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June 28, 2023

VIA E-MAIL AND FEDERAL EXPRESS

Mr. Steven Kahl
Executive Secretary
North Dakota Public Service Commission
600 E. Boulevard, Dept. 408
Bismarck, ND 58505-0480

Re: Otter Tail Power Company
Amend – Ashtabula I Wind Energy Facility Upgrade Project
Siting Application – Barnes County
Case No. PU-23- __

Dear Mr. Kahl:

Otter Tail Power Company (Otter Tail) plans to upgrade the Ashtabula I Wind Energy Facility (Upgrade Project) located in Barnes County, North Dakota. In support of the Upgrade Project, enclosed for filing in the above-referenced case are an original and six (6) copies of the following documents:

1. Certification of Timothy J. Rogelstad with accompanying:

    a. Exhibit A – Environmental and Regulatory Compliance Memorandum, with associated Figures and the following appendices:

        i. Appendix A – Acoustic Assessment Results and Sound Waivers;
        ii. Appendix B – Shadow Flicker Assessment Results;
        iii. Appendix C – FAA Filings;
        iv. Appendix D – Microwave Beam Path Study;
        v. Appendix E – Class I Literature Review – Cultural Resource Report and Unanticipated Discoveries Plan (PUBLIC); and
        vi. Appendix F – IPaC Resource List.

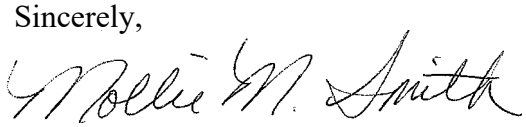
2. Application to Amend Orders and Certificates.

A filing fee check in the amount of $25,000 is also enclosed. An unredacted, NON-PUBLIC version of the Class I Literature Review – Cultural Resource Report and Unanticipated Discoveries Plan (the above-referenced Appendix E) and associated GIS data will be provided under separate cover with an Application for Protection of Information.

Fredrikson

Electronic copies of the enclosed documents and this letter were filed with the Commission today via e-mail. If you have any questions, please let me know.

Sincerely,



MOLLIE M. SMITH

MMS/79416050
Enclosures

cc: Lisa McFarland (w/ enclosures, via e-mail)
Bryce Haugen (w/ enclosures, via e-mail)

STATE OF NORTH DAKOTA

PUBLIC SERVICE COMMISSION

Otter Tail Power Company **Case No. PU-23-__**
Amend – Ashtabula I Wind Energy Facility Upgrade Project
Siting Application – Barnes County

CERTIFICATION OF TIMOTHY J. ROGELSTAD

STATE OF MINNESOTA)
) ss.
COUNTY OF OTTER TAIL)

Timothy J. Rogelstad, being first duly sworn upon oath, states and alleges as follows:

1. I am the President of Otter Tail Power Company (Otter Tail), which owns the Ashtabula I Wind Energy Facility (Facility) in Barnes County, North Dakota. I have the authority to bind Otter Tail with respect to the certifications made herein.

2. I provide this Certification pursuant to N.D.C.C. § 49-22-03(3)(a)(4).

3. Otter Tail plans to make equipment upgrades at the Facility, which involves replacing certain turbine technology (Upgrade Project).

4. The Upgrade Project will consist of removing and replacing the existing General Electric (GE) 1.5 megawatt (MW) turbine generator technology and 77 meter (252.6 feet) rotor diameter (RD) blades, hub, and gearbox with an upgraded technology package of GE 1.6 MW generator technology and 91 meter (298.6 feet) RD blades, hub, and gearbox. All 32 of the turbines will reuse the existing 80 meter (262.5 feet) structural steel towers and existing nacelles. As a result, the Upgrade Project will not affect the layout, which will remain as depicted in the as-built maps previously filed with the Commission.[1]

[1] *See* Docket Item #352 in Case No. PU-08-32.

5. Due to the increased blade length, the overall turbine height will increase from 118.5 meters (388.8 feet) to 125.5 meters (411.8 feet).

6. The Facility's total nameplate generating capacity would increase to 51.2 MW; however, the Facility's output would remain 48 MW in accordance with Otter Tail's Generator Interconnection Agreement.

7. Otter Tail plans to use the existing turbine foundations (with reinforcement, if needed), collection and communications systems, and permanent access roads. Other associated facilities will remain unchanged.

8. During installation of the upgraded equipment, existing access roads will be temporarily widened to accommodate delivery and staging of components and equipment. Temporary crane paths may also be needed to facilitate equipment removal and installation. A temporary laydown yard will also be used during installation. All activities are expected to occur within areas previously disturbed by initial construction.

9. The Upgrade Project activities are wholly within the site designated by the Commission for the Facility in its May 30, 2008 Findings of Fact, Conclusions of Law and Order (Case No. PU-08-32) (2008 Order), and are to improve the same type of facility for which Certificate of Site Compatibility No. 10 was issued.[2] *See* N.D.C.C. §§ 49-22-03(3)(a)(1), (3) and (4)(b).

10. Otter Tail has conducted an environmental and regulatory compliance analysis for the Upgrade Project, and an associated report prepared by its environmental consultant, Atwell, LLC (Atwell), is provided as **Exhibit A**. As set forth in **Exhibit A**:

[2] On July 2, 2008, the Commission issued a Certificate of Public Convenience and Necessity (CPCN) to Otter Tail for the Facility (Case No. PU-08-200). On April 13, 2009, the Commission issued an Order Granting Partial Certificate Transfer, authorizing the transfer of the 48 MW Facility to Otter Tail, and issuing Certificate of Site Compatibility No. 10 to Otter Tail for the 48 MW Facility (Case No. PU-09-53).

a. **Cultural Resources.** The Upgrade Project construction activities will occur primarily within areas previously surveyed for cultural resources, and all construction activities will occur within areas previously disturbed by initial Facility construction. Based on recommendations made by the State Historical Society of North Dakota (SHSND) for Otter Tail's Langdon Wind Energy Center Upgrade Project (Langdon Upgrade Project), if any Upgrade Project crane paths are located outside of areas previously surveyed for cultural resources, Otter Tail will complete cultural resource field surveys and will avoid any resources identified that are eligible or unevaluated for listing on the National Register of Historic Places (NRHP). Therefore, no cultural resources will be affected by the Upgrade Project.

b. **Architectural Resources.** Although not recommended at the time the Facility was originally permitted and constructed, based on communications with SHSND for the Langdon Upgrade Project, consideration is being given to the completion of an architectural history survey in the vicinity of wind energy generation facilities to identify architectural resources potentially eligible for NRHP-listing and to evaluate potential impact to those resources. Since the Upgrade Project involves technology upgrades to existing turbines, it is not anticipated that the limited modifications will adversely affect architectural history resources. However, in the event of an adverse impact, Otter Tail will coordinate with SHSND to identify appropriate mitigation, as needed.

c. **Wetlands.** Wetlands and waterbodies have been identified within the Upgrade Project Area. No permanent wetland impacts will occur as a result of Upgrade Project activities.

d. **Sound.** At Atwell's direction, Epsilon Associates, Inc. (Epsilon) completed a sound analysis for the Upgrade Project with the proposed upgraded technology. At the

time the Facility was permitted, the Commission did not have a sound standard for wind energy facilities. The Commission's current sound level requirement is 45 dBA or less within 100 feet of occupied residences and community buildings. With the upgraded equipment, sound levels within 100 feet of five occupied residences were modeled above 45 dBA, while sound levels were at or below 45 dBA within 100 feet of the remaining residences (no community buildings are present). Otter Tail has obtained sound waivers from the owners of three of the residences modeled above the 45 dBA requirement. With respect to the remaining two residences, Otter Tail is pursuing waivers. Additionally, Otter Tail has confirmed that the Upgrade Project is able to comply with the Commission's sound requirement at those two residences by installing noise-reduction technology, such as noise-reducing operation modes (NRO) and/or low noise trailing edge (LNTE) blades at up to eight turbines (as needed).

e. **Shadow Flicker.** Epsilon completed a shadow flicker assessment for the Upgrade Project with the proposed upgraded technology. The Commission does not have a shadow flicker standard, and shadow flicker was not addressed in the Commission's 2008 Order. The shadow flicker assessment demonstrates that shadow flicker levels are not anticipated to exceed 30 hours per year at any occupied residence.

f. **Exclusion and Avoidance Areas.** Otter Tail has analyzed the Upgrade Project's compliance with the Commission's current exclusion area and avoidance area criteria. With the exception of four turbines that are within the non-participating property line exclusion area, and one turbine that is within the county roadway exclusion area, the Upgrade Project complies with all exclusion areas. Otter Tail has identified the owners of the properties at issue and is pursuing waivers. With respect to the county roadway, Otter Tail plans to obtain approval from Barnes County. Otter Tail requests that the Commission

grant a variance conditioned upon submission of the landowner waivers and Barnes County approval. If any landowner is not willing to grant a waiver, or if Barnes County is not willing to grant approval, Otter Tail will not upgrade equipment at the affected turbine. Accordingly, the Upgrade Project will comply with all current exclusion area and avoidance area criteria, and construction activities associated with the Upgrade Project will not affect any known exclusion or avoidance areas within the designated site. *See* N.D.C.C. §§ 49-22-03(3)(a)(2) and (4)(a).

11. The Facility will continue to comply with all requirements set forth in the Commission's Orders regarding the Facility, including applicable laws and rules designating the site. *See* N.D.C.C. §§ 49-22-03(3)(a)(1) and (4)(c).

FURTHER AFFIANT SAYETH NOT.

Timothy J. Rogelstad

Subscribed and sworn to before me
this 27th day of June 2023.

Notary Public

79417279 v4

SETHRENA NOREEN SIMON
Notary Public-Minnesota
My Commission Expires Jan. 31, 2028

Exhibit A

Environmental and Regulatory Compliance Memorandum
Amend – Ashtabula I Wind Energy Facility Upgrade Project
Case No. PU-23-____

Introduction

Otter Tail Power Company (Otter Tail) has retained Atwell, LLC (Atwell) to prepare this memorandum to support Otter Tail's certification of compliance with N.D.C.C. § 49-22-03(3)(a) in connection with equipment upgrading activities (Upgrade Project) for its 48-megawatt (MW) Ashtabula I Wind Energy Facility (Facility). Otter Tail, with assistance from Atwell, analyzed the Upgrade Project with respect to environmental, cultural, and natural resources, as well as sound and shadow flicker. The following sections and referenced figures and appendices summarize the results of the analysis.

Description of the Upgrade Project

The Upgrade Project involves replacing the current General Electric (GE) 1.5 MW turbine technology with updated technology. More specifically, the Upgrade Project will consist of removing and replacing the existing GE 1.5 MW generator technology, 77-meter (252.6 feet) rotor diameter (RD) blades, hub, and gearbox with a new equipment upgrade package of GE 1.6 MW generator technology and 91 meter (298.6 feet) RD blades, hub, and gearbox. All 32 existing 80 meter (262.5 feet) structural steel towers will be used as well as existing nacelles and, as a result, turbine locations will not change. Otter Tail plans to use the existing turbine foundations (with reinforcement, if needed), collection/communications systems, and permanent access roads. Other associated facilities will remain unchanged.

Once removed, the existing 77-meter RD blades will be cut on-site to fit into legal load transportation-size pieces. Loads will be secured and/or covered or other steps will be taken to ensure materials do not escape during transport. Otter Tail's contractor will transport the loads to an out-of-state facility that will grind the blade materials for repurposing, and no blades will be deposited in a landfill.

During installation of the equipment upgrade technology, existing access roads will be temporarily widened to accommodate delivery of components and equipment. Temporary crane paths may also be needed to facilitate equipment removal and installation. A temporary laydown yard will also be used during installation. Otter Tail currently plans to install the equipment upgrade technology in mid-2025.

Figure 1 depicts the Upgrade Project Area and layout. Figure 2 depicts the proposed turbine technology.

Compliance with Exclusion and Avoidance Areas

Exclusion Areas

Per N.D.A.C. §§ 69-06-08-01(1) and (2), the geographical areas listed in Table 1 shall be excluded in the consideration of a site for an energy conversion facility. Based on the Commission's approach in prior equipment upgrade dockets, Otter Tail confirmed the Upgrade Project's compliance with the Commission's current exclusion area criteria. With the exception of four turbines that are within the non-participating property line exclusion area, and one turbine that is within the county roadway exclusion area, the Upgrade Project complies with all exclusion areas. Otter Tail identified the owners of the non-participating properties at issue and is pursuing waivers. With respect to the county roadway, Otter Tail plans to obtain approval from Barnes County. Otter Tail requests that the Commission grant a variance conditioned upon submission of the landowner waivers and Barnes County approval. If any landowner is not willing to grant a waiver, or if Barnes County is not willing to grant approval, Otter Tail will not upgrade equipment at the affected turbine. Exclusion areas are mapped for the Upgrade Project Area on Figure 3.

Table 1: Summary of Exclusion Areas

General Exclusion Area	Present Within Upgrade Project Area?	Description
Designated or registered national: parks; memorial parks; historic sites and landmarks; natural landmarks; historic districts; monuments; wilderness areas; wildlife areas; wild, scenic, or recreational rivers; wildlife refuges; and grasslands.	None	United States Fish and Wildlife Service (USFWS) administered Waterfowl Production Areas (WPA) are located in the vicinity of the Upgrade Project Area. A minimum 0.25-mile buffer was and continues to be maintained from each WPA.
Designated or registered state: parks; forests; forest management lands; historic sites; monuments; historical markers; archaeological sites; grasslands; wild, scenic, or recreational rivers; game refuges; game management areas; management areas; and nature preserves.	None	N/A
County parks and recreational areas; municipal parks; parks owned or administered by other governmental subdivisions; hardwood draws; and enrolled woodlands.	None	N/A
Areas critical to the life stages of threatened or endangered animal or plant species.	None	N/A

Table 1: Summary of Exclusion Areas		
General Exclusion Area	**Present Within Upgrade Project Area?**	**Description**
Areas where animal or plant species that are unique or rare to this state would be irreversibly damaged.	None	N/A
Areas within 1,200 feet of the geographic center of an intercontinental ballistic missile (ICBM) launch or launch control facility.	None	N/A
Areas within thirty feet [9.14 meters] on either side of a direct line between an intercontinental ballistic missile (ICBM) launch facility and a missile alert or launch control facilities to avoid microwave interference. This restriction only applies to aboveground structures, not to surface features, such as roads, or belowground infrastructure.	None	N/A
Additional Exclusion Areas for Wind Energy Conversion Facilities – Areas within:		
1.1x the turbine height from the nearest edge of an interstate or state roadway right-of-way (ROW).	None	N/A
1.1x the turbine height plus 75 feet from the centerline of any county or maintained township roadway.	Present	One turbine is located within the exclusion area for a county roadway. Otter Tail plans to obtain approval from Barnes County, and requests a variance from the Commission conditioned on providing a copy of the County approval.
1.1x the turbine height from the nearest edge of railroad ROW.	None	N/A
1.1x the turbine height from the neared edge of a 115 kV or higher transmission line ROW.	Present	No turbines will be located within this exclusion area.

Table 1: Summary of Exclusion Areas		
General Exclusion Area	**Present Within Upgrade Project Area?**	**Description**
1.1x the turbine height from the property line of a non-participating landowner and 3x the height of the turbine from an inhabited rural residence of a non-participating landowner, unless a variance is granted. A variance may be granted if an authorized representative or agent of the permittee, the nonparticipating landowner, and affected parties with associated wind rights file a written agreement expressing all parties' support for a variance to reduce the setback requirement in this subsection. A nonparticipating landowner is a landowner that has not signed a wind option or an easement agreement with the permittee of the wind energy conversion facility as defined in NDCC Chapter 17-04.	Present	Four turbines would be located within the non-participating property line exclusion area with the equipment upgrade technology. Otter Tail is in the process of obtaining waivers from the landowner(s) to support issuance of variances. No turbines will be located within 3x the height of the upgraded turbines from a non-participating inhabited residence.

Avoidance Areas

Per N.D.A.C. §§ 69-06-08-01(3) and (4), the geographical areas listed in Table 2 may not be approved as a site for an energy conversion facility unless the applicant shows that under the circumstances there is no reasonable alternative or (in the case of the sound limit) a waiver has been obtained. Based on the Commission's approach in prior equipment upgrade dockets, Otter Tail confirmed the Upgrade Project's compliance with the Commission's current avoidance area criteria.

Table 2: Summary of Avoidance Areas		
Avoidance Area	**Present Within Upgrade Project Area?**	**Description**
Historical resources which are not designated as exclusion areas.	None	No impacts to historical resources are anticipated. An Unanticipated Discoveries Plan has been prepared for the Upgrade Project. A copy of that plan is provided as Appendix E.
Areas within the city limits of a city or the boundaries of a military installation.	None	N/A

Table 2: Summary of Avoidance Areas		
Avoidance Area	**Present Within Upgrade Project Area?**	**Description**
Areas within known floodplains as defined by the geographical boundaries of the hundred-year flood.	None	N/A
Areas that are geologically unstable.	None	N/A
Woodlands and wetlands.	Present	No wetlands or woodlands will be impacted by the Upgrade Project.
Areas of recreational significance which are not designated as exclusion areas.	None	N/A
A geographic area where, due to the operation of the facility, the sound levels within one hundred feet on an inhabited residence or community building will exceed forty-five dBA. The sound level avoidance area criteria may be waived in writing by the owner of the occupied residence or the community building.	Present	Five residences were initially modeled to have sound levels in excess of the Commission's sound standard with the Upgrade Project. Otter Tail has sound waivers from the owners of three of the residences, and is pursuing waivers from the owners of the other two residences. Additionally, Otter Tail has confirmed that the Commission's sound standard can be met at those two residences by installing noise-reduction technology. As such, Otter Tail will comply with the Commission's sound standard.

Setback Compliance

In addition to compliance with the setbacks set forth above, the Upgrade Project continues to comply with the setback commitments listed in Table 3, which were made at the time a Certificate of Site Compatibility was issued for the Ashtabula I Wind Energy Facility.

Table 3: Setback Distances for Wind Turbines	
Setback Type	**Distance**
USFWS WPA	0.25 miles
Occupied Residence	1,400 feet
Existing transmission lines, roads and railroads	420 feet
Property Boundary	130 feet

Socioeconomics

The Upgrade Project will have positive impacts on socioeconomics by extending the life of the Facility, which, in turn, extends the time period for which landowners will receive easement payments. In addition, the Upgrade Project will create temporary construction jobs, with associated opportunities for increased local spending.

Land Use

The Upgrade Project will be constructed entirely within the previously-designated site, and turbine and other permanent infrastructure locations will remain the same. As a result, land use will also remain unchanged. The Upgrade Project will result in temporary disturbances, including temporary widening of access roads to accommodate transportation of components and equipment, a temporary laydown yard, and temporary crane paths (as needed). Temporarily impacted areas will be restored in compliance with applicable provisions of the Commission's Findings of Fact, Conclusions of Law and Order, dated May 30, 2008 (Case No. PU-08-32) (2008 Order).

Public Services

The Upgrade Project will result in a temporary increase in traffic in and near the Upgrade Project Area, but is not anticipated to interfere with local road use. Otter Tail will coordinate with Barnes County and the townships, as appropriate, regarding local road use, will obtain all necessary road use permits, and will restore roads impacted by the Upgrade Project in accordance with the requirements of the Commission's 2008 Order and as required by Barnes County and the townships.

Sound, Shadow Flicker, and Human Health and Safety

As noted above, the Upgrade Project continues to maintain a turbine setback of 1,400 feet from occupied residences. Based on an initial sound analysis, sound levels within 100 feet of five occupied residences were modeled above 45 dBA with the Upgrade Project. Otter Tail has obtained sound waivers from the owners of three of the residences. With respect to the remaining two residences, Otter Tail is pursuing waivers. Additionally, Otter Tail has confirmed that the Upgrade Project is able to comply with the Commission's sound requirement by installing noise-reduction technology, such as noise-reducing operation modes (NRO) and/or low noise trailing edge (LNTE) blades at up to eight turbines (as needed). Copies of noise waivers obtained to-date are provided in Appendix A. A copy of the sound study report completed for the Upgrade Project (using GE 1.6 MW turbines with 91 meter RD and noise-reduction technology) is also provided in Appendix A. [1]

[1] At the time the sound modeling was conducted, Otter Tail had not yet confirmed the participation status of one of the five residences, which was conservatively identified as non-participating. As a result, only two waivers are listed in the report and noise-reduction technology was modeled to ensure compliance without a waiver at three residences. Otter Tail has since confirmed the residence at issue is participating, and Otter Tail has a sound waiver for the residence.

At the time the Facility was permitted, the Commission did not specifically address shadow flicker. However, Otter Tail conducted a shadow flicker assessment for the Upgrade Project utilizing realistic modeling inputs. Based on the assessment, shadow flicker levels from the Upgrade Project will not exceed 30 hours per year at any occupied residences (Appendix B).

Otter Tail has submitted form 7460-1 to the Federal Aviation Administration (FAA) for each turbine (*see* Appendix C). Otter Tail will obtain Determinations of No Hazard from the FAA and will provide copies to the Commission prior to construction.

Comsearch completed a microwave study for the Upgrade Project. Based on the analysis, Comsearch found that none of the turbines would obstruct microwave beam paths in the area with the upgraded equipment (Appendix D). The microwave study was conducted using turbines with a 97 meter RD, but the conclusions of the study are also applicable to turbines with a 91 meter RD.

The Upgrade Project will continue to comply with all safety-related and other conditions of the Commission's 2008 Order.

Cultural and Architectural Resources

In February of 2023, staff from Atwell conducted background research at the State Historical Society of North Dakota (SHSND) for information on previously identified archaeological sites and architectural properties within one mile (1.6 km) of the Upgrade Project Area and on surveys previously conducted within the Upgrade Project Area (Appendix E – Class I Literature Review).

The Upgrade Project construction activities will occur primarily within areas previously surveyed for cultural resources, and all construction activities will occur within areas previously disturbed by initial Facility construction. Based on recommendations made by the SHSND regarding Otter Tail's Langdon Wind Energy Center Upgrade Project (Langdon Upgrade Project), if any Upgrade Project crane paths are located outside of areas previously surveyed for cultural resources, Otter Tail will complete cultural resource field surveys and will avoid any resources identified that are eligible or unevaluated for listing on the National Register of Historic Places (NRHP). Additionally, Otter Tail has prepared an Unanticipated Discoveries Plan, which will be implemented during Upgrade Project construction (*see* Appendix E).

Although not recommended at the time the Facility was originally permitted and constructed, based on communications with SHSND regarding the Langdon Upgrade Project, consideration is being given to the completion of an architectural history survey in the vicinity of wind energy generation facilities to identify architectural resources potentially eligible for NRHP-listing and to evaluate potential impact to those resources. Since the Upgrade Project involves technology upgrades to existing turbines, it is not anticipated that the limited modifications will adversely affect architectural history resources. However, in the event of an adverse impact, Otter Tail will coordinate with SHSND to identify appropriate mitigation, as needed.

The Class I Literature Review, which includes the Unanticipated Discoveries Plan, has been submitted to the SHSND for review.

Recreational Resources

The Upgrade Project will not impact any recreational resources. The Upgrade Project continues to maintain a setback of at least 0.25 miles from nearby WPAs.

Land-Based Economics

The Upgrade Project will not result in any additional long-term land impact; as a result, the Upgrade Project will also not result in any long-term impacts to agricultural use or production. Otter Tail will compensate landowners for any temporary impacts to cropland in accordance with the terms of its wind lease agreements, as applicable.

Soils

Upgrade Project construction may result in minor short-term impacts to soils within the disturbance area. During construction, short-term impacts may include soil compaction, vegetation clearing, and the potential for localized soil erosion and sedimentation. No other impacts are anticipated. Measures to control erosion will be implemented during Upgrade Project construction to avoid or minimize soil erosion. Erosion and sedimentation will be reduced by implementation of best management practices (BMPs) such as mulching, hydroseeding, wildlife-friendly erosion control blankets, silt fence installation, matting, and revegetation, as appropriate. Once construction is completed, soils will be revegetated in accordance with Natural Resources Conservation Service requirements (unless otherwise specified by the landowner and approved by the Commission). No adverse impacts to soil resources are expected as a result of the Upgrade Project.

Geologic and Groundwater Resources

The Upgrade Project is not expected to disturb any geologic or groundwater resources.

Waterbodies, Wetlands, and Floodplain Resources

Previously, a wetland delineation survey was conducted within the Facility boundary in 2008 (TetraTech EC, INC. 2008). The wetland delineation was performed in accordance with the *1987 U.S. Army Corps of Engineers Wetland Delineation Manual* (USACE 1987). The report did not identify any temporary or permanent impacts to wetlands within the Project Area. The Upgrade Project will remain within the areas previously disturbed by initial Facility construction, and no temporary or permanent impacts wetlands or waterbodies are anticipated.

The Upgrade Project is located outside of Federal Emergency Management Agency (FEMA) mapped floodplains. As a result, the Upgrade Project will not impact floodplains.

Vegetation

No trees or shrubs will be removed in connection with the Upgrade Project. Otter Tail will comply with the site restoration and reseeding conditions in the Commission's 2008 Order and all other applicable permitting requirements.

Wildlife

Impacts to wildlife are expected to be minimal as the proposed construction disturbance areas were previously disturbed and are of low-quality habitat. If construction activities are planned during the springtime, ground nesting bird clearance surveys in uncultivated areas will be conducted, as applicable, prior to construction.

The USFWS Information for Planning and Consultation (IPaC) system was reviewed for a list of threatened, endangered, and candidate species that could occur within or near the Upgrade Project Area. The northern long-eared bat, Dakota Skipper, and monarch butterfly have the potential to occur in Barnes County. According to the USFWS IPaC system, no Designated Critical Habitat is present in the Upgrade Project Area. The existing turbines were built in open terrain outside of forested areas and riparian corridors. Additionally, Upgrade Project construction activities will be confined to previously disturbed areas, and no tree removal is anticipated. As a result, no impacts to these species are anticipated.

The Upgrade Project is not anticipated to have any measurable change in impact on migrating birds or bats. Impacts are expected to be similar to other operating wind projects in the area. Otter Tail will develop a Wildlife Conservation Strategy for the Facility, which will outline BMPs that are to be undertaken for the life of the Facility to minimize risks to birds, bats, and other wildlife from operation of the wind energy facility.

An IPaC Resource List is provided in Appendix F.

Conclusion

Table 4 below summarizes Otter Tail's environmental and regulatory analysis of the Upgrade Project. As indicated in Table 4 and the prior sections, the Upgrade Project complies with the requirements of N.D.C.C. § 49-22-03(3)(a), including the Commission's current exclusion area and avoidance area criteria. Additionally, the Upgrade Project will continue to comply with all applicable siting laws, rules, and Commission orders, including the conditions specified in the Commission's 2008 Order.

Summary Table

Table 4: Summary of Environmental Resource Impact Analysis and Avoidance/Minimization Measures		
Resource	**Potential Impact of Upgrade Project**	**Avoidance and/or Minimization Measures**
Socioeconomics	Positive economic and social impacts.	None proposed.
Land Use	Temporary disturbances only; will utilize previously disturbed areas.	Will restore temporarily impacted areas in compliance with applicable provisions of the Commission's 2008 Order.
Public Services	A temporary increase in traffic due to construction will occur.	Will coordinate with Barnes County and applicable townships regarding local road use, obtain all necessary road use permits, and restore roads impacted by the Upgrade Project in accordance with the requirements of the Commission's 2008 Order and as required by Barnes County and the townships.
Human Health and Safety	Turbine lighting will continue to meet FAA and Commission requirements. Shadow flicker is predicted to be 30 hours per year or less at all occupied residences.	None proposed.
Sound	Initial modeling analysis determined that the sound may exceed 45 dBA within 100 feet of five occupied residences. Modeling was conducted with NRO and/or LNTE added to up to eight turbines.	Otter Tail has obtained sound waivers from the owners of three residences with sound levels in excess of the sound limit. Otter Tail is pursuing waivers from the remaining two residences. Additionally, Otter Tail has confirmed that the Commission's sound requirement can be met at those two residences by installing noise-reduction technology. Accordingly, the Upgrade Project will comply

Table 4: Summary of Environmental Resource Impact Analysis and Avoidance/Minimization Measures		
Resource	**Potential Impact of Upgrade Project**	**Avoidance and/or Minimization Measures**
		with the current sound regulations.
Cultural/Architectural History Resources	Upgrade Project activities will occur within areas previously surveyed for cultural resources and/or in areas previously disturbed by initial Facility construction. The Upgrade Project is not anticipated to impact cultural or architectural history resources.	Prepared an Unanticipated Discoveries Plan.
Recreational Resources	No impacts to recreational resources are anticipated.	Will continue to maintain a setback of 0.25 miles from nearby WPAs.
Land Based Economics	Minimal cropland will be temporarily impacted during construction. No additional long-term impacts to agricultural use or production are anticipated.	Will compensate landowners for any temporary impacts to cropland in accordance with the terms of its wind lease agreements, as applicable.
Soils	Temporary land disturbance may cause soil surface to become more prone to wind and water erosion.	Will implement Best Management Practices (BMPs) to minimize erosion and sedimentation and will restore temporarily impacted areas.
Geologic and Groundwater Resources	No impacts to geological and groundwater resources are anticipated.	None proposed.
Waterbodies, Wetlands, and Floodplain Resources	No impacts are anticipated.	Will implement BMPs to minimize erosion and sedimentation.

Table 4: Summary of Environmental Resource Impact Analysis and Avoidance/Minimization Measures		
Resource	**Potential Impact of Upgrade Project**	**Avoidance and/or Minimization Measures**
Vegetation	Will utilize previously disturbed areas; no trees or shrubs will be removed.	Will comply with the site restoration and reseeding conditions in the Commission's 2008 Order and all other applicable requirements.
Wildlife	Construction impacts will be confined to previously disturbed locations and minimal impacts to wildlife anticipated. The Upgrade Project is not anticipated to have an impact on threatened or endangered species or have any measurable change in impact on migrating birds or bats.	Will implement BMPs from the Facility's Wildlife Conservation Strategy to minimize risks to birds, bats, and other wildlife.

References

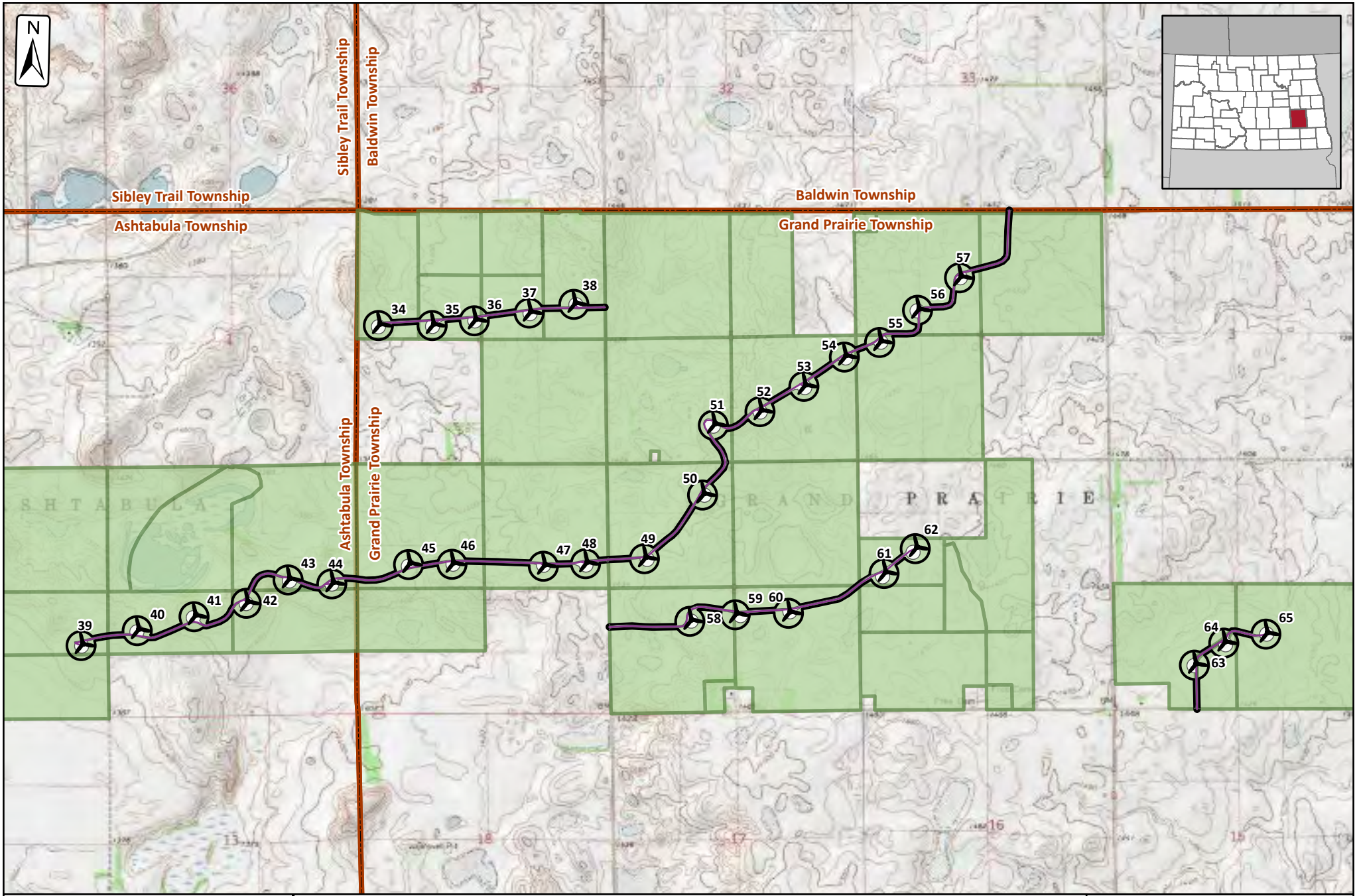
TetraTech EC, INC. 2008. Wetland and Other Waters Delineation Report: Ashtabula Wind Farm, LLC, North Dakota. TetraTech EC, INC.

USACE [U.S. Army Corps of Engineers]. 1987. Corps of Engineers Wetlands Delineation Manual. USACE, Environmental Laboratory Report No.: Technical Report Y-87-1 (online edition). http://el.erdc.usace.army.mil/elpubs/pdf/wlman87.pdf.

Attachments

Figure 1. Upgrade Project Map
Figure 2. Wind Turbine Diagram
Figure 3. Exclusion and Avoidance Area Map

Appendix A – Acoustic Assessment Results and Sound Waivers
Appendix B – Shadow Flicker Assessment Results
Appendix C – FAA Filings
Appendix D – Microwave Beam Path Study
Appendix E – Class I Literature Review – Cultural Resource Report and Unanticipated Discoveries Plan (PUBLIC)
Appendix F – IPaC Resource List



Ashtabula I Wind Upgrade Project

Figure 1- Site Overview

Barnes County, North Dakota

Issue Date: 6/27/2023

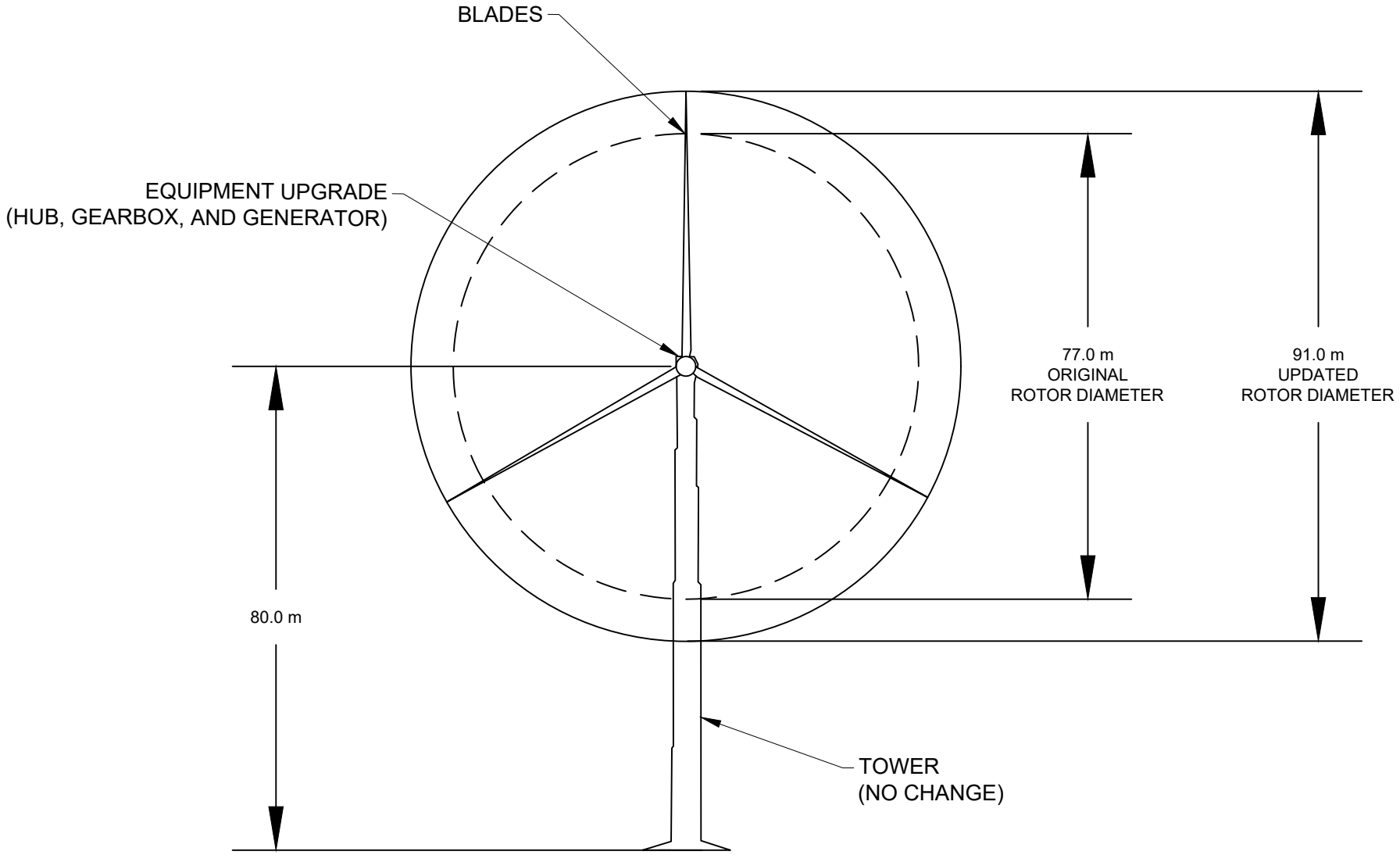
Existing Turbine Locations
Existing Access Roads
Disturbance Area (~77 acres)
Environmental Study Area
Township
Participating Parcels

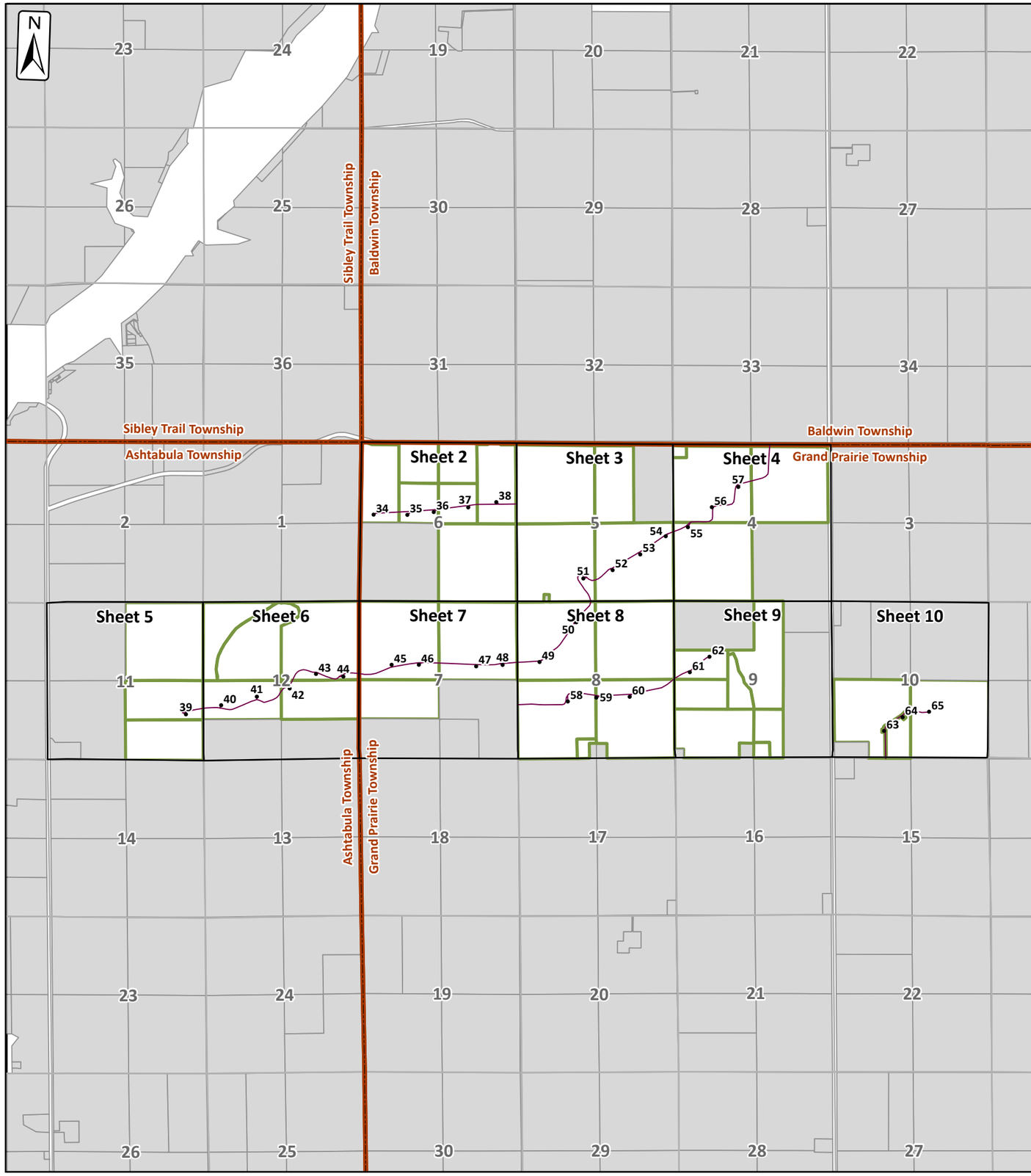
SOURCE: USGS Topo Maps

ATWELL

0 0.75 Miles

FIGURE 2: PROPOSED TURBINE UPGRADE





OTP Ashtabula I Repower Exclusions and Avoidance
Turbine Details: Hub height of 80 meters, Rotor diameter of 91 meters

Public Service Commission

Setback Requirement	Setback Distance (ft/m)	Closest Turbine	Measured Distance (ft)
1.1x the turbine height from the nearest edge of an interstate or state roadway right-of-way (ROW).	452.9 / 138.1	57	16,872
1.1x the turbine height plus 75 feet from the centerline of any county or maintained township roadway.	527.9 / 160.9	48 39	482 *variance to be obtained 609
1.1x the turbine height from the nearest edge of railroad ROW.	452.9 / 138.1	57	29,569
1.1x the turbine height from the neared edge of a 115 kV or higher transmission line ROW.	452.9 / 138.1	63	1,545
1.1x the turbine height from the property line of a nonparticipating landowner.	452.9 / 138.1	62 34 35 36 54	220 *waiver to be obtained 283 *waiver to be obtained 286 *waiver to be obtained 393 *waiver to be obtained 460
3x the height of the turbine from an inhabited rural residence of a non-participating landowner.	1,235.2 / 376.5	58	1,555

Previous Commitments (PU-08-32)

Setback Requirement	Setback Distance (ft)	Closest Turbine	Measured Distance (ft)
1,400 ft from Occupied Residence	1,400	58	1,555
420 ft from Existing Transmission Lines, Roads and Railroads	420	63	1,545
0.25 miles from USFWS Waterfowl Production Area	1,320	63	24,723

SECTIONS	4, 5, 6, 7, 8, 9, 10, 11, 12
TOWNRANGE	T142N R97W; T142N R98W
TOWNSHIPS	Ashtabula and Grand Prairie Townships
COUNTY, STATE	Barnes County, ND

