Appendix X

Obstruction and Airspace Analysis

Invenergy Wind, LLC
Philips Project
20-N-0437.004

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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 Phillips 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 660 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 will limit WTG construction to heights ranging from 3,273 feet to 3,600 feet AMSL. WTGs that exceed these limits, may receive NPHs from the FAA requiring significant revisions to the airspace to allow construction.

The Project may be in the LoS of FAA/DoD radar. An in-depth radar impact study after filing could be required. See section on Radar Systems Interference for more detail.

IAPs into Philip Airport (PHP) overlie most of the Project area and will limit WTGs to a tip height of 3,500 feet AMSL. However, ground elevation does not exceed 2,840 feet AMSL beneath any of these IAP segments (according to ASI topography), therefore, 660-foot WTGs should be approvable without impact. See section on IAPs for more detail.

IFR Departures from PHP RWY 30 have been depicted to an altitude of 3,600 feet AMSL and overlie areas towards the southeast boundary of the Project. However, ground elevation does not exceed 2,613 feet AMSL beneath this 40:1 slope (according to ASI topography), therefore IFR Departures will not have an impact. See section on IFR Departures for more detail.

Areas towards the southeastern boundary of the Project may impact Philip VOR/DME. WTGs sighted within eight NM of the VOR/DME will require FAA further study to determine what impact (if any) the structures may have on the VOR/DME's signal. See section on Philip VOR/DME for more detail.

The Project will not impact any Imaginary Surfaces, TPA, Enroute Airways, MVAs, Military Airspace, Approach Circling Areas, or MSAs.

All WTGs greater than 499 feet AGL will receive a Notice of Presumed Hazard (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 impact 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 issues, potential VFR Flyways, or interference of Philip VOR/DME:

660-foot WTGs should be approvable anywhere in Sectors A-C (according to ASl topography) (See attached Figure 14 and Table 4).

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 7400.2L, 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 heights up to 660 feet AGL proposed in an area of approximately 316.57 NM^2 or about 268,308 acres in Haakon County, South Dakota. Please see Figure 1 depicting the Project boundaries and surrounding area in the regional setting.

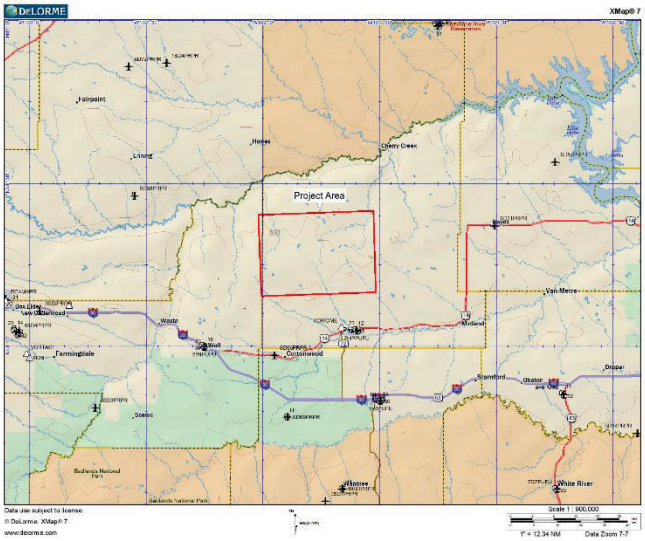

Figure 1: Regional Setting

Terrain within the Project area varies from approximately 2,050 feet AMSL to 2,828 feet AMSL. With a proposed overall WTG height up to 660 feet AGL, the highest point of the Project could theoretically be 3,488 feet AMSL. A 112-foot buffer is added for terrain variations and to establish the "Target Height[1]" of 3,600 feet AMSL.

The nearest public-use facility subject to the Federal regulatory criteria above is Philip Airport (FAA Identifier: PHP), which is located approximately 6.60 NM south of the Project Boundary. PHP is an IFR airport with three IAPs: RNAV (GPS) RWYs 12, & 30 and VOR-A; one paved runway (12/30) & one turf runway (05/23); 13 based aircraft; and approximately 1,300 annual operations.

There are two 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
Kadoka Municipal Airport (5V8)	29.35	SE	VFR
Wall Municipal Airport (6V4)	26.95	SW	VFR

[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. Imaginary Surfaces will not impact the Project.

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. Be advised for any given airport, the FAA may apply a Traffic Pattern category that may not necessarily represent the type of traffic the airport receives, but the airport must be protected using that criteria. TPA will not impact the Project.

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. There are no Victor Airways overlying the Project area, hence, Enroute Airways will not have an impact (See Figure 2).

