced visibility and low cloud ceilings. ASI analyzed 13 IAPs as part of this evaluation (See Table 1).

The VOR or TACAN RWY 25 approach into PIR overlies the Project in Initial and Missed Approach segments near the northwestern boundary (See Figure 7):

- The Procedure Turn area has an MDA at 3,700 feet AMSL and a 1,000-foot ROC, which equates to an OCS of 2,700 feet AMSL.

- The Missed Approach Holding Pattern has an MDA at 3,700 feet AMSL and a 1,000-foot ROC, which equates to an OCS of 2,700 feet AMSL.

  Note:
  - The Project will not impact this approach as ground elevation does not exceed 2,050 feet AMSL beneath either approach segment.

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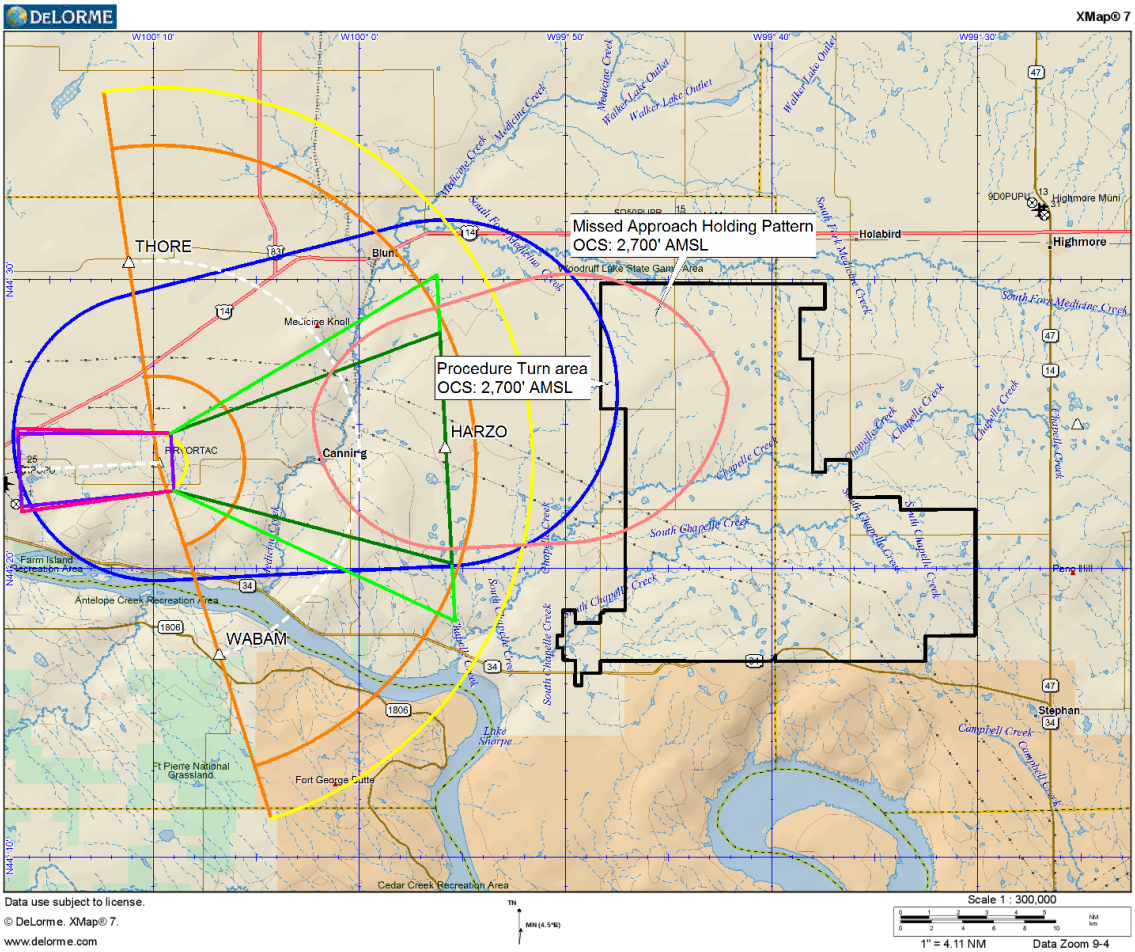