CLIENT: Otter Tail Power Company

Ashtabula I Wind Upgrade Project
Figure 3: Exclusions and Avoidance

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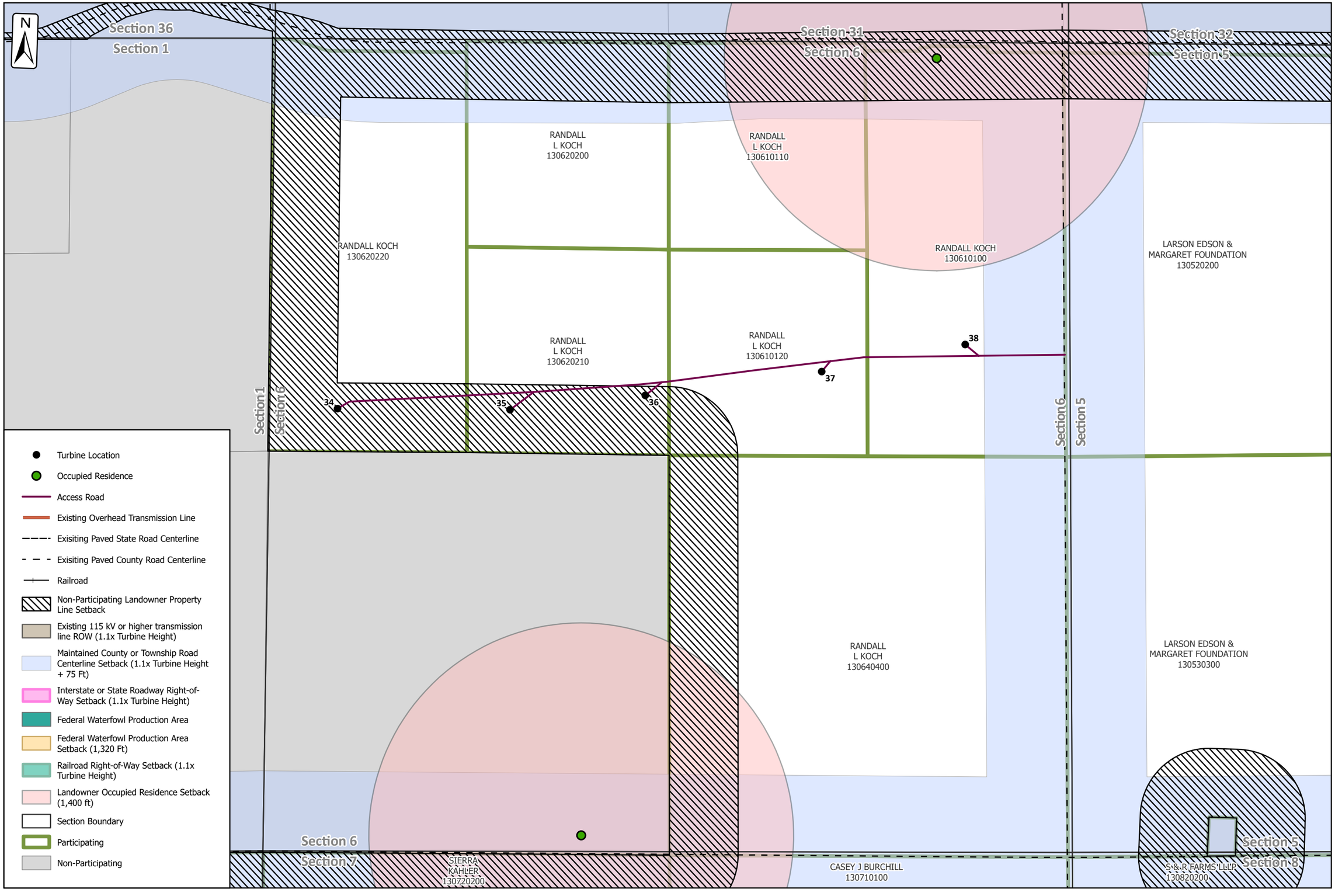

SECTIONS	4, 5, 6, 7, 8, 9, 10, 11, 12
TOWN/RANGE	T142N R67W; T142N R68W
TOWNSHIPS	Ashtabula and Grand Prairie Townships
COUNTY, STATE	Barnes County, ND

CLIENT: Otter Tail Power Company

OTP Ashtabula I Wind Repower
Figure 3: Exclusions and Avoidance

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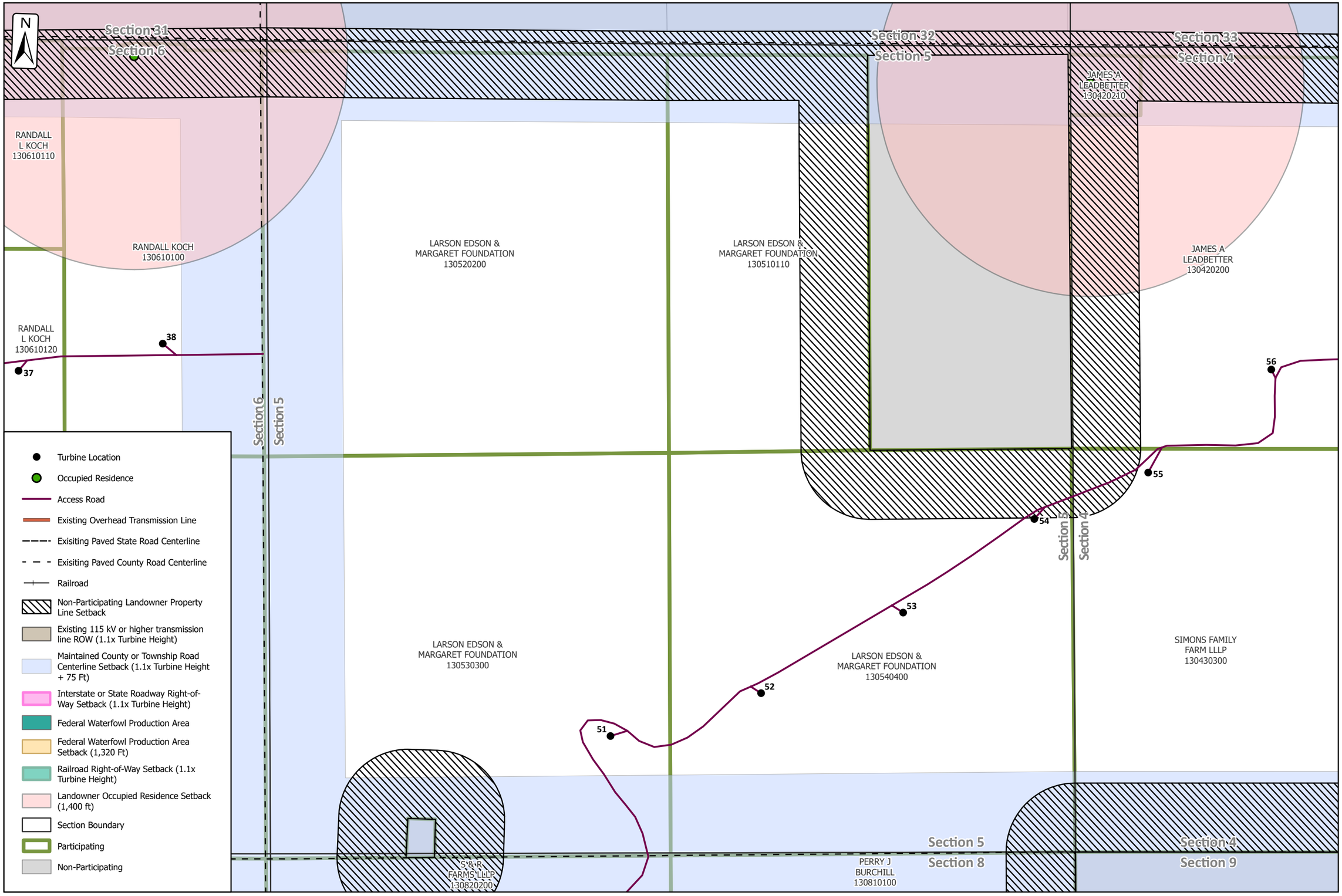

ATWELL

SECTIONS	4, 5, 6, 7, 8, 9, 10, 11, 12
TOWNRANGE	T142N R67W; T142N R68W
TOWNSHIPS	Ashtabula and Grand Prairie Townships
COUNTY, STATE	Barnes County, ND

CLIENT: Otter Tail Power Company

OTP Ashtabula I Wind Repower
Figure 3: Exclusions and Avoidance

SCALE: 0 130 260 Feet

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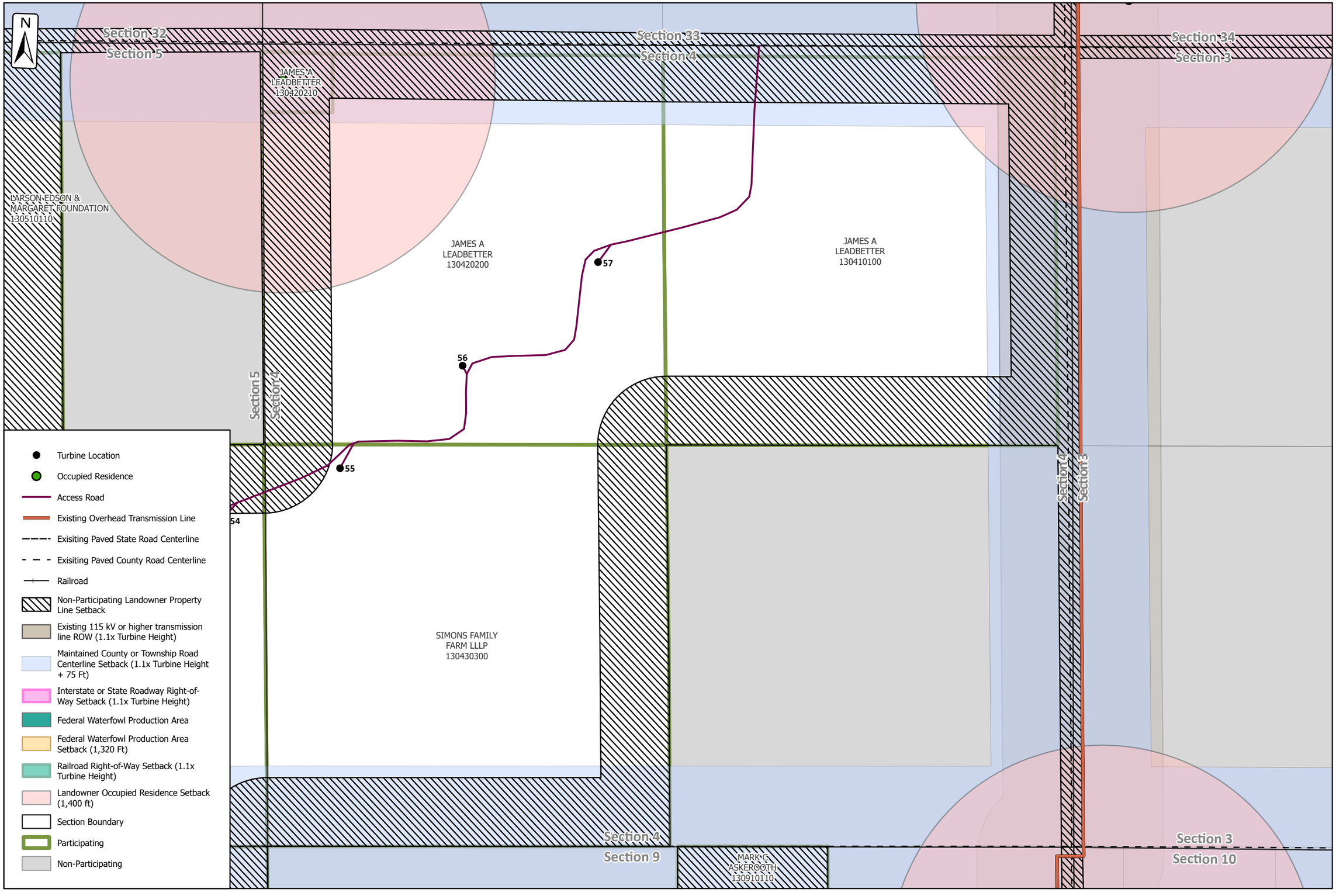

ATWELL

SECTIONS	4, 5, 6, 7, 8, 9, 10, 11, 12
TOWN/RANGE	T142N R67W; T142N R58W
TOWNSHIPS	Ashtabula and Grand Prairie Townships
COUNTY, STATE	Barnes County, ND

CLIENT: Otter Tail Power Company

OTP Ashtabula I Wind Repower
Figure 3: Exclusions and Avoidance

SCALE: 0 130 260 Feet

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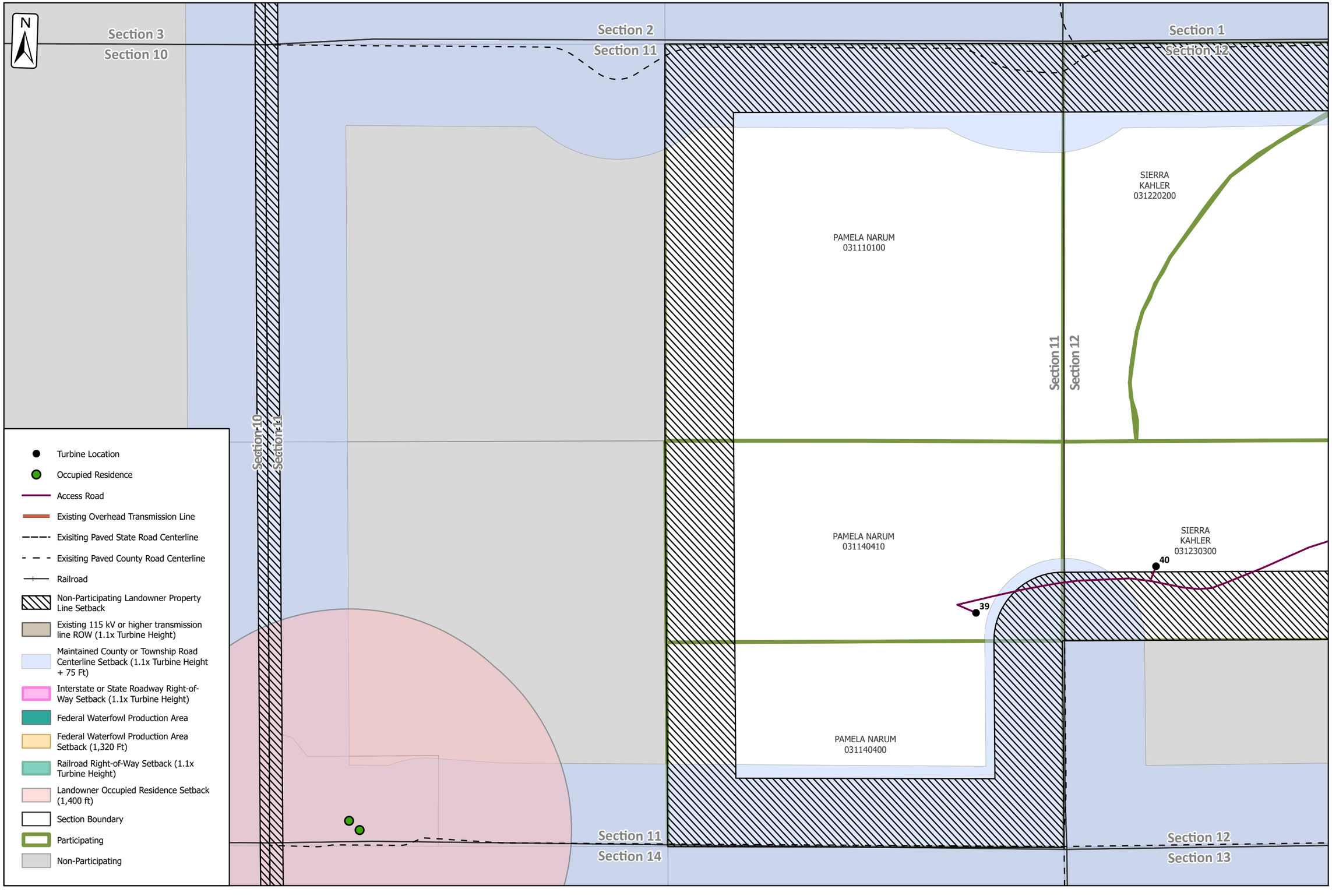

ATWELL

SECTIONS	4, 5, 6, 7, 8, 9, 10, 11, 12
TOWNRANGE	T142N R67W; T142N R58W
TOWNSHIPS	Ashtabula and Grand Prairie Townships
COUNTY, STATE	Barnes County, ND

CLIENT: Otter Tail Power Company

OTP Ashtabula I Wind Repower

Figure 3: Exclusions and Avoidance

SCALE: 0 130 260 Feet

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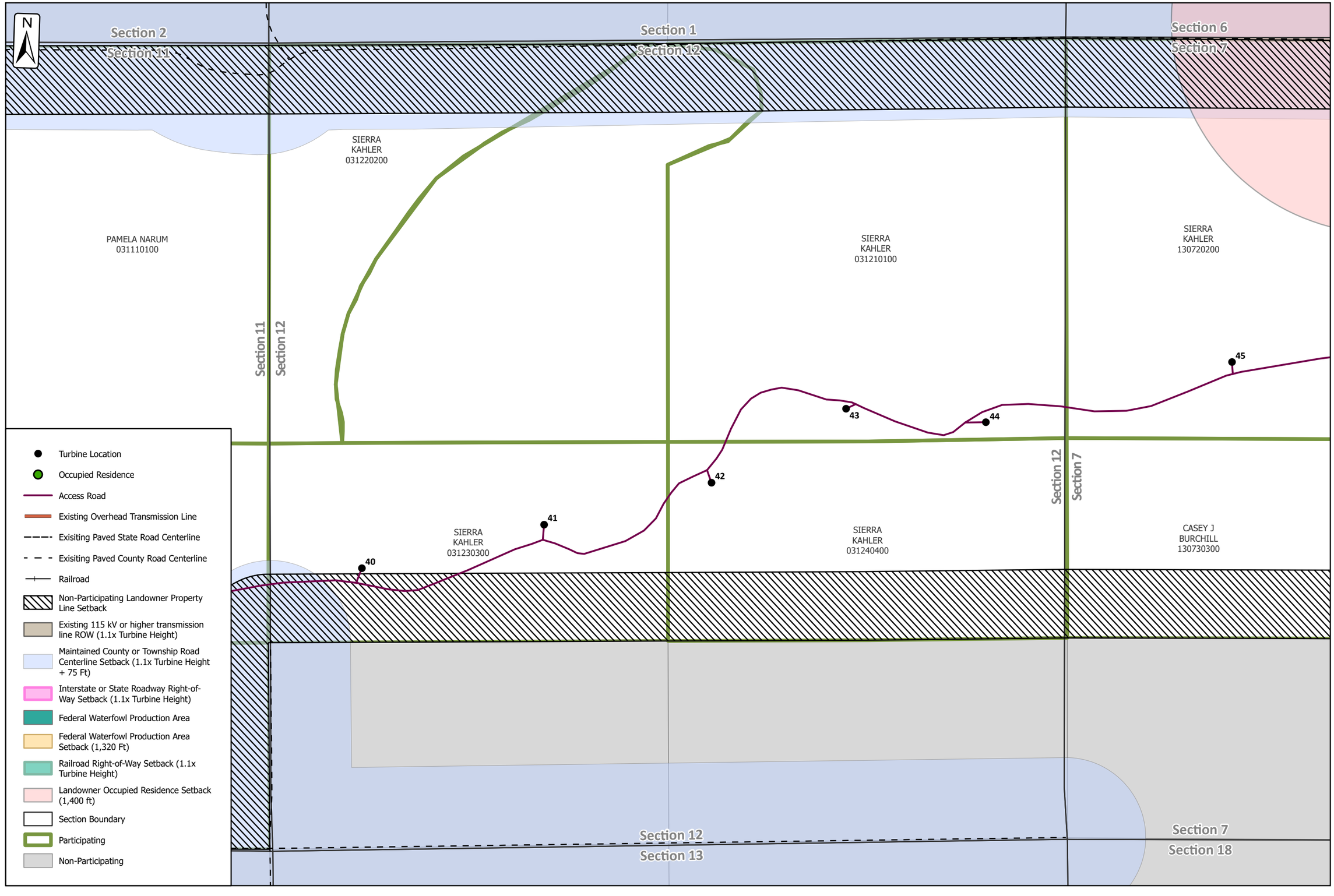

ATWELL

SECTIONS	4, 5, 6, 7, 8, 9, 10, 11, 12
TOWN/RANGE	T142N R57W; T142N R58W
TOWNSHIPS	Ashtabula and Grand Prairie Townships
COUNTY, STATE	Barnes County, ND

CLIENT: Otter Tail Power Company

OTP Ashtabula I Wind Repower

Figure 3: Exclusions and Avoidance

SCALE: 0 130 260 Feet

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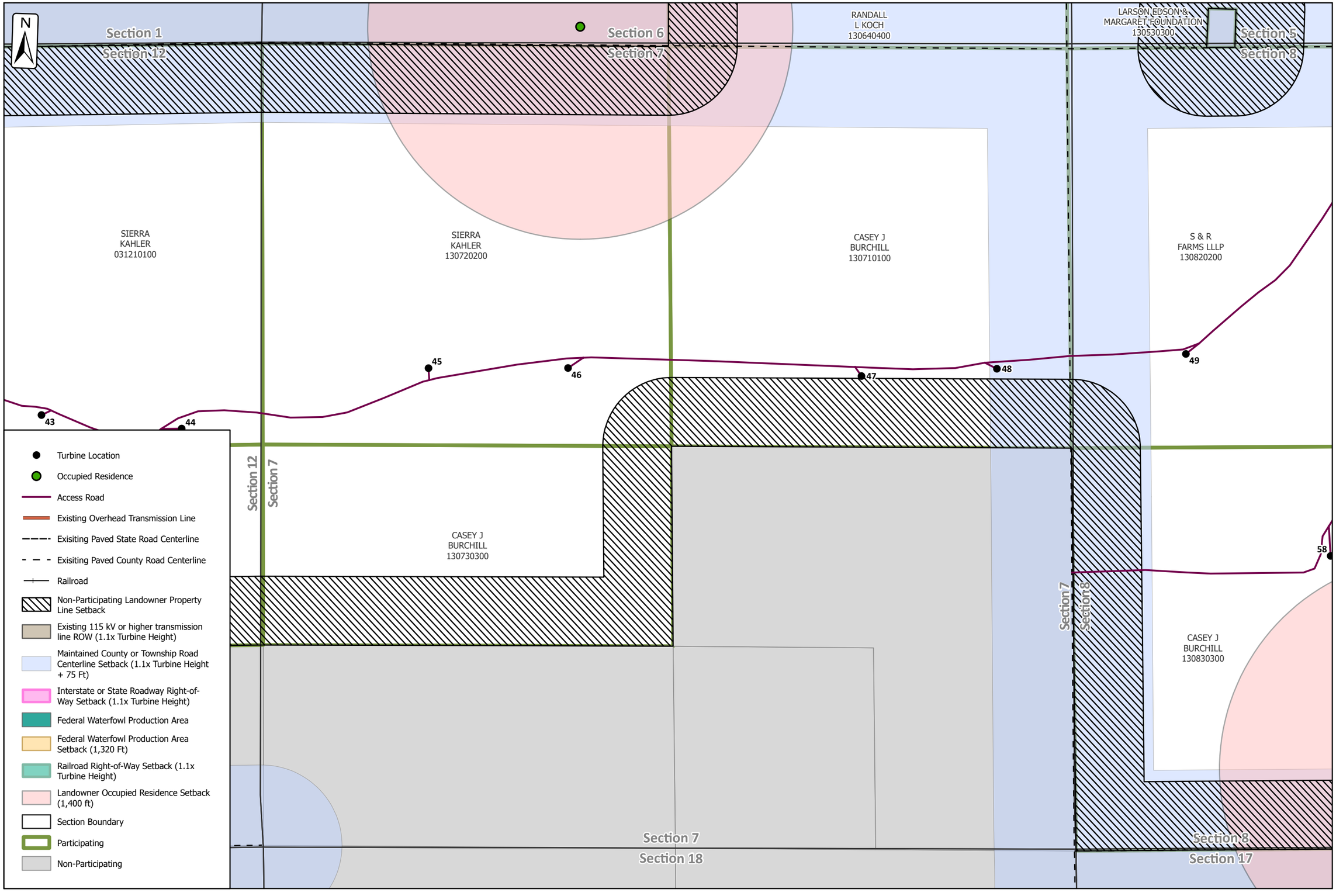

ATWELL

SECTIONS	4, 5, 6, 7, 8, 9, 10, 11, 12
TOWN/RANGE	T142N R67W; T142N R68W
TOWNSHIPS	Ashtabula and Grand Prairie Townships
COUNTY, STATE	Barnes County, ND

CLIENT: Otter Tail Power Company

OTP Ashtabula I Wind Repower
Figure 3: Exclusions and Avoidance

SCALE: 0 130 260 Feet

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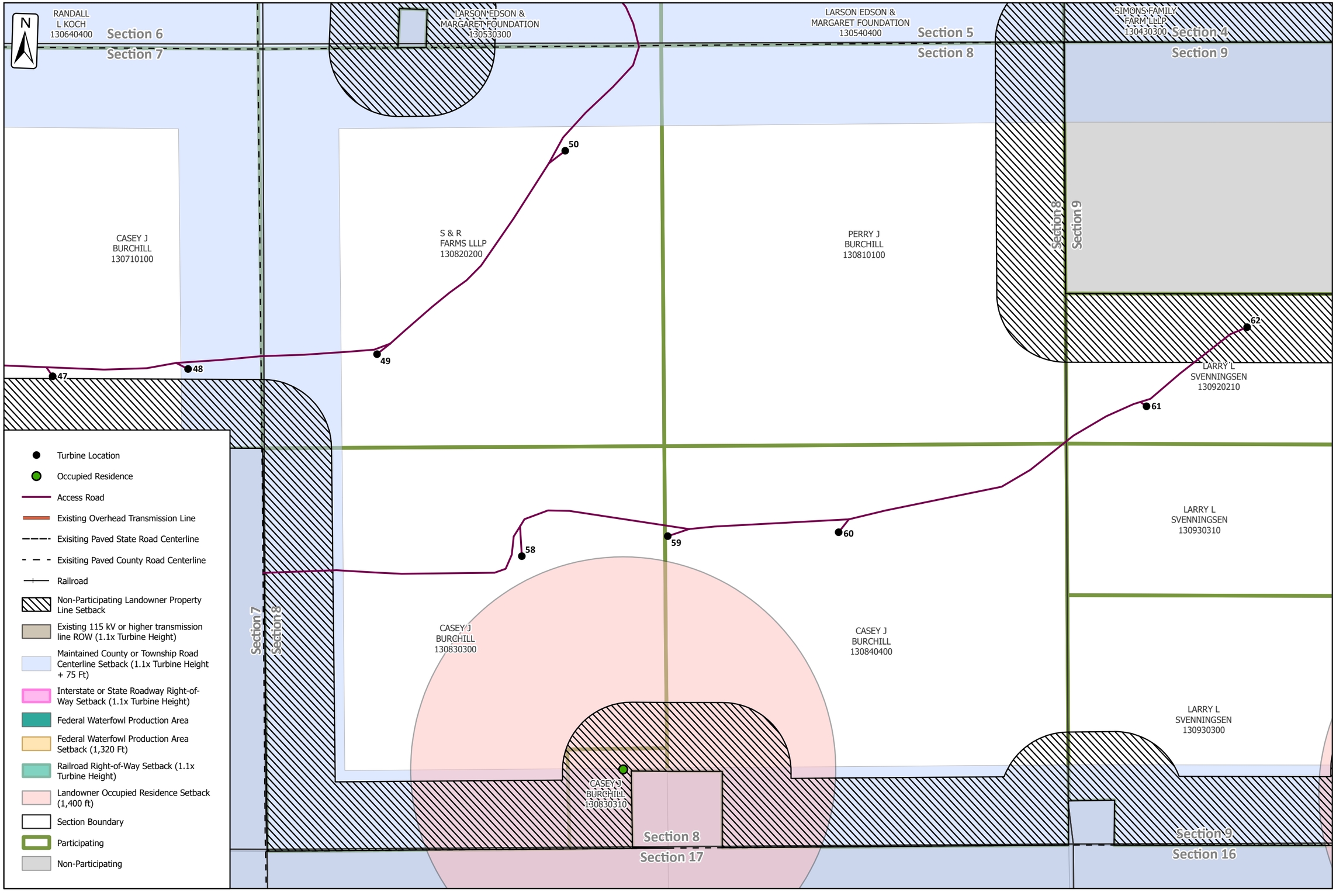

ATWELL

SECTIONS	4, 5, 6, 7, 8, 9, 10, 11, 12
TOWN/RANGE	T142N R67W; T142N R68W
TOWNSHIPS	Ashtabula and Grand Prairie Townships
COUNTY, STATE	Barnes County, ND

CLIENT: Otter Tail Power Company

OTP Ashtabula I Wind Repower
Figure 3: Exclusions and Avoidance

SCALE: 0 130 260 Feet

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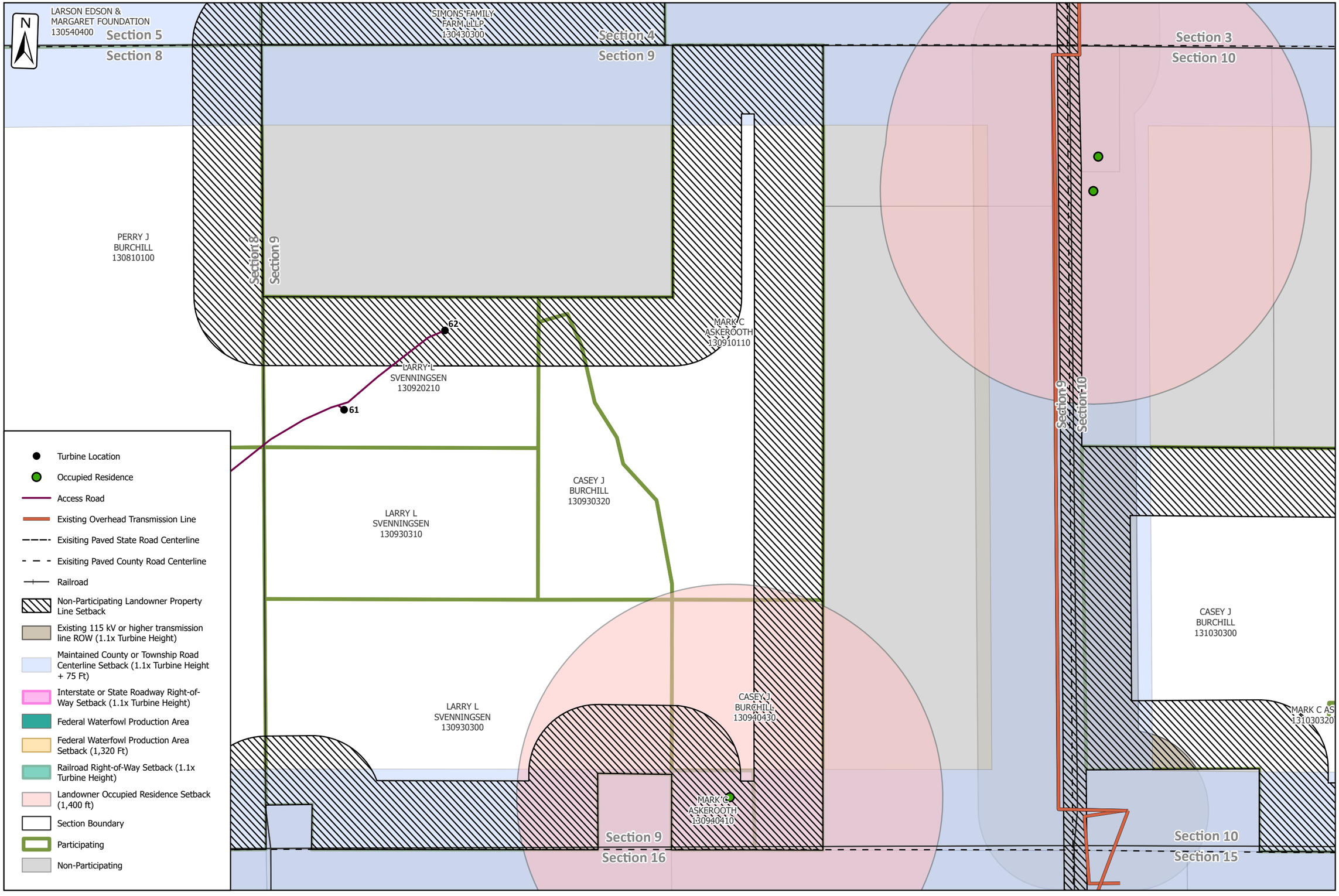

ATWELL

SECTIONS	4, 5, 6, 7, 8, 9, 10, 11, 12
TOWNRANGE	T142N R97W; T142N R98W
TOWNSHIPS	Ashtabula and Grand Prairie Townships
COUNTY, STATE	Barnes County, ND

CLIENT: Otter Tail Power Company

OTP Ashtabula I Wind Repower
Figure 3: Exclusions and Avoidance

SCALE: 0 130 260 Feet

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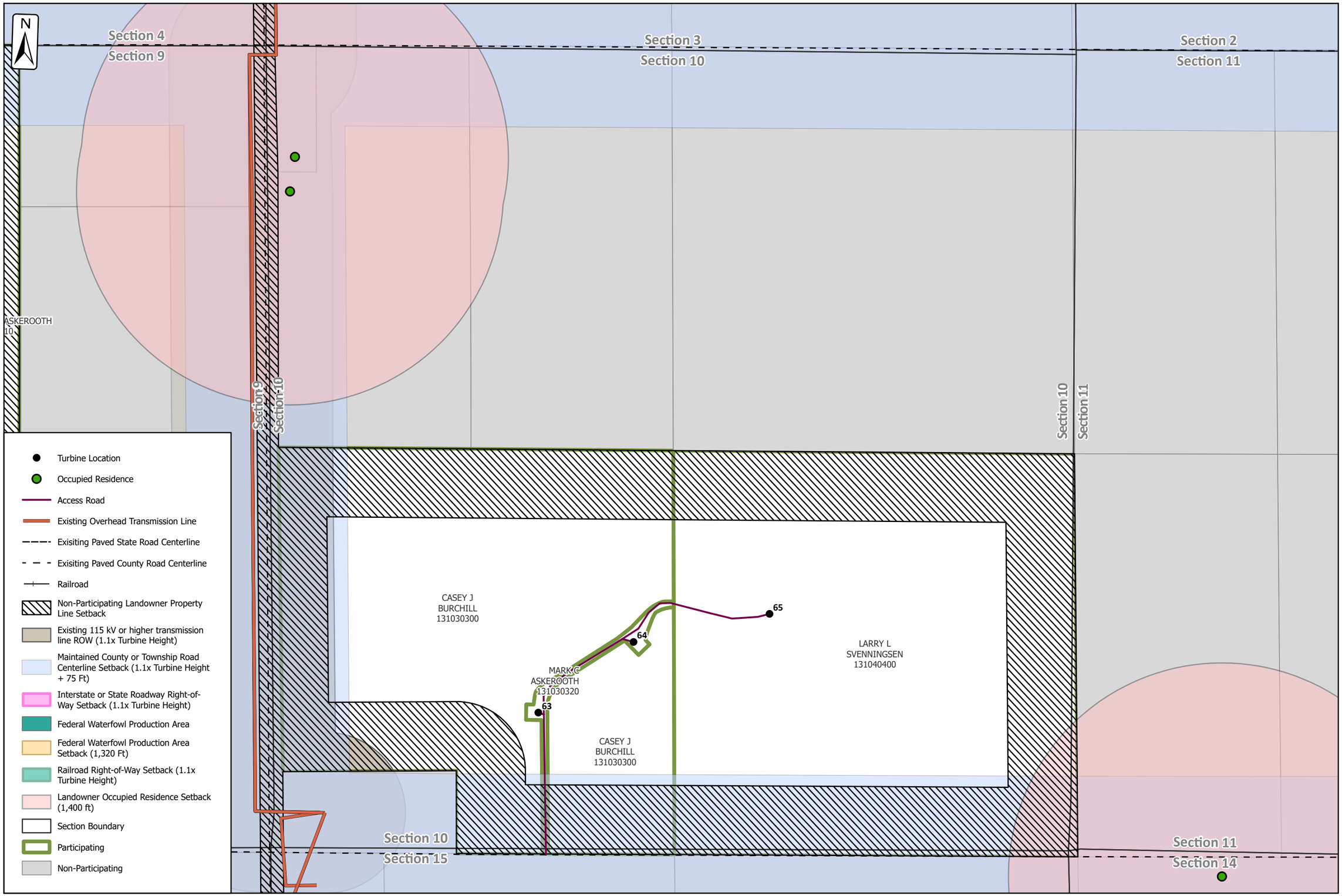

ATWELL

SECTIONS	4, 5, 6, 7, 8, 9, 10, 11, 12
TOWN/RANGE	T142N R67W; T142N R58W
TOWNSHIPS	Ashtabula and Grand Prairie Townships
COUNTY, STATE	Barnes County, ND

CLIENT: Otter Tail Power Company

OTP Ashtabula I Wind Repower
Figure 3: Exclusions and Avoidance

SCALE: 0 130 260 Feet

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Appendix A – Acoustic Assessment Results and Sound Waivers

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SOUND LEVEL ASSESSMENT REPORT

Otter Tail Ashtabula Wind Repower Project
Barnes County, North Dakota

Prepared for:

Atwell, LLC
311 North Main
Ann Arbor, Michigan 48104

Prepared by:

Epsilon Associates, Inc.
3 Mill & Main Place, Suite 250
Maynard, MA 01754

June 23, 2023

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1.0 EXECUTIVE SUMMARY

The Ashtabula Wind Energy Center Repowering Project (the Project) is an existing wind park in Barnes County, North Dakota that is planned to be repowered by Otter Tail Power Company (Otter Tail). Atwell has retained Epsilon Associates, Inc. (Epsilon) to conduct a sound level assessment for this Project. This report presents the results of the sound level modeling from the proposed repower in Barnes County.

This sound level assessment includes computer modeling to predict worst-case future L_{eq} sound levels from the Project, and a comparison of operational sound levels to the North Dakota Administrative Code Energy Conversion Facility Siting Criteria of 45 dBA within 100 feet of an inhabited residence. Additionally, receptors that have signed noise waivers with Otter Tail Power have been compared to the Waiver criterion of 50 dBA within 200 feet of the inhabited residence. Sound level modeling was conducted for all Otter Tail Ashtabula Wind Repower wind turbines.

The L_{eq} sound levels modeled at receptors in Barnes County ranged from 28 to 46 dBA. The highest L_{eq} sound level modeled at a receptor that has signed a waiver with Otter Tail is 46 dBA. The highest L_{eq} sound level modeled at a receptor that has not signed a waiver with Otter Tail is 45 dBA. Using the mitigation described in this report, the L_{eq} sound levels at all receptors without a signed waiver are at or below the limit of 45 dBA within 100 feet of an inhabited residence. Therefore, the Project meets the State's regulations with respect to sound.

2.0 INTRODUCTION

The proposed repower Project will consist of 32 repowered wind turbines. The proposed wind turbines are all GE 1.6MW units with a rotor diameter of 91 meters and a hub height of 80 meters. Figure 2-1 shows the locations of the 32 wind turbines in Barnes County over aerial imagery.

A detailed discussion of sound from wind turbines is presented in a white paper prepared by the Renewable Energy Research Laboratory.[1] A few points are repeated herein. Wind turbine sound can originate from two different sources: mechanical sound from the interaction of turbine components, and aerodynamic sound produced by the flow of air over the rotor blades. Prior to the 1990's, both were significant contributors to wind turbine sound. However, recent advances in wind turbine design have greatly reduced the contribution of mechanical sound. Aerodynamic sound has also been reduced from modern wind turbines due to slower rotational speeds and changes in materials of construction. Aerodynamic sound, in general, is broadband (has contributions from a wide range of frequencies). It originates from encounters of the wind turbine blades with localized airflow inhomogeneities and wakes from other turbine blades and from airflow across the surface of the blades, particularly the front and trailing edges. Aerodynamic sound generally increases with increasing wind speed up to a certain point, then typically remains constant, even with higher wind speeds. However, sound levels in general also increase with increasing wind speed with or without the presence of wind turbines.

This report presents the findings of a sound level modeling analysis for the Project. The Project wind turbines were modeled in CadnaA using sound data from GE technical reports. The results of this analysis are found within this report.

[1] Renewable Energy Research Laboratory, Department of Mechanical and Industrial Engineering, University of Massachusetts at Amherst, Wind Turbine Acoustic Noise, June 2002, amended January 2006.

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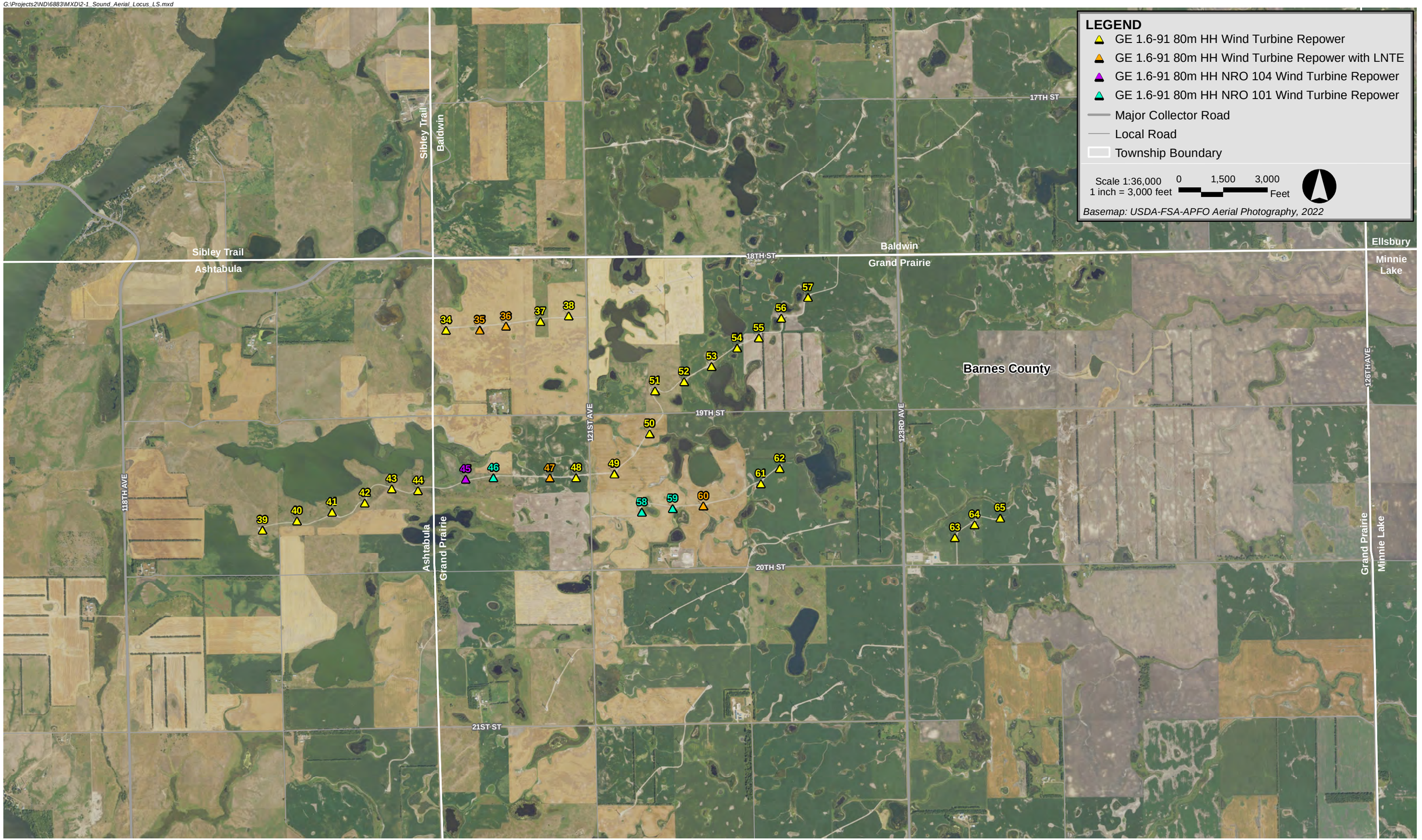

Ashtabula Repower **Barnes County, North Dakota**

Epsilon Associates Inc.

Figure 2-1
Aerial Locus

3.0 SOUND TERMINOLOGY

There are several ways in which sound levels are measured and quantified. All of them use the logarithmic decibel (dB) scale. The following information defines the sound level terminology used in this analysis.

The decibel scale is logarithmic to accommodate the wide range of sound intensities found in the environment. A property of the decibel scale is that the sound pressure levels of two or more separate sounds are not directly additive. For example, if a sound of 50 dB is added to another sound of 50 dB, the total is only a 3-decibel increase (53 dB), which is equal to doubling in sound energy, but not equal to a doubling in decibel quantity (100 dB). Thus, every 3-dB change in sound level represents a doubling or halving of sound energy. The human ear does not perceive changes in the sound pressure level as equal changes in loudness. Scientific research demonstrates that the following general relationships hold between sound level and human perception for two sound levels with the same or very similar frequency characteristics[2]:

- 3 dB increase or decrease results in a change in sound that is just perceptible to the average person,
- 5 dB increase or decrease is described as a clearly noticeable change in sound level, and
- 10 dB increase or decrease is described as twice or half as loud.

Another mathematical property of decibels is that if one source of sound is at least 10 dB louder than another source, then the total sound level is simply the sound level of the higher-level source. For example, a sound source at 60 dB plus another sound source at 47 dB is equal to 60 dB.