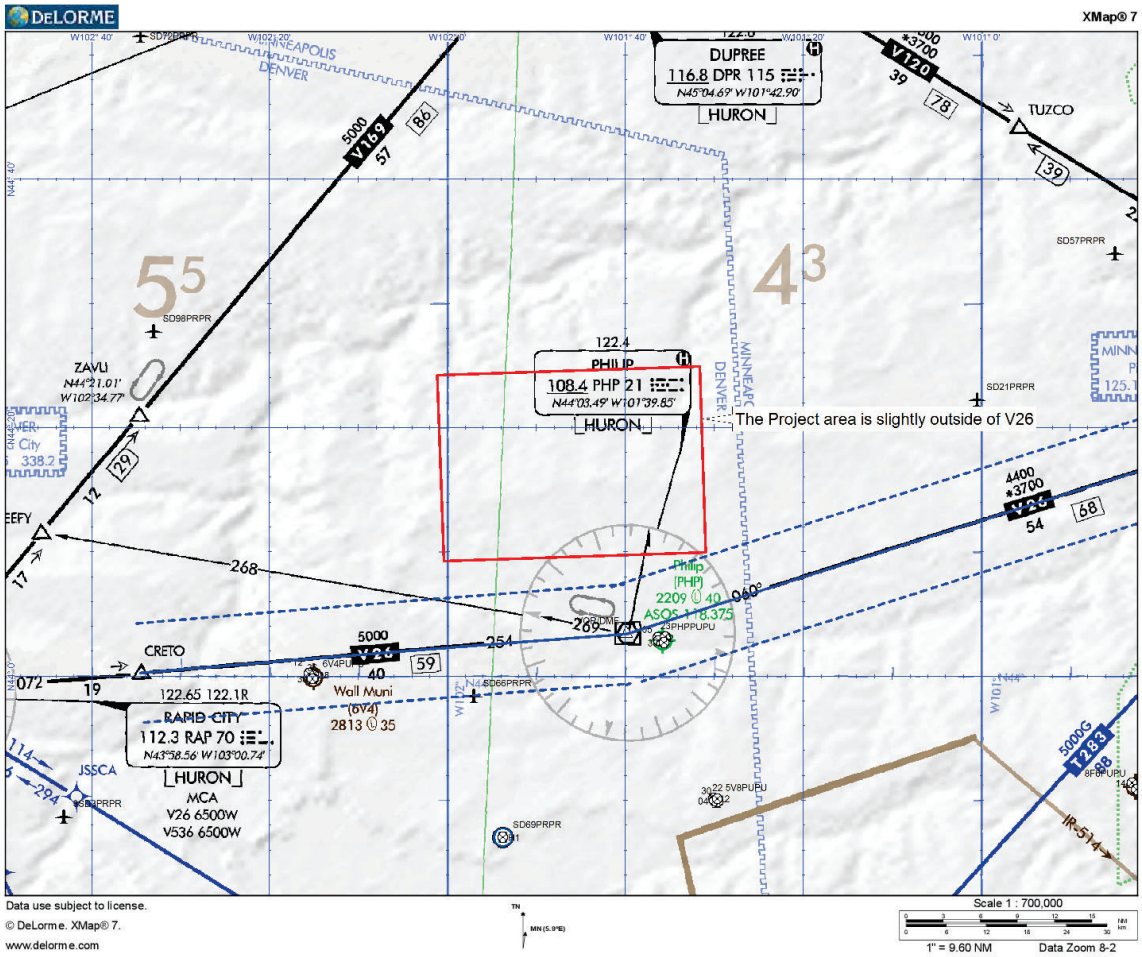

Figure 2: Enroute Chart

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 only ASR facility within 60NM of the Project is at Ellsworth Air Force Base (RCA).

- According to a DoD specialist from RCA RAPCON, the Project area is outside of RCA's airspace since their ASR only covers a 40 NM radial, hence, MVAs will not have an impact.

Radar Systems Interference

The DoD Screening Tool indicates that areas of the Project are visible to FAA/DoD LRR (See Figure 3), however, LoS calculations indicate no LoS (See Figures 4 & 5). There is one ASRs within 65 NM of the Project and one ARSRs within 105 NM of the Project (See Table 2). An in-depth radar impact study after filing may be required.

The Project will not impact NEXRAD weather radar (See Figure 6). Further weather radar study after filing will not be necessary.