Figure 7: PIR VOR or TACAN RWY 25

As a point of information, the RNAV (GPS) RWY 25 approach into PIR overlies the Project area in Initial segments (See Figure 8):

- The Initial Holding Pattern has an MDA at 4,000 feet AMSL and a 1,000-foot ROC, which equates to an OCS of 3,000 feet AMSL.

- The Feeder Route Primary has an MDA at 4,000 feet AMSL and a 1,000-foot ROC, which equates to an OCS of 3,000 feet AMSL.

- The ROC in the Feeder Route Secondary area is 500 feet at the primary boundary, tapering uniformly to zero feet at the outer edge. This equates to an OCS of 3,500-4,000 feet AMSL.

  Note:
  - The Project will not impact this approach as its limits are above the Target Height.

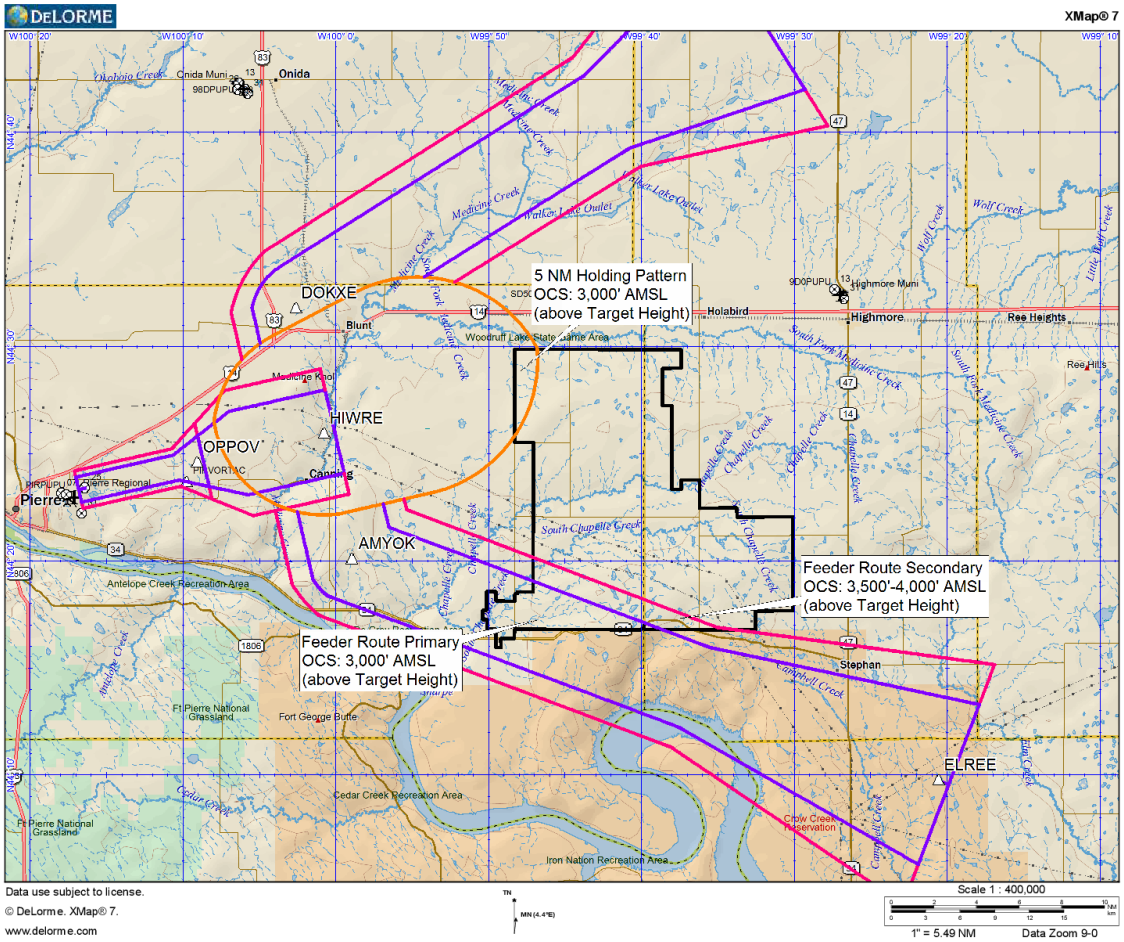


Figure 8: PIR RNAV (GPS) RWY 25

Furthermore, the ILS or LOC RWY 31 approach into PIR overlies western areas of the Project in Initial segments (See Figure 9):

- The Arc Primary area has an MDA at 4,000 feet AMSL and a 1,000-foot ROC, which equates to an OCS of 3,000 feet AMSL.

- The ROC in the Arc Secondary area is 500 feet at the primary boundary, tapering uniformly to zero feet at the outer edge. This equates to an OCS of 3,500-4,000 feet AMSL.

  Note:
  - The Project will not impact this approach as its limits are above the Target Height.