A sound level meter (SLM) that is used to measure sound is a standardized instrument.[3] It contains "weighting networks" (e.g., A-, C-, Z-weightings) to adjust the frequency response of the instrument. Frequencies, reported in Hertz (Hz), are detailed characterizations of sounds, often addressed in musical terms as "pitch" or "tone". The most commonly used weighting network is the A-weighting because it most closely approximates how the human ear responds to sound at various frequencies. The A-weighting network is the accepted scale used for community sound level measurements; therefore, sounds are frequently reported as detected with a sound level meter using this weighting. A-weighted sound levels emphasize middle frequency sounds (i.e., middle pitched – around 1,000 Hz), and de-emphasize low and high frequency sounds. These sound levels are reported in decibels designated as "dBA". The C-weighting network has a nearly flat response for frequencies between 63 Hz and 4,000 Hz and is noted as dBC. Z-weighted sound levels are measured sound levels without any weighting curve and are otherwise referred

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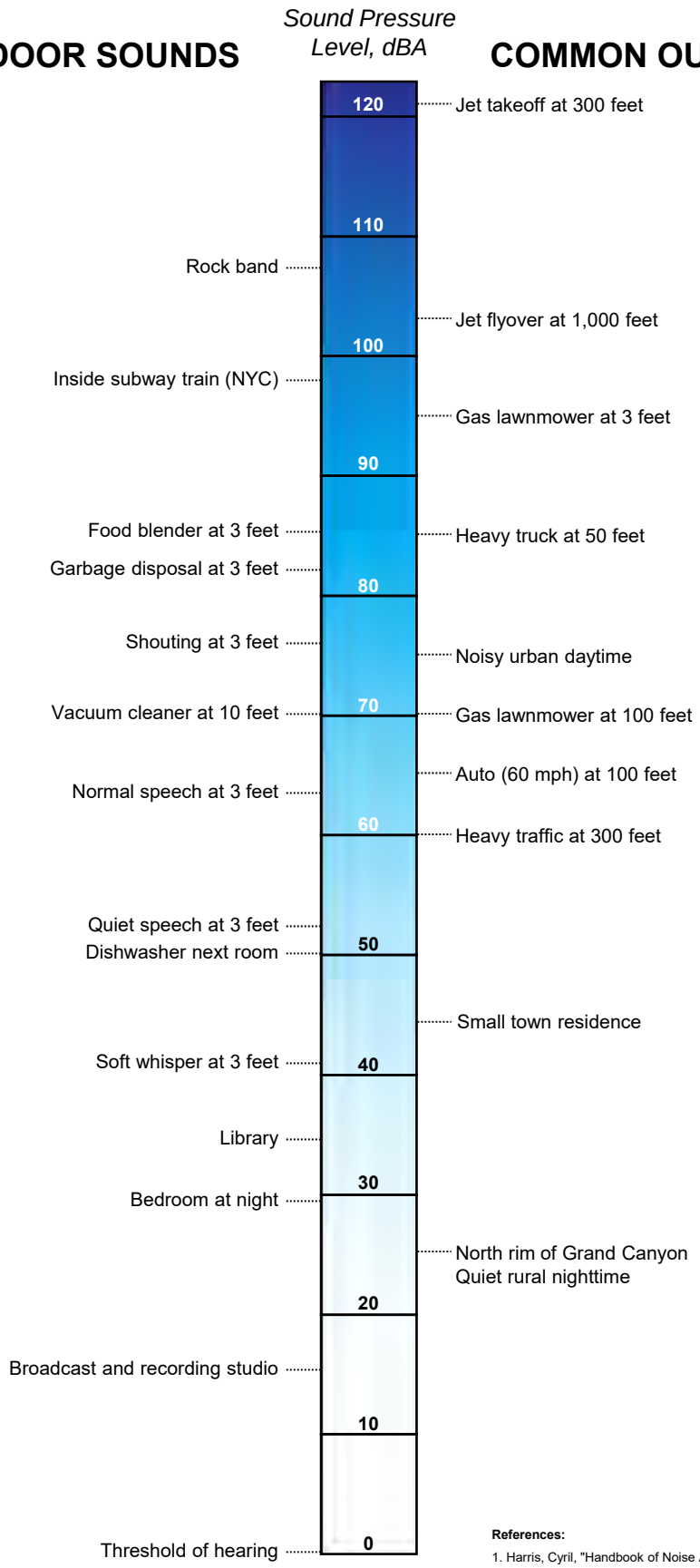
2 Bies, David, and Colin Hansen. 2009. *Engineering Noise Control: Theory and Practice*, 4th Edition. New York: Taylor and Francis.

3 *American National Standard Electroacoustics – Sound Level Meters – Part 1: Specifications,* ANSI S1.4-2014 (R2019), published by the Standards Secretariat of the Acoustical Society of America, Melville, NY.

to as “unweighted”. Sound pressure levels for some common indoor and outdoor environments are shown in Figure 3-1.

Because the sounds in our environment vary with time they cannot simply be described with a single number. Two methods are used for describing variable sounds. These are exceedance levels and the equivalent level, both of which are derived from some number of moment-to-moment A-weighted sound level measurements. Exceedance levels are values from the cumulative amplitude distribution of all the sound levels observed during a measurement period. Exceedance levels are designated L_n, where n can have a value between 0 and 100 in terms of percentage. The L_{eq} is a sound level metric that is commonly reported in community sound level monitoring and is utilized in this report. The L_{eq} is described in further detail below.

- L_{eq}, the equivalent level, is the level of a hypothetical steady sound that would have the same energy (*i.e.,* the same time-averaged mean square sound pressure) as the actual fluctuating sound observed. The equivalent level is designated L_{eq} and is typically A-weighted. The equivalent level represents the time average of the fluctuating sound pressure, but because sound is represented on a logarithmic scale and the averaging is done with linear mean square sound pressure values, the L_{eq} is mostly determined by loud sounds if there are fluctuating sound levels.



References:

1. Harris, Cyril, "Handbook of Noise Acoustical Measurements and Noise Control", p 1-10., 1998
2. "Controlling Noise", USAF, AFMC, AFDTC, Elgin AFB, Fact Sheet, August 1996
3. California Dept. of Trans., "Technical Noise Supplement", Oct, 1998

Figure 3-1

Common Indoor and Outdoor Sound Levels

4.0 NOISE REGULATIONS

4.1 Federal Regulations

There are no federal community noise regulations applicable to this Project.

4.2 North Dakota State Regulations

The Project, located in North Dakota, is required to comply with the following sound requirement:

Section 69-06-08-01 Energy Conversion Facility Siting Criteria

4. Additional avoidance areas for wind energy conversion facilities. A wind energy conversion facility site must not include a geographic area where, due to operation of the facility, the sound levels within one hundred feet of an inhabited residence or a community building will exceed forty-five dBA. The sound level avoidance area criteria may be waived in writing by the owner of the occupied residence or the community building.

4.3 Local Regulations

There are no local community noise regulations applicable to this Project.

Therefore, modeling receptors were evaluated in this analysis against the 45 dBA limit.

5.0 MODELED SOUND LEVELS

5.1 Sound Sources

5.1.1 Project Wind Turbines

The sound level analysis for the Project includes 32 wind turbines. These 32 wind turbines are depicted in Figure 5-1. The array consists of one (1) wind turbine model: the GE 1.6-91 at a hub height of 80-meters. Wind turbines 35, 36, 47, and 60 will have Low Noise Trailing Edge (LNTE) blades. Wind turbine 45 will be in Noise Reduced Operations (NRO) 104 mode. Wind turbines 46, 58 and 59 will be in Noise Reduced Operations (NRO) 101 mode. The GE 1.6-91 wind turbines have a rotor diameter of 91 meters. Technical reports from GE[4,5] were provided to Epsilon which documented the expected sound power levels associated with the GE 1.6-91.

5.2 Modeling Methodology

The sound impacts associated with the proposed wind turbines were predicted using the CadnaA sound level calculation software developed by DataKustik GmbH. This software uses the ISO 9613-2 international standard for sound propagation.[6] The benefits of this software are a more refined set of computations due to the inclusion of topography, ground attenuation, multiple building reflections (if applicable), drop-off with distance, and atmospheric absorption. The CadnaA software allows for octave band calculation of sound from multiple sources as well as computation of diffraction.

Inputs and significant parameters employed in the model are described below and summarized in Table 5-1 below.

- *Project Array:* This analysis is for the wind turbine array provided to Epsilon on December 20, 2022. The Project array is identified in Figure 5-1. The wind turbine coordinates are provided in Appendix A.

- *Modeling Receptor Locations:* A modeling receptor dataset dated January 26, 2023 was provided to Epsilon. The dataset included 316 receptors. This dataset was clipped such that only receptors within 1.5 miles of an Otter Tail Ashtabula wind turbine were included in the analysis. Atwell provided additional information indicating if each receptor was inhabited or uninhabited. Atwell also provided information of a new construction residential building in the Project area. The resulting 21 inhabited receptors were input to the CadnaA model. All modeling receptors were input as discrete points at a height of 1.5 meters above ground level to mimic the ears of a typical standing

---

4 General Electric Company, Technical Documentation Wind Turbine Generator Systems 1.6-91 – 60 Hz Product Acoustic Specifications, Rev. 03, 2021.

5 General Electric Company, Technical Documentation Wind Turbine Generator Systems 1.6-91 RePower with LNTE – 60 Hz Product Acoustic Specifications, Rev. 03, 2021.

6 *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation,* International Standard ISO 9613-2:1996 (International Organization for Standardization, Geneva, Switzerland, 1996).

person. In order to provide robust modeling coverage of each inhabited location, additional modeling locations were included offset by 100 feet away (or 200 feet for receptors with signed waivers) from the center point of the receptor in each of the four cardinal directions (north, south, east and west). Therefore, each inhabited location was evaluated at a total of five locations; the center point of the receptor itself, and at the four offset locations on land 100 feet (or 200 feet for receptors with signed waivers) from the receptor. This resulted in a total of 105 receptors. The center points of the modeled locations (receptors) are shown in Figure 5-1. Details of each modeling location are presented in Appendix B.

- *Modeling Grid:* A modeling grid with 20-meter spacing was calculated for the entire Project Area and the surrounding region. The grid was modeled at a height of 1.5 meters above ground level for consistency with the discrete modeling points. This modeling grid allowed for the creation of sound level isolines.

- *Terrain Elevation:* Elevation contours for the modeling domain were directly imported into CadnaA which allowed for consideration of terrain shielding where appropriate. The terrain height contour elevations for the modeling domain were generated from elevation information derived from the National Elevation Dataset (NED) developed by the U.S. Geological Survey.

- *Source Sound Levels:* Sound power levels used in the modeling were described in Section 5.1. Documentation from GE provided levels that represent "worst-case" operational sound level emissions for the Project's proposed wind turbines were input into the model.

- *Meteorological Conditions:* A temperature of 10°C (50°F) and a relative humidity of 70% was assumed in the model.

- *Ground Attenuation:* Spectral ground absorption was calculated using a G-factor of 0 which corresponds to "hard ground" consisting of a hard ground surface. The model, consistent with the standard, allows inputs between 0 (hard ground) and 1 (porous ground). This is a conservative approach as the vast majority of the area is actually agricultural.

Octave band sound power levels corresponding to the highest available wind turbine broadband sound power level for each wind turbine type were input into CadnaA to model wind turbine generated L_{eq} sound pressure levels during conditions when worst-case sound power levels are expected. Sound pressure levels were modeled at 105 receptors representing 21 inhabited locations within the vicinity of the Project. In addition to modeling at discrete points, sound levels were also modeled throughout a large grid of points, each spaced 20 meters apart to allow for the generation of sound level isolines.

Several modeling assumptions inherent in the ISO 9613-2 calculation methodology, or selected as conditional inputs by Epsilon, were implemented in the CadnaA model to ensure conservative results (i.e., higher sound levels), and are described below:

- All modeled sources were assumed to be operating simultaneously and at the design wind speed corresponding to the greatest sound level impacts.

- As per ISO 9613-2, the model assumed favorable conditions for sound propagation, corresponding to a moderate, well-developed ground-based temperature inversion, as might occur on a calm, clear night or equivalently downwind propagation.

- Meteorological conditions assumed in the model (T=10°C/RH=70%) were selected to minimize atmospheric attenuation in the 500 Hz and 1 kHz octave bands where the human ear is most sensitive.

- No additional attenuation due to tree shielding, air turbulence, or wind shadow effects was considered in the model.

Table 5-1 Summary of Key Sound Level Modeling Inputs

Modeling Parameter	Description / Value
Wind Turbine Array	Provided by Atwell
Terrain	U.S.G.S. Data
Wind Turbine Sound Power Levels	GE Specifications Documentation
Meteorological Conditions	T=10°C / RH=70%
Ground Absorption Factor	0

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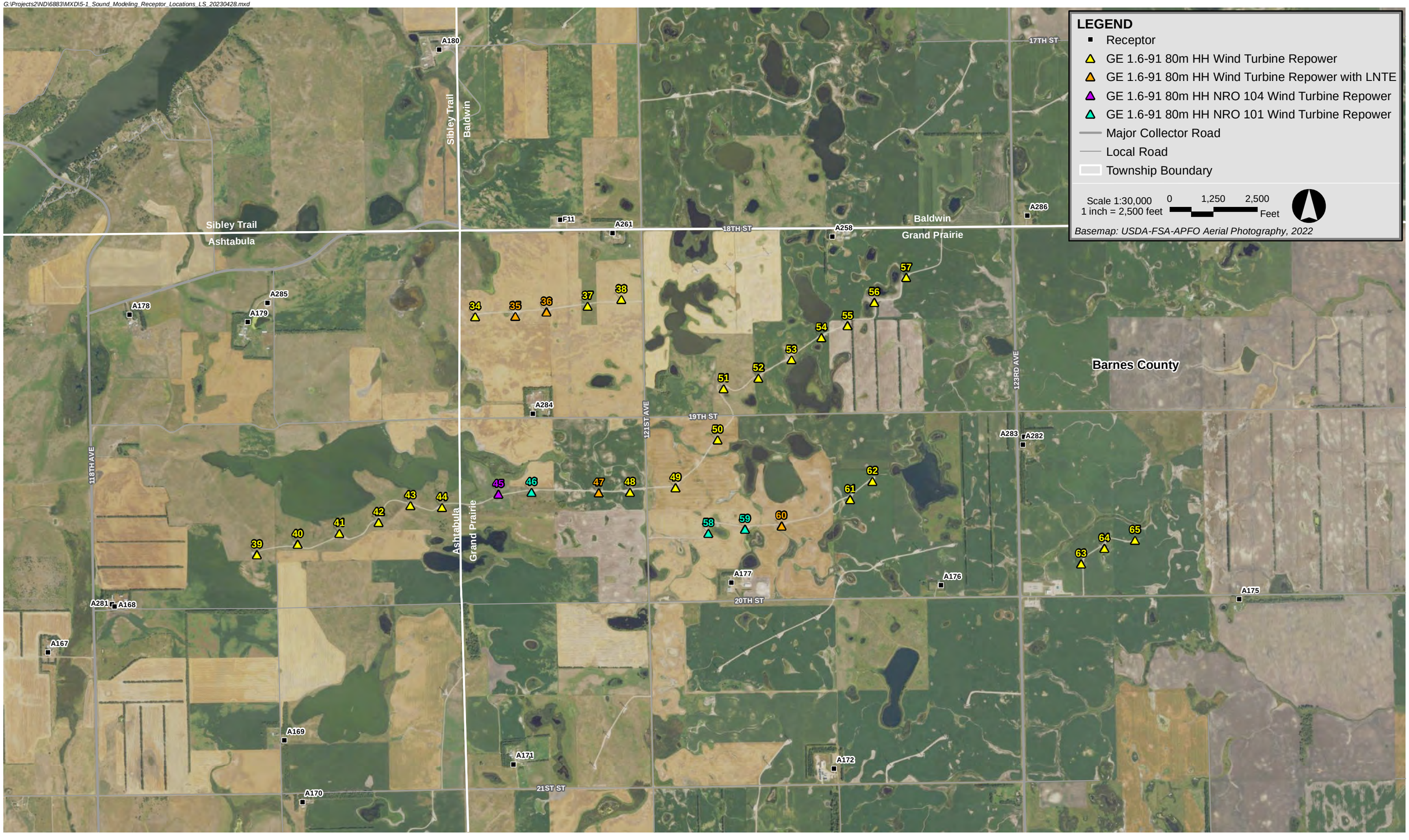

Ashtabula Repower **Barnes County, North Dakota**

Epsilon Associates Inc.

Figure 5-1
Sound Level Modeling Locations

5.3 Sound Level Modeling Results

All modeled sound levels, as output from CadnaA are A-weighted equivalent sound levels (L_{eq}, dBA). Table B-1.1 in Appendix B shows the predicted broadband (dBA) sound levels at the 21 receptors and their additional offset locations modeled for the Project. The broadband L_{eq} sound levels range from 28 to 46 dBA. These sound levels represent the worst-case future L_{eq} sound levels produced by the Project wind turbines. The maximum modeled sound level of 46 dBA occurs at receptors A258 and A261, which have signed waivers with Otter Tail Power. The highest modeled sound level at a receptor which has not signed a waiver with Otter Tail Power is 45 dBA, which occurs at two receptors (A177 and A284). Table B-1.2 in Appendix B shows the predicted sound levels sorted from high to low.

In addition to the discrete modeling points, L_{eq} sound level isolines generated from the modeling grid are presented in Figure 5-2.

G:\Projects2\ND\6883\MXD\5-2_Sound_Modeling_Results_LS_20230428.mxd

LEGEND

- GE 1.6-91 80m HH Wind Turbine Repower
- GE 1.6-91 80m HH Wind Turbine Repower with LNTE
- GE 1.6-91 80m HH NRO 104 Wind Turbine Repower
- GE 1.6-91 80m HH NRO 101 Wind Turbine Repower
- Receptor
- Major Collector Road
- Local Road
- Township Boundary

Sound Level Modeling Results (dBA)

35 40 45 50 55

Scale 1:36,000
1 inch = 3,000 feet
0 1,500 3,000 Feet

Basemap: USDA-FSA-APFO Aerial Photography, 2022

Sibley Trail
Baldwin
Ashtabula
Grand Prairie
Barnes County
Minnie Lake
17TH ST
18TH ST
19TH ST
20TH ST
21ST ST
118TH AVE
121ST AVE
123RD AVE
126TH AVE

Ashtabula Repower Barnes County, North Dakota

Figure 5-2
Sound Level Modeling Results

6.0 EVALUATION OF SOUND LEVELS

The Project is subject to the requirements contained in the North Dakota Energy Conversion Facility Siting Criteria**.** Sound levels from operation of the Project are limited by these regulations to 45 dBA within 100 feet of an inhabited residence. Additionally, sound levels from the operation of the Project are limited to 50 dBA within 200 feet of an inhabited residence for any location with a signed Noise Waiver with Otter Tail Power. All modeled sound levels, as output from CadnaA and presented in Appendix B, are A-weighted equivalent sound levels (L_{eq}, dBA). These levels may be used in evaluating measured sound pressure levels over typical averaging durations, (i.e., ten (10) minutes or one (1) hour).

A review of Table B-1.2 in Appendix B shows the highest sound level within 100 feet of an inhabited residence that has not signed a waiver with Otter Tail Power in this analysis to be 45 dBA. This occurs at Receptors A177 and A284. The results also show that the highest sound level within 200 feet of an inhabited residence that has signed a waiver with Otter Tail Power in this analysis to be 46 dBA. This occurs at Receptors A258 and A261. Therefore, the Project is in compliance with the North Dakota Administrative Code Energy Conversion Facility Siting Criteria with respect to sound.

7.0 CONCLUSIONS

A comprehensive sound level modeling assessment was conducted for the Otter Tail Ashtabula Wind Repower Project within Barnes County, North Dakota. Sound levels resulting from the operation of all 32 Project wind turbines were calculated at 105 modeling receptors, and isolines were generated from a grid encompassing the area surrounding the wind turbines. The predicted L_{eq} sound levels at all receptors in the study area ranged from 28 to 46 dBA. Predicted sound levels at all receptor locations that have not signed a waiver with Otter Tail Power are all at or below the state limit of 45 dBA within 100 feet of an inhabited residence. Predicted sound levels at all receptor locations that have signed waivers with Otter Tail Power are below the waiver limit of 50 dBA within 200 feet of an inhabited residence. Thus, the Project meets the requirements with respect to sound in the regulations.

Appendix A
Sound Source Coordinates

Table A-1: Wind Turbine Coordinates

Wind Turbine ID	Wind Turbine Type	Hub Height (m)	Coordinates NAD83 UTM Zone 14N (meters)	
			X (Easting)	Y (Northing)
34	GE 1.6-91	80	578932.82	5221992.08
35	GE 1.6-91	80	579281.66	5221996.74
36	GE 1.6-91	80	579554.22	5222033.96
37	GE 1.6-91	80	579909.88	5222083.20
38	GE 1.6-91	80	580204.73	5222142.76
39	GE 1.6-91	80	577033.81	5219922.21
40	GE 1.6-91	80	577389.11	5220015.87
41	GE 1.6-91	80	577751.91	5220109.20
42	GE 1.6-91	80	578092.09	5220202.81
43	GE 1.6-91	80	578370.79	5220350.98
44	GE 1.6-91	80	578644.17	5220332.15
45	GE 1.6-91	80	579135.63	5220450.17
46	GE 1.6-91	80	579423.66	5220465.14
47	GE 1.6-91	80	580007.59	5220461.87
48	GE 1.6-91	80	580280.68	5220465.57
49	GE 1.6-91	80	580674.80	5220504.04
50	GE 1.6-91	80	581040.63	5220920.28
51	GE 1.6-91	80	581095.28	5221365.84
52	GE 1.6-91	80	581397.21	5221458.57
53	GE 1.6-91	80	581683.19	5221618.11
54	GE 1.6-91	80	581946.11	5221810.81
55	GE 1.6-91	80	582172.02	5221914.08
56	GE 1.6-91	80	582404.05	5222117.37
57	GE 1.6-91	80	582681.70	5222332.42
58	GE 1.6-91	80	580960.93	5220108.14
59	GE 1.6-91	80	581278.71	5220145.50
60	GE 1.6-91	80	581597.15	5220172.33
61	GE 1.6-91	80	582192.98	5220402.74
62	GE 1.6-91	80	582388.15	5220561.06
63	GE 1.6-91	80	584203.29	5219842.09
64	GE 1.6-91	80	584406.18	5219978.13
65	GE 1.6-91	80	584670.83	5220048.37

Appendix B

Sound Level Modeling Results - Tabular

Table B-1.1: Sound Level Modeling Results Sorted by Receptor ID

Receptor ID	Signed Waiver	Coordinates UTM NAD83 Zone 14N		Project Only L_{eq} Sound Level (dBA)
		X (m)	Y (m)	
A167	No	575218.28	5219071.08	33
A167-E	No	575248.75	5219071.47	33
A167-S	No	575218.67	5219040.61	32
A167-W	No	575187.82	5219070.69	32
A167-N	No	575217.90	5219101.55	33
A168	No	575774.24	5219489.86	35
A168-E	No	575804.71	5219490.25	36
A168-S	No	575774.63	5219459.40	35
A168-W	No	575743.77	5219489.47	35
A168-N	No	575773.85	5219520.33	36
A169	No	577273.49	5218307.23	36
A169-E	No	577303.95	5218307.62	36
A169-S	No	577273.88	5218276.76	36
A169-W	No	577243.02	5218306.83	36
A169-N	No	577273.09	5218337.69	36
A170	Yes	577430.75	5217768.83	30
A170-E	Yes	577461.22	5217769.23	28
A170-S	Yes	577431.15	5217738.36	33
A170-W	Yes	577400.29	5217768.43	29
A170-N	Yes	577430.36	5217799.30	34
A171	No	579265.26	5218098.36	35
A171-E	No	579295.73	5218098.76	35
A171-S	No	579265.67	5218067.89	35
A171-W	No	579234.79	5218097.95	35
A171-N	No	579264.85	5218128.82	36
A172	No	582053.38	5218060.04	34
A172-E	No	582083.85	5218060.46	35
A172-S	No	582053.81	5218029.57	34
A172-W	No	582022.92	5218059.62	34
A172-N	No	582052.96	5218090.51	35
A175	No	585576.54	5219534.46	38
A175-E	No	585607.01	5219534.90	38
A175-S	No	585576.98	5219504.00	38
A175-W	No	585546.08	5219534.03	39
A175-N	No	585576.10	5219564.93	38
A176	Yes	582984.79	5219656.29	41
A176-E	Yes	583015.26	5219656.71	40
A176-S	Yes	582985.22	5219625.82	40
A176-W	Yes	582954.32	5219655.86	41
A176-N	Yes	582984.36	5219686.75	42
A177	No	581161.73	5219680.59	45
A177-E	No	581192.19	5219681.01	45

Table B-1.1: Sound Level Modeling Results Sorted by Receptor ID

Receptor ID	Signed Waiver	Coordinates UTM NAD83 Zone 14N		Project Only L_{eq} Sound Level (dBA)
		X (m)	Y (m)	
A177-S	No	581162.14	5219650.13	45
A177-W	No	581131.26	5219680.18	45
A177-N	No	581161.31	5219711.06	45
A178	No	575927.34	5222008.56	29
A178-E	No	575957.81	5222008.95	30
A178-S	No	575927.73	5221978.10	29
A178-W	No	575896.88	5222008.17	29
A178-N	No	575926.95	5222039.03	30
A179	No	576953.92	5221944.49	36
A179-E	No	576984.39	5221944.89	35
A179-S	No	576954.32	5221914.02	35
A179-W	No	576923.46	5221944.09	36
A179-N	No	576953.53	5221974.96	36
A180	No	578619.96	5224316.01	34
A180-E	No	578650.43	5224316.41	34
A180-S	No	578620.37	5224285.54	34
A180-W	No	578589.50	5224315.61	34
A180-N	No	578619.56	5224346.48	34
A258	Yes	582039.11	5222688.12	45
A258-E	Yes	582069.58	5222688.54	46
A258-S	Yes	582039.54	5222657.65	46
A258-W	Yes	582008.65	5222687.70	45
A258-N	Yes	582038.69	5222718.59	45
A261	Yes	580127.81	5222718.05	45
A261-E	Yes	580158.28	5222718.46	45
A261-S	Yes	580128.22	5222687.58	46
A261-W	Yes	580097.34	5222717.64	45
A261-N	Yes	580127.40	5222748.52	38
A281	No	575795.70	5219471.50	36
A281-E	No	575826.17	5219471.89	36
A281-S	No	575796.09	5219441.04	35
A281-W	No	575765.24	5219471.12	35
A281-N	No	575795.32	5219501.97	36
A282	No	583697.45	5220879.28	41
A282-E	No	583727.92	5220879.71	41
A282-S	No	583697.88	5220848.81	41
A282-W	No	583666.98	5220878.85	40
A282-N	No	583697.02	5220909.74	41
A283	No	583706.45	5220948.40	41
A283-E	No	583736.91	5220948.83	41
A283-S	No	583706.88	5220917.93	41
A283-W	No	583675.98	5220947.97	41

Table B-1.1: Sound Level Modeling Results Sorted by Receptor ID

Receptor ID	Signed Waiver	Coordinates UTM NAD83 Zone 14N		Project Only L_{eq} Sound Level (dBA)
		X (m)	Y (m)	
A283-N	No	583706.02	5220978.87	41
A284	No	579433.58	5221148.89	45
A284-E	No	579464.05	5221149.29	45
A284-S	No	579433.99	5221118.42	45
A284-W	No	579403.11	5221148.48	45
A284-N	No	579433.17	5221179.35	45
A285	No	577126.46	5222111.93	37
A285-E	No	577156.93	5222112.33	37
A285-S	No	577126.85	5222081.46	37
A285-W	No	577095.99	5222111.54	37
A285-N	No	577126.06	5222142.40	37
A286	No	583735.28	5222871.02	38
A286-E	No	583765.74	5222871.45	38
A286-S	No	583735.71	5222840.55	38
A286-W	No	583704.81	5222870.59	38
A286-N	No	583734.85	5222901.49	38
F11	No	579672.00	5222836.00	44
F11-E	No	579702.48	5222836.00	44
F11-S	No	579672.00	5222866.48	44
F11-W	No	579641.52	5222836.00	44
F11-N	No	579672.00	5222805.52	43

Table B-1.2: Sound Level Modeling Results Sorted by Sound Level

Receptor ID	Signed Waiver	Coordinates UTM NAD83 Zone 14N		Project Only L_{eq} Sound Level (dBA)
		X (m)	Y (m)	
A258-S	Yes	582040	5222658	46
A261-S	Yes	580128	5222688	46
A258-E	Yes	582070	5222689	46
A177-N	No	581161	5219711	45
A258	Yes	582039	5222688	45
A284	No	579434	5221149	45
A284-E	No	579464	5221149	45
A284-S	No	579434	5221118	45
A284-W	No	579403	5221148	45
A284-N	No	579433	5221179	45
A261-W	Yes	580097	5222718	45
A177	No	581162	5219681	45
A177-E	No	581192	5219681	45
A258-W	Yes	582009	5222688	45
A261	Yes	580128	5222718	45
A177-W	No	581131	5219680	45
A258-N	Yes	582039	5222719	45
A177-S	No	581162	5219650	45
A261-E	Yes	580158	5222718	45
F11-S	No	579672	5222866	44
F11-E	No	579702	5222836	44
F11	No	579672	5222836	44
F11-W	No	579642	5222836	44
F11-N	No	579672	5222806	43
A176-N	Yes	582984	5219687	42
A176-W	Yes	582954	5219656	41
A282-S	No	583698	5220849	41
A176	Yes	582985	5219656	41
A282-E	No	583728	5220880	41
A282-N	No	583697	5220910	41
A282	No	583697	5220879	41
A283-S	No	583707	5220918	41
A283	No	583706	5220948	41
A283-W	No	583676	5220948	41
A283-N	No	583706	5220979	41
A283-E	No	583737	5220949	41
A282-W	No	583667	5220879	40
A176-E	Yes	583015	5219657	40
A176-S	Yes	582985	5219626	40
A175-W	No	585546	5219534	39
A286-W	No	583705	5222871	38
A286-S	No	583736	5222841	38

Table B-1.2: Sound Level Modeling Results Sorted by Sound Level

Receptor ID	Signed Waiver	Coordinates UTM NAD83 Zone 14N		Project Only L_{eq} Sound Level (dBA)
		X (m)	Y (m)	
A175-N	No	585576	5219565	38
A286	No	583735	5222871	38
A261-N	Yes	580127	5222749	38
A286-E	No	583766	5222871	38
A286-N	No	583735	5222901	38
A175	No	585577	5219534	38
A175-S	No	585577	5219504	38
A175-E	No	585607	5219535	38
A285-E	No	577157	5222112	37
A285-S	No	577127	5222081	37
A285	No	577126	5222112	37
A285-W	No	577096	5222112	37
A285-N	No	577126	5222142	37
A169-N	No	577273	5218338	36
A179-W	No	576923	5221944	36
A169	No	577273	5218307	36
A169-E	No	577304	5218308	36
A169-W	No	577243	5218307	36
A169-S	No	577274	5218277	36
A179	No	576954	5221944	36
A281-E	No	575826	5219472	36
A281-N	No	575795	5219502	36
A168-E	No	575805	5219490	36
A168-N	No	575774	5219520	36
A179-N	No	576954	5221975	36
A171-N	No	579265	5218129	36
A281	No	575796	5219472	36
A168	No	575774	5219490	35
A171	No	579265	5218098	35
A171-E	No	579296	5218099	35
A171-W	No	579235	5218098	35
A179-S	No	576954	5221914	35
A281-S	No	575796	5219441	35
A168-S	No	575775	5219459	35
A171-S	No	579266	5218068	35
A281-W	No	575765	5219471	35
A168-W	No	575744	5219489	35
A179-E	No	576984	5221945	35
A172-E	No	582084	5218060	35
A172-N	No	582053	5218091	35
A172	No	582053	5218060	34
A172-S	No	582054	5218030	34

Table B-1.2: Sound Level Modeling Results Sorted by Sound Level

Receptor ID	Signed Waiver	Coordinates UTM NAD83 Zone 14N		Project Only L_{eq} Sound Level (dBA)
		X (m)	Y (m)	
A172-W	No	582023	5218060	34
A170-N	Yes	577430	5217799	34
A180-S	No	578620	5224286	34
A180	No	578620	5224316	34
A180-E	No	578650	5224316	34
A180-W	No	578589	5224316	34
A180-N	No	578620	5224346	34
A170-S	Yes	577431	5217738	33
A167-E	No	575249	5219071	33
A167	No	575218	5219071	33
A167-N	No	575218	5219102	33
A167-S	No	575219	5219041	32
A167-W	No	575188	5219071	32
A178-N	No	575927	5222039	30
A170	Yes	577431	5217769	30
A178-E	No	575958	5222009	30
A178	No	575927	5222009	29
A178-S	No	575928	5221978	29
A178-W	No	575897	5222008	29
A170-W	Yes	577400	5217768	29
A170-E	Yes	577461	5217769	28

DOCUMENT NUMBER 263841

AFTER RECORDING RETURN TO

Carlos Megias
FPL Energy, LLC
700 Universe Blvd. (LAW/JB)
Juno Beach, FL 33408

(This space reserved for recording information)

ASSIGNMENT AND ASSUMPTION OF REAL PROPERTY INTERESTS

THIS ASSIGNMENT AND ASSUMPTION OF REAL PROPERTY INTERESTS (the "**Assignment**") is made and dated as of this 7th day of October, 2008 (the "**Effective Date**") by and between Ashtabula Wind, LLC, a Delaware limited liability company ("**Assignor**") and Otter Tail Corporation, a Minnesota Corporation doing business as Otter Tail Power Company ("**Assignee**").

RECITALS

WHEREAS, Assignor is currently developing a wind-powered electric generating project with a nameplate capacity of approximately 159 megawatts ("**MW**") located in Barnes County, North Dakota (the "**Ashtabula Project**");

WHEREAS, Assignee desires to purchase a 48 MW portion of the Ashtabula Project and the Assets related thereto (the "**OTP Project**");

WHEREAS, Assignor desires to sell, and Assignee desires to purchase the OTP Project on the terms and subject to the conditions set forth in the Purchase and Sale Agreement entered into by and between Assignor and Assignee on July 31, 2008 ("**Agreement**");

WHEREAS, Assignor entered into Wind Farm Easement Agreements and Collection Easements (collectively the "**Easements**") with various property owners for the purpose of constructing, operating and maintaining the Ashtabula Project;

WHEREAS, pursuant to the Agreement, Assignor desires to assign to Assignee, and Assignee desires to accept from Assignor an assignment of those Easements in the Ashtabula Project for the OTP Project as more specifically set forth herein.

NOW, THEREFORE, in consideration of Ten and NO/100 Dollars ($10.00), and other good and valuable consideration, the receipt and adequacy of which is hereby acknowledged, the parties agree as follows:

AGREEMENT

Return To: Cameron D. Sillers
908 3rd St.
LANGDON ND 58249

(This space reserved for recording information)

1. Assignor hereby grants, assigns, transfers and conveys to Assignee, all of its rights, title and interest in and to the Easements set forth in **Exhibit "A"** and legally described in **Exhibit "B"** attached hereto and made a part hereof..

2. Assignee hereby accepts said assignment as the successor to the Easements and agrees to comply with each of the terms and conditions of the assigned Easements, from and after the Effective Date. Assignor and Assignee shall provide written notice of this Assignment to the various property owners that are parties to the Easements.

3. If any provision of this Assignment or the application of any such provision to any person or circumstance shall be held invalid, illegal or unenforceable in any respect by a court of competent jurisdiction, such invalidity, illegality or unenforceability shall not affect any other provision hereof.

4. No provision set forth in this Assignment shall be deemed to enlarge, alter or amend the terms or provisions of the Easements. This Assignment shall be governed by and construed in accordance with the laws of the State of North Dakota.

5. This Assignment may be executed in one or more counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same instrument.

6. This Assignment shall be binding upon and inure to the benefit of the parties hereto and their respective successors and assigns and may be executed in counterparts, each of which shall be deemed an original and all of which shall be one and the same instrument.

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2 of 12

Return To: Cameron D. Sillers
908 3rd St.
LANGDON ND 58249

(This space reserved for recording information)

IN WITNESS WHEREOF, Assignor and Assignee have executed this Assignment as of the date first above written.

Assignor:
Ashtabula Wind, LLC,
A Delaware limited liability company

By: _____
Dean R. Gosselin, Vice President

STATE OF FLORIDA)
)
COUNTY OF PALM BEACH)

The foregoing instrument was duly acknowledged before me this 7th day of October, 2008, by Dean R. Gosselin, as Vice President of Ashtabula Wind, LLC, a Delaware limited liability company, who subscribed to the foregoing instrument and acknowledged that he executed the same on behalf of said limited liability company and that he was duly authorized to do so.

Rita M. Ellman
Commission # DD41559
Expires June 17, 200
Troy Fain - Insurance, Inc. 800-

_____
Notary Public, State of Florida

_____
Notary Printed Name

_____
My Commission Expires:

Return To: Cameron D. Sillers
908 3rd St.
LANGDON ND 58249

(This space reserved for recording information)

IN WITNESS WHEREOF, Assignor and Assignee have executed this Assignment as of the date first above written.

Assignee:
Otter Tail Corporation,
a Minnesota Corporation, d/b/a
Otter Tail Power Company

By: _____
Charles MacFarlane, President

STATE OF MINNESOTA)
)
COUNTY OF OTTER TAIL)

The foregoing instrument was duly acknowledged before me this 30th day of September, 2008, by Charles MacFarlane, as President of Otter Tail Corporation, a Minnesota Corporation, d/b/a Otter Tail Power Company, who subscribed to the foregoing instrument and acknowledged that he executed the same on behalf of said limited liability company and that he was duly authorized to do so.

Nancy LuAnn Olson
Notary Public, State of Minnesota

Nancy LuAnn Olson
Notary Printed Name

1-31-2010
My Commission Expires:

NANCY LUANN OLSON
NOTARY PUBLIC—MINNESOTA
My Commission Expires JAN. 31, 2010

DLI- 6204542v1

263841
4 of 12

Return To: Cameron D. Sillers
908 3rd St.
LANGDON ND 58249

(This space reserved for recording information)

EXHIBIT A
Easements to be Assigned

The following Easements are assigned:

Wind Farm Easement Agreements:

Tracts 1a, 1b and 1c:
That certain Wind Farm Easement Agreement, dated October 6, 2008, a memorandum of which is filed October 9, 2008 as Document No. 263830.

Tract 2a, 2b and 2c:
That certain Wind Farm Easement Agreement, dated November 7, 2007, a memorandum of which is filed February 4, 2008 as Document No. 261620.

Tracts 3a, 3b and 3c:
That certain Wind Farm Easement Agreement, dated October 6, 2008, a memorandum of which is filed October 9, 2008 as Document No. 263832.

Tracts 4a and 4b:
That certain Wind Farm Easement Agreement, dated December 17, 2007, a memorandum of which is filed February 4, 2008 as Document No. 261656.

Tract 5:
That certain Wind Farm Easement Agreement, dated October 2, 2008, a memorandum of which is filed October 9, 2008 as Document No. 263833.

Tracts 6a and 6b:
That certain Wind Farm Easement Agreement, dated November 27, 2007, a memorandum of which is filed February 4, 2008 as Document No. 261588.

Tract 7:
That certain Wind Farm Easement Agreement October 2, 2008, a memorandum of which is filed October 9, 2008 as Document No. 263834.

Tract 8:
That certain Wind Farm Easement Agreement, dated November 7, 2007, a memorandum of which is filed February 4, 2008 as Document No. 261575.

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Return To: Cameron D. Sillers
908 3rd St.
LANGDON ND 58249

(This space reserved for recording information)

Tracts 9a, 9b and 9c:
That certain Wind Farm Easement Agreement, dated February 18, 2008, a memorandum of which is filed April 8, 2008 as Document No. 262365.

Tracts 10a and 10b:
That certain Wind Farm Easement Agreement, dated October 2, 2008, a memorandum of which is filed October 9, 2008 as Document No. 263837.

Tract 11:
That certain Wind Farm Easement Agreement, dated August 10, 2007, a memorandum of which is filed November 23, 2007 as Document No. 261013.

Tract 12:
That certain Wind Farm Easement Agreement, dated January 18, 2008, a memorandum of which is filed March 27, 2008 as Document No. 262174.

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EXHIBIT B
Legal Descriptions of the Easements

Wind Farm Easements

Tract 1a: The SW¼ of Section 10, Township 142N, Range 57 West of the 5th P.M., Barnes County, North Dakota, according to the United States Government Survey thereof excepting all that portion previously acquired for public highway right-of-way and all of that portion lying within 33 feet of the Section lines;
AND LESS all that part of the Southwest Quarter (SW¼) of Section 10, Township 142 North, Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota, described as follows:
Beginning at a point that lies North 88°28'12" East along the South line of said Section 10, a distance of 965.00 feet from the Southwest corner of Section 10; thence North 02°18'37" West a distance of 522.00 feet; thence North 88°28'12" East a distance of 250.36 feet; thence South 02°18'37" East a distance of 522.00 feet to the South line of said Section 10; thence South 88°28'12" along the South line of said Section 10 a distance of 250.36 feet to the point of beginning;
AND LESS all that part of the Southwest Quarter (SW¼) of Section 10, Township 142 North, Range 57 West of the Fifth Principal Meridian, Barnes County, North Dakota, described as follows:
Beginning at the Southwest Corner of Section 10; thence North 02°18'37" West along the West line of said Section 10 a distance of 522.00 feet; thence North 88°28'12" East a distance of 965.00 Feet; thence South 02°18'37" East a distance of 522.00 Feet to the South Line of said Section 10; thence South 88°28'12" West along the South Line of said Section 10 a distance of 965.00 Feet to the point of beginning.

Tract 1b: Auditors Lot Number 1 of SE¼ of Section 9, Township 142N, Range 57W, Barnes County, North Dakota, and more particularly described as follows: Beginning at the Southwest corner of the SE¼ of said Section 9; thence N02°18'47"W along the Quarter line a distance of 495.00 feet to an iron pin; thence N88°16'14"E a distance of 525.00 feet to an iron pin; thence S02°18'47"E a distance of 495.00 feet to an iron pin on the South line of said Section 9; thence S88°16'14"W along the Section line a distance of 525.00 feet to the Point of Beginning.

Tract 1c: That certain tract of land beginning at a point 100 rods West of the SE corner of Section 9, Township 142N, Range 57W, Barnes County, North Dakota; thence running North

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320 rods; thence West 60 rods; thence South 100 rods; thence West 53 1/3 rods; thence South 120 rods; thence East 53 1/3 rods; thence South 100 rods; thence East 60 rods to the point of beginning, LESS AND EXCEPT Auditors Lot Number 1 of SE¼ of Section 9, Township 142N, Range 57W, Barnes County, North Dakota, and more particularly described as follows:

Beginning at the Southwest corner of the SE¼ of said Section 9, thence N02°18'47"W along the Quarter line a distance of 495.00 feet to an iron pin; thence N88°16'14"E a distance of 525.00 feet to an iron pin; thence S02°18'47"E a distance of 495.00 feet to an iron pin on the South line of said Section 9; thence S88°16'14"W along the Section line a distance of 525.00 feet to the Point of Beginning.

Tract 2a: The NE¼ of Section 7, Township 142N, Range 57 of the 5th P.M., Barnes County, North Dakota, according to the United States Government Survey thereof.

Tract 2b: The Southwest Quarter (SW¼), Section Thirty-two (32), Township One Hundred Forty-three North (143N), Range Fifty-seven West (57W) of the Fifth Principal Meridian, Barnes County, North Dakota, according to the United States Government Survey thereof;

LESS all that portion of the SW¼, Section 32, Township 143, Range 57, lying within a strip of land, said strip being 40 feet wide, lying adjacent to the south and west lines of the SW¼, Section 32, Township 143, Range 57 and described as follows: Beginning at the NW corner of said SW¼, Section 32, thence running S0°15'E 2075.1 ft. thence along a 10° curve to the left, 895.7 ft. thence S89°49'E 2075.5 ft. to the SE corner of said SW¼, Section 32, also including all that portion lying between said strip and the South and West lines of said SW¼, Section 32, excepting all that portion lying within 33 ft. of the section line (tract contains 2.21 acres, more or less);

AND LESS the south 65 feet of the SW¼, Section 32, Township 143N, Range 57W of the 5th P.M. Excepting all that portion lying within 33 feet of the Section line of the West 572 feet and all that portion lying within 40 feet of the Section line of the east 2068 feet (33 feet plus 7 feet previously acquired for public highway right-of-way).

Tract 2c: The N½SW¼, Section 7, Township 142N, Range 57W of the 5th P.M., Barnes County, North Dakota, according to the United States Government Survey thereof.

Tract 3a: The SW¼ of Section 8, in Township 142N, of Range 57W of the 5th P.M., Barnes County, North Dakota, according to the United States Government Survey thereof,

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LESS the E.238' of the S.502' of the SW¼ of Section 8, Township 142, Range 57, Barnes County, North Dakota, subject to highways, easements, rights of way, mineral conveyances and mineral reservations of record.

Tract 3b: The SE¼ of Section 8, Township 142N, Range West 57W of the5th P.M., Barnes County, North Dakota, according to the United States Government Survey thereof;
LESS the W.365' of the S.502' of the SE¼, Section 8, Township 142, Range 57. Barnes County, North Dakota, containing 4.2 acres, more or less, subject to highways, easements, rights of way, mineral conveyances and mineral reservations of record.

Tract 3c: The NE¼, Section 8, Township 142N, Range 57W, Barnes County, North Dakota, according to the United States Government Survey thereof.

Tract 4a: The NE¼ and the N½SE¼ of Section 11, Township 142N, Range 58W of the 5th P.M., Barnes County, North Dakota.

Tract 4b: The S½SE¼, Section 11, Township 142N, Range 58W of the 5th P.M., Barnes County, North Dakota.

Tract 5: The SE¼; the W½NE¼; and the E½NW¼, Section 6, Township 142N, Range 57W of the Fifth Principal Meridian, Barnes County, North Dakota, according to the United States Government Survey thereof.

Tract 6a: The E½NE¼ of Section 6, Township 142N, Range 57W of the 5th P.M., Barnes County, North Dakota, LESS a tract of land in the E½NE¼, Section 6, Township 142N, Range 57W, Barnes County, North Dakota, and more particularly described as follows: Beginning at the NE corner of said Section 6, thence west along the north line of said Section 6 a distance of 1,326.8 feet to a point; thence south a distance of 50.9 feet to a point; thence S88°58'E a distance of 369.0 feet to a point; thence North a distance of 24.6 feet to a point; thence east a distance of 50.0 feet to a point; thence North 9.4 feet to a point; thence S88°58'E a distance of 400.0 feet to a point, thence south 37.8 feet to a point; thence S88°58'E a distance of 507.8 feet to a point; thence North 75.0 feet to the point of beginning. Excepting all that portion lying within 33 feet of the Section line.

Tract 6b: The W½NW¼, Section 6, Township 142N, Range 57W of the 5th P.M., Barnes County, North Dakota, according to the United States Government Survey thereof,

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LESS a tract of land situated in the W½NW¼, Section 6, Township 142, Range 57, Barnes County, North Dakota, and more particularly described as follows: Commencing at the Northwest corner of said Section 6, thence east along the north line of said Section 6 a distance of 288.2' to the point of beginning; thence continuing east a distance of 949.1' to a point; thence south 75.0' to a point; thence west a distance of 416.7' to a point; thence along a 3° curve to the right a distance of 539.6' to the point of beginning. Excepting all that portion lying within 33' of the section line.