Table 2: ASR and ARSR Regional Radar Stations

Name	Type	Distance (NM)	Direction
RCA	ASR	58.42	W
Gettysburg (QJB)	ARSR	89.58	NE

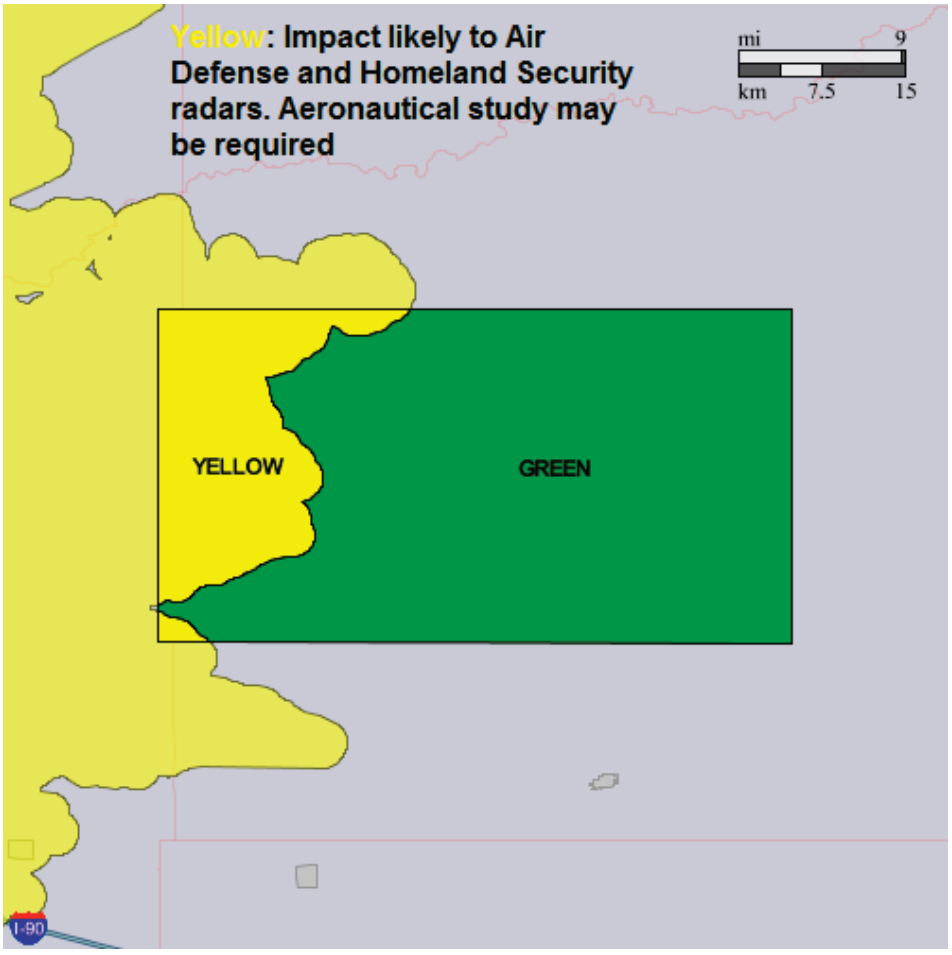

Figure 3: Long Range Radar Screening Tool

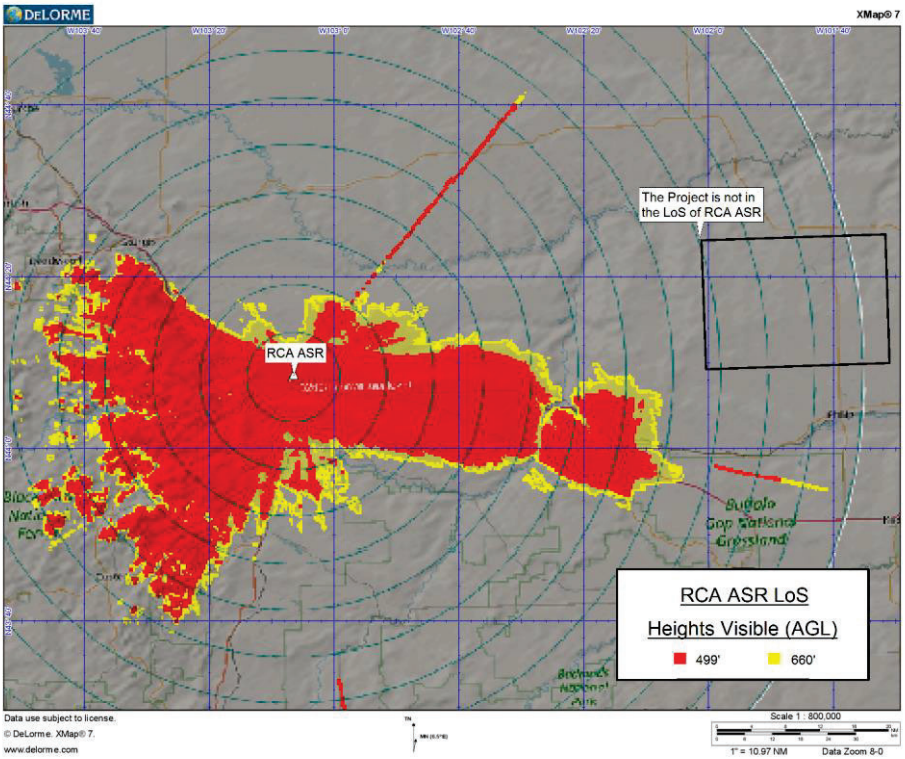

Figure 4: RCA ASR LoS

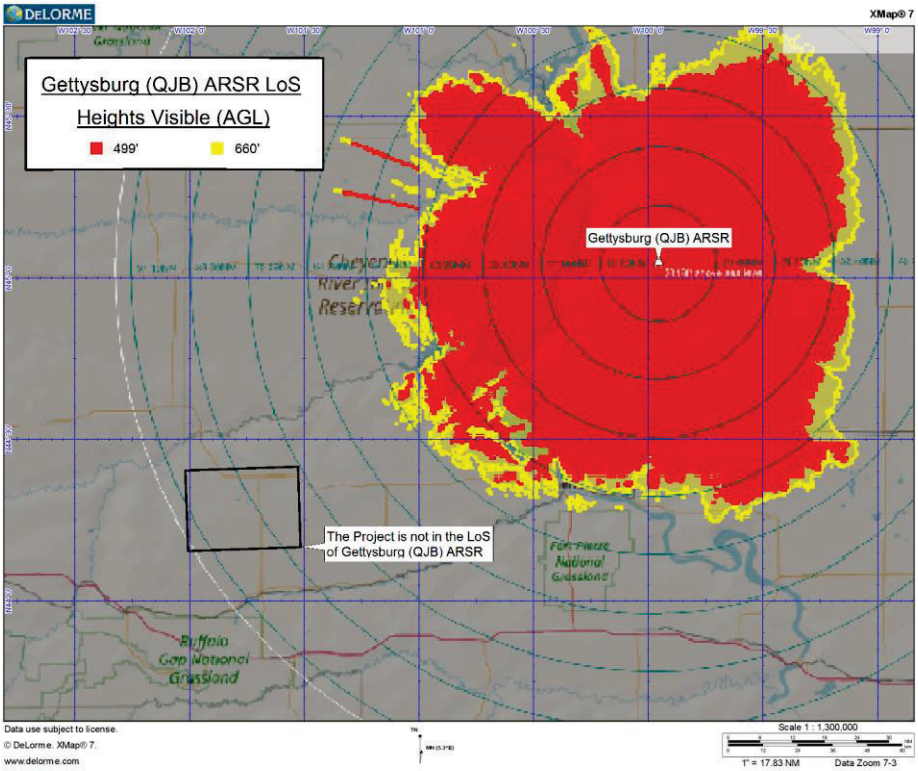

Figure 5: Gettysburg (QJB) ARSR LoS

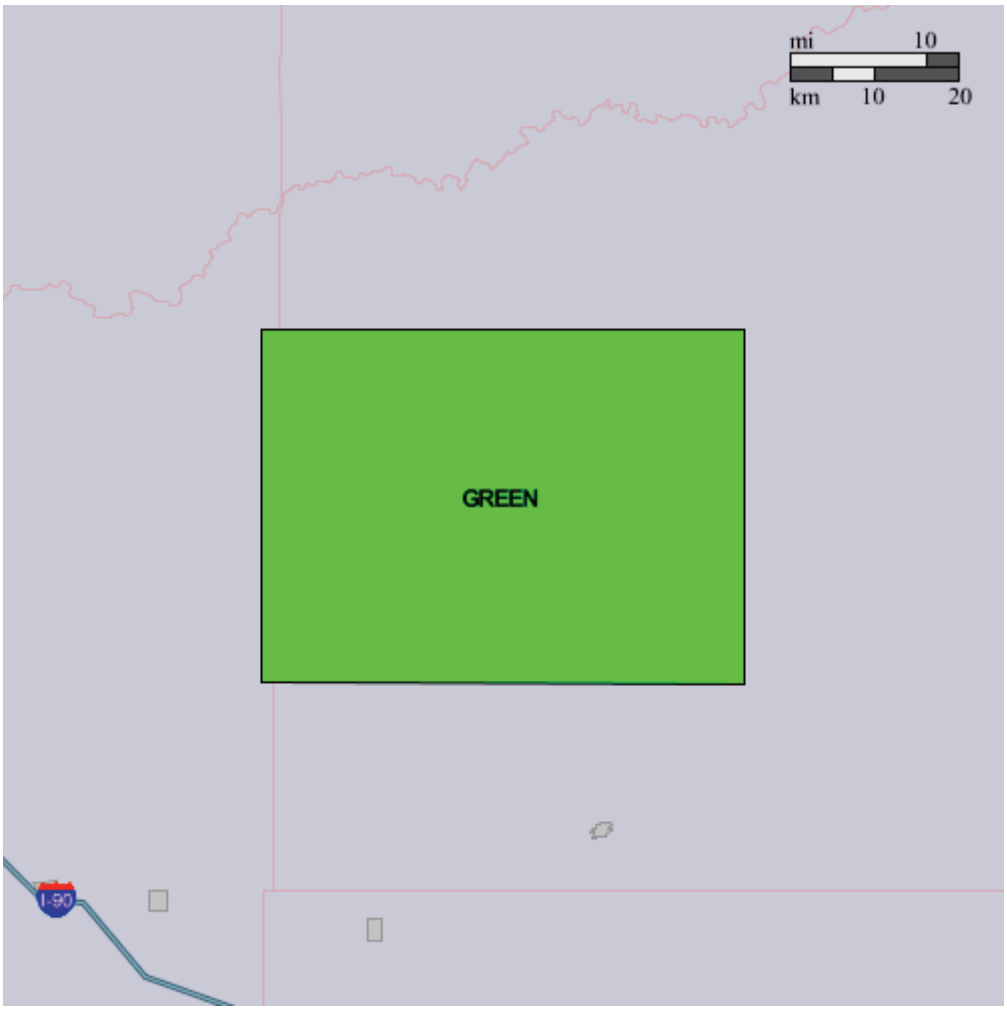

Figure 6: NEXRAD Screening Tool

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 7).

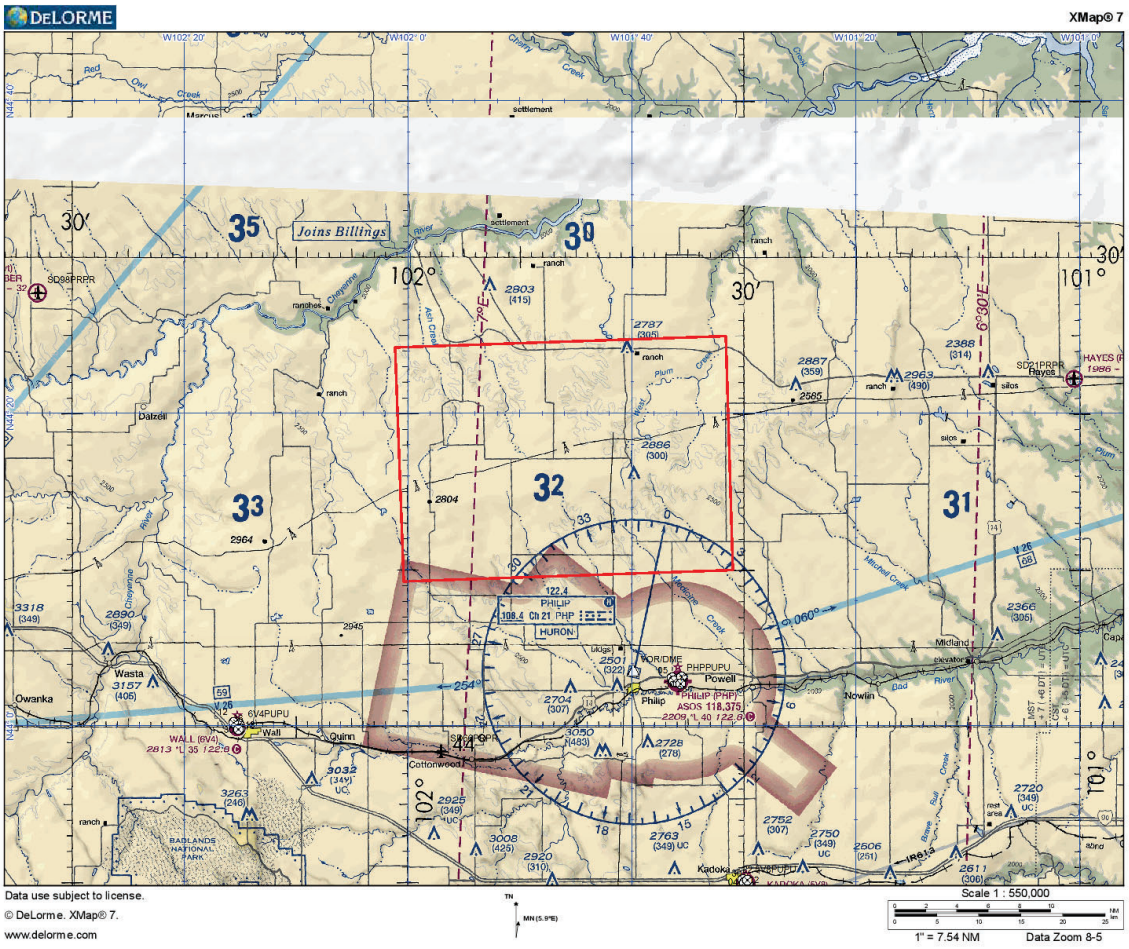

Figure 7: VFR Sectional Chart

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 three IAPs as part of this evaluation (See Table 1).

The RNAV (GPS) RWYs 12 & 30 approaches into PHP impact the Project in Initial/ Intermediate Approach, TAA, and Initial/ Missed Approach Hold segments, which overlie the entire Project area (See Figure 8):

- The Initial/ Intermediate Primary Surface, Northern Inner TAA, Southern Inner & Outer TAAs, and the Initial/ Missed Approach Hold at CUSED each have an MDA at 4,500 feet AMSL and a 1000-foot ROC. This equates to an OCS of 3,500 feet AMSL. According to ASI topography, ground elevation does not exceed 2,840 feet AMSL in the Project area, therefore, **660-foot WTGs** should be approvable without impact.