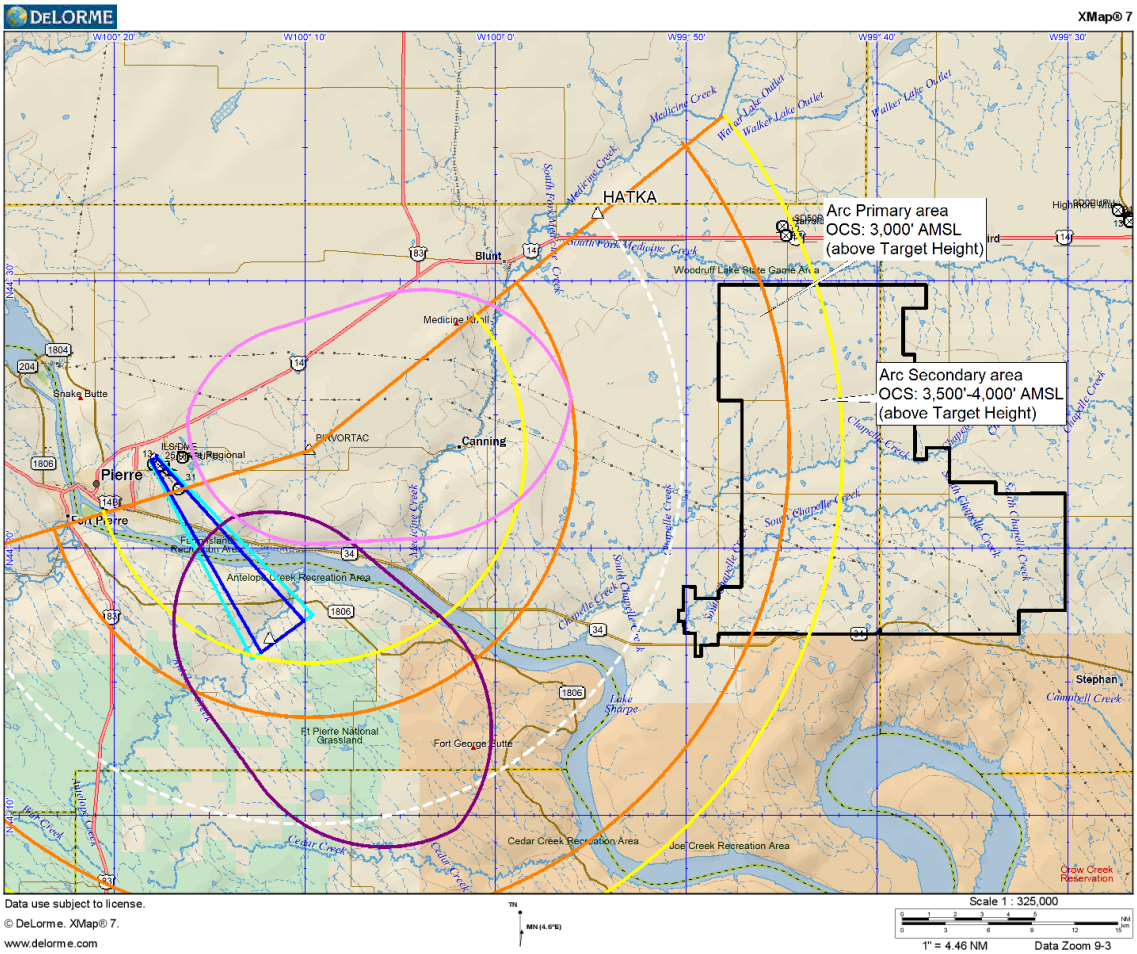


Figure 9: PIR ILS or LOC RWY 31

Minimum Safe Altitude

Minimum Safe Altitude (MSA) on approaches into PIR overlie the Project area with OCSs above the Target Height, hence, WTGs up to 650 feet AGL will not have an impact (See Figure 10).