Tract 7: The W½NE¼; the NW¼ and the S½ of Section 5, Township 142N, Range 57 West of the 5th P.M., Barnes County, North Dakota, according to the United States Government Survey thereof;
LESS: One acre of land situate in Barnes Co., viz:
Commencing fifty-four rods East of the Southwest corner of Section 5, Township 142, Range 57, then running North fourteen rods, then East eleven rods, thence South fourteen rods, thence West to place of starting;
LESS: A strip of land lying in the Fr. NW¼ of Section 5, Township 142, Range 57, said strip being described as follows:
A strip of land 40 feet wide lying South of, adjacent to and extending along the entire North line of said Fr. NW¼ of Section 5, excepting all that portion lying with 33 feet of the Section line. Tract contains 0.42 acres, more or less.
Also a strip of land lying in the Fr. W½NE¼, Section 5, Township 142, Range 57, said strip being described as follows: A strip of land 40 feet wide lying South of, adjacent to and extending along the entire North line of said Fr. W½NE¼ of Section 5, excepting all that portion lying within 33 feet of the Section line;
LESS: The North 75 feet of the W½NE¼ of Section 5, Township 142N, Range 57W, Barnes County, North Dakota, excepting all the portion lying within 40 feet of the Section line (33 feet plus 7 feet previously acquired for public highway right-of-way);
LESS: The North 75 fee of the W½NE¼ of Section 5, Township 142N, Range 57W, Barnes County, North Dakota, excepting all the portion lying within 33 feet of the Section line of the West 572 feet and all that portion lying with 40 feet of the Section line of the East 2068 feet (33 feet plus 7 feet previously acquired for public highway right-of-way).

Tract 8: The N½ of Section 4, Township 142N, Range 57W of the 5th P.M., Barnes County, North Dakota; LESS a strip of land lying in the Fr. NW¼, Section 4, Township 142N, Range 57W, said strip being described as follows: a strip of land 40 feet wide lying south of, adjacent to and extending along the entire north line of said NW¼, Section 4 excepting all that portion lying within 33 ft. of the section line;

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AND LESS a strip of land lying in the Fr. NE¼, Section 4, Township 142N, Range 57W, said strip being described as follows: a strip of land 40 feet wide lying south of, adjacent to and extending along the entire north line of said Fr. NE¼, Section 4, excepting all that portion lying within 33 ft. of the section line;

AND LESS the East 75.0' of the NE¼, Section 4, Township 142, Range 57, Barnes County, North Dakota. Excepting all that portion previously acquired for public highway right of way and all that portion within 33' of the section lines;
AND LESS the North 75' of the NE¼, Section 4, Township 142, Range 57, Barnes County, North Dakota. Excepting all that portion lying within 40' of the sec. Line (33 feet plus 7 feet previously acquired for public highway right of way);
AND LESS the North 75' of the NW¼, Section 4, Township 142, Range 57, Barnes County, North Dakota. Excepting all that portion lying within 40' of the sec. Line (33 feet plus 7 feet previously acquired for public highway right of way).

Tract 9a: The NE¼, Section 12, Township 142N, Range 58W, Barnes County, North Dakota.

Tract 9b: The N½S½ and Lots 2, 3, 4, and 5, of Section 12, Township 142N, Range 58W of the5th P.M., Barnes County, North Dakota.

Tract 9c: The NW¼, Section 7, Township 142N, Range 57W of the 5th P.M., Barnes County, North Dakota, according to the United States Government Survey thereof.

Tract 10a: That portion of the W½ of Section 9. Township 142, Range 57, Barnes County, North Dakota, described by metes and bounds as follows:
Beginning at a point 160 rods North and 106 and 2/3 rods East from the Southwest corner of said Section 9, thence running North 60 rods; thence West 106 and 2/3 rods; thence South 60 rods; thence East 106 and 2/3 rods, to the point of beginning;
Also that portion of Section 9, Township 142N, Range 57W, Barnes County, ND, bounded and particularly described as follows, to-wit: Beginning at a point 100 rods North of the Southwest corner of said Section 9; thence East 106 and 2/3 rods; thence North 60 rods; thence West 106 2/3 rods; thence South 60 rods, to the place of beginning;
Also all that part of the SW¼ of Section 9, Township 143N, Range 57W, Barnes County, ND, described by metes and bounds as follows, to-wit: Beginning with the Southwest corner of said Section 9, thence running East 160 rods along the south line of said section, to the Southeast corner of the SW¼ of said Section 9, thence running North a distance of 100 rods along the east line of the SW¼ of said Section 9; thence running West 160 rods along a line parallel to the

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south line of said section to a point on the west line of said section 9; thence South a distance of 100 rods along the west line of said section to the place of beginning, excepting two acres in the Southwest corner of said tract, still outstanding and held under former conveyance by deed to the Free Methodist Church, the said tract hereby conveyed. All of the said several measurements being based upon the Government Survey of the said section 9.

LESS: Beginning at the quarter stake at the Southeast corner of the SW¼ of Section 9, Township 142, Range 57, thence West 30 rods to a stake, thence North at right angles to the Section line 18 rods, to a stake, thence East 30 rods to the quarter line extending North and South through center of said Section, thence South along said quarter line 18 rods to the place of beginning.

LESS: Beginning at a point 18 rods due North of the quarter stake at the Southeast corner of the SW¼ of Section 9, in Township 142, Range 57, thence running due North for 12 rods, thence due West for 30 rods, thence due South 12 rods, thence due East 30 rods to the place of beginning.

Tract 10b: The SE¼ of Section 10, Township 142N, Range 57W of the 5th P.M., Barnes County, North Dakota. Subject to easements and rights of way.

Tract 11: The NW¼ of Section 8, Township 142N, Range 57W of the 5th P.M., Barnes County, North Dakota.

Tract 12: The SW¼ of Section 4, Township 142N, Range 57W of the 5th P.M., Barnes County, North Dakota.

DOCUMENT NUMBER **263841**

Grantor J
Grantee J
Indexed J
Checked CK'K

COUNTY RECORDER BARNES SEAL COUNTY STATE OF NORTH DAKOTA

Fee: $ 81.00 **263841**

OFFICE OF COUNTY RECORDER County of Barnes, North Dakota
I hereby certify that the within instrument was filed in this office on 10/9/2008 at 2:38 PM and was duly recorded.

Kristin Ochsner **County Recorder**

By _____ **Deputy**

DLI- 6204542v1

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Return To: Cameron D. Sillers
908 3rd St.
LANGDON ND 58249

WIND FARM EASEMENT AGREEMENT

1. **Parties**. This Wind Farm Easement Agreement ("**Agreement**") is made and entered as of the 6TH day of OCTOBER, 2008 ("**Effective Date**"), by and between Perry J. Burchill and Kathy L. Burchill ("**Owner**") and Ashtabula Wind, LLC, a Delaware limited liability company, an affiliate of FPL Energy, LLC, a Delaware limited liability company ("**Operator**") who are sometimes individually referred to as a "**Party**" and collectively as the "**Parties.**"

2. **Project**. This Agreement relates to the wind-powered electrical power generation and transmission project known as the "**Ashtabula Wind Energy Center**" to be located in Barnes County, North Dakota ("**Wind Farm**"), which may be wholly or partially located on the Owner's property legally described on the attached Exhibit "A" to this Agreement ("**Owner's Property**"). The Wind Farm shall include (i) the Easements referenced in Section 4 that are located on the Owner's Property, and (ii) the Improvements to be constructed on Owner's Property, including the Turbines referenced in Section 7.1. The Easements and Improvements are sometimes collectively referred to as the "**Operator Property.**"

[redacted]

[redacted]

4.7 **Noise Easement**. Owner grants Operator an irrevocable, non-exclusive easement for the right and privilege to generate and maintain audible noise levels in excess of fifty (50) dbA on and above the Noise Easement Property at any or all times of the day or night ("**Noise Easement**"). The "**Noise Easement Property**" shall mean the Owner's Property except those portions within a 200-foot radius circle (or lesser distance with Owner's prior written consent) centered on the inside of each presently existing, occupied residence on the Owner's Property. If noise levels emanating from the Turbines exceed fifty (50) dbA without the Owner's written consent as measured within 200 feet (or lesser agreed distance) from the inside of a presently existing residence on Owner's Property by an independent professional applying commonly accepted measurement instruments and standards, Operator shall reduce the noise level to 50 dbA at 200 feet (or lesser agreed distance) from the residence. Measures to be taken by Operator may include installing insulation or sound deadening material in the offending Turbine(s); installing landscaping, insulation, and sound deadening material at the residence; or, changing the operation of the Turbine(s) to reduce noise output.

[redacted]

Owner

Perry J. Burchill

Kathy L. Burchill

Operator
Ashtabula Wind, LLC,
a Delaware limited liability company

By: _____
Name: DEAN GOSSELIN
Title: VP

EXHIBIT "A"

Legal Description of Owner's Property

The SW¼ of Section 8, in Township 142N, of Range 57W of the 5th P.M., Barnes County, North Dakota, according to the United States Government Survey thereof,
LESS the E.238' of the S.502' of the SW¼ of Section 8, Township 142, Range 57, Barnes County, North Dakota, subject to highways, easements, rights of way, mineral conveyances and mineral reservations of record.

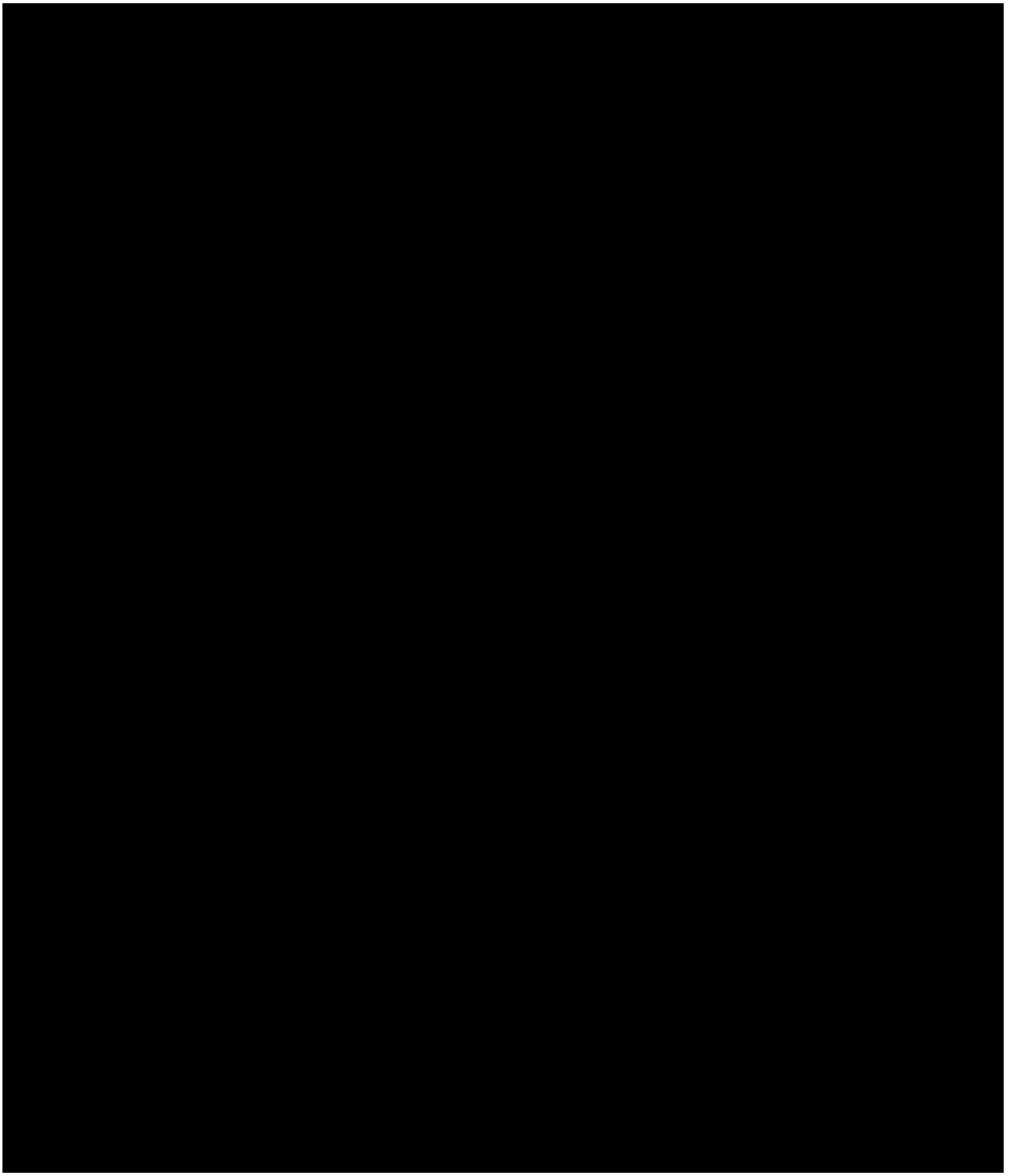
The SE¼,of Section 8, Township 142N, Range West 57W of the5th P.M., Barnes County, North Dakota, according to the United States Government Survey thereof;
LESS the W.365' of the S.502' of the SE¼, Section 8, Township 142, Range 57. Barnes County, North Dakota, containing 4.2 acres, more or less, subject to highways, easements, rights of way, mineral conveyances and mineral reservations of record.

The North Half (N 1/2) of the Northeast Quarter (NE ¼) and the South Half (S ½) of the Northeast Quarter (NE ¼) all in Section 8, Township 142, Range 57, Barnes County, North Dakota.

WIND FARM EASEMENT AGREEMENT

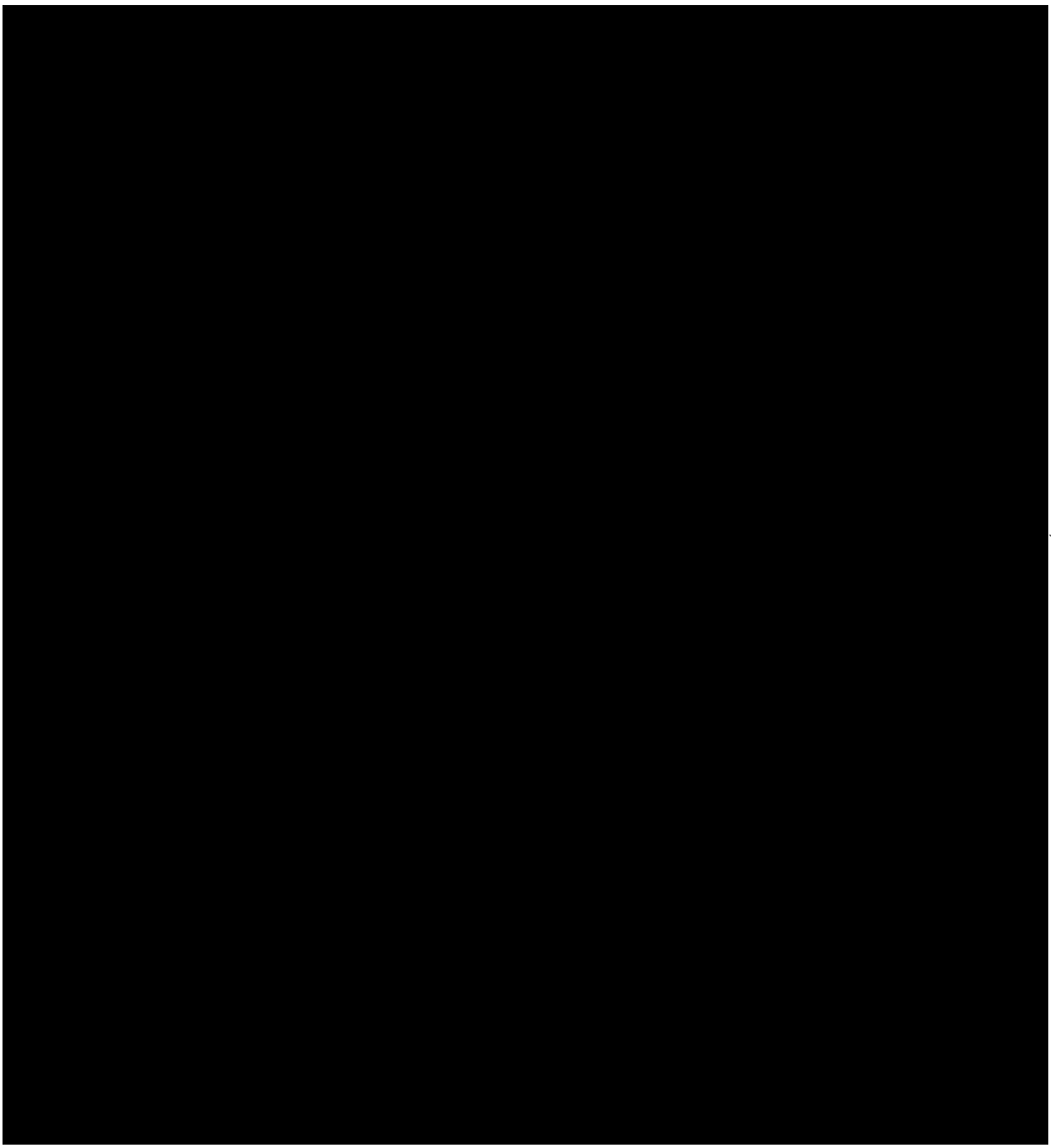
1. **Parties**. This Wind Farm Easement Agreement ("**Agreement**") is made and entered as of the 27 day of Nov., 2007 ("**Effective Date**"), by and between Randall Koch and Peggy Koch, husband and wife ("**Owner**") and Boulevard Associates, LLC, a Delaware limited liability company, an affiliate of FPL Energy, LLC, a Delaware limited liability company ("**Operator**") who are sometimes individually referred to as a "**Party**" and collectively as the "**Parties**."

2. **Project**. This Agreement relates to the wind-powered electrical power generation and transmission project known as the "Ashtabula Wind Energy Center" to be located in Barnes County, North Dakota ("**Wind Farm**"), which may be wholly or partially located on the Owner's property legally described on the attached **Exhibit "A"** to this Agreement ("**Owner's Property**"). Upon Operator's exercise of the Option (as defined below), the Wind Farm shall include (i) the Easements referenced in Section 4 that are located on the Owner's Property, and (ii) the Improvements to be constructed on Owner's Property, including the Turbines referenced in Section 7.1. The Easements and Improvements are sometimes collectively referred to as the "**Operator Property**."



4.7 **Noise Easement**. Owner grants Operator an irrevocable, non-exclusive easement for the right and privilege to generate and maintain audible noise levels in excess of fifty (50) dbA on and above the Noise Easement Property at any or all times of the day or night ("**Noise Easement**"). The "**Noise Easement Property**" shall mean the Owner's Property except those portions within a 200-foot radius circle (or lesser distance with Owner's prior written consent) centered on the inside of each presently existing, occupied residence on the Owner's Property. If noise levels emanating from the Turbines exceed fifty (50) dbA without the Owner's written

consent as measured within 200 feet (or lesser agreed distance) from the inside of a presently existing residence on Owner's Property by an independent professional applying commonly accepted measurement instruments and standards, Operator shall reduce the noise level to 50 dbA at 200 feet (or lesser agreed distance) from the residence. Measures to be taken by Operator may include installing insulation or sound deadening material in the offending Turbine(s); installing landscaping, insulation, and sound deadening material at the residence; or, changing the operation of the Turbine(s) to reduce noise output.



Owner

Randall Koch
Name: Randall Koch

Peggy Koch
Name: Peggy Koch

Operator
Boulevard Associates, LLC
a Delaware limited liability company

By: _____
Name: _____
Title: Dean R. Gosselin
Vice President

EXHIBIT "A"

Legal Description of Owner's Property

The West One-half of the Northwest Quarter (W1/2NW1/4) of Section Six (6), Township One Hundred Forty-two (142), North of Range Fifty-seven (57), West of the Fifth Principal Meridian, Barnes County, North Dakota, according to the United States Government Survey thereof.

The Southwest Quarter (SW1/4) of Section Thirty-one (31), Township One Hundred Forty-three (143) North of Range Fifty-seven (57), West of the Fifth Principal Meridian, Barnes County, North Dakota, according to the United States Government Survey thereof.

The East One-half of the Northeast Quarter (E1/2NE1/4) of Section Six (6), Township One Hundred Forty-two (142), North of Range Fifty-seven (57), West of the Fifth Principle Meridian, Barnes County, North Dakota, according to the United States Government Survey thereof.

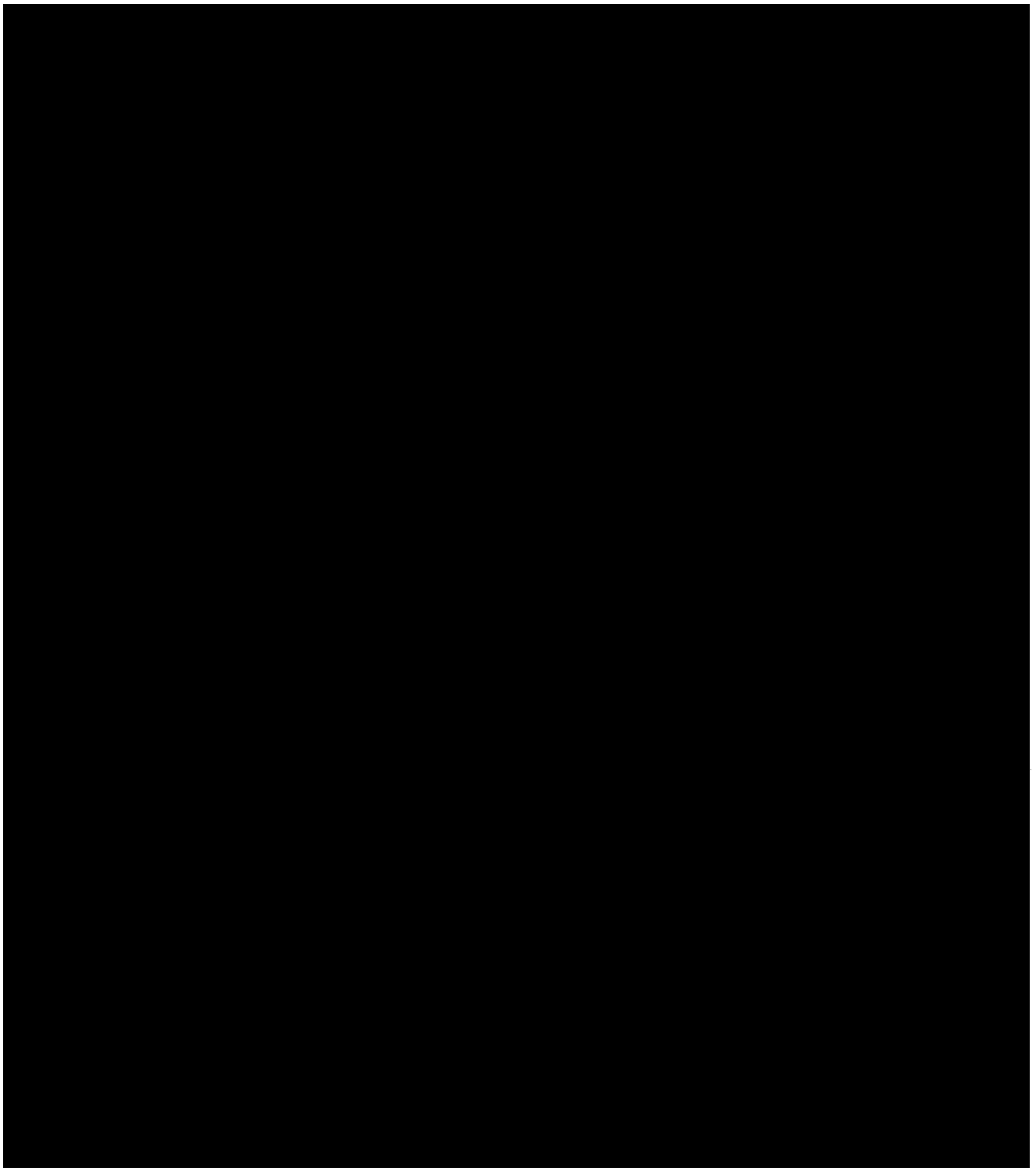
The Southeast Quarter of (SE ¼), of Section 31, Township 143 North, Range 57 West of the 5th P.M. in Barnes County, North Dakota.

WIND FARM EASEMENT AGREEMENT

1. **Parties**. This Wind Farm Easement Agreement ("**Agreement**") is made and entered as of the 7th day of November 2007 ("**Effective Date**"), by and between James H. Leadbetter and Marie Leadbetter, Husband and Wife, subject to the life estate of James A. Leadbetter and Virginia Leadbetter, Husband and Wife ("**Owner**") and Boulevard Associates, LLC, a Delaware limited liability company ("**Operator**") who are sometimes individually referred to as a "**Party**" and collectively as the "**Parties**."

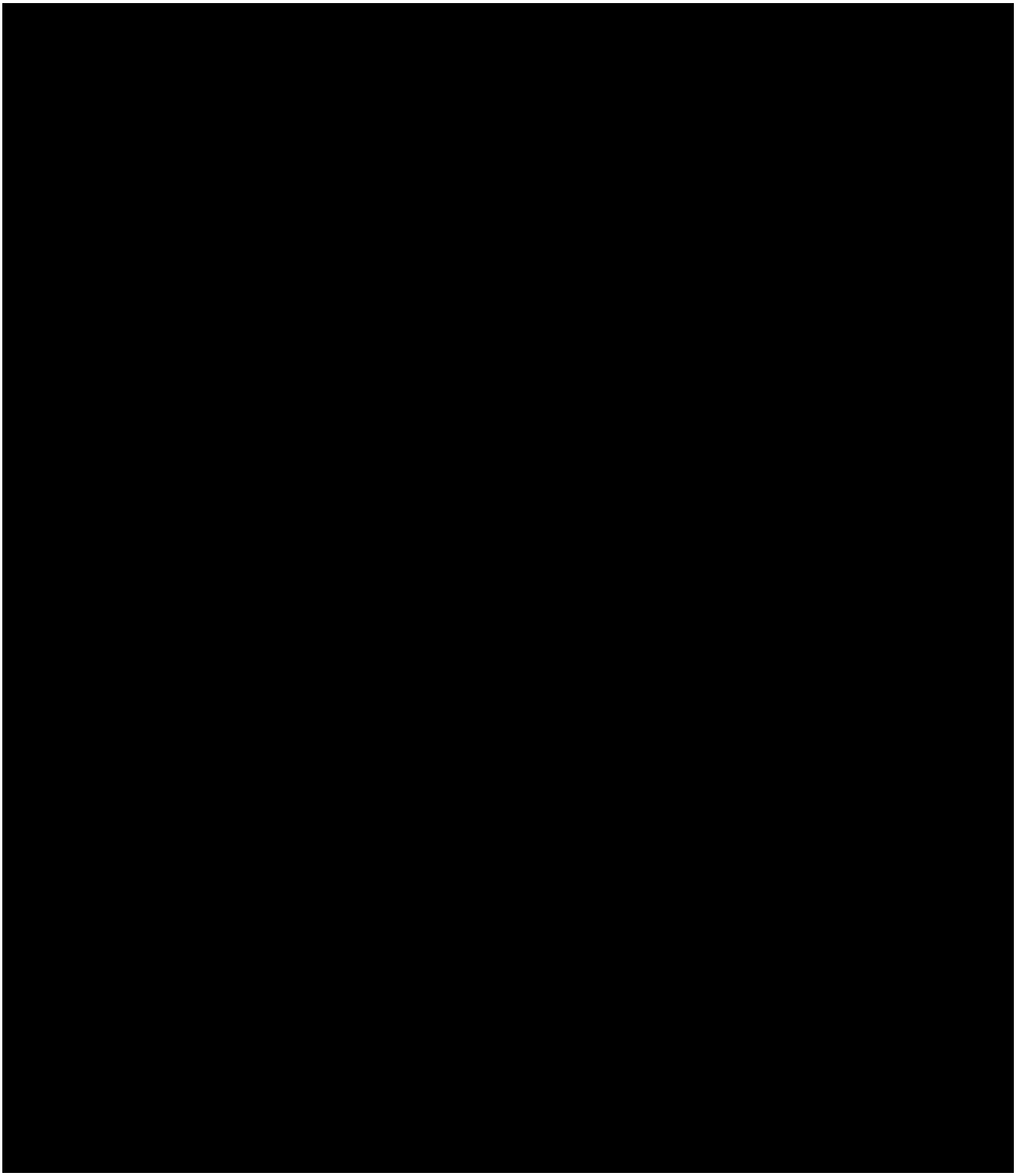
2. **Project**. This Agreement relates to the wind-powered electrical power generation and transmission project known as the "Ashtabula Wind Energy Center" to be located in Barnes County, North Dakota ("**Wind Farm**"), which may be wholly or partially located on the Owner's property legally described on the attached **Exhibit "A"** to this Agreement ("**Owner's Property**"). Upon Operator's exercise of the Option (as defined below), the Wind Farm shall include (i) the Easements referenced in Section 4 that are located on the Owner's Property, and (ii) the Improvements to be constructed on Owner's Property, including the Turbines referenced in Section 7.1. The Easements and Improvements are sometimes collectively referred to as the "**Operator Property**."

[redacted]



4.7 **Noise Easement**. Owner grants Operator an irrevocable, non-exclusive easement for the right and privilege to generate and maintain audible noise levels in excess of fifty (50) dbA on and above the Noise Easement Property at any or all times of the day or night ("**Noise Easement**"). The "**Noise Easement Property**" shall mean the Owner's Property except those portions within a 200-foot radius circle (or lesser distance with Owner's prior written consent) centered on the inside of each presently existing, occupied residence on the Owner's Property. If noise levels emanating from the Turbines exceed fifty (50) dbA without the Owner's written consent as measured within 200 feet (or lesser agreed distance) from the inside of a presently

existing residence on Owner's Property by an independent professional applying commonly accepted measurement instruments and standards, Operator shall reduce the noise level to 50 dbA at 200 feet (or lesser agreed distance) from the residence. Measures to be taken by Operator may include installing insulation or sound deadening material in the offending Turbine(s); installing landscaping, insulation, and sound deadening material at the residence; or, changing the operation of the Turbine(s) to reduce noise output.



Owner

Name: James A. Leadbetter

Name: James A. Leadbetter, Attorney in Fact for Virginia Leadbetter

Name: James H. Leadbetter

Name: Marie Leadbetter

Operator
Boulevard Associates, LLC
a Delaware limited liability company

By: _____
Name: _____
Title: Dean R. Gosselin
Vice President

EXHIBIT "A"

Legal Description of Owner's Property

The North Half (N ½) of Section 4 in Township 142, Range 57 West of the Fifth Principal Meridian, in Barnes County, North Dakota, subject to easements and rights of way of record.

The East One-Half of the Northwest Quarter (E ½ NW ¼), the West One-Half of the Northwest Quarter (W ½ NW ¼), the South Half of the Southeast Quarter (S ½ SE ¼), the North Half of the Southeast Quarter (N ½ SE ¼), in Section 3, Township 141, Range 57 West of the 5th P.M., Banes County, North Dakota.

Appendix B – Shadow Flicker Assessment Results

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SHADOW FLICKER MODELING REPORT

Ashtabula Wind Energy Center Repower Project
Barnes County, North Dakota

Prepared for:

Atwell, LLC
311 North Main
Ann Arbor, Michigan 48104

Prepared by:

Epsilon Associates, Inc.
3 Mill & Main Place, Suite 250
Maynard, MA 01754

June 1, 2023

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1.0 EXECUTIVE SUMMARY

The Ashtabula Wind Energy Center Repowering Project (the Project) is an existing wind park in Barnes County, North Dakota that is planned to be repowered by Otter Tail Power Company (Otter Tail). Atwell has retained Epsilon Associates, Inc. (Epsilon) to conduct a shadow flicker assessment for the proposed Project. This report presents results of the shadow flicker modeling from the proposed repower in Barnes County.

Shadow flicker modeling was conducted for the 32 Otter Tail Ashtabula General Electric (GE) repowered wind turbines. The purpose of this analysis is to predict the annual durations of wind turbine shadow flicker at nearby receptors. The maximum expected annual duration of shadow flicker at a modeling receptor resulting from the operation of all Otter Tail Ashtabula Wind wind turbines is 10 hours, 47 minutes per year. The modeling results are conservative in that modeling receptors were treated as "greenhouses" (i.e., having windows on all sides) and the surrounding area was assumed to be without vegetation or structures ("bare earth").

2.0 INTRODUCTION

The Ashtabula Wind Energy Center Repower Project will consist of 32 repowered wind turbines. The proposed wind turbines are all GE 1.6 MW units with a rotor diameter of 91 meters and a hub height of 80 meters. Figure 2-1 shows the locations of the 32 wind turbines over aerial imagery.

Shadow flicker can be defined as an intermittent change in the intensity of light in a given area resulting from the operation of a wind turbine due to its interaction with the sun. An indoor observer experiences repeated changes in the brightness of the room as shadows cast from the wind turbine blades briefly pass by windows as the blades rotate. In order for this to occur, the wind turbine must be operating, the sun must be shining, and the window must be within the shadow region of the wind turbine, otherwise there is no shadow flicker. A stationary wind turbine only generates a stationary shadow similar to any other structure.

This report presents the findings of a shadow flicker modeling study for the Project. The wind turbines were modeled with the WindPRO software package using information provided by Atwell. The expected annual duration of shadow flicker was calculated at modeling receptors and shadow flicker isolines for the area surrounding the Project were generated. The results of the modeling are found within this report.

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LEGEND

- GE 1.6-91 80m HH Wind Turbine Repower
- Major Collector Road
- Local Road
- Township Boundary

Scale 1:36,000
1 inch = 3,000 feet
0 1,500 3,000 Feet

Basemap: USDA-FSA-APFO Aerial Photography, 2022

Sibley Trail
Ashtabula
Baldwin
Grand Prairie
Barnes County
Ellsbury
Minnie Lake

17TH ST
18TH ST
19TH ST
20TH ST
21ST ST
118TH AVE
121ST AVE
123RD AVE
126TH AVE

34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65

Ashtabula Repower **Barnes County, North Dakota**

Epsilon Associates Inc.

Figure 2-1
Aerial Locus

3.0 SHADOW FLICKER MODELING

3.1 Modeling Methodology

Shadow flicker was modeled using a software package, WindPRO version 3.6. WindPRO is a software suite developed by EMD International A/S and is used for assessing potential environmental impacts from wind turbines. Using the Shadow module within WindPRO, worst-case shadow flicker in the area surrounding the wind turbines was calculated based on data inputs including: location of the wind turbines, location of discrete receptor points, wind turbine dimensions, flicker calculation limits, and terrain data. Based on these data, the model was able to incorporate the appropriate sun angle and maximum daily sunlight for this latitude into the calculations. The resulting worst-case calculations assume that the sun is always shining during daylight hours and that the wind turbine is always operating. The WindPRO Shadow module can be further refined by incorporating sunshine probabilities and wind turbine operational estimates by wind direction over the course of a year. The values produced by this further refinement are known as the "expected" shadow flicker. Both worst-case and expected annual shadow flicker durations are presented in this section.

This analysis is for the wind turbine array sent to Epsilon on December 20, 2022. Locations of the turbines are shown in Figure 3-1 and the coordinates are provided in Appendix A. All 32 wind turbines are GE 1.6-91 wind turbines with a 91-meter rotor diameter and a hub height of 80 meters. Each wind turbine has the following characteristics based on the technical data provided by Atwell:

		GE 1.6-91
♦ Rated Power	=	1,600 kW
♦ Hub Height	=	80 meters
♦ Rotor Diameter	=	91 meters
♦ Cut-in Wind Speed	=	3 m/s
♦ Cut-out Wind Speed	=	25 m/s

To-date, there are no federal, state, or local regulations regarding the maximum radial distance from a wind turbine to which shadow flicker should be analyzed applicable to this Project. In the United States, shadow flicker is commonly evaluated out to a distance of ten times the rotor diameter. For this Project, ten times the largest rotor diameter of the proposed wind turbines corresponds to a distance of 0.6 miles (910 m). Conservatively, this analysis includes shadow flicker calculations out to 1.25 miles (2,012 m) from each wind turbine in the model for the proposed layout and existing wind turbines.

A modeling receptor dataset was provided to Epsilon on January 26, 2023. The dataset included 316 receptors. This dataset was clipped such that only receptors within 1.5 miles of an Otter Tail Ashtabula wind turbine were included in the analysis. Atwell provided additional information indicating if each receptor was inhabited or uninhabited. Atwell also provided information of a new construction residential building in the Project area. The resulting 21 inhabited receptors were input to the model. Each modeling point was assumed to have a window facing all directions ("greenhouse" mode) which yields conservative results. All modeling receptors are identified in Figure 3-1. The model was set to limit calculations to 2,012 meters from a wind turbine, the equivalent of 1.25 miles. Consequently, shadow flicker at any of the modeling receptors greater than the corresponding limitation distance from a wind turbine was zero. In

addition to modeling discrete points, shadow flicker was calculated at grid points in the area surrounding the modeled wind turbines to generate flicker isolines. A 20-meter spacing was used for this grid.

The terrain height contour elevations for the modeling domain were generated from elevation information derived from the National Elevation Dataset (NED) developed by the U.S. Geological Survey. Conservatively, obstacles, i.e., buildings and vegetation, were excluded from the analysis. This is effectively a "bare earth" scenario which is conservative. When accounted for in the shadow flicker calculations, such obstacles may significantly mitigate or eliminate the flicker effect depending on their size, type, and location. In addition, shadow flicker durations were calculated only when the angle of the sun was at least 3° above the horizon.

Monthly sunshine probability values were input for each month from January to December. These numbers were obtained from a publicly available historical dataset for Fargo, North Dakota from the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Information (NCEI).[1] Table 3-1 shows the percentage of sunshine hours by month used in the shadow flicker modeling. These values are the percentages that the sun is expected to be shining during daylight hours.

The number of hours the wind turbines are expected to operate for the 16 cardinal wind directions was input into the model. A publicly available dataset[2] using measured data for a five-year period of hourly wind directions and wind speeds at 3 meters and 10 meters was obtained by Epsilon. Epsilon then scaled this dataset to 80 meters to calculate the typical annual number of operational hours per wind direction sector. These hours per wind direction sector are used by WindPRO to estimate the "wind direction" and "operation time" reduction factors. Based on this dataset, the wind turbines would operate 85% of the year. Table 3-2 shows the distribution of operational hours for the 16 wind directions.

[1] NCEI (formerly NCDC), https://www1.ncdc.noaa.gov/pub/data/ccd-data/pctpos20.dat. Accessed in March 2023.

[2] North Dakota Agricultural Weather Network (NDAWN), 2018-2022, Carrington, ND.

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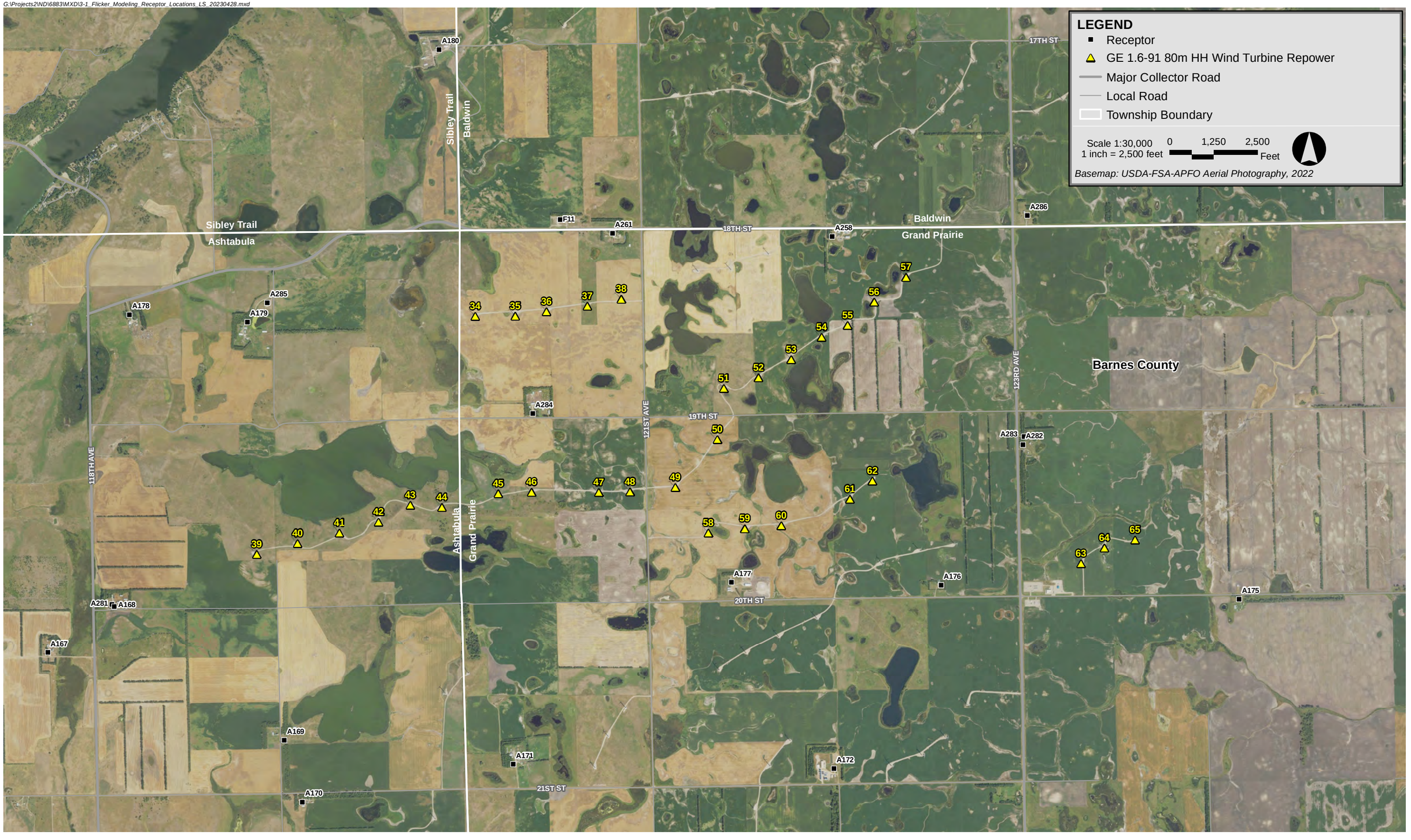

Ashtabula Repower **Barnes County, North Dakota**

Epsilon Associates Inc.

Figure 3-1
Shadow Flicker Modeling Locations

Table 3-1 Monthly Percent of Possible Sunshine

Month	Possible Sunshine
January	52%
February	54%
March	59%
April	57%
May	60%
June	64%
July	74%
August	71%
September	63%
October	51%
November	39%
December	39%

Table 3-2 Operational Hours per Wind Direction Sector

Wind Sector	Operational Hours
N	364
NNE	231
NE	235
ENE	234
E	299
ESE	398
SE	720
SSE	587
S	362
SSW	314
SW	482
WSW	477
W	675
WNW	931
NW	686
NNW	429
Annual	7424

3.2 Results

Following the modeling methodology outlined in Section 3.1, WindPRO was used to calculate shadow flicker at the 20 discrete modeling receptor points. In addition to the discrete modeling points, shadow flicker isolines were generated based on the grid calculations. Table B-1.1 in Appendix B presents the modeling results for the receptors sorted by ID. Table B-1.2 in Appendix B presents the modeling results for the receptors sorted by Expected Flicker. Both worst-case and expected values are presented.

The modeled worst-case annual shadow flicker duration for all 21 receptors ranged from 0 hours, 0 minutes per year to 41 hours, 40 minutes per year. The maximum flicker duration was at receptor A284.

The predicted expected annual shadow flicker duration ranged from 0 hours, 0 minutes per year to 10 hours, 47 minutes per year. The maximum expected flicker duration calculated was at receptor A284. Eight (8) of the receptors were predicted to experience no annual shadow flicker. Twelve (12) of the receptors were predicted to experience some shadow flicker but less than 10 hours per year. The modeling results showed that one (1) of the receptors would be expected to have between 10 hours and 30 hours of shadow flicker per year. Zero (0) receptors are expected to have over 30 hours of flicker per year. Figure 3-2 displays the modeled flicker isolines (expected hrs/yr) over aerial imagery in relation to modeled wind turbines and modeling receptors.