  Note:
  - The Northern Outer TAA overlies the Project area. It has an MDA at 4,800 feet AMSL and 1,000-foot ROC. This equates to OCSs of 3,800 feet AMSL, which is above the Target Height, therefore, the Northern Outer TAA will not have an impact.

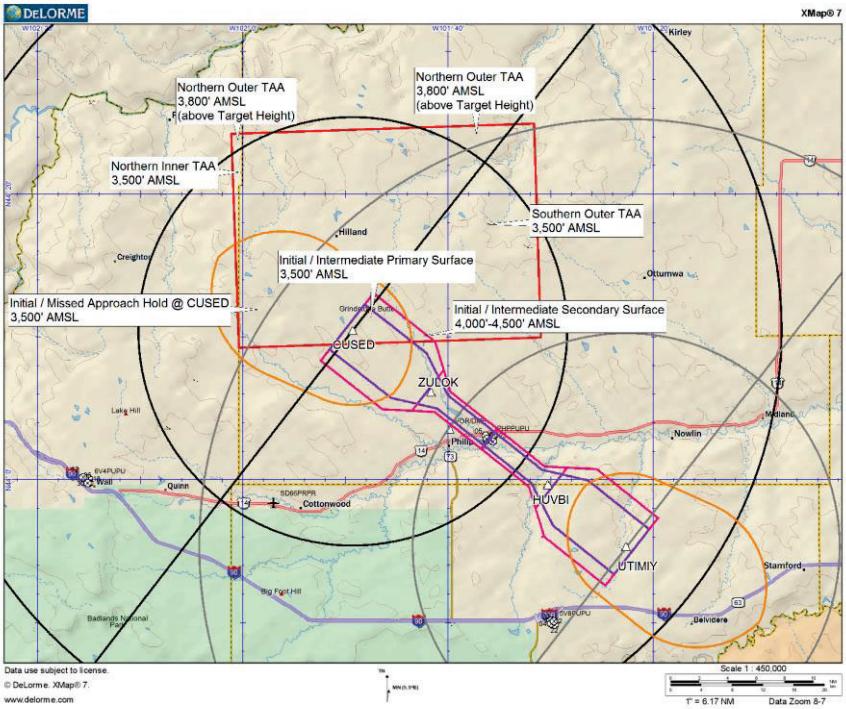

Figure 8: PHP RNAV (GPS) RWYs 12 & 30

The VOR-A approach into PHP impacts the Project in the Procedure Turn Area, which overlies the southwest corner of the Project area (See Figure 9):

- The Procedure Turn area has an MDA at 4,500 feet AMSL and a 1000-foot ROC. This equates to an OCS of 3,500 feet AMSL. According to ASI topography, ground elevation does not exceed 2,840 feet AMSL in the Project area, therefore, **660-foot WTGs** should be approvable without impact.

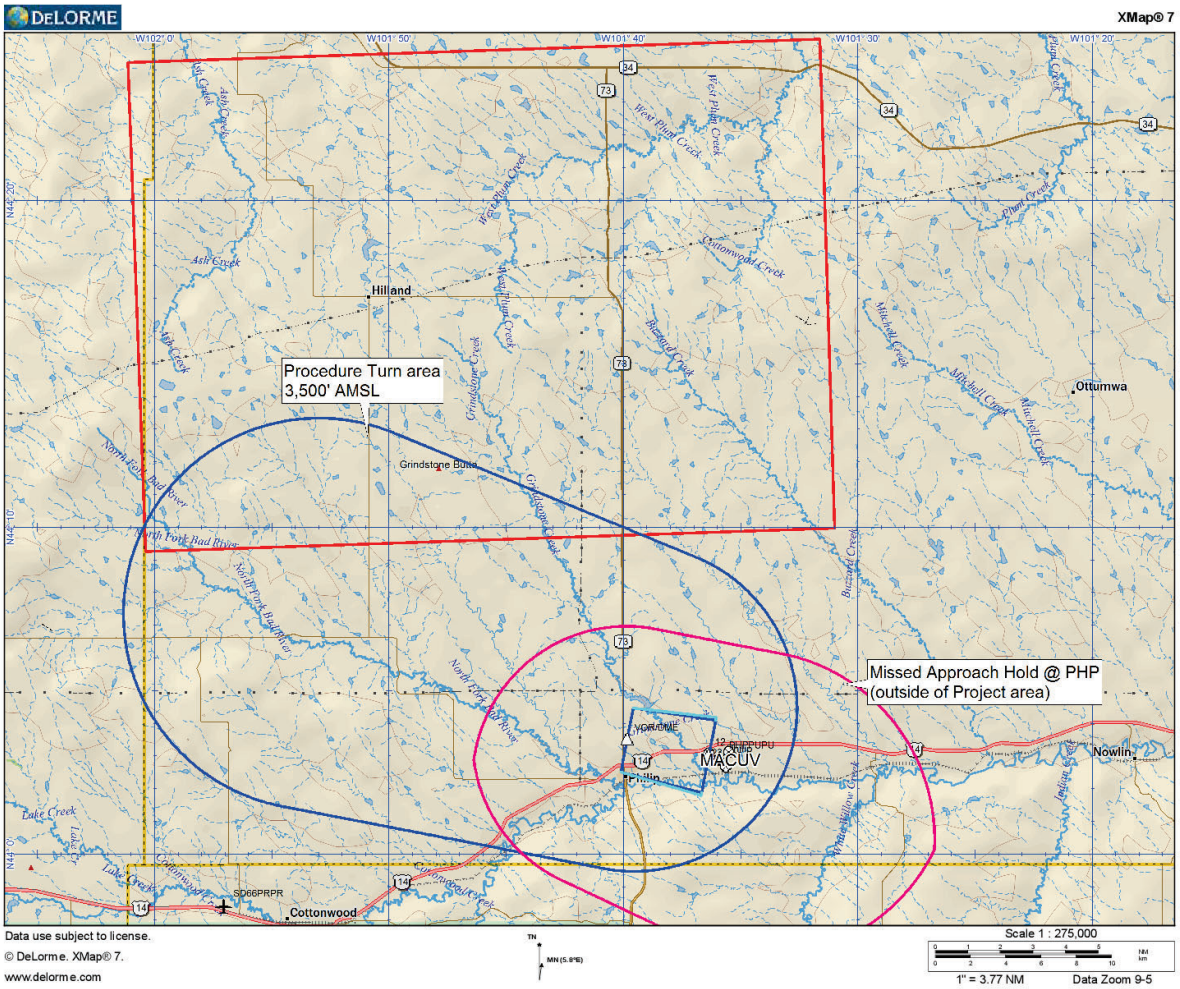

Figure 9: PHP VOR-A

Minimum Safe Altitude

Minimum Safe Altitude (MSA) on VOR-A approach into PHP overlies the Project area and has a limit below the Target Height. However, following FAA further study, MSAs should not have an impact as they are not considered a factor in determining adverse effect (See Figure 10).