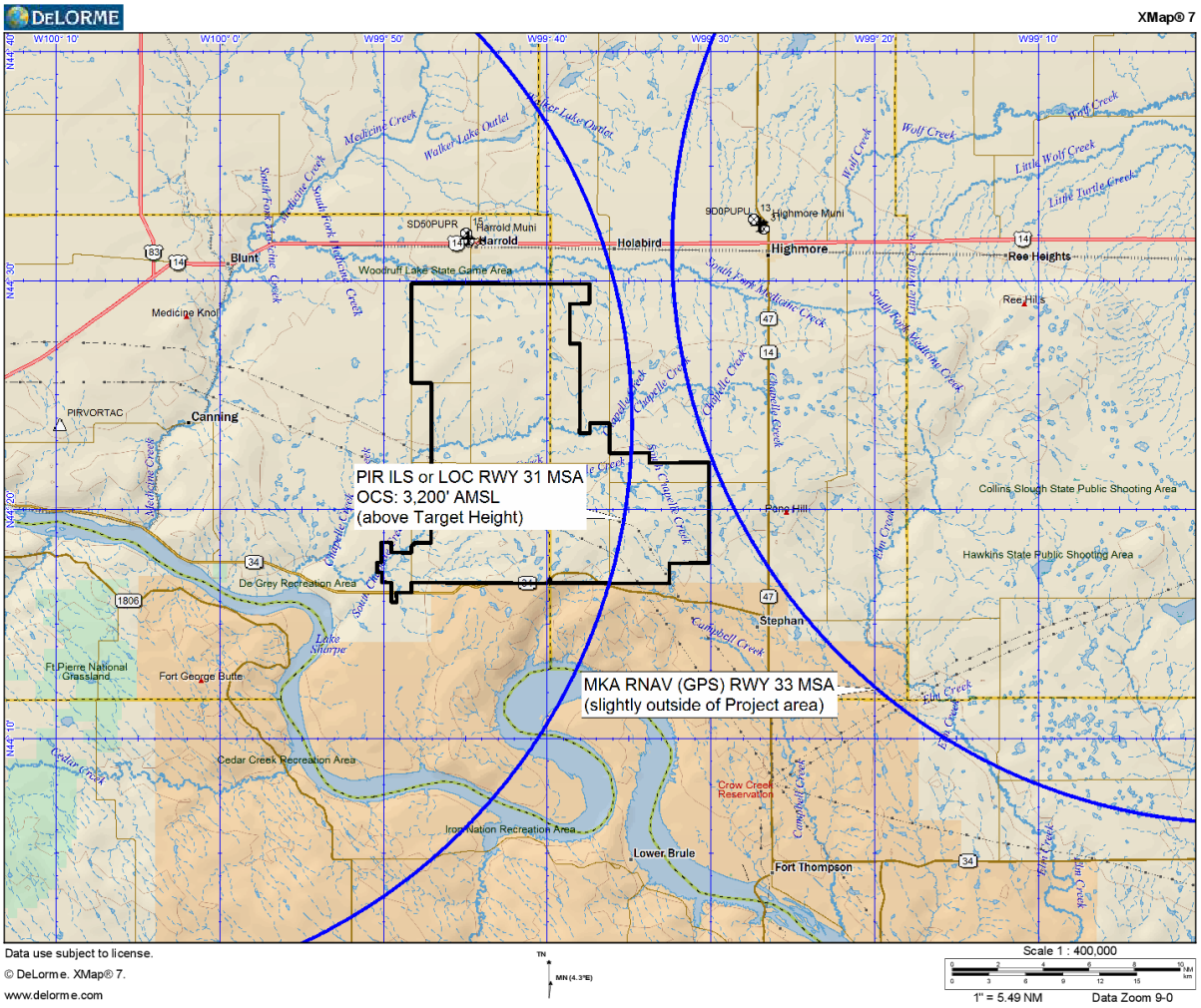


Figure 10: MSAs

Approach Circling Areas

IAPs may include Approach Circling Minimums, however, the Project area is outside of this airspace.

IFR and VFR Departure

The FAA protects aircraft from obstacles and terrain on departure, whether they are using VFR or IFR. IFR departures usually have prescribed procedures either charted in a SID or a standard/accelerated climb to an altitude. VFR departures have more directional flexibility but are constrained by specific ceiling and visibility minima requirements and the "see and avoid" practice of FAR Part 91 §91.113. The IFR diverse departure has a 40:1 slope that is measured from the edge of the ICA trapezoid out to the end of the departure. The VFR departure is incorporated inside of the TPA of the airport.

The Project will not impact IFR/VFR Departures.

VFR Flyways

A VFR Flyway is four SM wide, centered on a geographic landmark, i.e., highways, railroads, rivers, powerlines, canals, radials of a VOR NAVAID, Enroute Airways, and other man-made structures. Potential VFR Flyways in the Project area are depicted below, which may have an impact. The FAA will determine the potential for adverse impact, if any, upon VFR flights by structures sited within these possible Flyways that exceed the 499 feet AGL threshold. Depending on the activity level along the route, the FAA could declare the proposed structures sited within a VFR Flyway to be a potential hazard or perhaps an actual hazard to air navigation, which is unlikely (See Figure 11).