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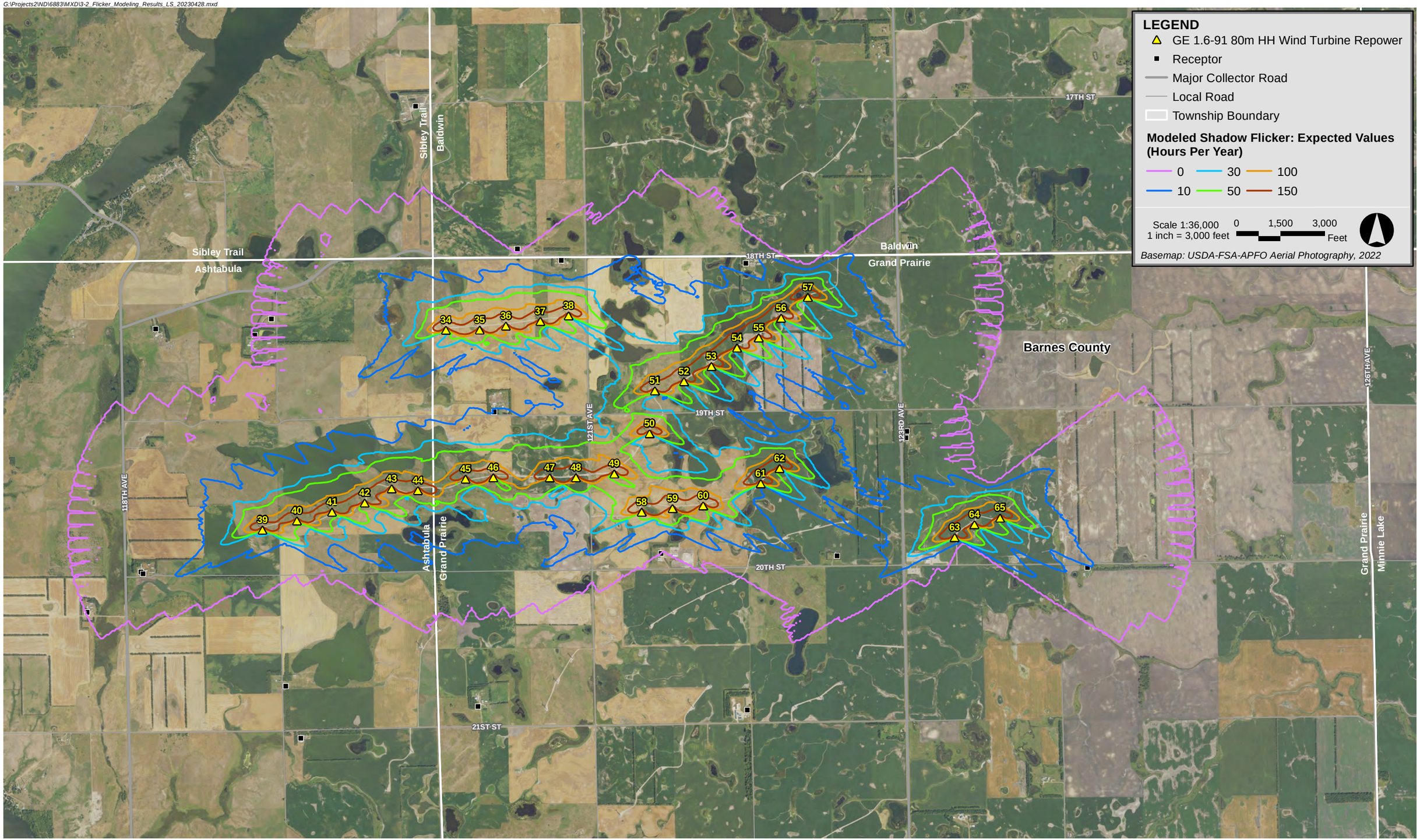

Ashtabula Repower **Barnes County, North Dakota**

Epsilon ASSOCIATES INC.

Figure 3-2
Shadow Flicker Modeling Results

Appendix A
Wind Turbine Coordinates

Table A-1: Wind Turbine Coordinates

Wind Turbine ID	Wind Turbine Type	Hub Height (m)	Coordinates NAD83 UTM Zone 14N (meters)	
			X (Easting)	Y (Northing)
34	GE 1.6-91	80	578932.82	5221992.08
35	GE 1.6-91	80	579281.66	5221996.74
36	GE 1.6-91	80	579554.22	5222033.96
37	GE 1.6-91	80	579909.88	5222083.20
38	GE 1.6-91	80	580204.73	5222142.76
39	GE 1.6-91	80	577033.81	5219922.21
40	GE 1.6-91	80	577389.11	5220015.87
41	GE 1.6-91	80	577751.91	5220109.20
42	GE 1.6-91	80	578092.09	5220202.81
43	GE 1.6-91	80	578370.79	5220350.98
44	GE 1.6-91	80	578644.17	5220332.15
45	GE 1.6-91	80	579135.63	5220450.17
46	GE 1.6-91	80	579423.66	5220465.14
47	GE 1.6-91	80	580007.59	5220461.87
48	GE 1.6-91	80	580280.68	5220465.57
49	GE 1.6-91	80	580674.80	5220504.04
50	GE 1.6-91	80	581040.63	5220920.28
51	GE 1.6-91	80	581095.28	5221365.84
52	GE 1.6-91	80	581397.21	5221458.57
53	GE 1.6-91	80	581683.19	5221618.11
54	GE 1.6-91	80	581946.11	5221810.81
55	GE 1.6-91	80	582172.02	5221914.08
56	GE 1.6-91	80	582404.05	5222117.37
57	GE 1.6-91	80	582681.70	5222332.42
58	GE 1.6-91	80	580960.93	5220108.14
59	GE 1.6-91	80	581278.71	5220145.50
60	GE 1.6-91	80	581597.15	5220172.33
61	GE 1.6-91	80	582192.98	5220402.74
62	GE 1.6-91	80	582388.15	5220561.06
63	GE 1.6-91	80	584203.29	5219842.09
64	GE 1.6-91	80	584406.18	5219978.13
65	GE 1.6-91	80	584670.83	5220048.37

Appendix B

Shadow Flicker Modeling Results: Modeling Receptors

Table B-1.1: Shadow Flicker Modeling Results at Discrete Points - Sorted by Receptor ID

Receptor ID	Coordinates UTM NAD83 Zone 14N (meters)		Worst Case Shadow Flicker Hours per Year	Expected Shadow Flicker Hours per Year
	X (Easting)	Y (Northing)	(HH:MM/year)	(HH:MM/year)
A167	575218.28	5219071.08	1:16	0:27
A168	575774.24	5219489.86	5:20	1:55
A169	577273.49	5218307.23	0:00	0:00
A170	577430.75	5217768.83	0:00	0:00
A171	579265.26	5218098.36	0:00	0:00
A172	582053.38	5218060.04	0:00	0:00
A175	585576.54	5219534.46	21:51	8:48
A176	582984.79	5219656.29	8:09	3:03
A177	581161.73	5219680.59	0:02	0:00
A178	575927.34	5222008.56	0:00	0:00
A179	576953.92	5221944.49	0:36	0:13
A180	578619.96	5224316.01	0:00	0:00
A258	582039.11	5222688.12	17:03	4:59
A261	580127.81	5222718.05	14:58	3:22
A281	575795.70	5219471.50	5:55	2:08
A282	583697.45	5220879.28	10:18	2:51
A283	583706.45	5220948.40	4:01	1:15
A284	579433.58	5221148.89	41:40	10:47
A285	577126.46	5222111.93	0:50	0:18
A286	583735.28	5222871.02	7:21	1:52
F11	579672.00	5222836.00	0:00	0:00

Table B-1.2: Shadow Flicker Modeling Results at Discrete Points - Sorted by Expected Flicker

Receptor ID	Coordinates UTM NAD83 Zone 14N (meters)		Worst Case Shadow Flicker Hours per Year	Expected Shadow Flicker Hours per Year
	X (Easting)	Y (Northing)	(HH:MM/year)	(HH:MM/year)
A284	579434	5221149	41:40	10:47
A175	585577	5219534	21:51	8:48
A258	582039	5222688	17:03	4:59
A261	580128	5222718	14:58	3:22
A176	582985	5219656	8:09	3:03
A282	583697	5220879	10:18	2:51
A281	575796	5219472	5:55	2:08
A168	575774	5219490	5:20	1:55
A286	583735	5222871	7:21	1:52
A283	583706	5220948	4:01	1:15
A167	575218	5219071	1:16	0:27
A285	577126	5222112	0:50	0:18
A179	576954	5221944	0:36	0:13
A169	577273	5218307	0:00	0:00
A170	577431	5217769	0:00	0:00
A171	579265	5218098	0:00	0:00
A172	582053	5218060	0:00	0:00
A177	581162	5219681	0:02	0:00
A178	575927	5222009	0:00	0:00
A180	578620	5224316	0:00	0:00
F11	579672	5222836	0:00	0:00

Project:
Otter Tail Ashtabula Wind

Description:
Barnes County, ND

Licensed user:
Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com
Calculated:
5/31/2023 2:12 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A167 - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (5057)

Assumptions for shadow calculations

Reference year for calendar 2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.52	0.54	0.59	0.57	0.60	0.64	0.74	0.71	0.63	0.51	0.39	0.39

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
364	231	235	234	299	398	720	587	362	314	482	477	675	931	686	429	7,424

	January	February	March	April	May		June	July		August		September	October	November	December
1	08:17	07:57	07:13	07:12	06:17		05:40	05:38		06:07		06:48	07:27	08:11	07:54
	16:50	17:31	18:12	19:56	20:38		21:16	21:30		21:06	3	06:35 (193)	20:15	19:15	18:16	16:43
2	08:17	07:56	07:11	07:10	06:15		05:39	05:38		06:09		06:38 (193)	06:49	07:28	08:13	07:55
	16:51	17:32	18:13	19:58	20:39		21:17	21:30		21:05	1	06:36 (193)	20:13	19:13	18:14	16:43
3	08:17	07:55	07:09	07:08	06:14		05:38	05:39		06:10		06:37 (193)	06:50	07:30	08:14	07:56
	16:52	17:34	18:15	19:59	20:41		21:18	21:29		21:04			20:11	19:11	18:13	16:42
4	08:17	07:53	07:07	07:06	06:12		05:38	05:40		06:11			06:51	07:31	08:15	07:58
	16:53	17:35	18:16	20:00	20:42		21:19	21:29		21:02			20:09	19:09	18:11	16:42
5	08:16	07:52	07:05	07:04	06:10		05:37	05:40		06:12			06:53	07:32	07:17	07:59
	16:54	17:37	18:18	20:02	20:43		21:19	21:29		21:01			20:07	19:07	17:10	16:42
6	08:16	07:51	07:04	07:02	06:09		05:37	05:41		06:14			06:54	07:34	07:18	08:00
	16:55	17:38	18:19	20:03	20:45		21:20	21:29		20:59			20:05	19:05	17:09	16:41
7	08:16	07:49	07:02	07:00	06:07		05:36	05:42		06:15			06:55	07:35	07:20	08:01
	16:56	17:40	18:21	20:05	20:46		21:21	21:28		20:58			20:03	19:03	17:07	16:41
8	08:16	07:48	07:00	06:58	06:06		05:36	05:42		06:16			06:57	07:37	07:21	08:02
	16:57	17:41	18:22	20:06	20:47		21:22	21:28		20:57			20:01	19:01	17:06	16:41
9	08:16	07:46	06:58	06:56	06:04		05:35	05:43		06:17			06:58	07:38	07:23	08:03
	16:58	17:43	18:24	20:07	20:49		21:23	21:27		20:55			19:59	18:57	17:04	16:41
10	08:15	07:45	06:56	06:55	06:03		05:35	05:44		06:19			06:59	07:39	07:24	08:04
	17:00	17:44	18:25	20:09	20:50		21:23	21:27		20:53			19:57	18:55	17:03	16:41
11	08:15	07:44	06:54	06:53	06:02		05:35	05:45		06:20			07:01	07:41	07:26	08:05
	17:01	17:46	18:27	20:10	20:51		21:24	21:26		20:52			19:55	18:53	17:02	16:41
12	08:14	07:42	07:52	06:51	06:00		06:26 (193)	05:35	05:46	06:21			07:02	07:42	07:27	08:06
	17:02	17:48	18:28	20:12	20:52	1	06:27 (193)	21:25	21:26	20:50			19:53	18:51	17:00	16:41
13	08:14	07:40	07:50	06:49	05:59		06:24 (193)	05:34	05:47	06:23			07:03	07:44	07:29	08:07
	17:03	17:49	19:30	20:13	20:54	3	06:27 (193)	21:25	21:25	20:49			19:51	18:49	16:59	16:41
14	08:13	07:39	07:48	06:47	05:58		06:23 (193)	05:34	05:48	06:24			07:05	07:45	07:30	08:08
	17:05	17:51	19:31	20:14	20:55	4	06:27 (193)	21:26	21:25	20:47			19:49	18:47	16:58	16:41
15	08:13	07:37	07:46	06:45	05:56		06:22 (193)	05:34	05:49	06:25			07:06	07:46	07:32	08:09
	17:06	17:52	19:32	20:16	20:56	5	06:27 (193)	21:26	21:24	20:45			19:47	18:45	16:57	16:41
16	08:12	07:36	07:44	06:43	05:55		06:21 (193)	05:34	05:49	06:27			07:07	07:48	07:33	08:09
	17:07	17:54	19:34	20:17	20:58	6	06:27 (193)	21:27	21:23	20:44			19:45	18:44	16:56	16:41
17	08:12	07:34	07:42	06:41	05:54		06:20 (193)	05:34	05:50	06:28			07:08	07:49	07:35	08:10
	17:09	17:55	19:35	20:18	20:59	7	06:27 (193)	21:27	21:22	20:42			19:43	18:42	16:55	16:41
18	08:11	07:32	07:40	06:39	05:53		06:19 (193)	05:34	05:51	06:29			07:10	07:51	07:36	08:11
	17:10	17:57	19:37	20:20	21:00	7	06:26 (193)	21:28	21:22	20:40			19:41	18:40	16:54	16:41
19	08:10	07:31	07:38	06:38	05:51		06:19 (193)	05:34	05:53	06:30			07:11	07:52	07:38	08:12
	17:11	17:58	19:38	20:21	21:01	5	06:24 (193)	21:28	21:21	20:39			19:39	18:38	16:53	16:42
20	08:09	07:29	07:36	06:36	05:50			05:34	05:54	06:32			07:12	07:53	07:39	08:12
	17:13	18:00	19:39	20:23	21:03			21:29	21:20	20:37			19:37	18:36	16:52	16:42
21	08:09	07:27	07:34	06:34	05:49			05:34	05:55	06:33			07:14	07:55	07:40	08:13
	17:14	18:00	19:41	20:24	21:04			21:29	21:19	20:35			19:35	18:35	16:51	16:42
22	08:08	07:26	07:32	06:32	05:48			05:34	05:56	06:34			07:15	07:56	07:42	08:13
	17:16	18:01	19:42	20:25	21:05			21:29	21:18	20:33			19:33	18:33	16:50	16:43
23	08:07	07:24	07:30	06:30	05:47			05:35	05:57	06:36			07:16	07:58	07:43	08:14
	17:17	18:03	19:44	20:27	21:06			21:29	21:17	20:32			19:31	18:31	16:49	16:43
24	08:06	07:22	07:28	06:29	05:46			05:35	05:58	06:37			07:18	07:59	07:45	08:14
	17:19	18:04	19:45	20:28	21:07			21:30	21:16	20:30			19:29	18:29	16:48	16:44
25	08:05	07:20	07:26	06:27	05:45			05:35	05:59	06:38			07:19	08:01	07:46	08:15
	17:20	18:06	19:47	20:30	21:08			21:30	21:15	20:28			19:27	18:28	16:47	16:45
26	08:04	07:18	07:24	06:25	05:44			05:36	06:00	06:30 (193)		06:40	07:20	08:02	07:47	08:15
	17:21	18:07	19:48	20:31	21:10			21:30	21:14	5	06:35 (193)	20:26	19:25	18:26	16:46	16:45
27	08:03	07:17	07:22	06:23	05:43			05:36	06:01	06:29 (193)		06:41	07:22	08:04	07:49	08:15
	17:23	18:09	19:49	20:32	21:11			21:30	21:13	7	06:36 (193)	20:24	19:23	18:24	16:46	16:46
28	08:02	07:15	07:20	06:22	05:43			05:36	06:03	06:30 (193)		06:42	07:23	08:05	07:50	08:16
	17:24	18:10	19:51	20:34	21:12			21:30	21:11	7	06:37 (193)	20:22	19:21	18:22	16:45	16:47
29	08:01		07:18	06:20	05:42			05:37	06:04	06:31 (193)		06:44	07:24	08:07	07:51	08:16
	17:26		19:52	20:35	21:13			21:30	21:10	6	06:37 (193)	20:20	19:19	18:21	16:44	16:47
30	08:00		07:16	06:18	05:41			05:37	06:05	06:32 (193)		06:45	07:26	08:08	07:53	08:16
	17:28		19:54	20:36	21:14			21:30	21:09	5	06:37 (193)	20:19	19:17	18:19	16:44	16:48
31	07:59		07:14		05:40				06:06	06:33 (193)		06:46		08:10		08:16
	17:29		19:55		21:15				21:08	4	06:37 (193)	20:17		18:18		16:49
Potential sun hours	278	286	367	406	465			475	481			442	380	339	283	266
Total, worst case						38				34			4			
Sun reduction						0.60				0.74			0.71			
Oper. time red.						0.85				0.85			0.85			
Wind dir. red.						0.63				0.63			0.63			
Total reduction						0.32				0.40			0.38			
Total, real						12				14			2			

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

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Calculated:
5/31/2023 2:12 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A168 - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (5058)

Assumptions for shadow calculations

Reference year for calendar 2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.52	0.54	0.59	0.57	0.60	0.64	0.74	0.71	0.63	0.51	0.39	0.39

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
364	231	235	234	299	398	720	587	362	314	482	477	675	931	686	429	7,424

	January	February	March	April			May			June	July	August			September	October	November	December
1	08:17	07:57	07:13	07:12			06:17		06:41 (190)	05:40	05:38	06:07			06:47	07:27	08:11	07:54
	16:50	17:31	18:12	19:56			20:38	13	06:54 (193)	21:16	21:30	21:06			20:15	19:15	18:16	16:43
2	08:17	07:56	07:11	07:10			06:15		06:39 (193)	05:39	05:38	06:09			06:49	07:28	08:12	07:55
	16:51	17:32	18:13	19:58			20:39	14	06:53 (193)	21:17	21:30	21:05			20:13	19:13	18:14	16:43
3	08:17	07:55	07:09	07:08			06:13		06:38 (193)	05:38	05:39	06:10			06:50	07:30	08:14	07:56
	16:52	17:34	18:15	19:59			20:40	16	06:54 (193)	21:18	21:29	21:04			20:11	19:11	18:13	16:42
4	08:17	07:53	07:07	07:06			06:12		06:37 (193)	05:38	05:40	06:11			06:51	07:31	08:15	07:57
	16:53	17:35	18:16	20:00			20:42	16	06:53 (193)	21:19	21:29	21:02			20:09	19:09	18:11	16:42
5	08:16	07:52	07:05	07:04			06:10		06:38 (193)	05:37	05:40	06:12		06:51 (193)	06:53	07:32	07:17	07:59
	16:54	17:37	18:18	20:02			20:43	15	06:53 (193)	21:19	21:29	21:01	8	06:59 (193)	20:07	19:07	17:10	16:42
6	08:16	07:51	07:04	07:02			06:09		06:38 (193)	05:37	05:41	06:14		06:49 (193)	06:54	07:34	07:18	08:00
	16:55	17:38	18:19	20:03			20:45	15	06:53 (193)	21:20	21:29	20:59	11	07:00 (193)	20:05	19:05	17:09	16:41
7	08:16	07:49	07:02	07:00			06:07		06:38 (193)	05:36	05:42	06:15		06:49 (193)	06:55	07:35	07:20	08:01
	16:56	17:40	18:21	20:05			20:46	14	06:52 (193)	21:21	21:28	20:58	13	07:02 (193)	20:03	19:03	17:07	16:41
8	08:16	07:48	07:00	06:58			06:06		06:40 (193)	05:36	05:42	06:16		06:48 (193)	06:57	07:37	07:21	08:02
	16:57	17:41	18:22	20:06			20:47	11	06:51 (193)	21:22	21:28	20:57	14	07:02 (193)	20:01	19:01	17:06	16:41
9	08:16	07:46	06:58	06:56			06:04		06:40 (193)	05:35	05:43	06:17		06:47 (193)	06:58	07:38	07:23	08:03
	16:58	17:43	18:24	20:07			20:49	9	06:49 (193)	21:23	21:27	20:55	15	07:02 (193)	19:59	18:57	17:04	16:41
10	08:15	07:45	06:56	06:55			06:03		06:44 (193)	05:35	05:44	06:19		06:46 (193)	06:59	07:39	07:24	08:04
	17:00	17:44	18:25	20:09			20:50	2	06:46 (193)	21:23	21:27	20:53	16	07:02 (193)	19:57	18:55	17:03	16:41
11	08:15	07:43	06:54	06:53			06:02			05:35	05:45	06:20		06:47 (193)	07:01	07:41	07:26	08:05
	17:01	17:46	18:27	20:10			20:51			21:24	21:26	20:52	16	07:03 (193)	19:55	18:53	17:02	16:41
12	08:14	07:42	07:52	06:51			06:00			05:35	05:46	06:21		06:48 (193)	07:02	07:42	07:27	08:06
	17:02	17:48	18:28	20:12			20:52			21:25	21:26	20:50	15	07:03 (193)	19:53	18:51	17:00	16:40
13	08:14	07:40	07:50	06:49			05:59			05:34	05:47	06:23		06:49 (190)	07:03	07:44	07:29	08:07
	17:03	17:49	19:29	20:13			20:54			21:25	21:25	20:49	13	07:02 (193)	19:51	18:49	16:59	16:41
14	08:13	07:39	07:48	06:47			05:58			05:34	05:48	06:24		06:50 (190)	07:04	07:45	07:30	08:08
	17:05	17:51	19:31	20:14			20:55			21:26	21:24	20:47	11	07:01 (193)	19:49	18:47	16:58	16:41
15	08:13	07:37	07:46	06:45			05:56			05:34	05:48	06:25		06:51 (190)	07:06	07:46	07:32	08:09
	17:06	17:52	19:32	20:16			20:56			21:26	21:24	20:45	9	07:00 (190)	19:47	18:45	16:57	16:41
16	08:12	07:36	07:44	06:43			05:55			05:34	05:49	06:27		06:53 (190)	07:07	07:48	07:33	08:09
	17:07	17:54	19:34	20:17			20:58			21:27	21:23	20:44	8	07:01 (190)	19:45	18:44	16:56	16:41
17	08:12	07:34	07:42	06:41			05:54			05:34	05:50	06:28		06:54 (190)	07:08	07:49	07:35	08:10
	17:09	17:55	19:35	20:18			20:59			21:27	21:22	20:42	6	07:00 (190)	19:43	18:42	16:55	16:41
18	08:11	07:32	07:40	06:39			05:53			05:34	05:51	06:29		06:55 (190)	07:10	07:51	07:36	08:11
	17:10	17:57	19:37	20:20			21:00			21:28	21:21	20:40	4	06:59 (190)	19:41	18:40	16:54	16:41
19	08:10	07:31	07:38	06:38			05:51			05:34	05:52	06:30		06:56 (190)	07:11	07:52	07:38	08:12
	17:11	17:58	19:38	20:21			21:01			21:28	21:21	20:39	1	06:57 (190)	19:39	18:38	16:53	16:42
20	08:09	07:29	07:36	06:36			05:50			05:34	05:54	06:32			07:12	07:53	07:39	08:12
	17:13	18:00	19:39	20:23			21:03			21:29	21:20	20:37			19:37	18:36	16:52	16:42
21	08:09	07:27	07:34	06:34			05:49			05:34	05:55	06:33			07:14	07:55	07:40	08:13
	17:14	18:00	19:41	20:24			21:04			21:29	21:19	20:35			19:35	18:34	16:51	16:42
22	08:08	07:26	07:32	06:32			05:48			05:34	05:56	06:34			07:15	07:56	07:42	08:13
	17:16	18:01	19:42	20:25			21:05			21:29	21:18	20:33			19:33	18:33	16:50	16:43
23	08:07	07:24	07:30	06:30			05:47			05:35	05:57	06:36			07:16	07:58	07:43	08:14
	17:17	18:03	19:44	20:27			21:06			21:29	21:17	20:32			19:31	18:31	16:49	16:43
24	08:06	07:22	07:28	06:29			05:46			05:35	05:58	06:37			07:18	07:59	07:45	08:14
	17:18	18:04	19:45	20:28			21:07			21:30	21:16	20:30			19:29	18:29	16:48	16:44
25	08:05	07:20	07:26	06:27			05:45			05:35	05:59	06:38			07:19	08:01	07:46	08:15
	17:20	18:06	19:47	20:30			21:08			21:30	21:15	20:28			19:27	18:27	16:47	16:45
26	08:04	07:18	07:24	06:25		06:49 (190)	05:44			05:36	06:00	06:40			07:20	08:02	07:47	08:15
	17:21	18:07	19:48	20:31	3	06:52 (190)	21:10			21:30	21:14	20:26			19:25	18:26	16:46	16:45
27	08:03	07:17	07:22	06:23		06:47 (190)	05:43			05:36	06:01	06:41			07:22	08:04	07:49	08:15
	17:23	18:09	19:49	20:32	5	06:52 (190)	21:11			21:30	21:13	20:24			19:23	18:24	16:46	16:46
28	08:02	07:15	07:20	06:22		06:46 (190)	05:43			05:36	06:03	06:42			07:23	08:05	07:50	08:16
	17:24	18:10	19:51	20:34	7	06:53 (190)	21:12			21:30	21:11	20:22			19:21	18:22	16:45	16:47
29	08:01		07:18	06:20		06:44 (190)	05:42			05:37	06:04	06:44			07:24	08:07	07:51	08:16
	17:26		19:52	20:35	9	06:53 (190)	21:13			21:30	21:10	20:20			19:19	18:21	16:44	16:47
30	08:00		07:16	06:18		06:43 (190)	05:41			05:37	06:05	06:45			07:26	08:08	07:53	08:16
	17:27		19:53	20:36	11	06:54 (193)	21:14			21:30	21:09	20:19			19:17	18:19	16:44	16:48
31	07:58		07:14				05:40				06:06	06:46				08:10		08:16
	17:29		19:55				21:15				21:08	20:17				18:18		16:49
Potential sun hours	278	286	367	406			465			475	481	442			380	339	283	266
Total, worst case					35			125					160					
Sun reduction					0.57			0.60					0.71					
Oper. time red.					0.85			0.85					0.85					
Wind dir. red.					0.66			0.65					0.65					
Total reduction					0.32			0.33					0.39					
Total, real					11			42					63					

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

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Calculated:
5/31/2023 2:12 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A175 - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (5065)

Assumptions for shadow calculations

Reference year for calendar 2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.52	0.54	0.59	0.57	0.60	0.64	0.74	0.71	0.63	0.51	0.39	0.39

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
364	231	235	234	299	398	720	587	362	314	482	477	675	931	686	429	7,424

	January	February	March	April	May	June	July	August	September	October	November	December
1	08:16	07:57	07:12	07:12	06:16	05:39	20:41 (174)	05:37	20:44 (174)	06:07	20:23 (199)	06:47	07:27	08:10	07:53
	16:50	17:30	18:11	19:56	20:37	21:15 9	20:50 (174)	21:29 19	21:03 (174)	21:06 16	20:39 (199)	20:14	19:14	18:15	16:43
2	08:16	07:56	07:11	07:10	06:15	05:38	20:41 (174)	05:38	20:44 (174)	06:08	20:22 (199)	06:48	07:28	08:12	07:55
	16:50	17:32	18:13	19:57	20:39	21:16 10	20:51 (174)	21:29 18	21:02 (174)	21:05 17	20:39 (199)	20:12	19:12	18:14	16:42
3	08:16	07:54	07:09	07:08	06:13	05:38	20:40 (174)	05:38	20:45 (174)	06:09	20:22 (199)	06:50	07:29	08:13	07:56
	16:51	17:33	18:14	19:59	20:40	21:17 12	20:52 (174)	21:29 17	21:02 (174)	21:03 16	20:38 (199)	20:10	19:10	18:12	16:42
4	08:16	07:53	07:07	07:06	06:11 20:17 (199)	05:37	20:40 (174)	05:39	20:45 (174)	06:11	20:22 (199)	06:51	07:31	08:15	07:57
	16:52	17:35	18:16	20:00	20:41 2 20:19 (199)	21:18 13	20:53 (174)	21:29 17	21:02 (174)	21:02 15	20:37 (199)	20:08	19:08	18:11	16:41
5	08:16	07:52	07:05	07:04	06:10 20:16 (199)	05:37	20:40 (174)	05:40	20:45 (174)	06:12	20:22 (199)	06:52	07:32	07:16	07:58
	16:53	17:36	18:17	20:01	20:43 5 20:21 (199)	21:19 13	20:53 (174)	21:28 16	21:01 (174)	21:00 14	20:36 (199)	20:06	19:06	17:09	16:41
6	08:16	07:50	07:03	07:02	06:08 20:14 (199)	05:36	20:40 (174)	05:40	20:46 (174)	06:13	20:22 (199)	06:53	07:33	07:18	07:59
	16:54	17:38	18:19	20:03	20:44 7 20:21 (199)	21:20 14	20:54 (174)	21:28 15	21:01 (174)	20:59 12	20:34 (199)	20:04	19:04	17:08	16:41
7	08:16	07:49	07:01	07:00	06:07 20:13 (199)	05:36	20:39 (174)	05:41	20:46 (174)	06:14	20:23 (199)	06:55	07:35	07:19	08:00
	16:56	17:39	18:20	20:04	20:45 10 20:23 (199)	21:21 15	20:54 (174)	21:28 15	21:01 (174)	20:57 9	20:32 (199)	20:03	19:02	17:07	16:41
8	08:15	07:47	06:59	06:58	06:05 20:12 (199)	05:35	20:40 (174)	05:42	20:46 (174)	06:16	20:23 (199)	06:56	07:36	07:21	08:01
	16:57	17:41	18:22	20:05	20:47 12 20:24 (199)	21:21 16	20:56 (174)	21:27 14	21:00 (174)	20:56 8	20:31 (199)	20:01	19:00	17:05	16:40
9	08:15	07:46	06:57	06:56	06:04 20:12 (199)	05:35	20:40 (174)	05:43	20:47 (174)	06:17	20:25 (199)	06:57	07:37	07:22	08:02
	16:58	17:42	18:23	20:07	20:48 13 20:25 (199)	21:22 17	20:57 (174)	21:27 13	21:00 (174)	20:54 5	20:30 (199)	19:59	18:56	17:04	16:40
10	08:15	07:44	06:55	06:54	06:02 20:12 (199)	05:35	20:40 (174)	05:43	20:47 (174)	06:18	20:26 (199)	06:59	07:39	07:24	08:04
	16:59	17:44	18:25	20:08	20:49 15 20:27 (199)	21:23 17	20:57 (174)	21:26 13	21:00 (174)	20:53 2	20:28 (199)	19:57	18:54	17:03	16:40
11	08:14	07:43	06:53	06:52	06:01 20:12 (199)	05:34	20:40 (174)	05:44	20:48 (174)	06:19		07:00	07:40	07:25	08:04
	17:00	17:45	18:26	20:10	20:51 15 20:27 (199)	21:24 17	20:57 (174)	21:26 12	21:00 (174)	20:51		19:55	18:53	17:01	16:40
12	08:14	07:41	07:51	06:50	06:00 20:12 (199)	05:34	20:40 (174)	05:45	20:48 (174)	06:21		07:01	07:42	07:27	08:05
	17:01	17:47	18:28	20:11	20:52 17 20:29 (199)	21:24 18	20:58 (174)	21:25 10	20:58 (174)	20:50		19:53	18:51	17:00	16:40
13	08:13	07:40	07:49	06:48	05:58 20:12 (199)	05:34	20:40 (174)	05:46	20:49 (174)	06:22		07:03	07:43	07:28	08:06
	17:03	17:49	19:29	20:12	20:53 17 20:29 (199)	21:25 19	20:59 (174)	21:25 9	20:58 (174)	20:48		19:51	18:49	16:59	16:40
14	08:13	07:38	07:47	06:46	05:57 20:13 (199)	05:34	20:40 (174)	05:47	20:50 (174)	06:23		07:04	07:44	07:30	08:07
	17:04	17:50	19:30	20:14	20:55 16 20:29 (199)	21:25 19	20:59 (174)	21:24 7	20:57 (174)	20:47		19:49	18:47	16:58	16:40
15	08:12	07:37	07:46	06:44	05:56 20:13 (199)	05:34	20:41 (174)	05:48	20:51 (174)	06:25		07:05	07:46	07:31	08:08
	17:05	17:52	19:32	20:15	20:56 15 20:28 (199)	21:26 19	21:00 (174)	21:23 6	20:57 (174)	20:45		19:47	18:45	16:56	16:40
16	08:12	07:35	07:44	06:43	05:54 20:14 (199)	05:33	20:41 (174)	05:49	20:52 (174)	06:26		07:07	07:47	07:33	08:09
	17:07	17:53	19:33	20:17	20:57 13 20:27 (199)	21:26 19	21:00 (174)	21:23 4	20:56 (174)	20:43		19:45	18:43	16:55	16:40
17	08:11	07:33	07:42	06:41	05:53 20:15 (199)	05:33	20:41 (174)	05:50	20:55 (174)	06:27	20:03 (164)	07:08	07:49	07:34	08:10
	17:08	17:55	19:35	20:18	20:58 11 20:26 (199)	21:27 20	21:01 (174)	21:22 1	20:56 (174)	20:42 4	20:07 (164)	19:42	18:41	16:54	16:41
18	08:10	07:32	07:40	06:39 19:54 (164)	05:52 20:16 (199)	05:33	20:41 (174)	05:51		06:29	20:01 (164)	07:09	07:50	07:36	08:10
	17:09	17:56	19:36	20:19 4 19:58 (164)	21:00 9 20:25 (199)	21:27 20	21:01 (174)	21:21		20:40 9	20:10 (164)	19:40	18:39	16:53	16:41
19	08:10	07:30	07:38	06:37 19:54 (164)	05:51 20:19 (199)	05:34	20:41 (174)	05:52		06:30	19:59 (164)	07:11	07:52	07:37	08:11
	17:11	17:58	19:38	20:21 6 20:00 (164)	21:01 4 20:23 (199)	21:28 20	21:01 (174)	21:20		20:38 12	20:11 (164)	19:38	18:38	16:52	16:41
20	08:09	07:28	07:36	06:35 19:53 (164)	05:50	05:34	20:41 (174)	05:53		06:31	19:57 (164)	07:12	07:53	07:39	08:12
	17:12	17:59	19:39	20:22 8 20:01 (164)	21:02	21:28 21	21:02 (174)	21:19		20:36 14	20:11 (164)	19:36	18:36	16:51	16:42
21	08:08	07:27	07:34	06:33 19:52 (164)	05:49	05:34	20:41 (174)	05:54		06:33	19:56 (164)	07:13	07:54	07:40	08:12
	17:14	18:01	19:40	20:23 10 20:02 (164)	21:03	21:28 21	21:02 (174)	21:18		20:35 14	20:10 (164)	19:34	18:34	16:50	16:42
22	08:07	07:25	07:32	06:32 19:51 (164)	05:48	05:34	20:41 (174)	05:55		06:34	19:57 (164)	07:15	07:56	07:41	08:13
	17:15	18:01	19:42	20:25 12 20:03 (164)	21:04	21:29 21	21:02 (174)	21:17		20:33 12	20:09 (164)	19:32	18:32	16:49	16:42
23	08:06	07:23	07:30	06:30 19:52 (164)	05:47	05:34	20:42 (174)	05:56		06:35	19:56 (164)	07:16	07:57	07:43	08:13
	17:16	18:02	19:43	20:26 13 20:05 (164)	21:06	21:29 21	21:03 (174)	21:16		20:31 11	20:07 (164)	19:30	18:30	16:48	16:43
24	08:05	07:21	07:28	06:28 19:52 (164)	05:46	05:34	20:42 (174)	05:57		06:36	19:56 (164)	07:17	07:59	07:44	08:14
	17:18	18:04	19:45	20:28 14 20:06 (164)	21:07	21:29 21	21:03 (174)	21:15		20:29 9	20:05 (164)	19:28	18:29	16:47	16:43
25	08:05	07:20	07:26	06:26 19:52 (164)	05:45	05:35	20:42 (174)	05:59		06:38	19:56 (164)	07:18	08:00	07:46	08:14
	17:19	18:05	19:46	20:29 13 20:05 (164)	21:08	21:29 20	21:02 (174)	21:14		20:27 7	20:03 (164)	19:26	18:27	16:47	16:44
26	08:04	07:18	07:24	06:25 19:54 (164)	05:44	05:35	20:43 (174)	06:00	20:29 (199)	06:39	19:57 (164)	07:20	08:02	07:47	08:15
	17:21	18:07	19:47	20:30 10 20:04 (164)	21:09	21:29 20	21:03 (174)	21:13 4	20:33 (199)	20:26 5	20:02 (164)	19:24	18:25	16:46	16:45
27	08:02	07:16	07:22	06:23 19:55 (164)	05:43	05:35	20:43 (174)	06:01	20:26 (199)	06:40	19:58 (164)	07:21	08:03	07:48	08:15
	17:22	18:08	19:49	20:32 6 20:01 (164)	21:10	21:29 20	21:03 (174)	21:12 9	20:35 (199)	20:24 2	20:00 (164)	19:22	18:24	16:45	16:45
28	08:01	07:14	07:20	06:21	05:42 20:46 (174)	05:36	20:43 (174)	06:02	20:25 (199)	06:42		07:22	08:05	07:50	08:15
	17:24	18:10	19:50	20:33	21:11 1 20:47 (174)	21:29 19	21:02 (174)	21:11 11	20:36 (199)	20:22		19:20	18:22	16:45	16:46
29	08:00		07:18	06:19	05:41 20:43 (174)	05:36	20:44 (174)	06:03	20:25 (199)	06:43		07:24	08:06	07:51	08:15
	17:25		19:52	20:35	21:12 4 20:47 (174)	21:29 19	21:03 (174)	21:10 13	20:38 (199)	20:20		19:18	18:20	16:44	16:47
30	07:59		07:16	06:18	05:40 20:42 (174)	05:37	20:43 (174)	06:04	20:24 (199)	06:44		07:25	08:08	07:52	08:16
	17:27		19:53	20:36	21:13 6 20:48 (174)	21:29 19	21:02 (174)	21:08 15	20:39 (199)	20:18		19:16	18:19	16:43	16:48
31	07:58		07:14		05:40 20:42 (174)			06:06	20:23 (199)	06:46			08:09		08:16
	17:28		19:54		21:14 7 20:49 (174)			21:07 16	20:39 (199)	20:16			18:17		16:48
Potential sun hours	278	286	367	406	465	475	481	442		380	339	283	266		
Total, worst case				96	199	529	274	213							
Sun reduction				0.57	0.60	0.64	0.74	0.71							
Oper. time red.				0.85	0.85	0.85	0.85	0.85							
Wind dir. red.				0.72	0.72	0.72	0.72	0.72							
Total reduction				0.35	0.37	0.39	0.45	0.43							
Total, real				33	73	206	124	92							

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm) Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker Last time (hh:mm) with flicker	(WTG causing flicker first time) (WTG causing flicker last time)

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Calculated:
5/31/2023 2:12 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A176 - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (5066)

Assumptions for shadow calculations

Reference year for calendar 2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.52	0.54	0.59	0.57	0.60	0.64	0.74	0.71	0.63	0.51	0.39	0.39

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
364	231	235	234	299	398	720	587	362	314	482	477	675	931	686	429	7,424

	January	February	March	April		May		June	July	August		September		October	November	December
1	08:16	07:57	07:13	07:12		06:16		05:39	05:37	06:07		20:29 (213)	06:47	07:12 (164)	07:27	08:11	07:53
	16:50	17:30	18:12	19:56		20:37		21:15	21:29	21:06	6	20:35 (213)	20:14	07:25 (164)	19:14	18:16	16:43
2	08:16	07:56	07:11	07:10		06:15		05:38	05:38	06:08		20:28 (213)	06:48	07:13 (164)	07:28	08:12	07:55
	16:51	17:32	18:13	19:57		20:39		21:16	21:29	21:05	9	20:37 (213)	20:12	07:25 (164)	19:12	18:14	16:42
3	08:16	07:54	07:09	07:08		06:13		05:38	05:39	06:09		20:27 (213)	06:50	07:15 (164)	07:29	08:14	07:56
	16:52	17:33	18:15	19:59		20:40		21:17	21:29	21:03	12	20:39 (213)	20:11	07:26 (164)	19:10	18:13	16:42
4	08:16	07:53	07:07	07:06		06:12	20:16 (213)	05:37	05:39	06:11		20:26 (213)	06:51	07:16 (164)	07:31	08:15	07:57
	16:53	17:35	18:16	20:00		20:41	3 20:19 (213)	21:18	21:29	21:02	11	20:37 (213)	20:09	07:25 (164)	19:08	18:11	16:42
5	08:16	07:52	07:05	07:04		06:10	20:16 (213)	05:37	05:40	06:12		20:25 (213)	06:52	07:17 (164)	07:32	07:17	07:58
	16:54	17:36	18:17	20:01		20:43	5 20:21 (213)	21:19	21:29	21:01	11	20:36 (213)	20:07	07:24 (164)	19:06	17:10	16:41
6	08:16	07:50	07:03	07:02		06:08	20:15 (213)	05:36	05:41	06:13		20:25 (213)	06:54	07:18 (164)	07:33	07:18	07:59
	16:55	17:38	18:19	20:03		20:44	6 20:21 (213)	21:20	21:28	20:59	9	20:34 (213)	20:05	07:23 (164)	19:04	17:08	16:41
7	08:16	07:49	07:01	07:00	07:23 (164)	06:07	20:15 (213)	05:36	05:41	06:14		20:24 (213)	06:55	07:20 (164)	07:35	07:20	08:01
	16:56	17:39	18:20	20:04	3 07:26 (164)	20:45	8 20:23 (213)	21:21	21:28	20:58	8	20:32 (213)	20:03	2 07:22 (164)	19:02	17:07	16:41
8	08:15	07:48	06:59	06:58	07:21 (164)	06:05	20:15 (213)	05:35	05:42	06:16		20:24 (213)	06:56		07:36	07:21	08:02
	16:57	17:41	18:22	20:06	6 07:27 (164)	20:47	9 20:24 (213)	21:21	21:27	20:56	7	20:31 (213)	20:01		19:00	17:05	16:40
9	08:15	07:46	06:57	06:56	07:19 (164)	06:04	20:15 (213)	05:35	05:43	06:17		20:25 (213)	06:58		07:38	07:23	08:03
	16:58	17:43	18:23	20:07	8 07:27 (164)	20:48	10 20:25 (213)	21:22	21:27	20:55	5	20:30 (213)	19:59		18:57	17:04	16:40
10	08:15	07:45	06:55	06:54	07:17 (164)	06:03	20:16 (213)	05:35	05:44	06:18		20:25 (213)	06:59		07:39	07:24	08:04
	16:59	17:44	18:25	20:08	10 07:27 (164)	20:49	11 20:27 (213)	21:23	21:26	20:53	3	20:28 (213)	19:57		18:55	17:03	16:40
11	08:14	07:43	06:54	06:52	07:15 (164)	06:01	20:16 (213)	05:34	05:44	06:20		20:26 (213)	07:00		07:40	07:26	08:05
	17:00	17:46	18:26	20:10	11 07:26 (164)	20:51	11 20:27 (213)	21:24	21:26	20:52	1	20:27 (213)	19:55		18:53	17:01	16:40
12	08:14	07:42	07:52	06:50	07:14 (164)	06:00	20:17 (213)	05:34	05:45	06:21			07:01		07:42	07:27	08:06
	17:02	17:47	18:28	20:11	12 07:26 (164)	20:52	10 20:27 (213)	21:24	21:25	20:50			19:53		18:51	17:00	16:40
13	08:14	07:40	07:50	06:48	07:12 (164)	05:58	20:19 (213)	05:34	05:46	06:22			07:03		07:43	07:28	08:06
	17:03	17:49	19:29	20:13	13 07:25 (164)	20:53	7 20:26 (213)	21:25	21:25	20:48			19:51		18:49	16:59	16:40
14	08:13	07:38	07:48	06:46	07:11 (164)	05:57		05:34	05:47	06:24		20:16 (201)	07:04		07:45	07:30	08:07
	17:04	17:50	19:31	20:14	13 07:24 (164)	20:55		21:26	21:24	20:47	6	20:22 (201)	19:49		18:47	16:58	16:40
15	08:13	07:37	07:46	06:45	07:08 (199)	05:56		05:34	05:48	06:25		20:14 (201)	07:05		07:46	07:31	08:08
	17:05	17:52	19:32	20:15	12 07:22 (164)	20:56		21:26	21:23	20:45	7	20:21 (201)	19:47		18:45	16:56	16:40
16	08:12	07:35	07:44	06:43	07:06 (174)	05:55		05:34	05:49	06:26		20:13 (201)	07:07		07:47	07:33	08:09
	17:07	17:53	19:33	20:17	7 07:18 (164)	20:57		21:27	21:23	20:43	6	20:19 (201)	19:45		18:43	16:55	16:41
17	08:11	07:34	07:42	06:41	07:04 (174)	05:53		05:34	05:50	06:27		20:12 (201)	07:08		07:49	07:34	08:10
	17:08	17:55	19:35	20:18	6 07:10 (199)	20:58		21:27	21:22	20:42	5	20:17 (201)	19:43		18:41	16:54	16:41
18	08:11	07:32	07:40	06:39	07:03 (174)	05:52		05:34	05:51	06:29		20:12 (201)	07:09		07:50	07:36	08:11
	17:10	17:56	19:36	20:19	7 07:10 (199)	21:00		21:27	21:21	20:40	4	20:16 (201)	19:41		18:40	16:53	16:41
19	08:10	07:30	07:38	06:37	07:01 (174)	05:51		05:34	05:52	06:30		20:12 (201)	07:11		07:52	07:37	08:11
	17:11	17:58	19:38	20:21	8 07:09 (199)	21:01		21:28	21:20	20:38	2	20:14 (201)	19:39		18:38	16:52	16:41
20	08:09	07:29	07:36	06:35	06:59 (174)	05:50		05:34	05:53	06:31			07:12		07:53	07:39	08:12
	17:12	17:59	19:39	20:22	8 07:07 (199)	21:02		21:28	21:19	20:37			19:37		18:36	16:51	16:42
21	08:08	07:27	07:34	06:34	06:58 (199)	05:49		05:34	05:54	06:33			07:13		07:55	07:40	08:12
	17:14	18:01	19:40	20:24	7 07:05 (199)	21:03		21:29	21:18	20:35			19:35		18:34	16:50	16:42
22	08:07	07:25	07:32	06:32		05:48		05:34	05:55	06:34			07:15		07:56	07:42	08:13
	17:15	18:01	19:42	20:25		21:05		21:29	21:17	20:33			19:33		18:32	16:49	16:43
23	08:07	07:23	07:30	06:30		05:47		05:34	05:56	06:35		07:03 (199)	07:16		07:57	07:43	08:13
	17:17	18:03	19:43	20:26		21:06		21:29	21:16	20:31	6	07:09 (199)	19:30		18:31	16:48	16:43
24	08:06	07:22	07:28	06:28		05:46		05:35	05:58	06:37		07:02 (174)	07:17		07:59	07:44	08:14
	17:18	18:04	19:45	20:28		21:07		21:29	21:15	20:29	9	07:11 (199)	19:28		18:29	16:48	16:44
25	08:05	07:20	07:26	06:26	20:06 (201)	05:45		05:35	05:59	06:38		07:03 (174)	07:19		08:00	07:46	08:14
	17:20	18:06	19:46	20:29	1 20:07 (201)	21:08		21:29	21:14	20:28	8	07:11 (199)	19:26		18:27	16:47	16:44
26	08:04	07:18	07:24	06:25	20:06 (201)	05:44		05:35	06:00	06:39		07:05 (174)	07:20		08:02	07:47	08:15
	17:21	18:07	19:48	20:31	3 20:09 (201)	21:09		21:29	21:13	20:26	7	07:12 (199)	19:24		18:25	16:46	16:45
27	08:03	07:16	07:22	06:23	20:05 (201)	05:43		05:36	06:01	06:41		07:06 (174)	07:21		08:03	07:48	08:15
	17:23	18:09	19:49	20:32	5 20:10 (201)	21:10		21:30	21:12	20:24	6	07:12 (199)	19:22		18:24	16:45	16:45
28	08:02	07:14	07:20	06:21	20:05 (201)	05:42		05:36	06:02	06:42		07:07 (174)	07:23		08:05	07:50	08:15
	17:24	18:10	19:50	20:33	6 20:11 (201)	21:11		21:30	21:11	20:22	5	07:12 (199)	19:20		18:22	16:45	16:46
29	08:00		07:18	06:20	20:07 (201)	05:41		05:36	06:03	06:43		07:08 (199)	07:24		08:06	07:51	08:16
	17:26		19:52	20:35	6 20:13 (201)	21:12		21:30	21:10	20:20	11	07:22 (164)	19:18		18:20	16:44	16:47
30	07:59		07:16	06:18	20:07 (201)	05:41		05:37	06:05	06:44		07:10 (199)	07:25		08:08	07:52	08:16
	17:27		19:53	20:36	7 20:14 (201)	21:13		21:29	21:09	20:18	13	07:24 (164)	19:16		18:19	16:43	16:48
31	07:58		07:14			05:40			06:06	06:46		07:11 (164)			08:09		08:16
	17:29		19:55			21:14			21:07	20:16	14	07:25 (164)			18:17		16:49
Potential sun hours	278	286	367	406		465		475	481	442			380		339	283	266
Total, worst case					159		80				191			59			
Sun reduction					0.57		0.60				0.71			0.63			
Oper. time red.					0.85		0.85				0.85			0.85			
Wind dir. red.					0.68		0.72				0.70			0.68			
Total reduction					0.33		0.37				0.42			0.36			
Total, real					52		29				81			21			