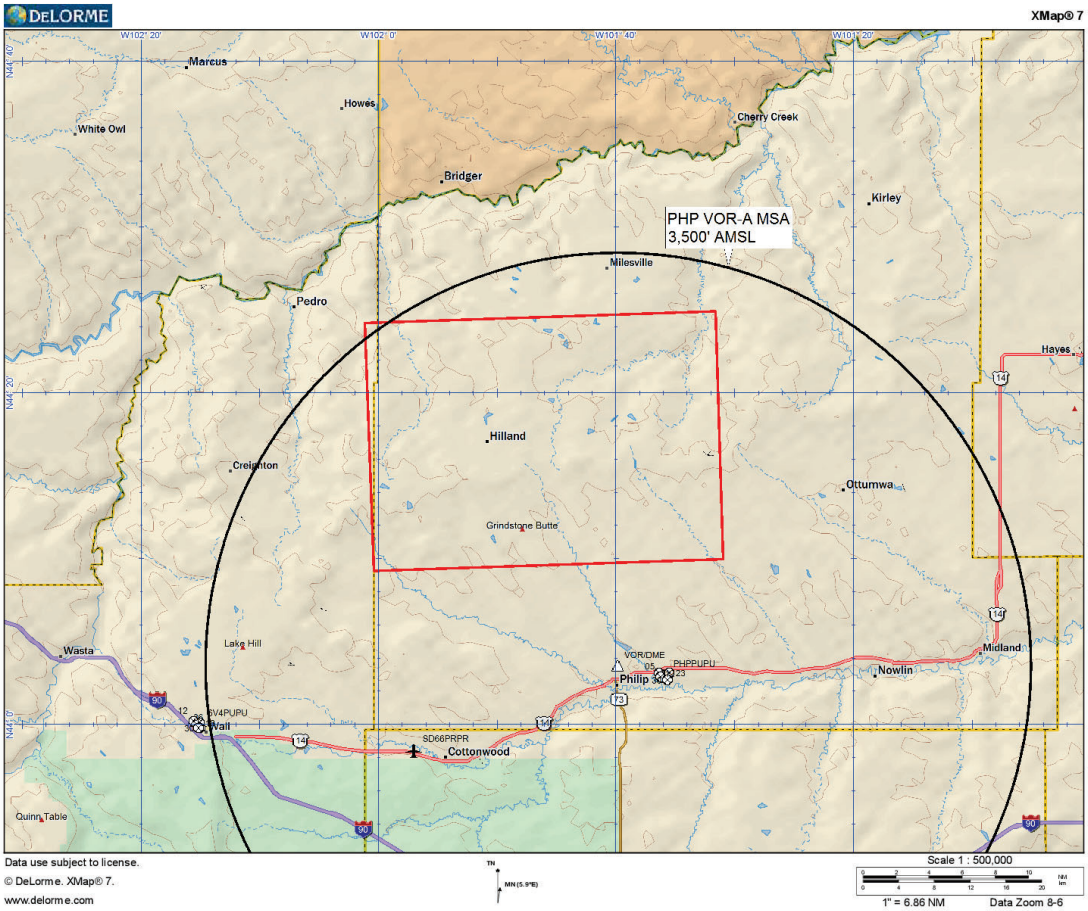

Figure 10: PHP VOR-A MSA

Approach Circling Areas

IAPs may include Approach Circling Minimums, however, the Project is outside any Approach Circling Areas.

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. IFR Departures from PHP RWY 30 have been depicted to an altitude of 3,600 feet AMSL. According to ASI topography, ground elevation does not exceed 2,613 feet AMSL beneath this 40:1 departure slope, therefore, IFR departures will not impact the Project (See Figure 11).