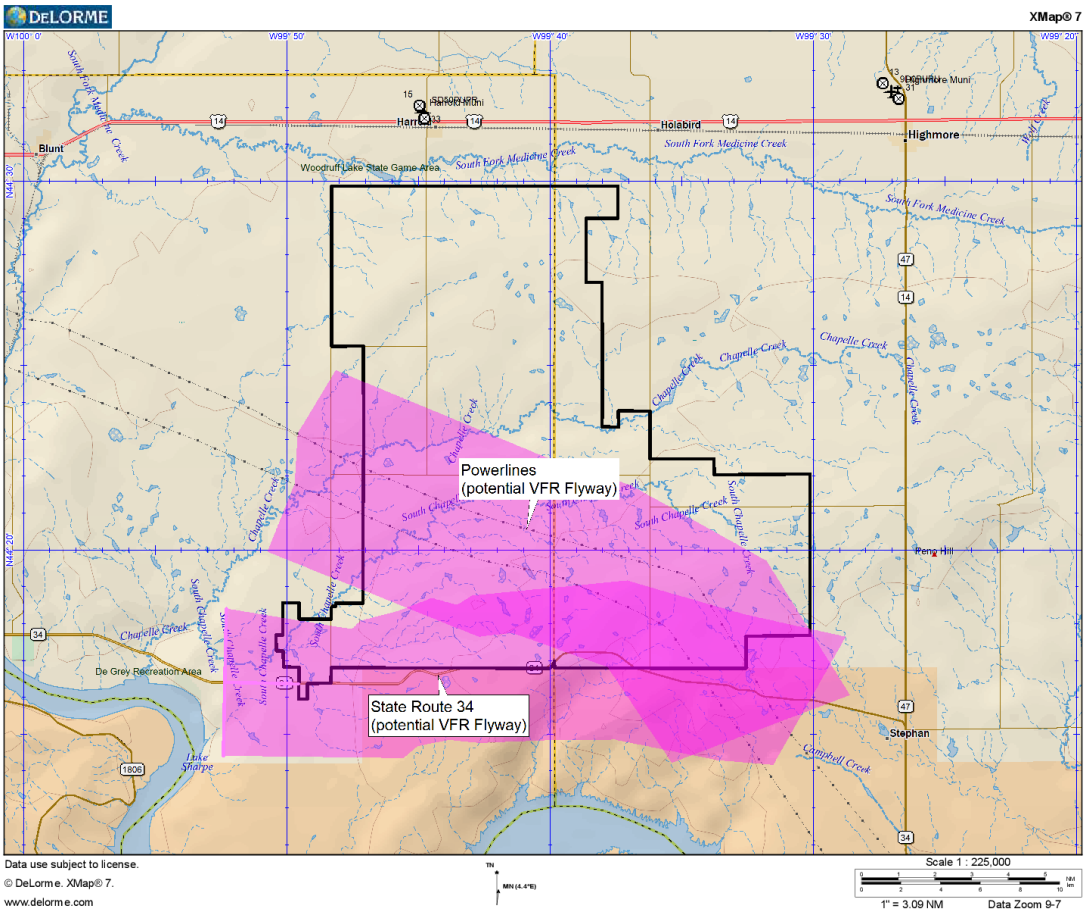


Figure 11: Potential VFR Flyways 2X2SM Wide

Vertical Findings

Mapping and analysis of the relevant and material aviation factors of the Project's airspace environment indicates the following vertical AMSL limits of each Project Sector (See Table 4 and attached Figure 12). Table 5 indicates ground elevations at which 650-foot AGL WTGs can be built.

Table 4: Vertical Limits

SECTOR	LIMIT (ft AMSL)	CAUSAL FACTOR
A	2,700	PIR VOR or TACAN RWY 25 Procedure Turn area & Missed Approach Holding Pattern
B	2,899	Target Height

Table 5: Maximum Ground Elevation to Build

SECTOR	650-foot WTG LIMIT (ft AMSL)
A	2,050
B	2,249

According to ASI Topography and Vertical Limits in Table 4:

- Ground elevation does not exceed 2,050 feet AMSL in Sector A or 2,249 feet AMSL in Sector B, therefore, 650-foot AGL WTGs should be approvable anywhere in the Project area.

Conclusion

The results of this analysis indicate that an FAA aeronautical study will likely identify the following airspace impacts resulting from the proposed WTGs up to 650-foot AGL:

- **Imaginary Surfaces:** The Project will not impact Imaginary Surfaces.

- **Traffic Pattern Airspace:** The Project will not impact TPA.

- **Enroute Airways**: Victor Airways V26 and V120 overlie the Project area and have MEAs with OCSs of 3,049 and 2,949 feet AMSL respectively, which are above the Target Height, hence, the Project will not impact MEAs. However, V10 has a MOCA with an OCS of 2,449 feet AMSL, which is below the Target Height. A MOCA is an Obstruction Standard of FAR Part 77, §77.17(a)(4). For any structures exceeding an Obstruction Standard, the FAA may initially issue NPHs. Please note that as a measure of impact severity, Obstruction Standards are not considered ultimate operational limitations, in the absence of any other limiting factor, and the FAA should issue DNHs after conducting a more in-depth impact study (See Table 2 and Figure 2).