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm) Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker Last time (hh:mm) with flicker	(WTG causing flicker first time) (WTG causing flicker last time)

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Richard Lampeter / rlampeter@epsilonassociates.com

Calculated:
5/31/2023 2:12 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A179 - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (5069)

Assumptions for shadow calculations

Reference year for calendar 2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.52	0.54	0.59	0.57	0.60	0.64	0.74	0.71	0.63	0.51	0.39	0.39

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
364	231	235	234	299	398	720	587	362	314	482	477	675	931	686	429	7,424

	January	February	March		April	May	June	July	August	September			October	November	December
1	08:17	07:57	07:13		07:12	06:17	05:39	05:38	06:07	06:47			07:27	08:11	07:54
	16:50	17:30	18:12		19:56	20:38	21:16	21:30	21:06	20:15			19:15	18:16	16:43
2	08:17	07:56	07:11		07:10	06:15	05:39	05:38	06:08	06:49			07:28	08:12	07:55
	16:51	17:32	18:13		19:58	20:39	21:17	21:30	21:05	20:13			19:13	18:14	16:43
3	08:17	07:55	07:09		07:08	06:13	05:38	05:39	06:10	06:50			07:30	08:14	07:56
	16:52	17:33	18:15		19:59	20:40	21:18	21:29	21:04	20:11			19:11	18:13	16:42
4	08:17	07:53	07:07		07:06	06:12	05:38	05:39	06:11	06:51			07:31	08:15	07:58
	16:53	17:35	18:16		20:00	20:42	21:19	21:29	21:02	20:09			19:09	18:11	16:42
5	08:16	07:52	07:05		07:04	06:10	05:37	05:40	06:12	06:53			07:32	07:17	07:59
	16:54	17:37	18:18		20:02	20:43	21:19	21:29	21:01	20:07			19:07	17:10	16:41
6	08:16	07:51	07:03		07:02	06:09	05:36	05:41	06:13	06:54			07:34	07:18	08:00
	16:55	17:38	18:19		20:03	20:45	21:20	21:29	20:59	20:05			19:05	17:08	16:41
7	08:16	07:49	07:02		07:00	06:07	05:36	05:41	06:15	06:55			07:35	07:20	08:01
	16:56	17:40	18:21		20:05	20:46	21:21	21:28	20:58	20:03			19:03	17:07	16:41
8	08:16	07:48	07:00		06:58	06:06	05:36	05:42	06:16	06:57			07:37	07:21	08:02
	16:57	17:41	18:22		20:06	20:47	21:22	21:28	20:57	20:01			19:01	17:06	16:41
9	08:16	07:46	06:58		06:56	06:04	05:35	05:43	06:17	06:58			07:38	07:23	08:03
	16:58	17:43	18:24		20:07	20:49	21:23	21:27	20:55	19:59			18:57	17:04	16:41
10	08:15	07:45	06:56		06:54	06:03	05:35	05:44	06:19	06:59			07:39	07:24	08:04
	16:59	17:44	18:25		20:09	20:50	21:23	21:27	20:53	19:57			18:55	17:03	16:40
11	08:15	07:43	06:54		06:52	06:01	05:35	05:45	06:20	07:00			07:41	07:26	08:05
	17:01	17:46	18:27		20:10	20:51	21:24	21:26	20:52	19:55			18:53	17:02	16:40
12	08:14	07:42	07:52		06:51	06:00	05:34	05:46	06:21	07:02			07:42	07:27	08:06
	17:02	17:47	18:28		20:11	20:52	21:25	21:26	20:50	19:53			18:51	17:00	16:40
13	08:14	07:40	07:50		06:49	05:59	05:34	05:46	06:22	07:03			07:43	07:29	08:07
	17:03	17:49	19:29		20:13	20:54	21:25	21:25	20:49	19:51			18:49	16:59	16:40
14	08:13	07:39	07:48		06:47	05:57	05:34	05:47	06:24	07:04			07:45	07:30	08:08
	17:04	17:51	19:31		20:14	20:55	21:26	21:25	20:47	19:49			18:47	16:58	16:40
15	08:13	07:37	07:46		06:45	05:56	05:34	05:48	06:25	07:06		07:30 (148)	07:46	07:32	08:09
	17:06	17:52	19:32		20:16	20:56	21:26	21:24	20:45	19:47	6	07:36 (148)	18:45	16:57	16:41
16	08:12	07:36	07:44		06:43	05:55	05:34	05:49	06:26	07:07		07:31 (148)	07:48	07:33	08:09
	17:07	17:54	19:34		20:17	20:58	21:27	21:23	20:44	19:45	5	07:36 (148)	18:44	16:56	16:41
17	08:12	07:34	07:42		06:41	05:54	05:34	05:50	06:28	07:08		07:33 (148)	07:49	07:35	08:10
	17:08	17:55	19:35		20:18	20:59	21:27	21:22	20:42	19:43	4	07:37 (148)	18:42	16:54	16:41
18	08:11	07:32	07:40		06:39	05:52	05:34	05:51	06:29	07:10		07:34 (148)	07:51	07:36	08:11
	17:10	17:57	19:37		20:20	21:00	21:28	21:22	20:40	19:41	2	07:36 (148)	18:40	16:53	16:41
19	08:10	07:31	07:38		06:37	05:51	05:34	05:52	06:30	07:11			07:52	07:38	08:12
	17:11	17:58	19:38		20:21	21:01	21:28	21:21	20:39	19:39			18:38	16:52	16:42
20	08:09	07:29	07:36		06:36	05:50	05:34	05:53	06:32	07:12			07:53	07:39	08:12
	17:13	18:00	19:39		20:23	21:03	21:29	21:20	20:37	19:37			18:36	16:51	16:42
21	08:09	07:27	07:34		06:34	05:49	05:34	05:54	06:33	07:14			07:55	07:40	08:13
	17:14	18:00	19:41		20:24	21:04	21:29	21:19	20:35	19:35			18:34	16:50	16:42
22	08:08	07:25	07:32		06:32	05:48	05:34	05:56	06:34	07:15			07:56	07:42	08:13
	17:15	18:01	19:42		20:25	21:05	21:29	21:18	20:33	19:33			18:33	16:50	16:43
23	08:07	07:24	07:30		06:30	05:47	05:35	05:57	06:36	07:16			07:58	07:43	08:14
	17:17	18:03	19:44		20:27	21:06	21:29	21:17	20:32	19:31			18:31	16:49	16:43
24	08:06	07:22	07:28		06:28	05:46	05:35	05:58	06:37	07:18			07:59	07:45	08:14
	17:18	18:04	19:45		20:28	21:07	21:30	21:16	20:30	19:29			18:29	16:48	16:44
25	08:05	07:20	07:26		06:27	05:45	05:35	05:59	06:38	07:19			08:01	07:46	08:15
	17:20	18:06	19:46		20:30	21:08	21:30	21:15	20:28	19:27			18:27	16:47	16:44
26	08:04	07:18	07:24	07:47 (148)	06:25	05:44	05:35	06:00	06:40	07:20			08:02	07:47	08:15
	17:21	18:07	19:48	1 07:48 (148)	20:31	21:10	21:30	21:14	20:26	19:25			18:26	16:46	16:45
27	08:03	07:17	07:22	07:45 (148)	06:23	05:43	05:36	06:01	06:41	07:22			08:04	07:49	08:16
	17:23	18:09	19:49	3 07:48 (148)	20:32	21:11	21:30	21:13	20:24	19:23			18:24	16:46	16:46
28	08:02	07:15	07:20	07:43 (148)	06:22	05:42	05:36	06:02	06:42	07:23			08:05	07:50	08:16
	17:24	18:10	19:51	4 07:47 (148)	20:34	21:12	21:30	21:11	20:22	19:21			18:22	16:45	16:46
29	08:01		07:18	07:41 (148)	06:20	05:42	05:37	06:04	06:43	07:24			08:07	07:51	08:16
	17:26		19:52	5 07:46 (148)	20:35	21:13	21:30	21:10	20:20	19:19			18:21	16:44	16:47
30	08:00		07:16	07:39 (148)	06:18	05:41	05:37	06:05	06:45	07:26			08:08	07:53	08:16
	17:27		19:53	6 07:45 (148)	20:36	21:14	21:30	21:09	20:19	19:17			18:19	16:44	16:48
31	07:58		07:14			05:40		06:06	06:46				08:10		08:16
	17:29		19:55			21:15		21:08	20:17				18:17		16:49
Potential sun hours	278	286	367		406	466	475	481	443	380			339	283	266
Total, worst case				19							17				
Sun reduction				0.59							0.63				
Oper. time red.				0.85							0.85				
Wind dir. red.				0.70							0.70				
Total reduction				0.35							0.37				
Total, real				7							6				

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

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Calculated:
5/31/2023 2:12 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A258 - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (5148)

Assumptions for shadow calculations

Reference year for calendar 2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.52	0.54	0.59	0.57	0.60	0.64	0.74	0.71	0.63	0.51	0.39	0.39

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
364	231	235	234	299	398	720	587	362	314	482	477	675	931	686	429	7,424

	January	February	March	April	May	June	July	August	September	October	November	December
1	08:16	07:57	08:23 (222)	07:13	17:50 (147)	07:12	06:16	05:39	05:37	06:07	06:47	07:27	08:11	08:47 (222)	07:54
	16:50	17:30 19	08:42 (222)	18:12 1	17:51 (147)	19:56	20:38	21:16	21:30	21:06	20:14	19:14	18:16 28	09:15 (222)	16:43
2	08:16	07:56	08:22 (222)	07:11		07:10	06:15	05:38	05:38	06:08	06:48	07:28	08:12	08:47 (222)	07:55
	16:51	17:32 22	08:44 (222)	18:13		19:57	20:39	21:17	21:29	21:05	20:13	19:12	18:14 29	09:16 (222)	16:42
3	08:16	07:54	08:20 (222)	07:09		07:08	06:13	05:38	05:38	06:09	06:50	07:29	08:14	08:46 (222)	07:56
	16:51	17:33 24	08:44 (222)	18:15		19:59	20:40	21:17	21:29	21:03	20:11	19:10	18:13 29	09:15 (222)	16:42
4	08:16	07:53	08:19 (222)	07:07		07:06	06:12	05:37	05:39	06:11	06:51	07:31	08:15	08:46 (222)	07:57
	16:52	17:35 26	08:45 (222)	18:16		20:00	20:42	21:18	21:29	21:02	20:09	19:08	18:11 30	09:16 (222)	16:42
5	08:16	07:52	08:17 (222)	07:05		07:04	06:10	05:37	05:40	06:12	06:52	07:32	07:17	07:47 (222)	07:58
	16:54	17:36 28	08:45 (222)	18:18		20:02	20:43	21:19	21:29	21:01	20:07	19:06	17:10 29	08:16 (222)	16:41
6	08:16	07:50	08:17 (222)	07:03		07:02	06:08	05:36	05:40	06:13	06:54	07:33	07:18	07:46 (222)	08:00
	16:55	17:38 29	08:46 (222)	18:19		20:03	20:44	21:20	21:28	20:59	20:05	19:04	17:08 30	08:16 (222)	16:41
7	08:16	07:49	08:16 (222)	07:01		07:00	06:07	05:36	05:41	06:14	06:55	07:35	07:20	07:47 (222)	08:01
	16:56	17:39 30	08:46 (222)	18:20		20:04	20:46	21:21	21:28	20:58	20:03	19:02	17:07 29	08:16 (222)	16:41
8	08:16	07:48	08:17 (222)	06:59		06:58	06:05	05:35	05:42	06:16	06:56	07:36	07:21	07:48 (222)	08:02
	16:57	17:41 29	08:46 (222)	18:22		20:06	20:47	21:22	21:28	20:56	20:01	19:00	17:05 27	08:15 (222)	16:40
9	08:15	07:46	08:16 (222)	06:57		06:56	06:04	05:35	05:43	06:17	06:58	07:38	07:23	07:50 (222)	08:03
	16:58	17:42 30	08:46 (222)	18:23		20:07	20:48	21:22	21:27	20:55	19:59	18:57	17:04 25	08:15 (222)	16:40
10	08:15	07:45	08:17 (222)	06:56		06:54	06:03	05:35	05:44	06:18	06:59	07:39	07:24	07:52 (222)	08:04
	16:59	17:44 29	08:46 (222)	18:25		20:08	20:50	21:23	21:27	20:53	19:57	18:55	17:03 23	08:15 (222)	16:40
11	08:15	07:43	08:17 (222)	06:54		06:52	06:01	05:34	05:44	06:20	07:00	07:40	07:26	07:53 (222)	08:05
	17:00	17:46 29	08:46 (222)	18:26		20:10	20:51	21:24	21:26	20:52	19:55	18:53	17:01 20	08:13 (222)	16:40
12	08:14	07:42	08:18 (222)	07:52		06:50	06:00	05:34	05:45	06:21	07:02	07:42	07:27	07:55 (222)	08:06
	17:02	17:47 28	08:46 (222)	18:28		20:11	20:52	21:24	21:26	20:50	19:53	18:51	17:00 18	08:13 (222)	16:40
13	08:14	07:40	08:18 (222)	07:50		06:48	05:58	05:34	05:46	06:22	07:03	07:43	07:29	07:56 (222)	08:07
	17:03	17:49 27	08:45 (222)	19:29		20:13	20:54	21:25	21:25	20:48	19:51	18:49	16:59 16	08:12 (222)	16:40
14	08:13	07:39	08:19 (222)	07:48		06:46	05:57	05:34	05:47	06:23	07:04	07:45 18:23 (147)	07:30	07:58 (222)	08:08
	17:04	17:50 25	08:44 (222)	19:31		20:14	20:55	21:26	21:24	20:47	19:49	18:47 1 18:24 (147)	16:58 13	08:11 (222)	16:40
15	08:13	07:37	08:20 (222)	07:46		06:45	05:56	05:34	05:48	06:25	07:05	07:46 18:21 (147)	07:32	08:00 (222)	08:08
	17:05	17:52 23	08:43 (222)	19:32		20:15	20:56	21:26	21:24	20:45	19:47	18:45 2 18:23 (147)	16:56 10	08:10 (222)	16:40
16	08:12	07:35	08:21 (222)	07:44		06:43	05:55	05:34	05:49	06:26	07:07	07:47 18:19 (147)	07:33	08:01 (222)	08:09
	17:07	17:53 21	08:42 (222)	19:33		20:17	20:57	21:27	21:23	20:43	19:45	18:43 1 18:20 (147)	16:55 6	08:07 (222)	16:40
17	08:11	07:34	08:22 (222)	07:42		06:41	05:53	05:34	05:50	06:27	07:08	07:49	07:34		08:10
	17:08	17:55 18	08:40 (222)	19:35		20:18	20:59	21:27	21:22	20:42	19:43	18:41	16:54		16:41
18	08:11	07:32	08:25 (222)	07:40		06:39	05:52	05:34	05:51	06:29	07:09	07:50	07:36		08:11
	17:09	17:56 13	08:38 (222)	19:36		20:20	21:00	21:28	21:21	20:40	19:41	18:40	16:53		16:41
19	08:10	07:30	08:31 (222)	07:38		06:37	05:51	05:34	05:52	06:30	07:11	07:52	07:37		08:11
	17:11	17:58 1	08:32 (222)	19:38		20:21	21:01	21:28	21:20	20:38	19:39	18:38	16:52		16:41
20	08:09	07:29		07:36		06:35	05:50	05:34	05:53	06:31	07:12	07:53	07:39		08:12
	17:12	17:59		19:39		20:22	21:02	21:28	21:20	20:37	19:37	18:36	16:51		16:42
21	08:08	07:27		07:34		06:34	05:49	05:34	05:54	06:33	07:13	07:55	07:40		08:13
	17:14	18:01		19:41		20:24	21:04	21:29	21:19	20:35	19:35	18:34	16:50		16:42
22	08:08	07:25		07:32		06:32	05:48	05:34	05:55	06:34	07:15	07:56	07:42		08:13
	17:15	18:01		19:42		20:25	21:05	21:29	21:18	20:33	19:33	18:32	16:49		16:42
23	08:07	07:23		07:30		06:30	05:47	05:34	05:56	06:35	07:16	07:58	07:43		08:14
	17:17	18:03		19:43		20:26	21:06	21:29	21:17	20:31	19:31	18:31	16:48		16:43
24	08:06	07:22		07:28		06:28	05:46	05:34	05:57	06:37	07:17	07:59	07:44		08:14
	17:18	18:04		19:45		20:28	21:07	21:29	21:16	20:29	19:29	18:29	16:48		16:43
25	08:05	07:20		07:26		06:26	05:45	05:35	05:59	06:38	07:19	08:00 08:56 (222)	07:46		08:15
	17:20	18:06		19:46		20:29	21:08	21:30	21:15	20:28	19:26	18:27 11 09:07 (222)	16:47		16:44
26	08:04	07:18		07:24		06:25	05:44	05:35	06:00	06:39	07:20	08:02 08:53 (222)	07:47		08:15
	17:21	18:07		19:48		20:31	21:09	21:30	21:13	20:26	19:24	18:25 17 09:10 (222)	16:46		16:45
27	08:03 08:29 (222)	07:16	17:47 (147)	07:22		06:23	05:43	05:35	06:01	06:41	07:21	08:03 08:51 (222)	07:48		08:15
	17:23 3 08:32 (222)	18:09 1	17:48 (147)	19:49		20:32	21:10	21:30	21:12	20:24	19:22	18:24 20 09:11 (222)	16:45		16:45
28	08:02 08:28 (222)	07:14	17:47 (147)	07:20		06:21	05:42	05:36	06:02	06:42	07:23	08:05 08:50 (222)	07:50		08:16
	17:24 8 08:36 (222)	18:10 2	17:49 (147)	19:50		20:33	21:11	21:30	21:11	20:22	19:20	18:22 23 09:13 (222)	16:45		16:46
29	08:01 08:27 (222)			07:18		06:20	05:41	05:36	06:03	06:43	07:24	08:06 08:48 (222)	07:51		08:16
	17:26 11 08:38 (222)			19:52		20:35	21:13	21:30	21:10	20:20	19:18	18:20 25 09:13 (222)	16:44		16:47
30	07:59 08:25 (222)			07:16		06:18	05:40	05:37	06:05	06:44	07:25	08:08 08:48 (222)	07:52		08:16
	17:27 14 08:39 (222)			19:53		20:36	21:14	21:30	21:09	20:18	19:16	18:19 26 09:14 (222)	16:43		16:48
31	07:58 08:24 (222)			07:14			05:40		06:06	06:46		08:09 08:47 (222)			08:16
	17:29 17 08:41 (222)			19:55			21:15		21:07	20:16		18:17 27 09:14 (222)			16:48
Potential sun hours	278	286	367	406	466	475	481	443	380	339	283	266
Total, worst case	53	454	1							153	362	
Sun reduction	0.52	0.54	0.59							0.51	0.39	
Oper. time red.	0.85	0.85	0.85							0.85	0.85	
Wind dir. red.	0.72	0.72	0.66							0.72	0.72	
Total reduction	0.32	0.33	0.33							0.31	0.24	
Total, real	17	149	0							47	86	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

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Calculated:
5/31/2023 2:12 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A261 - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (5151)

Assumptions for shadow calculations

Reference year for calendar 2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.52	0.54	0.59	0.57	0.60	0.64	0.74	0.71	0.63	0.51	0.39	0.39

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
364	231	235	234	299	398	720	587	362	314	482	477	675	931	686	429	7,424

	January			February			March	April	May	June	July	August	September	October	November			December		
1	08:16		16:11 (250)	07:57		16:56 (148)	07:13	07:12	06:16	05:39	05:37	06:07	06:47	07:27	08:11			07:54		08:23 (120)
	16:50	12	16:23 (250)	17:30	9	17:05 (148)	18:12	19:56	20:38	21:16	21:30	21:06	20:15	19:14	18:16			16:43	19	16:15 (250)
2	08:16		16:11 (250)	07:56		16:57 (148)	07:11	07:10	06:15	05:39	05:38	06:08	06:49	07:28	08:12			07:55		08:25 (120)
	16:51	13	16:24 (250)	17:32	10	17:07 (148)	18:13	19:57	20:39	21:17	21:30	21:05	20:13	19:12	18:14			16:42	18	16:16 (250)
3	08:16		16:11 (250)	07:55		16:58 (148)	07:09	07:08	06:13	05:38	05:39	06:10	06:50	07:30	08:14			07:56		15:59 (250)
	16:52	13	16:24 (250)	17:33	10	17:08 (148)	18:15	19:59	20:40	21:18	21:29	21:04	20:11	19:10	18:13			16:42	17	16:16 (250)
4	08:16		16:11 (250)	07:53		17:00 (148)	07:07	07:06	06:12	05:37	05:39	06:11	06:51	07:31	08:15			07:57		15:58 (250)
	16:53	14	16:25 (250)	17:35	9	17:09 (148)	18:16	20:00	20:42	21:18	21:29	21:02	20:09	19:08	18:11			16:42	17	16:15 (250)
5	08:16		16:12 (250)	07:52		17:02 (148)	07:05	07:04	06:10	05:37	05:40	06:12	06:52	07:32	07:17			07:59		15:58 (250)
	16:54	14	16:26 (250)	17:36	4	17:06 (148)	18:18	20:02	20:43	21:19	21:29	21:01	20:07	19:06	17:10			16:41	16	16:14 (250)
6	08:16		16:13 (250)	07:51			07:03	07:02	06:09	05:36	05:41	06:13	06:54	07:34	07:18			08:00		15:59 (250)
	16:55	14	16:27 (250)	17:38			18:19	20:03	20:44	21:20	21:28	20:59	20:05	19:04	17:08			16:41	16	16:15 (250)
7	08:16		16:14 (250)	07:49			07:01	07:00	06:07	05:36	05:41	06:15	06:55	07:35	07:20			08:01		15:59 (250)
	16:56	15	16:29 (250)	17:39			18:21	20:04	20:46	21:21	21:28	20:58	20:03	19:03	17:07			16:41	15	16:14 (250)
8	08:16		16:14 (250)	07:48			06:59	06:58	06:06	05:35	05:42	06:16	06:56	07:36	07:21		16:30 (148)	08:02		16:00 (250)
	16:57	15	16:29 (250)	17:41			18:22	20:06	20:47	21:22	21:28	20:56	20:01	19:01	17:05	8	16:38 (148)	16:41	14	16:14 (250)
9	08:15		16:15 (250)	07:46			06:58	06:56	06:04	05:35	05:43	06:17	06:58	07:38	07:23		16:29 (148)	08:03		16:00 (250)
	16:58	16	16:31 (250)	17:43			18:23	20:07	20:48	21:23	21:27	20:55	19:59	18:57	17:04	11	16:40 (148)	16:40	14	16:14 (250)
10	08:15		16:15 (250)	07:45			06:56	06:54	06:03	05:35	05:44	06:18	06:59	07:39	07:24		16:28 (148)	08:04		16:00 (250)
	16:59	17	16:32 (250)	17:44			18:25	20:09	20:50	21:23	21:27	20:53	19:57	18:55	17:03	11	16:39 (148)	16:40	13	16:13 (250)
11	08:15		16:16 (250)	07:43			06:54	06:52	06:01	05:34	05:44	06:20	07:00	07:41	07:26		16:27 (148)	08:05		16:01 (250)
	17:00	18	16:34 (250)	17:46			18:26	20:10	20:51	21:24	21:26	20:52	19:55	18:53	17:01	10	16:37 (148)	16:40	12	16:13 (250)
12	08:14		08:42 (120)	07:42			07:52	06:50	06:00	05:34	05:45	06:21	07:02	07:42	07:27		16:27 (148)	08:06		16:01 (250)
	17:02	19	16:34 (250)	17:47			18:28	20:11	20:52	21:25	21:26	20:50	19:53	18:51	17:00	9	16:36 (148)	16:40	12	16:13 (250)
13	08:14		08:42 (120)	07:40			07:50	06:48	05:59	05:34	05:46	06:22	07:03	07:43	07:29		16:28 (148)	08:07		16:02 (250)
	17:03	18	16:34 (250)	17:49			19:29	20:13	20:54	21:25	21:25	20:49	19:51	18:49	16:59	7	16:35 (148)	16:40	11	16:13 (250)
14	08:13		08:41 (120)	07:39			07:48	06:47	05:57	05:34	05:47	06:24	07:04	07:45	07:30		16:27 (148)	08:08		16:02 (250)
	17:04	18	16:33 (250)	17:50			19:31	20:14	20:55	21:26	21:24	20:47	19:49	18:47	16:58	6	16:33 (148)	16:40	11	16:13 (250)
15	08:13		08:40 (120)	07:37			07:46	06:45	05:56	05:34	05:48	06:25	07:06	07:46	07:32		16:28 (148)	08:08		16:03 (250)
	17:06	18	16:33 (250)	17:52			19:32	20:15	20:56	21:26	21:24	20:45	19:47	18:45	16:57	4	16:32 (148)	16:40	11	16:14 (250)
16	08:12		08:40 (120)	07:35			07:44	06:43	05:55	05:34	05:49	06:26	07:07	07:48	07:33		16:27 (148)	08:09		16:02 (250)
	17:07	17	16:33 (250)	17:53			19:34	20:17	20:57	21:27	21:23	20:44	19:45	18:43	16:55	3	16:30 (148)	16:41	11	16:13 (250)
17	08:12		08:39 (120)	07:34			07:42	06:41	05:53	05:34	05:50	06:28	07:08	07:49	07:35		16:29 (148)	08:10		16:03 (250)
	17:08	14	16:31 (250)	17:55			19:35	20:18	20:59	21:27	21:22	20:42	19:43	18:41	16:54	1	16:30 (148)	16:41	10	16:13 (250)
18	08:11		08:38 (120)	07:32			07:40	06:39	05:52	05:34	05:51	06:29	07:10	07:50	07:36			08:11		16:04 (250)
	17:10	9	16:28 (250)	17:57			19:36	20:20	21:00	21:28	21:21	20:40	19:41	18:40	16:53			16:41	10	16:14 (250)
19	08:10		08:37 (120)	07:30			07:38	06:37	05:51	05:34	05:52	06:30	07:11	07:52	07:37			08:11		16:05 (250)
	17:11	7	08:44 (120)	17:58			19:38	20:21	21:01	21:28	21:21	20:38	19:39	18:38	16:52			16:41	9	16:14 (250)
20	08:09		08:37 (120)	07:29			07:36	06:35	05:50	05:34	05:53	06:31	07:12	07:53	07:39			08:12		16:05 (250)
	17:12	6	08:43 (120)	18:00			19:39	20:22	21:02	21:28	21:20	20:37	19:37	18:36	16:51			16:42	9	16:14 (250)
21	08:09			07:27			07:34	06:34	05:49	05:34	05:54	06:33	07:13	07:55	07:40			08:13		16:06 (250)
	17:14			18:00			19:41	20:24	21:04	21:29	21:19	20:35	19:35	18:34	16:50			16:42	9	16:15 (250)
22	08:08			07:25			07:32	06:32	05:48	05:34	05:55	06:34	07:15	07:56	07:42			08:13		16:06 (250)
	17:15			18:01			19:42	20:25	21:05	21:29	21:18	20:33	19:33	18:32	16:49			16:43	9	16:15 (250)
23	08:07			07:24			07:30	06:30	05:47	05:34	05:56	06:35	07:16	07:58	07:43		08:15 (120)	08:14		16:07 (250)
	17:17			18:03			19:43	20:27	21:06	21:29	21:17	20:31	19:31	18:31	16:48	4	08:19 (120)	16:43	9	16:16 (250)
24	08:06			07:22			07:28	06:28	05:46	05:35	05:58	06:37	07:17	07:59	07:45		08:14 (120)	08:14		16:07 (250)
	17:18			18:04			19:45	20:28	21:07	21:30	21:16	20:30	19:29	18:29	16:48	7	08:21 (120)	16:44	9	16:16 (250)
25	08:05			07:20			07:26	06:27	05:45	05:35	05:59	06:38	07:19	08:01	07:46		08:15 (120)	08:15		16:07 (250)
	17:20			18:06			19:46	20:29	21:08	21:30	21:15	20:28	19:27	18:27	16:47	7	08:22 (120)	16:44	9	16:16 (250)
26	08:04			07:18			07:24	06:25	05:44	05:35	06:00	06:39	07:20	08:02	07:47		08:17 (120)	08:15		16:08 (250)
	17:21			18:07			19:48	20:31	21:09	21:30	21:14	20:26	19:25	18:26	16:46	12	16:09 (250)	16:45	10	16:18 (250)
27	08:03		16:55 (148)	07:16			07:22	06:23	05:43	05:36	06:01	06:41	07:21	08:03	07:49		08:18 (120)	08:15		16:08 (250)
	17:23	2	16:57 (148)	18:09			19:49	20:32	21:11	21:30	21:12	20:24	19:23	18:24	16:45	16	16:11 (250)	16:45	10	16:18 (250)
28	08:02		16:55 (148)	07:15			07:20	06:21	05:42	05:36	06:02	06:42	07:23	08:05	07:50		08:19 (120)	08:16		16:08 (250)
	17:24	4	16:59 (148)	18:10			19:50	20:33	21:12	21:30	21:11	20:22	19:21	18:22	16:45	17	16:12 (250)	16:46	10	16:18 (250)
29	08:01		16:55 (148)				07:18	06:20	05:41	05:36	06:03	06:43	07:24	08:06	07:51		08:21 (120)	08:16		16:08 (250)
	17:26	6	17:01 (148)				19:52	20:35	21:13	21:30	21:10	20:20	19:18	18:21	16:44	18	16:14 (250)	16:47	11	16:19 (250)
30	08:00		16:56 (148)				07:16	06:18	05:41	05:37	06:05	06:45	07:25	08:08	07:52		08:22 (120)	08:16		16:10 (250)
	17:27	7	17:03 (148)				19:53	20:36	21:14	21:30	21:09	20:18	19:16	18:19	16:44	18	16:14 (250)	16:48	11	16:21 (250)
31	07:58		16:55 (148)				07:14		05:40		06:06	06:46		08:09				08:16		16:10 (250)
	17:29	8	17:03 (148)				19:55		21:15		21:08	20:16		18:17				16:49	11	16:21 (250)
Potential sun hours	278			286			367	406	466	475	481	443	380	339	283			266		
Total, worst case		314			42											169			373	
Sun reduction		0.52			0.54											0.39			0.39	
Oper. time red.		0.85			0.85											0.85			0.85	
Wind dir. red.		0.60			0.61											0.63			0.59	
Total reduction		0.27			0.28											0.21			0.19	
Total, real		84			12											35			72	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Licensed user:
Epsilon Associates, Inc
3 Clock Tower Place, Suite 250
US-MAYNARD MA 01754
978 897 7100
Richard Lampeter / rlampeter@epsilonassociates.com

Calculated:
5/31/2023 2:12 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A281 - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (5171)

Assumptions for shadow calculations

Reference year for calendar 2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.52	0.54	0.59	0.57	0.60	0.64	0.74	0.71	0.63	0.51	0.39	0.39

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
364	231	235	234	299	398	720	587	362	314	482	477	675	931	686	429	7,424

	January	February	March	April			May			June	July	August			September	October	November	December
1	08:17	07:57	07:13	07:12			06:17		06:41 (190)	05:40	05:38	06:07			06:47	07:27	08:11	07:54
	16:50	17:31	18:12	19:56			20:38	9	06:50 (190)	21:16	21:30	21:06			20:15	19:15	18:16	16:43
2	08:17	07:56	07:11	07:10			06:15		06:39 (190)	05:39	05:38	06:09		06:49 (193)	06:49	07:28	08:12	07:55
	16:51	17:32	18:13	19:58			20:39	11	06:50 (190)	21:17	21:30	21:05	7	06:56 (193)	20:13	19:13	18:14	16:43
3	08:17	07:55	07:09	07:08			06:13		06:38 (190)	05:38	05:39	06:10		06:47 (193)	06:50	07:30	08:14	07:56
	16:52	17:34	18:15	19:59			20:40	12	06:50 (193)	21:18	21:29	21:04	11	06:58 (193)	20:11	19:11	18:13	16:42
4	08:17	07:53	07:07	07:06			06:12		06:36 (193)	05:38	05:40	06:11		06:46 (193)	06:51	07:31	08:15	07:57
	16:53	17:35	18:16	20:00			20:42	14	06:50 (193)	21:19	21:29	21:02	12	06:58 (193)	20:09	19:09	18:11	16:42
5	08:16	07:52	07:05	07:04			06:10		06:35 (193)	05:37	05:40	06:12		06:45 (193)	06:53	07:32	07:17	07:59
	16:54	17:37	18:18	20:02			20:43	16	06:51 (193)	21:19	21:29	21:01	14	06:59 (193)	20:07	19:07	17:10	16:42
6	08:16	07:51	07:04	07:02			06:09		06:34 (193)	05:37	05:41	06:14		06:44 (193)	06:54	07:34	07:18	08:00
	16:55	17:38	18:19	20:03			20:45	17	06:51 (193)	21:20	21:29	20:59	15	06:59 (193)	20:05	19:05	17:09	16:41
7	08:16	07:49	07:02	07:00			06:07		06:34 (193)	05:36	05:42	06:15		06:44 (193)	06:55	07:35	07:20	08:01
	16:56	17:40	18:21	20:05			20:46	16	06:50 (193)	21:21	21:28	20:58	16	07:00 (193)	20:03	19:03	17:07	16:41
8	08:16	07:48	07:00	06:58			06:06		06:34 (193)	05:36	05:42	06:16		06:44 (193)	06:57	07:37	07:21	08:02
	16:57	17:41	18:22	20:06			20:47	16	06:50 (193)	21:22	21:28	20:57	16	07:00 (193)	20:01	19:01	17:06	16:41
9	08:16	07:46	06:58	06:56			06:04		06:34 (193)	05:35	05:43	06:17		06:44 (193)	06:58	07:38	07:23	08:03
	16:58	17:43	18:24	20:07			20:49	15	06:49 (193)	21:23	21:27	20:55	16	07:00 (193)	19:59	18:57	17:04	16:41
10	08:15	07:45	06:56	06:55			06:03		06:35 (193)	05:35	05:44	06:19		06:45 (193)	06:59	07:39	07:24	08:04
	17:00	17:44	18:25	20:09			20:50	13	06:48 (193)	21:23	21:27	20:53	14	06:59 (193)	19:57	18:55	17:03	16:41
11	08:15	07:43	06:54	06:53			06:02		06:37 (193)	05:35	05:45	06:20		06:46 (190)	07:01	07:41	07:26	08:05
	17:01	17:46	18:27	20:10			20:51	11	06:48 (193)	21:24	21:26	20:52	13	06:59 (193)	19:55	18:53	17:02	16:41
12	08:14	07:42	07:52	06:51			06:00		06:38 (193)	05:35	05:46	06:21		06:48 (190)	07:02	07:42	07:27	08:06
	17:02	17:48	18:28	20:12			20:52	8	06:46 (193)	21:25	21:26	20:50	11	06:59 (190)	19:53	18:51	17:00	16:40
13	08:14	07:40	07:50	06:49			05:59		06:41 (193)	05:34	05:47	06:23		06:49 (190)	07:03	07:44	07:29	08:07
	17:03	17:49	19:29	20:13			20:54	1	06:42 (193)	21:25	21:25	20:49	10	06:59 (190)	19:51	18:49	16:59	16:41
14	08:13	07:39	07:48	06:47			05:58			05:34	05:48	06:24		06:50 (190)	07:04	07:45	07:30	08:08
	17:05	17:51	19:31	20:14			20:55			21:26	21:24	20:47	8	06:58 (190)	19:49	18:47	16:58	16:41
15	08:13	07:37	07:46	06:45			05:56			05:34	05:48	06:25		06:51 (190)	07:06	07:46	07:32	08:09
	17:06	17:52	19:32	20:16			20:56			21:26	21:24	20:45	7	06:58 (190)	19:47	18:45	16:57	16:41
16	08:12	07:36	07:44	06:43			05:55			05:34	05:49	06:27		06:53 (190)	07:07	07:48	07:33	08:09
	17:07	17:54	19:34	20:17			20:58			21:27	21:23	20:44	5	06:58 (190)	19:45	18:44	16:56	16:41
17	08:12	07:34	07:42	06:41			05:54			05:34	05:50	06:28		06:54 (190)	07:08	07:49	07:35	08:10
	17:09	17:55	19:35	20:18			20:59			21:27	21:22	20:42	2	06:56 (190)	19:43	18:42	16:55	16:41
18	08:11	07:32	07:40	06:39			05:53			05:34	05:51	06:29			07:10	07:51	07:36	08:11
	17:10	17:57	19:37	20:20			21:00			21:28	21:21	20:40			19:41	18:40	16:54	16:41
19	08:10	07:31	07:38	06:38			05:51			05:34	05:52	06:30			07:11	07:52	07:38	08:12
	17:11	17:58	19:38	20:21			21:01			21:28	21:21	20:39			19:39	18:38	16:53	16:42
20	08:09	07:29	07:36	06:36			05:50			05:34	05:54	06:32			07:12	07:53	07:39	08:12
	17:13	18:00	19:39	20:23			21:03			21:29	21:20	20:37			19:37	18:36	16:52	16:42
21	08:09	07:27	07:34	06:34			05:49			05:34	05:55	06:33			07:14	07:55	07:40	08:13
	17:14	18:00	19:41	20:24			21:04			21:29	21:19	20:35			19:35	18:34	16:51	16:42
22	08:08	07:26	07:32	06:32			05:48			05:34	05:56	06:34			07:15	07:56	07:42	08:13
	17:16	18:01	19:42	20:25			21:05			21:29	21:18	20:33			19:33	18:33	16:50	16:43
23	08:07	07:24	07:30	06:30			05:47			05:35	05:57	06:36			07:16	07:58	07:43	08:14
	17:17	18:03	19:44	20:27			21:06			21:29	21:17	20:32			19:31	18:31	16:49	16:43
24	08:06	07:22	07:28	06:29			05:46			05:35	05:58	06:37			07:18	07:59	07:45	08:14
	17:18	18:04	19:45	20:28			21:07			21:30	21:16	20:30			19:29	18:29	16:48	16:44
25	08:05	07:20	07:26	06:27			05:45			05:35	05:59	06:38			07:19	08:01	07:46	08:15
	17:20	18:06	19:47	20:30			21:08			21:30	21:15	20:28			19:27	18:27	16:47	16:45
26	08:04	07:18	07:24	06:25			05:44			05:36	06:00	06:40			07:20	08:02	07:47	08:15
	17:21	18:07	19:48	20:31			21:10			21:30	21:14	20:26			19:25	18:26	16:46	16:45
27	08:03	07:17	07:22	06:23		06:47 (190)	05:43			05:36	06:01	06:41			07:22	08:04	07:49	08:15
	17:23	18:09	19:49	20:32	1	06:48 (190)	21:11			21:30	21:13	20:24			19:23	18:24	16:46	16:46
28	08:02	07:15	07:20	06:22		06:46 (190)	05:43			05:36	06:03	06:42			07:23	08:05	07:50	08:16
	17:24	18:10	19:51	20:34	4	06:50 (190)	21:12			21:30	21:11	20:22			19:21	18:22	16:45	16:47
29	08:01		07:18	06:20		06:44 (190)	05:42			05:37	06:04	06:44			07:24	08:07	07:51	08:16
	17:26		19:52	20:35	6	06:50 (190)	21:13			21:30	21:10	20:20			19:19	18:21	16:44	16:47
30	08:00		07:16	06:18		06:43 (190)	05:41			05:37	06:05	06:45			07:26	08:08	07:53	08:16
	17:27		19:53	20:36	8	06:51 (190)	21:14			21:30	21:09	20:19			19:17	18:19	16:44	16:48
31	07:58		07:14				05:40				06:06	06:46				08:10		08:16
	17:29		19:55				21:15				21:08	20:17				18:18		16:49
Potential sun hours	278	286	367	406			465			475	481	442			380	339	283	266
Total, worst case					19			159					177					
Sun reduction					0.57			0.60					0.71					
Oper. time red.					0.85			0.85					0.85					
Wind dir. red.					0.65			0.65					0.65					
Total reduction					0.32			0.33					0.39					
Total, real					6			53					69					

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

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Calculated:
5/31/2023 2:12 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A282 - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (5172)

Assumptions for shadow calculations

Reference year for calendar 2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.52	0.54	0.59	0.57	0.60	0.64	0.74	0.71	0.63	0.51	0.39	0.39

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
364	231	235	234	299	398	720	587	362	314	482	477	675	931	686	429	7,424