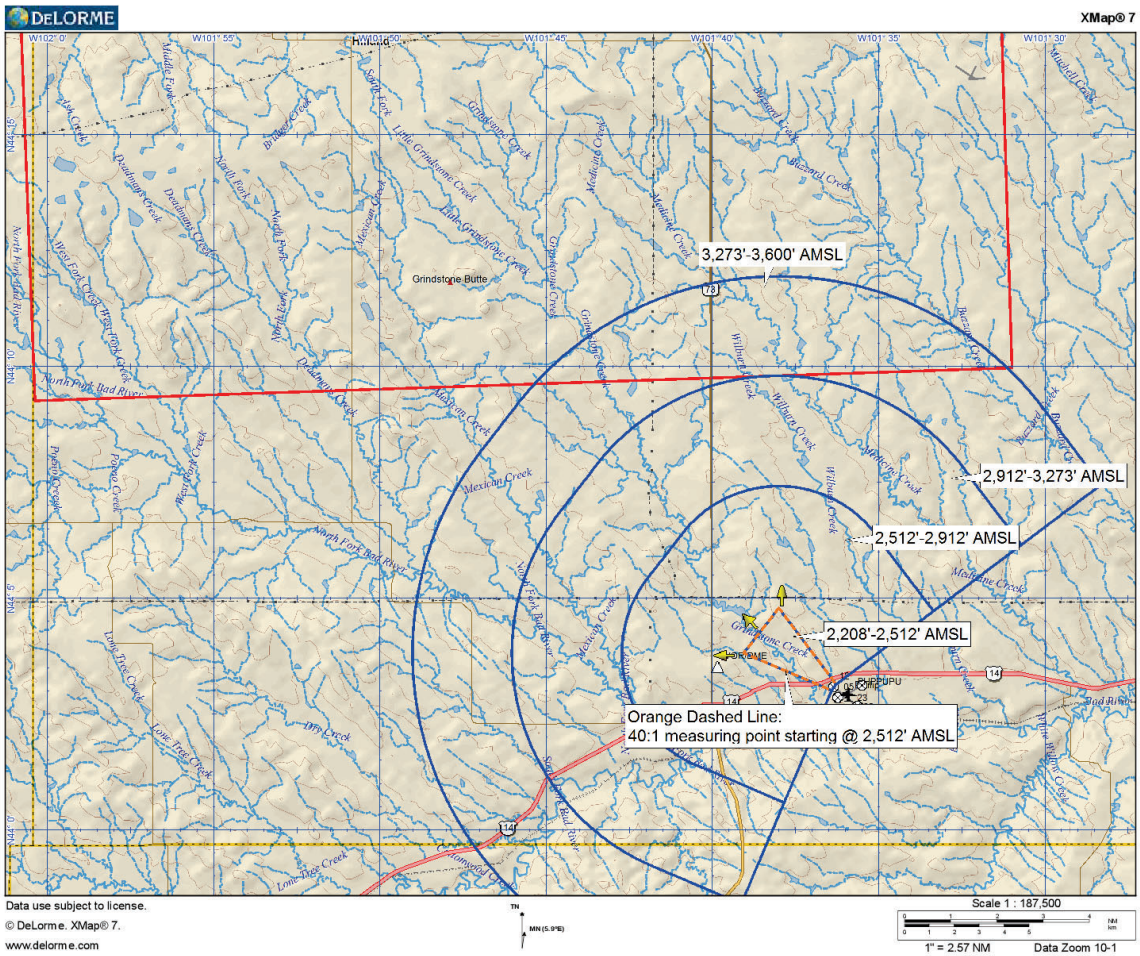

Figure 11: PHP IFR Departures

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 12).

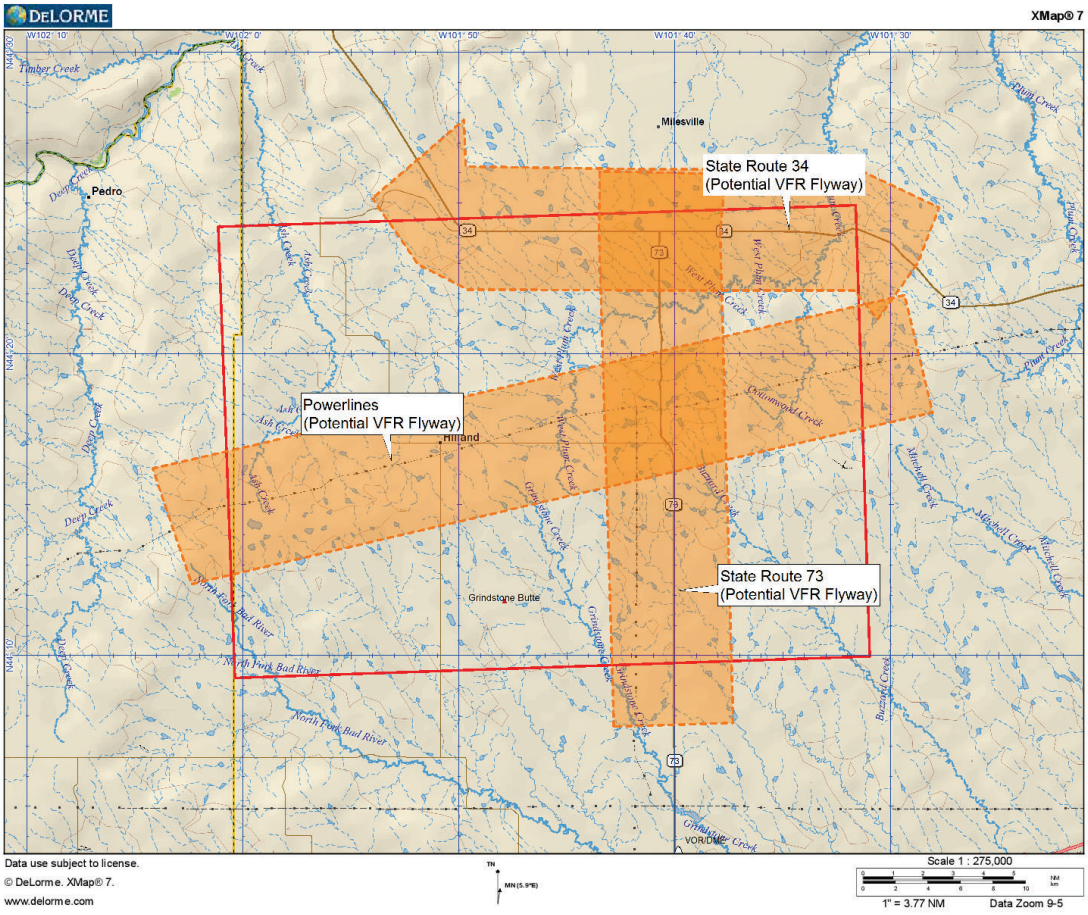

Figure 12: Potential VFR Flyways 2X2SM Wide

Philip VOR/DME

Philip VOR/DME is located approximately 6.25 NM south of the Project boundary. WTGs sighted within eight NM of the VOR/DME will require FAA further study to determine what impact (if any) the structures may have on the VOR/DME's signal. If the FAA determines the Project has an adverse effect on the VOR/DME signal, 660-foot WTGs may not be approvable (See Figure 13).