- **Minimum Vectoring Altitude Sectors**: The Project will not impact MVAs.

- **Radar Line of Sight:** The Project area could be in the LoS of FAA/DoD radar, particularly the ARSR at Gettysburg (QJB). An in-depth radar impact study after filing may be required (See Table 3 and Figures 3 and 4).

- **Military Airspace and Training Routes:** The Project will not impact Military Airspace (See Figure 6).

- **NAVAIDs:** The Project will not impact NAVAIDs.

- **Instrument Approach Procedures:** IAPs into PIR overlie the Project area and will limit construction to 2,700 feet AMSL near the northwestern boundary. Although this limit is below the Target Height, ground elevation does not exceed 2,050 feet AMSL beneath it, therefore, the Project will not impact IAPs (See Figures 7-9).

- **Minimum Safe Altitude:** The Project will not impact MSAs (See Figure 10).

- **Approach Circling Areas:** The Project will not impact Approach Circling Areas.

- **Instrument Departures:** The Project will not impact IFR/VFR Departures.

- **VFR Flyways:** The Project has potential VFR Flyways running through it which may cause WTGs to be a hazard. FAA filing will be required to determine if this is the case, which is unlikely (See Figure 11).

- **Private Airports:** The Project will not impact any Private Airports.

Cautionary Notes

- The FAA makes changes to the National Airspace System every day. New approaches are published, departure procedures are changed, new runways are planned, MVAs are modified, etc. Consequently, it is possible for the study findings to become obsolete in a relatively short time. We recommend the study findings be reviewed for currency before filing sites within the study area. Studies older than 12 months should automatically be re-visited, and their findings confirmed.

- While Federal requirements take precedence, local requirements for tall structures may still exist within the county and the municipality in addition to the Federal regulations. Furthermore, there may also be local zoning ordinances adopted at nearby airports. The FAA does not protect private airports or heliports without IAPs. It is highly advisable to contact the specific county and/or city the WTGs are in for any special requirements before construction as well as check with private facilities.

- Furthermore, study findings are intended as a planning tool in conjunction with the resolution of other pertinent issues. Actual construction activities are not advisable until DNHs are issued for any structures that require filing.

- During the aeronautical study process, the FAA may request a certified survey with an accuracy of either 1A or 2C for mitigation. Those must be provided to receive DNHs.

- Approximate study times from the FAA filing are: Initial review 30-90 days. If Further Study (which includes a Public Comment period, if necessary) is required: an additional 60 days, with a possibility of more.

- 14 CFR 77.17 (a) states that: An existing object, including a mobile object, is, and a future object would be an obstruction to air navigation if it is of greater height than any of the following heights or surfaces:

    1) A height of 499 feet AGL at the site of the object. Any object that exceeds 499 feet AGL will exceed the Obstruction Standard and receive an NPH and may be circularized via public notice. It will require a further study requested from the FAA.