	January			February			March			April		May			June		
1	08:16		08:45 (174)	07:57			07:13		17:42 (144)	07:12		06:16			05:39		20:47 (233)
	16:50	13	08:58 (174)	17:30			18:12	8	17:50 (144)	19:56		20:37			21:15	3	20:50 (233)
2	08:16		08:46 (174)	07:56			07:11		17:51 (205)	07:10		06:15			05:38		20:49 (233)
	16:51	12	08:58 (174)	17:32			18:13	2	17:53 (205)	19:57		20:39			21:16	2	20:51 (233)
3	08:16		08:47 (174)	07:54			07:09		17:50 (205)	07:08		06:13			05:38		
	16:51	11	08:58 (174)	17:33			18:14	4	17:54 (205)	19:59		20:40			21:17		
4	08:16		08:48 (174)	07:53			07:07		17:49 (205)	07:06		06:11			05:37		
	16:52	10	08:58 (174)	17:35			18:16	7	17:56 (205)	20:00		20:41			21:18		
5	08:16		08:49 (174)	07:52			07:05		17:49 (205)	07:04		06:10			05:37		
	16:53	9	08:58 (174)	17:36			18:17	8	17:57 (205)	20:01		20:43			21:19		
6	08:16		08:51 (174)	07:50			07:03		17:48 (205)	07:02		06:08			05:36		
	16:55	7	08:58 (174)	17:38			18:19	11	17:59 (205)	20:03		20:44			21:20		
7	08:16		08:52 (174)	07:49			07:01		17:48 (205)	07:00		06:07			05:36		
	16:56	4	08:56 (174)	17:39			18:20	12	18:00 (205)	20:04		20:45			21:21		
8	08:15			07:48			06:59		17:49 (205)	06:58		06:05			05:35		
	16:57			17:41			18:22	13	18:02 (205)	20:06		20:47			21:21		
9	08:15			07:46			06:57		17:50 (205)	06:56		06:04			05:35		
	16:58			17:42			18:23	11	18:01 (205)	20:07		20:48			21:22		
10	08:15			07:45			06:55		17:52 (205)	06:54		06:03			05:35		
	16:59			17:44			18:25	6	17:58 (205)	20:08		20:49			21:23		
11	08:14			07:43			06:53			06:52		06:01			05:34		
	17:00			17:46			18:26			20:10		20:51			21:24		
12	08:14			07:42			07:52			06:50		06:00			05:34		
	17:02			17:47			18:28			20:11		20:52			21:24		
13	08:14			07:40			07:50			06:48		05:58			05:34		
	17:03			17:49			19:29			20:13		20:53			21:25		
14	08:13			07:38			07:48			06:46		05:57			05:34		
	17:04			17:50			19:30			20:14		20:55			21:26		
15	08:13			07:37			07:46			06:45		05:56			05:34		
	17:05			17:52			19:32			20:15		20:56			21:26		
16	08:12			07:35			07:44			06:43		05:55			05:34		
	17:07			17:53			19:33			20:17		20:57			21:27		
17	08:11			07:34			07:42			06:41		05:53			05:34		
	17:08			17:55			19:35			20:18		20:58			21:27		
18	08:11			07:32			07:40			06:39		05:52			05:34		
	17:09			17:56			19:36			20:19		21:00			21:27		
19	08:10			07:30			07:38			06:37		05:51			05:34		
	17:11			17:58			19:38			20:21		21:01			21:28		
20	08:09			07:29			07:36			06:35		05:50			05:34		
	17:12			17:59			19:39			20:22		21:02			21:28		
21	08:08			07:27			07:34			06:33		05:49			05:34		
	17:14			18:01			19:40			20:24		21:03			21:29		
22	08:07			07:25			07:32			06:32		05:48			05:34		
	17:15			18:01			19:42			20:25		21:05			21:29		
23	08:07			07:23			07:30			06:30		05:47			05:34		
	17:17			18:02			19:43			20:26		21:06			21:29		
24	08:06			07:22		17:41 (144)	07:28			06:28		05:46			05:34		
	17:18			18:04	2	17:43 (144)	19:45			20:28		21:07			21:29		
25	08:05			07:20		17:40 (144)	07:26			06:26		05:45			05:35		
	17:19			18:06	5	17:45 (144)	19:46			20:29		21:08			21:29		
26	08:04			07:18		17:40 (144)	07:24			06:25		05:44		20:43 (233)	05:35		
	17:21			18:07	6	17:46 (144)	19:47			20:31		21:09	1	20:44 (233)	21:29		
27	08:03			07:16		17:40 (144)	07:22			06:23		05:43		20:45 (233)	05:35		
	17:22			18:09	8	17:48 (144)	19:49			20:32		21:10	1	20:46 (233)	21:30		
28	08:02			07:14		17:41 (144)	07:20			06:21		05:42		20:45 (233)	05:36		
	17:24			18:10	8	17:49 (144)	19:50			20:33		21:11	2	20:47 (233)	21:30		
29	08:00						07:18			06:20		05:41		20:45 (233)	05:36		
	17:26						19:52			20:35		21:12	2	20:47 (233)	21:30		
30	07:59						07:16			06:18		05:40		20:46 (233)	05:37		
	17:27						19:53			20:36		21:13	3	20:49 (233)	21:29		
31	07:58						07:14					05:40		20:46 (233)			
	17:29						19:54					21:14	3	20:49 (233)			
Potential sun hours	278			286			367			406		466			475		
Total, worst case		66			29			82					12			5	
Sun reduction		0.52			0.54			0.59					0.60			0.64	
Oper. time red.		0.85			0.85			0.85					0.85			0.85	
Wind dir. red.		0.71			0.66			0.66					0.72			0.72	
Total reduction		0.31			0.30			0.33					0.37			0.39	
Total, real		21			9			27					4			2	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

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Calculated:
5/31/2023 2:12 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A282 - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (5172)

Assumptions for shadow calculations

Reference year for calendar 2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.52	0.54	0.59	0.57	0.60	0.64	0.74	0.71	0.63	0.51	0.39	0.39

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
364	231	235	234	299	398	720	587	362	314	482	477	675	931	686	429	7,424

	July		August	September	October		November	December		
1	05:37		06:07	06:47	07:27		08:11	07:53		
	21:29		21:06	20:14	19:14		18:16	16:43		
2	05:38		06:08	06:48	07:28		08:12	07:55		
	21:29		21:05	20:12	19:12		18:14	16:42		
3	05:38		06:09	06:50	07:29		08:14	07:56		
	21:29		21:03	20:10	19:10		18:12	16:42		
4	05:39		06:11	06:51	07:31		08:15	07:57		
	21:29		21:02	20:09	19:08		18:11	16:42		
5	05:40		06:12	06:52	07:32		18:29 (205)	07:17	07:58	
	21:29		21:01	20:07	19:06	6	18:35 (205)	17:10	16:41	
6	05:40		06:13	06:54	07:33		18:27 (205)	07:18	07:59	
	21:28		20:59	20:05	19:04	11	18:38 (205)	17:08	16:41	
7	05:41		06:14	06:55	07:35		18:25 (205)	07:20	08:01	08:38 (174)
	21:28		20:58	20:03	19:02	13	18:38 (205)	17:07	16:41	6 08:44 (174)
8	05:42		06:16	06:56	07:36		18:25 (205)	07:21	08:02	08:37 (174)
	21:27		20:56	20:01	19:00	11	18:36 (205)	17:05	16:40	8 08:45 (174)
9	05:43		06:17	06:58	07:38		18:23 (205)	07:23	08:03	08:37 (174)
	21:27		20:55	19:59	18:56	11	18:34 (205)	17:04	16:40	9 08:46 (174)
10	05:44		06:18	06:59	07:39		18:23 (205)	07:24	08:04	08:36 (174)
	21:26		20:53	19:57	18:55	9	18:32 (205)	17:03	16:40	11 08:47 (174)
11	05:44		06:20	07:00	07:40		18:23 (205)	07:26	08:05	08:36 (174)
	21:26		20:52	19:55	18:53	7	18:30 (205)	17:01	16:40	12 08:48 (174)
12	05:45		20:57 (233)	06:21	07:01	07:42	18:23 (205)	07:27	08:06	08:36 (174)
	21:25	2	20:59 (233)	20:50	19:53	18:51	5 18:28 (205)	17:00	16:40	13 08:49 (174)
13	05:46		20:55 (233)	06:22	07:03	07:43	18:24 (205)	07:28	08:06	08:37 (174)
	21:25	3	20:58 (233)	20:48	19:51	18:49	2 18:26 (205)	16:59	16:40	13 08:50 (174)
14	05:47		20:54 (233)	06:23	07:04	07:45	18:15 (144)	07:30	08:07	08:38 (174)
	21:24	3	20:57 (233)	20:47	19:49	18:47	8 18:23 (144)	16:58	16:40	13 08:51 (174)
15	05:48		20:54 (233)	06:25	07:05	07:46	18:14 (144)	07:31	08:08	08:38 (174)
	21:23	3	20:57 (233)	20:45	19:47	18:45	9 18:23 (144)	16:56	16:40	13 08:51 (174)
16	05:49		20:54 (233)	06:26	07:07	07:47	18:13 (144)	07:33	08:09	08:39 (174)
	21:23	2	20:56 (233)	20:43	19:45	18:43	7 18:20 (144)	16:55	16:40	13 08:52 (174)
17	05:50		20:54 (233)	06:27	07:08	07:49	18:12 (144)	07:34	08:10	08:40 (174)
	21:22	2	20:56 (233)	20:42	19:43	18:41	7 18:19 (144)	16:54	16:41	12 08:52 (174)
18	05:51		20:54 (233)	06:29	07:09	07:50	18:12 (144)	07:36	08:11	08:41 (174)
	21:21	1	20:55 (233)	20:40	19:41	18:39	4 18:16 (144)	16:53	16:41	12 08:53 (174)
19	05:52			06:30	07:11	07:52	18:12 (144)	07:37	08:11	08:41 (174)
	21:20			20:38	19:39	18:38	3 18:15 (144)	16:52	16:41	12 08:53 (174)
20	05:53			06:31	07:12	07:53	18:12 (144)	07:39	08:12	08:42 (174)
	21:19			20:36	19:37	18:36	1 18:13 (144)	16:51	16:42	12 08:54 (174)
21	05:54			06:33	07:13	07:55		07:40	08:12	08:42 (174)
	21:18			20:35	19:34	18:34		16:50	16:42	12 08:54 (174)
22	05:55			06:34	07:15	07:56		07:42	08:13	08:43 (174)
	21:17			20:33	19:32	18:32		16:49	16:42	12 08:55 (174)
23	05:56			06:35	07:16	07:57		07:43	08:14	08:43 (174)
	21:16			20:31	19:30	18:31		16:48	16:43	12 08:55 (174)
24	05:57			06:37	07:17	07:59		07:44	08:14	08:44 (174)
	21:15			20:29	19:28	18:29		16:48	16:43	12 08:56 (174)
25	05:59			06:38	07:19	08:00		07:46	08:14	08:44 (174)
	21:14			20:28	19:26	18:27		16:47	16:44	12 08:56 (174)
26	06:00			06:39	07:20	08:02		07:47	08:15	08:45 (174)
	21:13			20:26	19:24	18:25		16:46	16:45	12 08:57 (174)
27	06:01			06:40	07:21	08:03		07:48	08:15	08:45 (174)
	21:12			20:24	19:22	18:24		16:45	16:45	12 08:57 (174)
28	06:02			06:42	07:23	08:05		07:50	08:15	08:45 (174)
	21:11			20:22	19:20	18:22		16:45	16:46	12 08:57 (174)
29	06:03			06:43	07:24	08:06		07:51	08:16	08:45 (174)
	21:10			20:20	19:18	18:20		16:44	16:47	13 08:58 (174)
30	06:04			06:44	07:25	08:08		07:52	08:16	08:45 (174)
	21:09			20:18	19:16	18:19		16:43	16:48	13 08:58 (174)
31	06:06			06:46		08:09			08:16	08:45 (174)
	21:07			20:16		18:17			16:48	13 08:58 (174)
Potential sun hours	481			442	380	339		283	266	
Total, worst case		16					114			294
Sun reduction		0.74					0.51			0.39
Oper. time red.		0.85					0.85			0.85
Wind dir. red.		0.72					0.66			0.71
Total reduction		0.45					0.29			0.23
Total, real		7					33			69

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm) Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker Last time (hh:mm) with flicker	(WTG causing flicker first time) (WTG causing flicker last time)

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Calculated:
5/31/2023 2:12 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A283 - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (5173)

Assumptions for shadow calculations

Reference year for calendar 2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.52	0.54	0.59	0.57	0.60	0.64	0.74	0.71	0.63	0.51	0.39	0.39

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
364	231	235	234	299	398	720	587	362	314	482	477	675	931	686	429	7,424

	January	February			March			April	May			June		
1	08:16	07:57			07:13		17:41 (205)	07:12	06:16			05:39		
	16:50	17:30			18:12	10	17:51 (205)	19:56	20:37			21:15		
2	08:16	07:56			07:11		17:42 (205)	07:10	06:15			05:38		
	16:51	17:32			18:13	11	17:53 (205)	19:57	20:39			21:16		
3	08:16	07:54			07:09		17:42 (205)	07:08	06:13			05:38		
	16:51	17:33			18:14	12	17:54 (205)	19:59	20:40			21:17		
4	08:16	07:53			07:07		17:43 (205)	07:06	06:11			05:37		
	16:52	17:35			18:16	11	17:54 (205)	20:00	20:41			21:18		
5	08:16	07:52			07:05		17:45 (205)	07:04	06:10			05:37		
	16:53	17:36			18:17	7	17:52 (205)	20:01	20:43			21:19		
6	08:16	07:50			07:03			07:02	06:08			05:36		
	16:55	17:38			18:19			20:03	20:44			21:20		
7	08:16	07:49			07:01			07:00	06:07			05:36		
	16:56	17:39			18:20			20:04	20:45			21:21		
8	08:15	07:48			06:59			06:58	06:05			05:35		
	16:57	17:41			18:22			20:06	20:47			21:21		
9	08:15	07:46			06:57			06:56	06:04			05:35		
	16:58	17:42			18:23			20:07	20:48			21:22		
10	08:15	07:45			06:55			06:54	06:03			05:35		
	16:59	17:44			18:25			20:08	20:49			21:23		
11	08:14	07:43			06:53			06:52	06:01			05:34		
	17:00	17:46			18:26			20:10	20:51			21:24		
12	08:14	07:42			07:52			06:50	06:00			05:34		
	17:02	17:47			18:28			20:11	20:52			21:24		
13	08:14	07:40			07:50			06:48	05:58			05:34		
	17:03	17:49			19:29			20:13	20:53			21:25		
14	08:13	07:38			07:48			06:46	05:57			05:34		
	17:04	17:50			19:30			20:14	20:55			21:26		
15	08:13	07:37			07:46			06:45	05:56			05:34		
	17:05	17:52			19:32			20:15	20:56			21:26		
16	08:12	07:35			07:44			06:43	05:55			05:34		
	17:07	17:53			19:33			20:17	20:57			21:27		
17	08:11	07:34			07:42			06:41	05:53			05:34		
	17:08	17:55			19:35			20:18	20:58			21:27		
18	08:11	07:32			07:40			06:39	05:52			05:34		
	17:09	17:56			19:36			20:19	21:00			21:27		
19	08:10	07:30			07:38			06:37	05:51			05:34		
	17:11	17:58			19:38			20:21	21:01			21:28		
20	08:09	07:29		17:35 (144)	07:36			06:35	05:50		20:37 (233)	05:34		21:01 (185)
	17:12	17:59	2	17:37 (144)	19:39			20:22	21:02	1	20:38 (233)	21:28	1	21:02 (185)
21	08:08	07:27		17:34 (144)	07:34			06:33	05:49		20:38 (233)	05:34		21:01 (185)
	17:14	18:01	4	17:38 (144)	19:40			20:24	21:03	1	20:39 (233)	21:29	1	21:02 (185)
22	08:07	07:25		17:34 (144)	07:32			06:32	05:48		20:38 (233)	05:34		21:01 (185)
	17:15	18:01	6	17:40 (144)	19:42			20:25	21:05	2	20:40 (233)	21:29	1	21:02 (185)
23	08:07	07:23		17:35 (144)	07:30			06:30	05:47		20:38 (233)	05:34		21:02 (185)
	17:17	18:02	7	17:42 (144)	19:43			20:26	21:06	3	20:41 (233)	21:29	1	21:03 (185)
24	08:06	07:22		17:35 (144)	07:28			06:28	05:46		20:39 (233)	05:34		21:02 (185)
	17:18	18:04	8	17:43 (144)	19:45			20:28	21:07	3	20:42 (233)	21:29	1	21:03 (185)
25	08:05	07:20		17:37 (144)	07:26			06:26	05:45		20:40 (233)	05:35		
	17:19	18:06	8	17:45 (205)	19:46			20:29	21:08	3	20:43 (233)	21:29		
26	08:04	07:18		17:43 (205)	07:24			06:25	05:44			05:35		
	17:21	18:07	3	17:46 (205)	19:47			20:31	21:09			21:30		
27	08:03	07:16		17:42 (205)	07:22			06:23	05:43			05:35		
	17:22	18:09	6	17:48 (205)	19:49			20:32	21:10			21:30		
28	08:02	07:14		17:41 (205)	07:20			06:21	05:42			05:36		
	17:24	18:10	8	17:49 (205)	19:50			20:33	21:11			21:30		
29	08:00				07:18			06:20	05:41			05:36		
	17:26				19:52			20:35	21:12			21:30		
30	07:59				07:16			06:18	05:40			05:37		
	17:27				19:53			20:36	21:13			21:30		
31	07:58				07:14				05:40					
	17:29				19:54				21:14					
Potential sun hours	278	286			367			406	466			475		
Total, worst case			52			51				13			5	
Sun reduction			0.54			0.59				0.60			0.64	
Oper. time red.			0.85			0.85				0.85			0.85	
Wind dir. red.			0.65			0.66				0.72			0.71	
Total reduction			0.30			0.33				0.37			0.39	
Total, real			16			17				5			2	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

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Calculated:
5/31/2023 2:12 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A283 - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (5173)

Assumptions for shadow calculations

Reference year for calendar 2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.52	0.54	0.59	0.57	0.60	0.64	0.74	0.71	0.63	0.51	0.39	0.39

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
364	231	235	234	299	398	720	587	362	314	482	477	675	931	686	429	7,424

	July		August	September	October		November	December
1	05:37		06:07	06:47	07:27		08:11	07:53
	21:29		21:06	20:14	19:14		18:16	16:43
2	05:38		06:08	06:48	07:28		08:12	07:55
	21:29		21:05	20:12	19:12		18:14	16:42
3	05:38		06:09	06:50	07:29		08:14	07:56
	21:29		21:03	20:10	19:10		18:12	16:42
4	05:39		06:11	06:51	07:31		08:15	07:57
	21:29		21:02	20:09	19:08		18:11	16:42
5	05:40		06:12	06:52	07:32		07:17	07:58
	21:29		21:01	20:07	19:06		17:10	16:41
6	05:40		06:13	06:54	07:33		07:18	07:59
	21:28		20:59	20:05	19:04		17:08	16:41
7	05:41		06:14	06:55	07:35		07:20	08:01
	21:28		20:58	20:03	19:02		17:07	16:41
8	05:42		06:16	06:56	07:36		07:21	08:02
	21:27		20:56	20:01	19:00		17:05	16:40
9	05:43		06:17	06:58	07:38		07:23	08:03
	21:27		20:55	19:59	18:56		17:04	16:40
10	05:44		06:18	06:59	07:39	18:19 (205)	07:24	08:04
	21:26		20:53	19:57	18:55	7 18:26 (205)	17:03	16:40
11	05:44		06:20	07:00	07:40	18:18 (205)	07:26	08:05
	21:26		20:52	19:55	18:53	10 18:28 (205)	17:01	16:40
12	05:45		06:21	07:01	07:42	18:16 (205)	07:27	08:06
	21:25		20:50	19:53	18:51	12 18:28 (205)	17:00	16:40
13	05:46		06:22	07:03	07:43	18:15 (205)	07:28	08:06
	21:25		20:48	19:51	18:49	11 18:26 (205)	16:59	16:40
14	05:47		06:23	07:04	07:45	18:14 (205)	07:30	08:07
	21:24		20:47	19:49	18:47	10 18:24 (205)	16:58	16:40
15	05:48		06:25	07:05	07:46	18:14 (205)	07:31	08:08
	21:23		20:45	19:47	18:45	9 18:23 (205)	16:56	16:40
16	05:49		06:26	07:07	07:47	18:14 (205)	07:33	08:09
	21:23		20:43	19:45	18:43	6 18:20 (205)	16:55	16:40
17	05:50		06:27	07:08	07:49	18:15 (205)	07:34	08:10
	21:22		20:42	19:43	18:41	4 18:19 (205)	16:54	16:41
18	05:51		06:29	07:09	07:50	18:08 (144)	07:36	08:11
	21:21		20:40	19:41	18:39	8 18:16 (205)	16:53	16:41
19	05:52		06:30	07:11	07:52	18:07 (144)	07:37	08:11
	21:20		20:38	19:39	18:38	8 18:15 (144)	16:52	16:41
20	05:53	20:50 (233)	06:31	07:12	07:53	18:05 (144)	07:39	08:12
	21:19	3 20:53 (233)	20:36	19:37	18:36	8 18:13 (144)	16:51	16:42
21	05:54	20:49 (233)	06:33	07:13	07:55	18:05 (144)	07:40	08:12
	21:18	3 20:52 (233)	20:35	19:34	18:34	6 18:11 (144)	16:50	16:42
22	05:55	20:48 (233)	06:34	07:15	07:56	18:04 (144)	07:42	08:13
	21:17	3 20:51 (233)	20:33	19:32	18:32	5 18:09 (144)	16:49	16:42
23	05:56	20:48 (233)	06:35	07:16	07:57	18:05 (144)	07:43	08:14
	21:16	2 20:50 (233)	20:31	19:30	18:31	3 18:08 (144)	16:48	16:43
24	05:57	20:48 (233)	06:37	07:17	07:59		07:44	08:14
	21:15	1 20:49 (233)	20:29	19:28	18:29		16:48	16:43
25	05:59	20:47 (233)	06:38	07:19	08:00		07:46	08:14
	21:14	1 20:48 (233)	20:28	19:26	18:27		16:47	16:44
26	06:00		06:39	07:20	08:02		07:47	08:15
	21:13		20:26	19:24	18:25		16:46	16:45
27	06:01		06:40	07:21	08:03		07:48	08:15
	21:12		20:24	19:22	18:24		16:45	16:45
28	06:02		06:42	07:23	08:05		07:50	08:15
	21:11		20:22	19:20	18:22		16:45	16:46
29	06:03		06:43	07:24	08:06		07:51	08:16
	21:10		20:20	19:18	18:20		16:44	16:47
30	06:04		06:44	07:25	08:08		07:52	08:16
	21:09		20:18	19:16	18:19		16:43	16:48
31	06:06		06:46		08:09			08:16
	21:07		20:16		18:17			16:48
Potential sun hours	481		442	380	339		283	266
Total, worst case		13				107		
Sun reduction		0.74				0.51		
Oper. time red.		0.85				0.85		
Wind dir. red.		0.72				0.66		
Total reduction		0.45				0.28		
Total, real		6				30		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm) Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker Last time (hh:mm) with flicker	(WTG causing flicker first time) (WTG causing flicker last time)

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SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A284 - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (5174)

Assumptions for shadow calculations

Reference year for calendar 2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.52	0.54	0.59	0.57	0.60	0.64	0.74	0.71	0.63	0.51	0.39	0.39

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
364	231	235	234	299	398	720	587	362	314	482	477	675	931	686	429	7,424

	January			February			March			April			May	June
1	08:16		08:46 (249)	07:57		08:23 (203)	07:13			07:12			06:16	05:39
	16:50	25	16:03 (124)	17:30	7	17:05 (214)	18:12			19:56			20:38	21:16
2	08:16		08:46 (249)	07:56		08:22 (203)	07:11			07:10			06:15	05:39
	16:51	24	16:03 (124)	17:32	5	08:27 (203)	18:13			19:57			20:39	21:17
3	08:16		08:45 (249)	07:55		08:20 (203)	07:09			07:08			06:13	05:38
	16:52	24	16:02 (124)	17:33	7	08:27 (203)	18:15			19:59			20:40	21:18
4	08:16		08:45 (249)	07:53		08:19 (203)	07:07			07:06			06:12	05:37
	16:53	22	16:01 (124)	17:35	9	08:28 (203)	18:16			20:00			20:42	21:18
5	08:16		08:45 (249)	07:52		08:17 (203)	07:05			07:04		07:27 (165)	06:10	05:37
	16:54	18	09:03 (249)	17:36	11	08:28 (203)	18:18			20:02	1	07:28 (165)	20:43	21:19
6	08:16		08:45 (249)	07:51		08:16 (203)	07:03			07:02		07:25 (165)	06:09	05:36
	16:55	19	09:04 (249)	17:38	13	08:29 (203)	18:19			20:03	4	07:29 (165)	20:44	21:20
7	08:16		08:45 (249)	07:49		08:15 (203)	07:01			07:00		07:23 (165)	06:07	05:36
	16:56	20	09:05 (249)	17:40	15	08:30 (203)	18:21			20:04	6	07:29 (165)	20:46	21:21
8	08:16		08:44 (249)	07:48		08:14 (203)	07:00			06:58		07:21 (165)	06:06	05:36
	16:57	21	09:05 (249)	17:41	15	08:29 (203)	18:22			20:06	8	07:29 (165)	20:47	21:22
9	08:15		08:45 (249)	07:46		08:15 (203)	06:58			06:56		07:19 (157)	06:04	05:35
	16:58	20	09:05 (249)	17:43	14	08:29 (203)	18:24			20:07	10	07:29 (165)	20:48	21:22
10	08:15		08:45 (249)	07:45		08:15 (203)	06:56		07:19 (217)	06:54		07:18 (157)	06:03	05:35
	16:59	22	16:32 (128)	17:44	13	08:28 (203)	18:25	4	07:23 (217)	20:09	11	07:29 (165)	20:50	21:23
11	08:15		08:46 (249)	07:43		08:16 (203)	06:54		07:17 (217)	06:52		07:16 (157)	06:01	05:35
	17:01	24	16:34 (128)	17:46	11	08:27 (203)	18:26	6	07:23 (217)	20:10	12	07:28 (165)	20:51	21:24
12	08:14		08:45 (249)	07:42		08:19 (203)	07:52		08:15 (217)	06:50		07:14 (157)	06:00	05:34
	17:02	26	16:34 (128)	17:47	6	08:25 (203)	18:28	8	08:23 (217)	20:11	12	07:26 (165)	20:52	21:25
13	08:14		08:46 (249)	07:40			07:50		08:13 (217)	06:49		07:13 (157)	05:59	05:34
	17:03	27	16:36 (128)	17:49			19:29	10	08:23 (217)	20:13	8	07:21 (157)	20:54	21:25
14	08:13		08:47 (249)	07:39			07:48		08:11 (217)	06:47		07:14 (157)	05:57	05:34
	17:04	28	16:37 (128)	17:50			19:31	11	08:22 (217)	20:14	4	07:18 (157)	20:55	21:26
15	08:13		08:40 (227)	07:37			07:46		08:11 (217)	06:45			05:56	05:34
	17:06	30	16:38 (128)	17:52			19:32	10	08:21 (217)	20:16			20:56	21:26
16	08:12		08:40 (227)	07:35			07:44		08:13 (217)	06:43			05:55	05:34
	17:07	34	16:41 (128)	17:54			19:34	6	08:19 (217)	20:17			20:57	21:27
17	08:11		08:39 (227)	07:34			07:42			06:41			05:54	05:34
	17:08	36	16:42 (128)	17:55			19:35			20:18			20:59	21:27
18	08:11		08:38 (227)	07:32			07:40			06:39			05:52	05:34
	17:10	38	16:43 (128)	17:57			19:36			20:20			21:00	21:28
19	08:10		08:37 (227)	07:30			07:38			06:37			05:51	05:34
	17:11	39	16:44 (128)	17:58			19:38			20:21			21:01	21:28
20	08:09		08:36 (227)	07:29			07:36			06:36			05:50	05:34
	17:12	40	16:46 (128)	18:00			19:39			20:22			21:02	21:28
21	08:09		08:36 (227)	07:27			07:34			06:34			05:49	05:34
	17:14	40	16:48 (128)	18:00			19:41			20:24			21:04	21:29
22	08:08		08:35 (227)	07:25			07:32			06:32			05:48	05:34
	17:15	41	16:50 (248)	18:01			19:42			20:25			21:05	21:29
23	08:07		08:35 (227)	07:24			07:30			06:30			05:47	05:34
	17:17	38	16:51 (248)	18:03			19:44			20:27			21:06	21:29
24	08:06		08:36 (227)	07:22			07:28			06:28			05:46	05:35
	17:18	32	16:53 (248)	18:04			19:45			20:28			21:07	21:29
25	08:05		08:37 (227)	07:20			07:26			06:27			05:45	05:35
	17:20	23	16:53 (248)	18:06			19:46			20:29			21:08	21:30
26	08:04		16:36 (128)	07:18			07:24			06:25			05:44	05:35
	17:21	17	16:53 (248)	18:07			19:48			20:31			21:09	21:30
27	08:03		16:40 (128)	07:16			07:22			06:23			05:43	05:36
	17:23	9	16:57 (214)	18:09			19:49			20:32			21:10	21:30
28	08:02		16:56 (214)	07:15			07:20			06:21			05:42	05:36
	17:24	3	16:59 (214)	18:10			19:51			20:33			21:12	21:30
29	08:01		16:57 (214)				07:18			06:20			05:41	05:37
	17:26	4	17:01 (214)				19:52			20:35			21:13	21:30
30	08:00		16:58 (214)				07:16			06:18			05:41	05:37
	17:27	5	17:03 (214)				19:53			20:36			21:14	21:30
31	07:58		16:58 (214)				07:14						05:40	
	17:29	6	17:04 (214)				19:55						21:15	
Potential sun hours	278			286			367			406			466	475
Total, worst case		755			126			55			76			
Sun reduction		0.52			0.54			0.59			0.57			
Oper. time red.		0.85			0.85			0.85			0.85			
Wind dir. red.		0.66			0.72			0.71			0.68			
Total reduction		0.29			0.33			0.36			0.33			
Total, real		220			41			20			25			

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm) Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker Last time (hh:mm) with flicker	(WTG causing flicker first time) (WTG causing flicker last time)

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Calculated:
5/31/2023 2:12 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A284 - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (5174)

Assumptions for shadow calculations

Reference year for calendar 2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.52	0.54	0.59	0.57	0.60	0.64	0.74	0.71	0.63	0.51	0.39	0.39

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
364	231	235	234	299	398	720	587	362	314	482	477	675	931	686	429	7,424

	July	August		September			October			November			December		
1	05:38	06:07		06:47		07:12 (157)	07:27		07:51 (217)	08:11		08:46 (203)	07:54		08:27 (249)
	21:30	21:06		20:15	11	07:23 (165)	19:15	11	08:02 (217)	18:16	10	08:56 (203)	16:43	27	16:17 (128)
2	05:38	06:08		06:49		07:14 (157)	07:28		07:52 (217)	08:12		08:45 (203)	07:55		08:28 (249)
	21:29	21:05		20:13	12	07:26 (165)	19:13	10	08:02 (217)	18:14	12	08:57 (203)	16:43	26	16:17 (128)
3	05:39	06:10		06:50		07:15 (157)	07:30		07:54 (217)	08:14		08:44 (203)	07:56		08:28 (249)
	21:29	21:04		20:11	12	07:27 (165)	19:11	8	08:02 (217)	18:13	14	08:58 (203)	16:42	24	16:16 (128)
4	05:39	06:11		06:51		07:16 (157)	07:31		07:55 (217)	08:15		08:44 (203)	07:57		08:29 (249)
	21:29	21:02		20:09	11	07:27 (165)	19:09	6	08:01 (217)	18:11	15	08:59 (203)	16:42	21	16:15 (128)
5	05:40	06:12		06:52		07:17 (157)	07:32		07:57 (217)	07:17		07:44 (203)	07:59		08:29 (249)
	21:29	21:01		20:07	9	07:26 (165)	19:07	4	08:01 (217)	17:10	15	07:59 (203)	16:41	20	08:49 (249)
6	05:41	06:13		06:54		07:19 (165)	07:34		07:58 (217)	07:18		07:45 (203)	08:00		08:30 (249)
	21:28	20:59		20:05	7	07:26 (165)	19:05	1	07:59 (217)	17:08	14	07:59 (203)	16:41	20	08:50 (249)
7	05:41	06:15		06:55		07:20 (165)	07:35			07:20		07:47 (203)	08:01		08:31 (249)
	21:28	20:58		20:03	5	07:25 (165)	19:03			17:07	12	07:59 (203)	16:41	19	08:50 (249)
8	05:42	06:16		06:56		07:21 (165)	07:36			07:21		07:48 (203)	08:02		08:32 (249)
	21:28	20:56		20:01	3	07:24 (165)	19:01			17:05	10	07:58 (203)	16:41	18	08:50 (249)
9	05:43	06:17		06:58			07:38			07:23		07:50 (203)	08:03		08:33 (249)
	21:27	20:55		19:59			18:57			17:04	8	07:58 (203)	16:40	18	08:51 (249)
10	05:44	06:18		06:59			07:39			07:24		07:52 (203)	08:04		08:34 (249)
	21:27	20:53		19:57			18:55			17:03	6	07:58 (203)	16:40	22	15:50 (124)
11	05:45	06:20		07:00			07:41			07:26		07:53 (203)	08:05		08:35 (249)
	21:26	20:52		19:55			18:53			17:01	7	16:35 (214)	16:40	24	15:52 (124)
12	05:45	06:21		07:02			07:42			07:27		16:30 (214)	08:06		08:36 (249)
	21:26	20:50		19:53			18:51			17:00	6	16:36 (214)	16:40	24	15:53 (124)
13	05:46	06:22		07:03			07:43			07:29		16:30 (214)	08:07		08:37 (249)
	21:25	20:49		19:51			18:49			16:59	5	16:35 (214)	16:40	24	15:54 (124)
14	05:47	06:24		07:04			07:45			07:30		16:29 (214)	08:08		08:38 (249)
	21:24	20:47		19:49			18:47			16:58	4	16:33 (214)	16:40	25	15:55 (124)
15	05:48	06:25		07:06			07:46			07:32		16:29 (214)	08:08		08:39 (249)
	21:24	20:45		19:47			18:45			16:57	3	16:32 (214)	16:40	25	15:56 (124)
16	05:49	06:26		07:07			07:48			07:33		16:20 (248)	08:09		08:39 (249)
	21:23	20:44		19:45			18:43			16:55	5	16:31 (214)	16:41	26	15:56 (124)
17	05:50	06:28		07:08			07:49			07:35		16:11 (128)	08:10		08:40 (249)
	21:22	20:42		19:43			18:42			16:54	16	16:30 (214)	16:41	25	15:57 (124)
18	05:51	06:29		07:10			07:50			07:36		08:13 (227)	08:11		08:41 (249)
	21:21	20:40		19:41			18:40			16:53	18	16:26 (248)	16:41	26	15:58 (124)
19	05:52	06:30		07:11			07:52			07:37		08:11 (227)	08:11		08:42 (249)
	21:21	20:38		19:39			18:38			16:52	24	16:27 (248)	16:41	25	15:59 (124)
20	05:53	06:32		07:12			07:53			07:39		08:10 (227)	08:12		08:42 (249)
	21:20	20:37		19:37			18:36			16:51	36	16:27 (248)	16:42	25	15:59 (124)
21	05:54	06:33		07:14			07:55			07:40		08:09 (227)	08:13		08:43 (249)
	21:19	20:35		19:35			18:34			16:50	40	16:25 (248)	16:42	26	16:00 (124)
22	05:55	06:34		07:15			07:56			07:42		08:11 (227)	08:13		08:43 (249)
	21:18	20:33		19:33			18:32			16:49	42	16:25 (248)	16:43	26	16:00 (124)
23	05:57	06:35		07:16			07:58			07:43		08:12 (227)	08:14		08:44 (249)
	21:17	20:31		19:31			18:31			16:49	41	16:23 (128)	16:43	26	16:01 (124)
24	05:58	06:37		07:17			07:59			07:45		08:14 (227)	08:14		08:44 (249)
	21:16	20:30		19:29			18:29			16:48	41	16:23 (128)	16:44	26	16:01 (124)
25	05:59	06:38		07:19			08:01			07:46		08:15 (227)	08:15		08:44 (249)
	21:15	20:28		19:27			18:27			16:47	38	16:21 (128)	16:44	25	16:01 (124)
26	06:00	06:39		07:20			08:02			07:47		08:17 (227)	08:15		08:45 (249)
	21:14	20:26		19:25			18:26			16:46	36	16:21 (128)	16:45	25	16:02 (124)
27	06:01	06:41		07:21			08:03			07:49		08:18 (227)	08:15		08:45 (249)
	21:12	20:24		19:23			18:24			16:45	35	16:20 (128)	16:46	26	16:02 (124)
28	06:02	06:42		07:23			08:05			07:50		08:19 (227)	08:16		08:45 (249)
	21:11	20:22		19:21			18:22			16:45	33	16:19 (128)	16:46	25	16:02 (124)
29	06:03	06:43		07:24		07:53 (217)	08:06			07:51		08:21 (227)	08:16		08:45 (249)
	21:10	20:20		19:19	7	08:00 (217)	18:21			16:44	31	16:19 (128)	16:47	26	16:02 (124)
30	06:05	06:45		07:25		07:52 (217)	08:08			07:52		08:27 (249)	08:16		08:46 (249)
	21:09	20:18		19:17	10	08:02 (217)	18:19			16:44	29	16:18 (128)	16:48	25	16:03 (124)
31	06:06	06:46	07:13 (157)				08:09		08:50 (203)				08:16		08:46 (249)
	21:08	20:16	7 07:20 (157)				18:17	3	08:53 (203)				16:49	25	16:03 (124)
Potential sun hours	481	442		380			339			283			266		
Total, worst case		7			87			43			606			745	
Sun reduction		0.71			0.63			0.51			0.39			0.39	
Oper. time red.		0.85			0.85			0.85			0.85			0.85	
Wind dir. red.		0.68			0.69			0.71			0.66			0.66	
Total reduction		0.41			0.37			0.31			0.22			0.22	
Total, real		3			32			13			133			161	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm) Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker Last time (hh:mm) with flicker	(WTG causing flicker first time) (WTG causing flicker last time)

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Calculated:
5/31/2023 2:12 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A285 - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (5175)

Assumptions for shadow calculations

Reference year for calendar 2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.52	0.54	0.59	0.57	0.60	0.64	0.74	0.71	0.63	0.51	0.39	0.39

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
364	231	235	234	299	398	720	587	362	314	482	477	675	931	686	429	7,424

	January	February	March		April	May	June	July	August	September		October	November	December
1	08:17	07:57	07:13		07:12	06:17	05:39	05:38	06:07	06:47		07:27	08:11	07:54
	16:50	17:30	18:12		19:56	20:38	21:16	21:30	21:06	20:15		19:15	18:16	16:43
2	08:17	07:56	07:11		07:10	06:15	05:39	05:38	06:08	06:49		07:28	08:12	07:55
	16:51	17:32	18:13		19:58	20:39	21:17	21:30	21:05	20:13		19:13	18:14	16:43
3	08:17	07:55	07:09		07:08	06:13	05:38	05:39	06:10	06:50		07:30	08:14	07:56
	16:52	17:33	18:15		19:59	20:40	21:18	21:29	21:04	20:11		19:11	18:13	16:42
4	08:17	07:53	07:07		07:06	06:12	05:37	05:39	06:11	06:51		07:31	08:15	07:57
	16:53	17:35	18:16		20:00	20:42	21:19	21:29	21:02	20:09		19:09	18:11	16:42
5	08:16	07:52	07:05		07:04	06:10	05:37	05:40	06:12	06:53		07:32	07:17	07:59
	16:54	17:37	18:18		20:02	20:43	21:19	21:29	21:01	20:07		19:07	17:10	16:41
6	08:16	07:51	07:03		07:02	06:09	05:36	05:41	06:13	06:54		07:34	07:18	08:00
	16:55	17:38	18:19		20:03	20:45	21:20	21:29	20:59	20:05		19:05	17:08	16:41
7	08:16	07:49	07:02		07:00	06:07	05:36	05:41	06:15	06:55		07:35	07:20	08:01
	16:56	17:40	18:21		20:05	20:46	21:21	21:28	20:58	20:03		19:03	17:07	16:41
8	08:16	07:48	07:00		06:58	06:06	05:36	05:42	06:16	06:57		07:37	07:21	08:02
	16:57	17:41	18:22		20:06	20:47	21:22	21:28	20:57	20:01		19:01	17:06	16:41
9	08:16	07:46	06:58		06:56	06:04	05:35	05:43	06:17	06:58		07:38	07:23	08:03
	16:58	17:43	18:24		20:07	20:49	21:23	21:27	20:55	19:59		18:57	17:04	16:41
10	08:15	07:45	06:56		06:54	06:03	05:35	05:44	06:19	06:59		07:39	07:24	08:04
	16:59	17:44	18:25		20:09	20:50	21:23	21:27	20:53	19:57		18:55	17:03	16:40
11	08:15	07:43	06:54		06:52	06:01	05:35	05:45	06:20	07:00		07:41	07:26	08:05
	17:01	17:46	18:27		20:10	20:51	21:24	21:26	20:52	19:55		18:53	17:02	16:40
12	08:14	07:42	07:52		06:51	06:00	05:34	05:46	06:21	07:02		07:42	07:27	08:06
	17:02	17:47	18:28		20:11	20:52	21:25	21:26	20:50	19:53		18:51	17:00	16:40
13	08:14	07:40	07:50		06:49	05:59	05:34	05:46	06:22	07:03		07:43	07:29	08:07
	17:03	17:49	19:29		20:13	20:54	21:25	21:25	20:49	19:51		18:49	16:59	16:40
14	08:13	07:39	07:48		06:47	05:57	05:34	05:47	06:24	07:04		07:45	07:30	08:08
	17:04	17:51	19:31		20:14	20:55	21:26	21:25	20:47	19:49		18:47	16:58	16:40
15	08:13	07:37	07:46		06:45	05:56	05:34	05:48	06:25	07:06		07:46	07:32	08:09
	17:06	17:52	19:32		20:16	20:56	21:26	21:24	20:45	19:47		18:45	16:57	16:41
16	08:12	07:36	07:44		06:43	05:55	05:34	05:49	06:26	07:07		07:48	07:33	08:09
	17:07	17:54	19:34		20:17	20:58	21:27	21:23	20:44	19:45		18:43	16:56	16:41
17	08:12	07:34	07:42	08:05 (148)	06:41	05:54	05:34	05:50	06:28	07:08		07:49	07:35	08:10
	17:08	17:55	19:35	1 08:06 (148)	20:18	20:59	21:27	21:22	20:42	19:43		18:42	16:54	16:41
18	08:11	07:32	07:40	08:03 (148)	06:39	05:52	05:34	05:51	06:29	07:10		07:51	07:36	08:11
	17:10	17:57	19:37	3 08:06 (148)	20:20	21:00	21:28	21:22	20:40	19:41		18:40	16:53	16:41
19	08:10	07:31	07:38	08:01 (148)	06:37	05:51	05:34	05:52	06:30	07:11		07:52	07:38	08:12
	17:11	17:58	19:38	5 08:06 (148)	20:21	21:01	21:28	21:21	20:39	19:39		18:38	16:52	16:42
20	08:09	07:29	07:36	07:59 (148)	06:36	05:50	05:34	05:53	06:32	07:12		07:53	07:39	08:12
	17:13	18:00	19:39	6 08:05 (148)	20:23	21:03	21:29	21:20	20:37	19:37		18:36	16:51	16:42
21	08:09	07:27	07:34	07:57 (148)	06:34	05:49	05:34	05:54	06:33	07:14		07:55	07:40	08:13
	17:14	18:00	19:41	7 08:04 (148)	20:24	21:04	21:29	21:19	20:35	19:35		18:34	16:50	16:42
22	08:08	07:25	07:32	07:58 (148)	06:32	05:48	05:34	05:56	06:34	07:15		07:56	07:42	08:13
	17:15	18:01	19:42	2 08:00 (148)	20:25	21:05	21:29	21:18	20:33	19:33		18:33	16:50	16:43
23	08:07	07:24	07:30		06:30	05:47	05:34	05:57	06:36	07:16	07:42 (148)	07:58	07:43	08:14
	17:17	18:03	19:44		20:27	21:06	21:29	21:17	20:32	19:31	4 07:46 (148)	18:31	16:49	16:43
24	08:06	07:22	07:28		06:28	05:46	05:35	05:58	06:37	07:18	07:42 (148)	07:59	07:45	08:14
	17:18	18:04	19:45		20:28	21:07	21:30	21:16	20:30	19:29	7 07:49 (148)	18:29	16:48	16:44
25	08:05	07:20	07:26		06:27	05:45	05:35	05:59	06:38	07:19	07:43 (148)	08:01	07:46	08:15
	17:20	18:06	19:46		20:30	21:08	21:30	21:15	20:28	19:27	6 07:49 (148)	18:27	16:47	16:44
26	08:04	07:18	07:24		06:25	05:44	05:35	06:00	06:40	07:20	07:44 (148)	08:02	07:47	08:15
	17:21	18:07	19:48		20:31	21:10	21:30	21:14	20:26	19:25	5 07:49 (148)	18:26	16:46	16:45
27	08:03	07:17	07:22		06:23	05:43	05:36	06:01	06:41	07:22	07:46 (148)	08:04	07:49	08:16
	17:23	18:09	19:49		20:32	21:11	21:30	21:13	20:24	19:23	3 07:49 (148)	18:24	16:46	16:46
28	08:02	07:15	07:20		06:22	05:42	05:36	06:02	06:42	07:23	07:47 (148)	08:05	07:50	08:16
	17:24	18:10	19:51		20:34	21:12	21:30	21:11	20:22	19:21	1 07:48 (148)	18:22	16:45	16:46
29	08:01		07:18		06:20	05:42	05:37	06:04	06:43	07:24		08:07	07:51	08:16
	17:26		19:52		20:35	21:13	21:30	21:10	20:20	19:19		18:21	16:44	16:47
30	08:00		07:16		06:18	05:41	05:37	06:05	06:45	07:26		08:08	07:53	08:16
	17:27		19:53		20:36	21:14	21:30	21:09	20:19	19:17		18:19	16:44	16:48
31	07:58		07:14			05:40		06:06	06:46			08:10		08:16
	17:29		19:55			21:15		21:08	20:17			18:17		16:49
Potential sun hours	278	286	367		406	466	475	481	443	380		339	283	266
Total, worst case				24							26			
Sun reduction				0.59							0.63			
Oper. time red.				0.85							0.85			
Wind dir. red.				0.71							0.71			
Total reduction				0.36							0.38			
Total, real				9							10			

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

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Calculated:
5/31/2023 2:12 PM/3.6.366

SHADOW - Calendar

Calculation: Points and Grid Shadow receptor: A286 - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (5176)

Assumptions for shadow calculations

Reference year for calendar 2023

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.52	0.54	0.59	0.57	0.60	0.64	0.74	0.71	0.63	0.51	0.39	0.39

Operational time

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
364	231	235	234	299	398	720	587	362	314	482	477	675	931	686	429	7,424