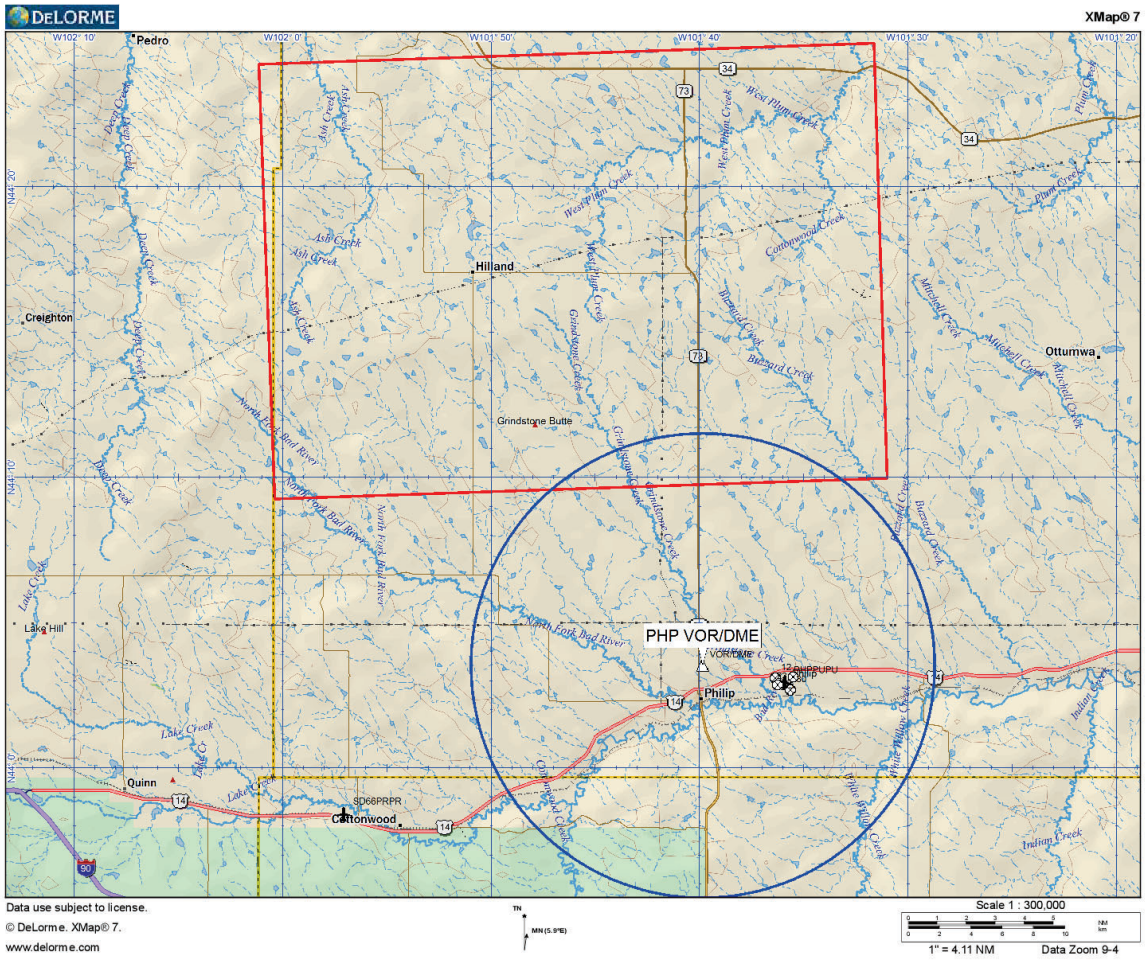

Figure 13: PHP VOR/DME

Vertical Findings

Mapping and analysis of the relevant and material aviation factors of the WTG's airspace environment indicates the following vertical AMSL limits of each Project Sector (See Table 3 and attached Figure 14). Table 4 indicates ground elevations at which 660-foot WTGs can be built.

Table 3: Vertical Limits

SECTOR	LIMIT (ft AMSL)	CAUSAL FACTOR
A	3,273-3,600	PHP RWY 30 IFR Departures
B	3,500	PHP RNAV (GPS) RWYs 12 & 30 and VOR-A approach segments
C	3,600	Target Height

Table 4: Maximum Ground Elevation to Build

SECTOR	660-foot WTG LIMIT (ft AMSL)
*A	2,613-2,940
*B	2,840
C	2,940

*According to ASI topography,

- Ground elevation does not exceed 2,613 feet AMSL beneath Sector A or 2,840 feet AMSL beneath Sector B, therefore, 660-foot WTGs should be approvable without impact.

Conclusion

The results of this analysis indicate that an FAA aeronautical study will likely identify the following airspace impacts resulting from the proposed 660-foot AGL WTGs:

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

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

- **Enroute Airways**: There are no Victor Airways overlying the Project area, hence, Enroute Airways will not have an impact (See Figure 2).

- **Minimum Vectoring Altitude Sectors**: There are no MVA Sectors overlying the Project area, hence, MVAs will not have an impact.

- **Radar Line of Sight:** The Project may be in the LoS of FAA/DoD radar. An in-depth radar impact study after filing could be required (See Table 2 and Figures 3-5).

- **Military Airspace and Training Routes:** Military Operations such as MOAs, Restricted Airspace, or MTRs will not impact the Project (See Figure 7).

- **Instrument Approach Procedures:** The RNAV (GPS) RWYs 12 & 30 and VOR-A approaches into PHP overlie the Project in Initial/ Intermediate Approach, TAA, Initial/ Missed Approach Hold, and Procedure Turn segments. Ground elevation does not exceed 2,840 feet AMSL (according to ASI topography) beneath any of these segments, therefore, IAPs will not impact the Project (See Figures 8 & 9).

- **Minimum Safe Altitude:** MSAs from the VOR-A approach into PHP overlies the Project area and has an OCS below the Target Height. However, following FAA further study, MSAs should not have an impact as they are not considered a factor in determining adverse effect (See Figure 10).

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

- **Instrument Departures:** IFR Departures from PHP RWY 30 have been depicted to an altitude of 3,600 feet AMSL and overlie areas towards the southeast boundary of the Project. However, ground elevation does not exceed 2,613 feet AMSL beneath this 40:1 slope, therefore IFR Departures will not have an impact (See Figure 11).

- **VFR Flyways:** The Project has several 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 12).

- **Philip VOR/DME:** WTGs sighted within eight NM of the VOR/DME will require FAA further study to determine what impact (if any) the structures may have on the VOR/DME's signal (See Figure 13).

    - 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.

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.