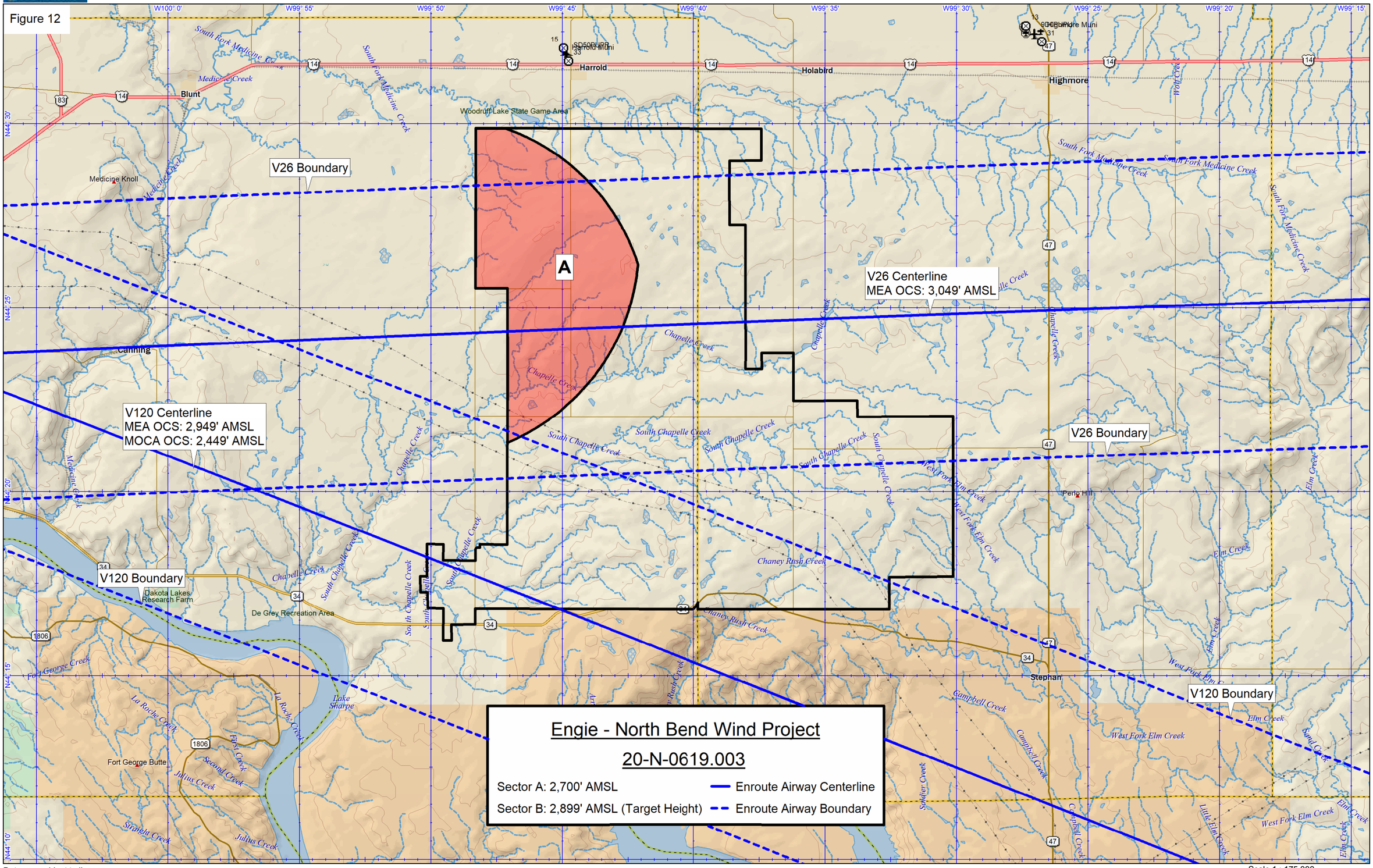
    2) A height that is 200 feet AGL, or above the established airport elevation, whichever is higher, within three NM of the established ARP, excluding heliports, with its longest runway more than 3,200 feet in actual length, and that height increases in the proportion of 100 feet for each additional NM from the airport up to a maximum

of 499 feet at six or more NM is in exceedance of the Obstruction Standard and will receive a NPH and could require a further study requested from the FAA.

- If the FAA determines that one impact or the cumulative impacts constitute a substantial adverse effect, that conclusion could be used as the basis for DOHs. In that event, for construction to proceed, mitigation options will have to be identified, approved, and implemented. Be advised that all mitigation options are subject to FAA approval, which is not guaranteed.

- For any structures exceeding an Obstruction Standard; the FAA may initially issue NPHs. However, please note that as a measure of impact severity, Obstruction Standards are not considered ultimate operational limitations, in the absence of any other limiting factor, and the FAA could issue DNHs after conducting a more in-depth impact study.

Figure 12



TN
MN (4.4°E)

Scale 1 : 175,000
1" = 2.40 NM
Data Zoom 10-2