	January	February	March	April	May	June	July	August	September	October	November	December
1	08:16	07:57 16:58 (185)	07:13	07:12	06:16	05:39	05:37	06:07	06:47	07:27	08:11 17:35 (222)	07:54
	16:50	17:30 7 17:05 (188)	18:11	19:56	20:37	21:15	21:29	21:06	20:14	19:14	18:16 17 17:52 (222)	16:43
2	08:16	07:56 16:59 (185)	07:11	07:10	06:15	05:38	05:38	06:08	06:48	07:28	08:12 17:36 (222)	07:55
	16:50	17:32 7 17:06 (188)	18:13	19:57	20:39	21:16	21:29	21:05	20:12	19:12	18:14 15 17:51 (222)	16:42
3	08:16	07:54 17:01 (188)	07:09	07:08	06:13	05:38	05:38	06:09	06:50	07:29	08:14 17:35 (222)	07:56
	16:51	17:33 7 17:08 (188)	18:14	19:59	20:40	21:17	21:29	21:03	20:11	19:10	18:12 13 17:48 (222)	16:42
4	08:16	07:53 17:02 (188)	07:07	07:06	06:11	05:37	05:39	06:11	06:51	07:31	08:15 17:35 (188)	07:57
	16:52	17:35 8 17:10 (188)	18:16	20:00	20:41	21:18	21:29	21:02	20:09	19:08	18:11 12 17:47 (222)	16:41
5	08:16	07:52 17:02 (188)	07:05	07:04	06:10	05:37	05:40	06:12	06:52	07:32	07:17 16:33 (188)	07:58
	16:53	17:36 10 17:12 (188)	18:17	20:01	20:43	21:19	21:29	21:01	20:07	19:06	17:09 12 16:45 (222)	16:41
6	08:16	07:50 17:03 (188)	07:03	07:02	06:08	05:36	05:40	06:13	06:54	07:33	07:18 16:33 (188)	07:59
	16:54	17:38 11 17:14 (188)	18:19	20:03	20:44	21:20	21:28	20:59	20:05	19:04	17:08 11 16:44 (188)	16:41
7	08:16	07:49 17:03 (188)	07:01	07:00	06:07	05:36	05:41	06:14	06:55	07:35	07:20 16:33 (188)	08:01
	16:56	17:39 12 17:15 (188)	18:20	20:04	20:46	21:21	21:28	20:58	20:03	19:02	17:07 10 16:43 (188)	16:41
8	08:16	07:48 17:05 (188)	06:59	06:58	06:05	05:35	05:42	06:16	06:56	07:36	07:21 16:32 (188)	08:02
	16:57	17:41 12 17:17 (222)	18:22	20:06	20:47	21:22	21:28	20:56	20:01	19:00	17:05 9 16:41 (188)	16:40
9	08:15	07:46 17:06 (222)	06:57	06:56	06:04	05:35	05:43	06:17	06:57	07:38	07:23 16:32 (188)	08:03
	16:58	17:42 12 17:18 (222)	18:23	20:07	20:48	21:22	21:27	20:55	19:59	18:56	17:04 8 16:40 (188)	16:40
10	08:15	07:45 17:06 (222)	06:55	06:54	06:02	05:35	05:43	06:18	06:59	07:39	07:24 16:31 (185)	08:04
	16:59	17:44 14 17:20 (222)	18:25	20:08	20:50	21:23	21:27	20:53	19:57	18:55	17:03 8 16:39 (188)	16:40
11	08:15	07:43 17:06 (222)	06:53	06:52	06:01	05:34	05:44	06:20	07:00	07:40	07:26 16:29 (185)	08:05
	17:00	17:46 16 17:22 (222)	18:26	20:10	20:51	21:24	21:26	20:52	19:55	18:53	17:01 8 16:37 (188)	16:40
12	08:14	07:42 17:06 (222)	07:52	06:50	06:00	05:34	05:45	06:21	07:01	07:42	07:27 16:29 (185)	08:06
	17:01	17:47 18 17:24 (222)	18:28	20:11	20:52	21:24	21:25	20:50	19:53	18:51	17:00 7 16:36 (188)	16:40
13	08:14	07:40 17:06 (222)	07:50	06:48	05:58	05:34	05:46	06:22	07:03	07:43	07:29 16:28 (185)	08:07
	17:03	17:49 18 17:24 (222)	19:29	20:13	20:53	21:25	21:25	20:48	19:51	18:49	16:59 6 16:34 (185)	16:40
14	08:13	07:38 17:07 (222)	07:48	06:46	05:57	05:34	05:47	06:23	07:04	07:45	07:30 16:29 (185)	08:07
	17:04	17:50 16 17:23 (222)	19:30	20:14	20:55	21:26	21:24	20:47	19:49	18:47	16:58 4 16:33 (185)	16:40
15	08:13	07:37 17:08 (222)	07:46	06:45	05:56	05:34	05:48	06:25	07:05	07:46	07:31 16:29 (185)	08:08
	17:05	17:52 14 17:22 (222)	19:32	20:15	20:56	21:26	21:23	20:45	19:47	18:45	16:56 3 16:32 (185)	16:40
16	08:12	07:35 17:09 (222)	07:44	06:43	05:54	05:33	05:49	06:26	07:07	07:47	07:33 16:29 (185)	08:09
	17:07	17:53 12 17:21 (222)	19:33	20:17	20:57	21:27	21:23	20:43	19:45	18:43	16:55 1 16:30 (185)	16:40
17	08:11	07:34 17:12 (222)	07:42	06:41	05:53	05:33	05:50	06:27	07:08	07:49	07:34	08:10
	17:08	17:55 6 17:18 (222)	19:35	20:18	20:59	21:27	21:22	20:42	19:43	18:41	16:54	16:41
18	08:11	07:32	07:40	06:39	05:52	05:33	05:51	06:29	07:09	07:50	07:36	08:11
	17:09	17:56	19:36	20:19	21:00	21:28	21:21	20:40	19:41	18:39	16:53	16:41
19	08:10	07:30	07:38	06:37	05:51	05:33	05:52	06:30	07:11	07:52	07:37	08:11
	17:11	17:58	19:38	20:21	21:01	21:28	21:20	20:38	19:39	18:38	16:52	16:41
20	08:09	07:29	07:36	06:35	05:50	05:34	05:53	06:31	07:12	07:53	07:39	08:12
	17:12	17:59	19:39	20:22	21:02	21:28	21:19	20:37	19:37	18:36	16:51	16:41
21	08:08	07:27	07:34	06:33	05:49	05:34	05:54	06:33	07:13	07:55	07:40	08:13
	17:14	18:01	19:40	20:24	21:03	21:29	21:19	20:35	19:35	18:34	16:50	16:42
22	08:07	07:25	07:32	06:32	05:48	05:34	05:55	06:34	07:15	07:56	07:42	08:13
	17:15	18:01	19:42	20:25	21:05	21:29	21:18	20:33	19:32	18:32	16:49	16:42
23	08:07	07:23	07:30	06:30	05:47	05:34	05:56	06:35	07:16	07:57	07:43	08:14
	17:16	18:02	19:43	20:26	21:06	21:29	21:17	20:31	19:30	18:30	16:48	16:43
24	08:06	07:22	07:28	06:28	05:46	05:34	05:57	06:37	07:17	07:59	07:44	08:14
	17:18	18:04	19:45	20:28	21:07	21:29	21:16	20:29	19:28	18:29	16:47	16:43
25	08:05	07:20	07:26	06:26	05:45	05:35	05:59	06:38	07:19	08:00	07:46	08:14
	17:19	18:05	19:46	20:29	21:08	21:29	21:14	20:28	19:26	18:27	16:47	16:44
26	08:04	07:18	07:24	06:25	05:44	05:35	06:00	06:39	07:20	08:02 17:43 (222)	07:47	08:15
	17:21	18:07	19:47	20:31	21:09	21:30	21:13	20:26	19:24	18:25 3 17:46 (222)	16:46	16:45
27	08:03 16:56 (185)	07:16	07:22	06:23	05:43	05:35	06:01	06:40	07:21	08:03 17:40 (222)	07:48	08:15
	17:22 1 16:57 (185)	18:08	19:49	20:32	21:10	21:30	21:12	20:24	19:22	18:24 10 17:50 (222)	16:45	16:45
28	08:02 16:56 (185)	07:14	07:20	06:21	05:42	05:36	06:02	06:42	07:23	08:05 17:38 (222)	07:50	08:15
	17:24 3 16:59 (185)	18:10	19:50	20:33	21:11	21:30	21:11	20:22	19:20	18:22 14 17:52 (222)	16:45	16:46
29	08:00 16:57 (185)		07:18	06:20	05:41	05:36	06:03	06:43	07:24	08:06 17:36 (222)	07:51	08:16
	17:25 4 17:01 (185)		19:52	20:35	21:12	21:30	21:10	20:20	19:18	18:20 16 17:52 (222)	16:44	16:47
30	07:59 16:56 (185)		07:16	06:18	05:40	05:37	06:04	06:44	07:25	08:08 17:36 (222)	07:52	08:16
	17:27 5 17:01 (185)		19:53	20:36	21:13	21:30	21:09	20:18	19:16	18:19 17 17:53 (222)	16:43	16:48
31	07:58 16:57 (185)		07:14		05:40		06:06	06:46		08:09 17:35 (222)		08:16
	17:28 6 17:03 (188)		19:54		21:14		21:07	20:16		18:17 18 17:53 (222)		16:48
Potential sun hours	278	286	367	406	466	475	481	443	380	339	283	266
Total, worst case	19	200								78	144	
Sun reduction	0.52	0.54								0.51	0.39	
Oper. time red.	0.85	0.85								0.85	0.85	
Wind dir. red.	0.61	0.62								0.63	0.62	
Total reduction	0.27	0.28								0.27	0.20	
Total, real	5	57								21	29	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm) Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker Last time (hh:mm) with flicker	(WTG causing flicker first time) (WTG causing flicker last time)

Appendix C – FAA Filings

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Otter Tail Power Company Ashtabula I Upgrade Project
Federal Aviation Administration (FAA) Filings

Turbine Number	Structure Name	Latitude	Longitude	ASN	Prior ASN	OE Status
45	A-45	47.132850	97.956489	2023-WTE-1027-OE	2008-AGL-3114-OE	Work in Progress
39	A-39	47.128303	97.984286	2023-WTE-1028-OE	2008-AGL-3108-OE	Work in Progress
38	A-38	47.147911	97.942139	2023-WTE-1029-OE	2008-AGL-3107-OE	Work in Progress
64	A-64	47.127939	97.887128	2023-WTE-1030-OE	2008-AGL-3133-OE	Work in Progress
34	A-34	47.146744	97.958919	2023-WTE-1031-OE	2008-AGL-3103-OE	Work in Progress
65	A-65	47.128456	97.883617	2023-WTE-1032-OE	2008-AGL-3134-OE	Work in Progress
42	A-42	47.130694	97.970289	2023-WTE-1033-OE	2008-AGL-3111-OE	Work in Progress
44	A-44	47.131839	97.962953	2023-WTE-1034-OE	2008-AGL-3113-OE	Work in Progress
62	A-62	47.133406	97.913625	2023-WTE-1035-OE	2008-AGL-3131-OE	Work in Progress
49	A-49	47.133092	97.936183	2023-WTE-1036-OE	2008-AGL-3118-OE	Work in Progress
48	A-48	47.132828	97.941403	2023-WTE-1037-OE	2008-AGL-3117-OE	Work in Progress
57	A-57	47.149311	97.909419	2023-WTE-1038-OE	2008-AGL-3126-OE	Work in Progress
55	A-55	47.145553	97.916239	2023-WTE-1039-OE	2008-AGL-3124-OE	Work in Progress
54	A-54	47.144669	97.919219	2023-WTE-1040-OE	2008-AGL-3123-OE	Work in Progress
35	A-35	47.146850	97.954475	2023-WTE-1041-OE	2008-AGL-3104-OE	Work in Progress
53	A-53	47.143039	97.922736	2023-WTE-1042-OE	2008-AGL-3122-OE	Work in Progress
37	A-37	47.147419	97.946022	2023-WTE-1043-OE	2008-AGL-3106-OE	Work in Progress
60	A-60	47.129967	97.924097	2023-WTE-1044-OE	2008-AGL-3129-OE	Work in Progress
43	A-43	47.131994	97.966597	2023-WTE-1045-OE	2008-AGL-3112-OE	Work in Progress
52	A-52	47.141608	97.926464	2023-WTE-1046-OE	2008-AGL-3121-OE	Work in Progress
46	A-46	47.132906	97.952717	2023-WTE-1047-OE	2008-AGL-3115-OE	Work in Progress
40	A-40	47.129122	97.979578	2023-WTE-1048-OE	2008-AGL-3109-OE	Work in Progress
56	A-56	47.147436	97.913086	2023-WTE-1049-OE	2008-AGL-3125-OE	Work in Progress
36	A-36	47.147039	97.950692	2023-WTE-1050-OE	2008-AGL-3105-OE	Work in Progress
47	A-47	47.132753	97.944994	2023-WTE-1051-OE	2008-AGL-3116-OE	Work in Progress
59	A-59	47.129819	97.928269	2023-WTE-1052-OE	2008-AGL-3128-OE	Work in Progress
41	A-41	47.129878	97.974761	2023-WTE-1053-OE	2008-AGL-3110-OE	Work in Progress
51	A-51	47.140833	97.930481	2023-WTE-1054-OE	2008-AGL-3120-OE	Work in Progress
50	A-50	47.136767	97.931300	2023-WTE-1055-OE	2008-AGL-3119-OE	Work in Progress
58	A-58	47.129533	97.932494	2023-WTE-1056-OE	2008-AGL-3127-OE	Work in Progress
61	A-61	47.132025	97.916189	2023-WTE-1057-OE	2008-AGL-3130-OE	Work in Progress
63	A-63	47.126656	97.889828	2023-WTE-1058-OE	2008-AGL-3132-OE	Work in Progress

Appendix D – Microwave Beam Path Study

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Wind Power GeoPlanner™

Microwave Study

Ashtabula & Ashtabula III

Prepared on Behalf of
Atwell, LLC

March 22, 2023

COMSEARCH®
A CommScope Company

Table of Contents

1. Introduction

Microwave bands that may be affected by the installation of wind turbine facilities operate over a wide frequency range (900 MHz – 23 GHz). Comsearch has developed and maintains comprehensive technical databases containing information on licensed microwave networks throughout the United States. These systems are the telecommunication backbone of the country, providing long-distance and local telephone service, backhaul for cellular and personal communication service, data interconnects for mainframe computers and the Internet, network controls for utilities and railroads, and various video services. This report focuses on the potential impact of wind turbines on licensed, proposed and applied non-federal government microwave systems.

2. Project Overview

Project Information

Name: Ashtabula & Ashtabula III

County: Barnes

State: North Dakota

Number of Turbines: 71

Blade Diameter: 97 meters

Hub Height: 80 meters

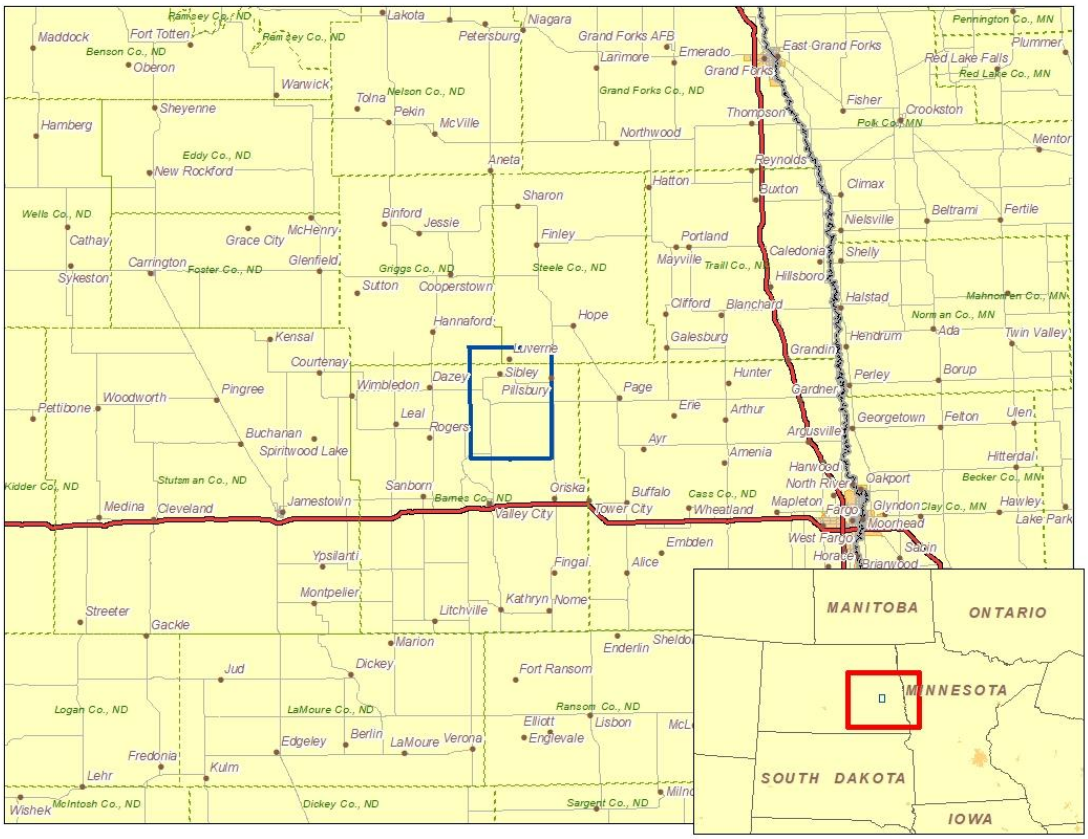


Figure 1: Area of Interest

3. Two-Dimensional Fresnel Zone Analysis

Methodology

Our obstruction analysis was performed using Comsearch's proprietary microwave database, which contains all non-government licensed, proposed and applied paths from 0.9 - 23 GHz[1]. First, we determined all microwave paths that intersect the area of interest[2] and listed them in Table 1. This path and the area of interest that encompasses the planned turbine locations are shown in Figure 2.

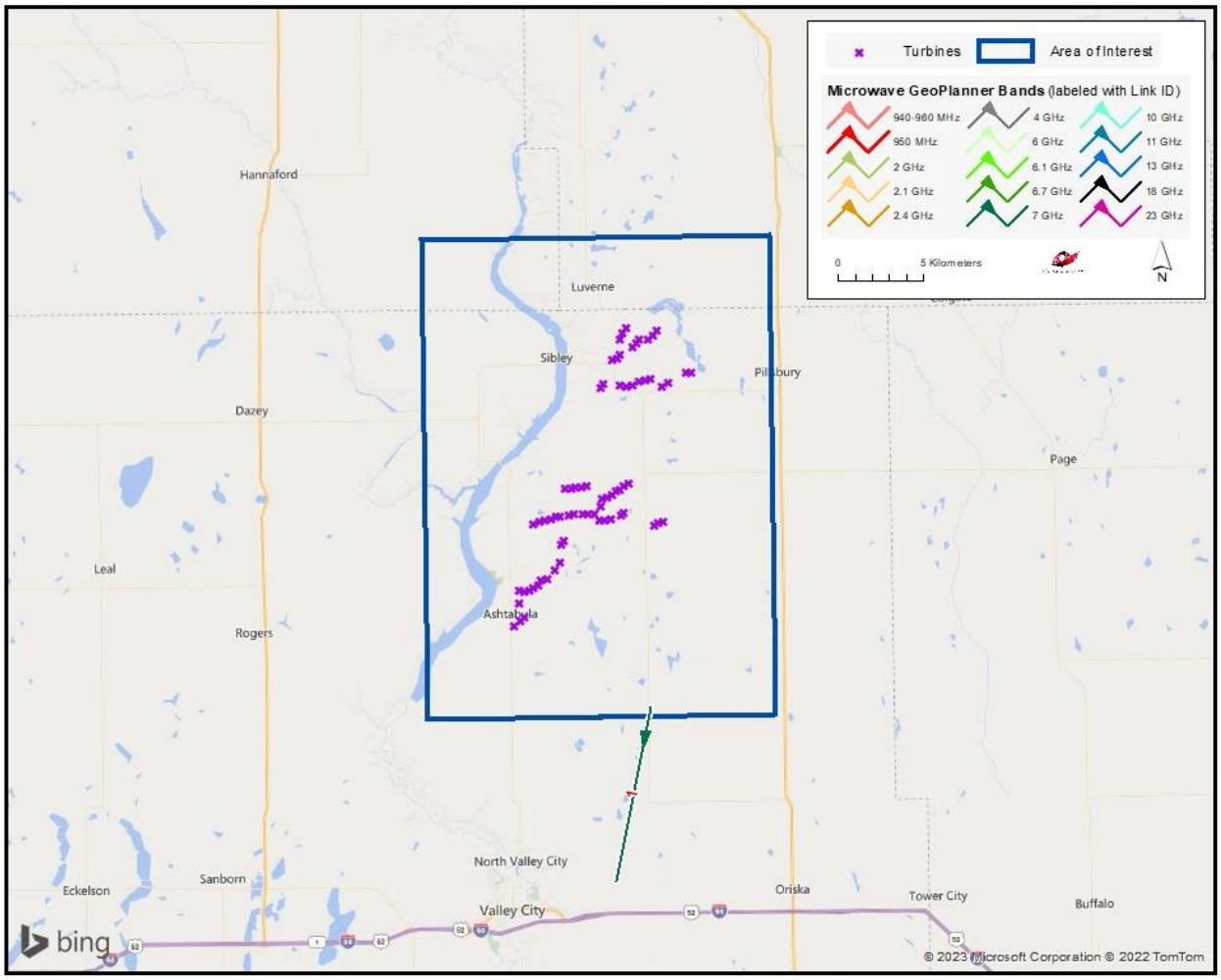


Figure 2: Microwave Paths that Intersect the Area of Interest

[1] Please note that this analysis does not include unlicensed microwave paths or federal government paths that are not registered with the FCC.

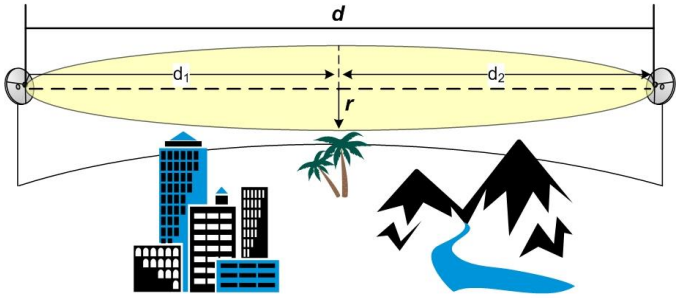
[2] We use FCC-licensed coordinates to determine which paths intersect the area of interest. It is possible that as-built coordinates may differ slightly from those on the FCC license.

ID	Status	Callsign 1	Callsign 2	Band	Path Length (km)	Licensee
1	Licensed	KAZ80	RXONLY	7 GHz	10.42	South Dakota Television, Inc

Table 1: Summary of Microwave Paths that Intersect the Area of Interest
(See enclosed mw_geopl.xlsx for more information and
GP_dict_matrix_description.xls for detailed field descriptions)

Next, we calculated a Fresnel Zone for the path based on the following formula:

$$r \cong 17.3\sqrt{\frac{n}{F_{GHz}}\left(\frac{d_1 d_2}{d_1 + d_2}\right)}$$



Where,

r	=	Fresnel Zone radius at a specific point in the microwave path, meters
n	=	Fresnel Zone number, 1
F_{GHz}	=	Frequency of microwave system, GHz
d_1	=	Distance from antenna 1 to a specific point in the microwave path, kilometers
d_2	=	Distance from antenna 2 to a specific point in the microwave path, kilometers

In general, this is the area where the planned wind turbines should be avoided, if possible. Likewise, Comsearch recommends that an area directly in front of each microwave antenna should be avoided. This corresponds to the Consultation Zone which measures 1 kilometer along the main beam of the antenna and 24 ft (7.3 meters) wide. A depiction of the Fresnel Zones and Consultation Zones for the microwave path listed can be found in Figure 3, and is also included in the enclosed shapefiles[3,4].

[3] The ESRI® shapefiles enclosed are in NAD 83 UTM Zone 14 projected coordinate system.

[4] Comsearch makes no warranty as to the accuracy of the data included in this report beyond the date of the report. The data provided in this report is governed by Comsearch's data license notification and agreement located at http://www.comsearch.com/files/data_license.pdf.

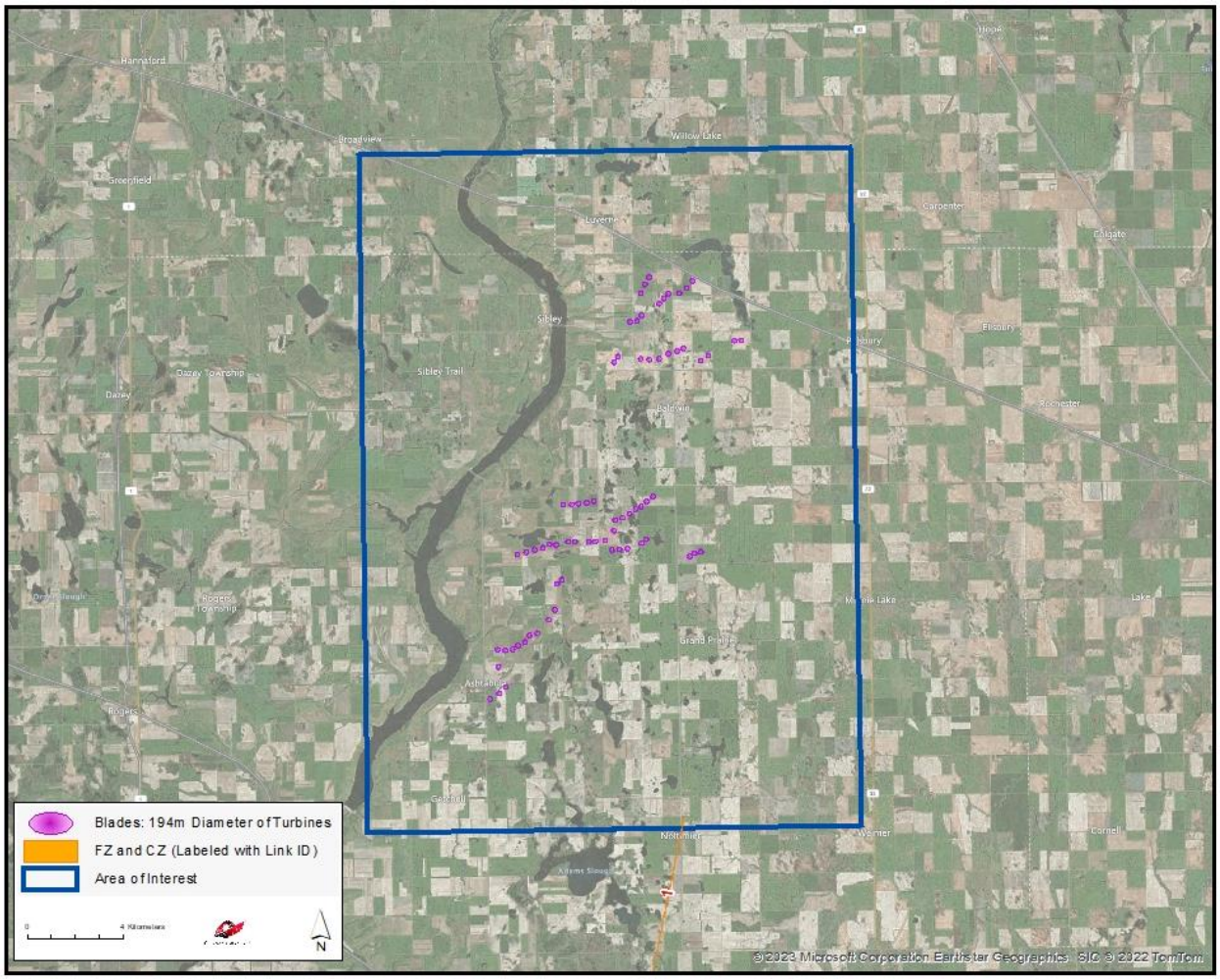


Figure 3: Microwave Paths with Fresnel Zones

4. Conclusion

Total Microwave Paths	Paths with Affected Fresnel Zones	Total Turbines	Turbines intersecting the Fresnel Zones
1	0	71	0

Table 2: Fresnel Zone Analysis Result

Our study identified one microwave path intersecting the Ashtabula & Ashtabula III area of interest. The Fresnel and Consultation Zones for this microwave path were calculated and mapped in order to assess the potential impact from the turbines. A total of seventy-one turbines were considered in the analysis, each with a blade diameter of 97 meters and a hub height of 80 meters. Of those turbines, none were found to have potential obstruction with the microwave systems in the area.

5. Contact

For questions or information regarding the Microwave Study, please contact:

Contact person: David Meyer
Title: Senior Manager
Company: Comsearch
Address: 21515 Ridgetop Circle, Suite 300, Sterling, VA 20166
Telephone: 703-726-5656
Fax: 703-726-5595
Email: David.Meyer@CommScope.com
Web site: www.comsearch.com

Appendix: Turbine Locations

Case ID	FAA ASN	Latitude	Longitude
3035149	38-020866	47.117191	-97.962791
3035175	38-020889	47.201893	-97.927689
3035164	38-020843	47.207191	-97.863693
3035146	38-020898	47.092793	-97.995888
3035161	38-020847	47.203491	-97.895088
3035142	38-020916	47.20269	-97.899994
3035139	38-020985	47.224991	-97.89959
3035171	38-020835	47.097992	-97.978493
3035152	38-020861	47.229691	-97.886093
3071426	missing	47.098801	-97.974007
3035173	38-020983	47.107391	-97.964188
3035158	38-020852	47.221394	-97.904694
3035168	38-020838	47.09259	-97.991692
3035155	38-020858	47.227093	-97.889488
3035151	38-020862	47.231392	-97.909889
3035174	38-020900	47.118793	-97.960091
3035169	38-020837	47.092892	-97.987694
3035153	38-020860	47.20079	-97.90519
3035177	38-020914	47.228592	-97.912292
3035148	38-020867	47.103893	-97.96769
3035157	38-020853	47.22319	-97.902092
3035144	38-020979	47.207291	-97.859894
3035154	38-020859	47.200493	-97.910492
3035176	38-020893	47.225391	-97.914589
3035170	38-020836	47.095592	-97.98069
3035159	38-020851	47.216991	-97.914589
3035167	38-020839	47.086391	-97.995689
3035143	38-020915	47.201691	-97.87809
3035162	38-020845	47.204491	-97.891792
3035160	38-020850	47.215092	-97.916893
3035156	38-020856	47.225193	-97.893494
3035165	38-020842	47.076591	-97.995293
3035150	38-020863	47.199692	-97.929993
3035163	38-020844	47.19989	-97.882294
3035147	38-020868	47.094193	-97.984589

Case ID	FAA ASN	Latitude	Longitude
3035166	38-020840	47.078892	-97.991493
3035145	38-020903	47.07439	-98.000191
3035140	38-020960	47.21479	-97.920792
3035141	38-020905	47.20079	-97.915291
3104371	38-020302	47.132893	-97.95269
3104415	38-020294	47.149292	-97.909393
3104421	38-020298	47.140793	-97.930489
3104381	38-020313	47.14669	-97.954292
3104373	38-020308	47.129093	-97.979591
3104382	38-020306	47.130692	-97.970291
3104447	38-020311	47.147392	-97.945992
3104424	38-020291	47.129993	-97.924088
3104405	38-020301	47.132793	-97.941391
3104430	38-020406	47.132793	-97.944992
3104449	38-020290	47.131992	-97.916191
3104416	38-020407	47.145592	-97.916191
3104457	38-020304	47.13179	-97.96299
3104444	38-020309	47.128292	-97.984291
3104458	38-020307	47.12989	-97.974792
3104413	38-020312	47.146992	-97.950691
3104450	38-020299	47.136791	-97.93129
3104374	38-020310	47.147892	-97.942093
3104461	38-020297	47.14159	-97.926491
3104414	38-020295	47.144691	-97.919189
3104433	38-020314	47.14669	-97.958893
3104391	38-020408	47.147392	-97.913094
3104401	38-020292	47.129791	-97.928291
3104440	38-020412	47.133392	-97.913589
3104411	38-020300	47.133091	-97.936188
3104446	38-020293	47.129494	-97.932487
3104394	38-020296	47.14299	-97.922691
3104404	38-020305	47.131992	-97.966591
3104407	38-020303	47.132793	-97.95649
3104383	38-020212	47.127892	-97.887093
3104435	38-020213	47.12849	-97.883591
3104436	38-020211	47.126694	-97.889793

Appendix E – Class I Literature Review – Cultural Resource Report and Unanticipated Discoveries Plan

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CLASS I LITERATURE REVIEW

ASHTABULA WIND UPGRADE PROJECT
BARNES COUNTY, NORTH DAKOTA

Prepared for

Otter Tail Power Company
215 S. Cascade Street
Fergus Falls, Minnesota 56537

Atwell Project No. 22007264

Submitted by Atwell, LLC

June 21, 2023

EXECUTIVE SUMMARY

In February of 2023, Atwell, LLC (Atwell) was contracted by Otter Tail Power Company (Otter Tail) to conduct a Class I literature review for the proposed Ashtabula Wind Upgrade Project (Project) located in Barnes County, North Dakota (Figure 1). The Project includes replacing current wind turbine technology with longer blades and new hub and gearbox with turbine generators being refurbished at 32 wind turbine locations. The existing Ashtabula Wind turbines are GE 1.5 megawatt [MW] turbines with a 77-meter rotor diameter and a total height of 388.8 meters, and these will be replaced with new wind turbine technology (GE 1.6 MW turbines with rotor diameters of up to 97-meters and a total height of up to 128.5 meters). The existing 32 turbine locations remain the same and Otter Tail plans to use the existing turbine structural steel towers, turbine foundations, collection/communication systems, permanent access roads, and other associated facilities whose locations will not change.

During installation of the equipment upgrades, existing access roads and the gravel ring around the turbines may be temporarily widened to accommodate delivery and staging of components and equipment. A temporary laydown yard will be utilized during the Project. The laydown yard and most of the areas where temporary access roads and construction easements will occur were previously used during initial project construction. In all cases, the planned temporary construction areas meet exclusion and avoidance area criteria.

Currently, no federal trigger has been identified for this Project; therefore, Section 106 regulations do not apply. Should Section 106 be triggered, methods for archaeological and aboveground architectural investigations should be determined through consultation with the lead federal agency and the State Historical Society of North Dakota (SHSND).

The SHSND files were reviewed and rendered the following information:

- One previously identified archaeological site lead is in the Study Area.
- One previously identified archaeological site is in the Study Area.
- No previously documented architectural resources are in the Study Area.
- No architectural or archaeological resources listed on the National Register of Historic Places are in the Study Area.

Based on a review of the data presented above in conjunction with the fact that the Disturbance Area has largely been previously surveyed (approximately 93%) and disturbed by the original construction of the wind farm, Atwell makes the following recommendations:

- The Project proceed as planned without additional archaeological resource work prior to construction.

- Provided that 32BA172 is still extant, Atwell recommends a 30m buffer area be placed around the resource for the duration of construction to prevent disturbances as originally recommended by Beaver Creek Inc. in the 2008 report (Grimsrud Burns 2008).
- An Unanticipated Discovery Plan should be developed to establish procedures and relevant contact information in the event that human remains or archaeological deposits are discovered during the construction, operational, and decommission phases of the Project. See Unanticipated Discovery Plan in **Appendix A**.
    - If buried archaeological resources are encountered, all activity should cease in the immediate area and within a 100-foot buffer area, and the artifacts should be left in place. Otter Tail's archaeologist should be contacted immediately, and unanticipated discovery procedures should be initiated.
    - If human remains are encountered, construction should stop in the immediate area of discovery and within a 100-foot buffer area, and law enforcement should be notified immediately. Law enforcement officials should determine whether the discovery is a crime scene and whether the remains are prehistoric or historic Native American remains. The SHSND should be contacted immediately if the human remains are determined to be prehistoric or historic in nature and/or Native American remains.

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INTRODUCTION

1.1 BACKGROUND

Atwell, LLC (Atwell) was contracted by Otter Tail Power Company (Otter Tail) to conduct a Class I literature review for the proposed Ashtabula Wind Upgrade Project (Project) located in Barnes County, North Dakota (Figure 1). The Project is located on approximately 77 acres of mixed-use agricultural land in the following locations: Township 142 North, Range 57 West, Sections 4-10, 15; Township 142 North, Range 58 West, Sections 11-12; Township 143 North, Range 57 West, Sections 33. These areas are located in Ashtabula and Grand Prairie Townships. The Project's Study Area comprises approximately 272 acres and encompasses a 300-foot buffer around the center point of each existing turbine and a 50-foot buffer (100-foot corridor) off the approximately 8.3 miles of existing access roads. The 80-acre Disturbance Area is the area where construction is expected to occur and includes a 150-foot buffer around the center point of each existing turbine and the footprint of the approximately 8.3 miles of existing access roads

The Project involves replacing current wind turbine technology with longer blades and new hub and gearbox with turbine generators being refurbished at 32 wind turbine locations. The existing Ashtabula Wind turbines are GE 1.5 megawatt [MW] turbines with a 77-meter rotor diameter and a total height of 388.8 feet, and these will be replaced with new wind turbine technology (GE 1.6 MW turbines with rotor diameter of up to 97-meters and a total height of up to 128.5 meters). The existing 32 turbine locations remain the same and Otter Tail plans to use the existing turbine structural steel towers, turbine foundations, collection/communication systems, permanent access roads, and other associated facilities whose locations will not change.

During installation of the equipment upgrades, existing access roads and the gravel ring around the turbines may be temporarily widened to accommodate delivery and staging of components and equipment. A temporary laydown yard will be utilized during the Project. The laydown yard and most of the areas where temporary access roads and construction easements will occur were previously used during initial project construction. In all cases, the planned temporary construction areas meet exclusion and avoidance area criteria.

1.2 APPLICABLE REGULATIONS

North Dakota does not have laws that mandate cultural resources surveys for private projects lacking characteristics that would trigger Section 106 of the National Historic Preservation Act of 1966, as amended (54 U.S.C. 306108), and its implementing regulations (36 CFR 800). The

exception to this is human remains. Human remains are protected under the North Dakota Century Code 23-06-27 (Protection of Human Burial Sites, Human Remains, and Burial Goods).

Currently, no federal trigger has been identified for this project; therefore, Section 106 regulations do not apply. Should Section 106 be triggered, methods for archaeological pedestrian survey and aboveground architectural survey should be determined through consultation with the lead federal agency and the State Historical Society of North Dakota (SHSND).

An Unanticipated Discovery Plan has been developed to establish procedures and relevant contact information in the event that human remains or archaeological deposits are discovered during the construction, operational, and decommission phases of the Project. See Unanticipated Discovery Plan in **Appendix A**.

2 METHODS

In February of 2023, staff from Atwell conducted background research at the SHSND for information on previously identified archaeological sites and architectural properties within one mile (1.6 km) of the Study Area and on surveys previously conducted within the Study Area.

3 ENVIRONMENT

The Project is located in Barnes County, North Dakota in a primarily rural agricultural area that is sparsely populated and supports a mix of grasslands, prairie potholes, cultivated cropland, hayfields, and pasturelands. Agricultural production (cultivated crops, hay, and pasture) is the primary land use within the Study Area. The Study Area is located west of state highway 32, and immediately south of 18th St. Southeast. Small farmsteads are located within the Study Area as well as small tracts of forested areas, wetlands, and natural stream corridors; however, these natural features are of limited size. Small, isolated woodlots, generally associated with wind breaks for farmsteads, are also scattered within the Study Area. Public roads are generally situated in a grid-like arrangement.

The Study Area is predominately located within the End Moraine Complex ecoregion of the Northern Glaciated Plains (Bryce et al. 1996). According to the United States Geological Service (USGS) ecoregion mapping data, this ecoregion is characterized by the following:

> The End Moraine Complex is a concentration of glacial features in east central North Dakota. Blue Mountain and Devils Lake Mountain are composed of blocks of surficial material scraped off and thrust up by the continental glacier at the south end of the Devils Lake basin. In the western part of the ecoregion, patches of stagnation moraine similar to the Missouri Coteau (42A) have high wetland densities. On the moraines south

of Devils Lake basin, favorable precipitation, aspect, and slightly higher elevations result in wooded lake margins and morainal ridges (Bryce et al. 1996).

The surficial geology in the region is relatively flat with little visual relief. The surface soil texture is primarily well drained loam (USDA 2017). The Study Area occupies several small hills and ridges in an otherwise typically flat landscape. Elevations within the Study Area range between 1,400 and 1,500 feet above mean sea level.

Natural Resource Conservation Service Soil Survey data for Barnes County identified 20 different types of soils within the Study Area. These soils vary greatly in texture, natural drainage, slope, and other characteristics. The Study Area is dominated by a variety of loam texture soils (Table 1):

Table 1: Soils throughout Project Area

Soil Type	Hydric	Percent of Project Area
G143C: Barnes-Buse-Langhei loams, 6 to 9 percent slopes	Yes	19.27%
G144B: Barnes-Buse loams, 3 to 6 percent slopes	No	13.37%
G143B: Barnes-Svea loams, 3 to 6 percent slopes	No	12.19%
G143F: Buse-Barnes loams, 15 to 35 percent slopes	No	10.22%
G143D: Barnes-Buse-Langhei loams, 9 to 15 percent slopes	No	8.88%
G490B: Gardena-Zell loams, 2 to 6 percent slopes	No	8.09%
G680F: Buse-Sioux complex, 9 to 35 percent slopes	No	8.01%
G272E: Sioux-Arvilla-Renshaw complex, 9 to 25 percent slopes	No	4.74%
G3A: Parnell silty clay loam, 0 to 1 percent slopes	No	3.04%
G272C: Sioux-Arvilla-Renshaw complex, 6 to 9 percent slopes	No	2.67%
G276B: Renshaw-Sioux complex, 2 to 6 percent slopes	No	2.53%
G100A: Hamerly-Tonka complex, 0 to 3 percent slopes	No	2.28%
G123A: Svea-Cavour loams, 0 to 3 percent slopes	No	1.45%
G167B: Balaton-Wyard loams, 0 to 6 percent slopes	No	1.14%
G732C: Lanona-Buse complex, 6 to 9 percent slopes	No	0.72%
G680C: Barnes-Sioux complex, 3 to 9 percent slopes	No	0.56%
G2A: Tonka silt loam, 0 to 1 percent slopes	No	0.41%
G4A: Southam silty clay loam, 0 to 1 percent slopes	Yes	0.37%
G12A: Vallers, saline-Parnell complex, 0 to 1 percent slopes	No	0.03%
G250A: Divide loam, 0 to 2 percent slopes	No	<0.01%

4 LITERATURE SEARCH

4.1 PREVIOUS CULTURAL RESOURCES STUDIES

Research indicated that two archaeological surveys have been conducted within the current Study Area.

Table 2: Previously Conducted Cultural Resources Surveys

Survey Number	Authors	Year	Title
010502	Christina Grimsrud Burns	2008	Ashtabula Wind Farm Project: A Class III Cultural Resource Inventory, Barnes County, North Dakota.
015989	Brittany Brooks	2015	BEK Communication Buried Fiber Optic Line – Valley City North: A Class II Reconnaissance and Class III Intensive Cultural Resource Inventory in Barnes County, North Dakota.

In 2008, a Class III Cultural Resources Inventory was conducted by Beaver Creek Archaeology Inc., on the behalf of FPL Energy, LLC to document cultural resources within the footprint of a proposed Ashtabula Wind Farm Project in Barnes County, North Dakota (Figure 2 Map Set; Grimsrud Burns 2008). The investigation identified two isolated finds (32BAx279 and 32BAx280), two prehistoric sites (32BA172 and 32BA173), and one historic architectural site (32BA174). Of the identified resources, isolate 32BAx280 and site 32BA172 are located within the Study Area.

In 2015, a Class II and Class III cultural resources inventory was conducted by Beaver Creek Archaeology Inc., on the behalf of BEK Communications to document cultural resources for a planned, buried fiber optics line in Barnes County, North Dakota. (Figure 2 Map Set; Brooks 2015) This survey identified one isolate find(32BAx293) and three archaeological sites (32BA279, 32BA280, and 32BA281), none of which fall within the current Study Area.

4.2 PREVIOUSLY RECORDED ARCHAEOLOGICAL SITES

One archaeological site (32BA172) and one archaeological site lead (32BAx280) have been previously recorded within the current Study Area (Figure 2 Map Set; Table 2). Site 32BA172 is a prehistoric site consisting of a large stone circle and a small stone cairn. Site 32BAx280 is an isolated find consisting of a single biface fragment. Previous surveys at these locations did not reveal any additional archaeological deposits (Grimsrud Burns 2008).

Table 3. Previously Documented Archaeological Resources within the Study Area

Site Number	Description	Status
32BA172	Stone Circle and Stone Cairn Features	Potentially Eligible
32BAx280	Isolated Biface Fragment	Not Eligible

An additional five archaeological sites, and four archaeological site leads have been previously identified within one mile of the Study Area (Figure 2 Map Set; Table 3).

Table 4. Previously Documented Archaeological Resources within One Mile

Site Number	Description	Status
32BAx320	Isolated Historic Scatter	Recommended Not Eligible
32BAx330	Isolated Lithics	Recommended Not Eligible
32BAx323	Isolated Historic	Recommended Not Eligible
32BAx331	Isolated Historic	Recommended Not Eligible
32BA1194	Historic Artifact Scatter	Recommended Not Eligible
32BA1192	Historic Artifact Scatter	Recommended Not Eligible
32BA1191	Historic Artifact Scatter	Recommended Not Eligible
32BA173	Prehistoric Stone Cairn	Potentially Eligible
32BA198	Prehistoric Stone Cairn	Potentially Eligible

4.3 PREVIOUSLY RECORDED ARCHITECTURAL HISTORY PROPERTIES

No historical architectural properties have been recorded within the Study Area. One historic architectural site (32BA174) and two architectural lead sites (32BAx84 and 32BAx304) are recorded within one mile of the Study Area. Site 32BA174 was recorded as a windmill with an associated historic artifact scatter. It was evaluated as not eligible in 2008, prior to its removal during construction of wind energy buildings and utilities. Lead site 32BAx84 is recorded as the Grand Prairie Free Methodist Church and Free Cemetery. The church was destroyed prior to being recorded and the cemetery is unevaluated for NRHP eligibility. Site 32BAx304 is an historic-aged farmstead complex which was previously recommended as not eligible for the NRHP. (Figure 2 Map Set; Table 4)

Table 5. Previously Documented Architectural Historical Sites within One Mile

Site Number	Description	Status
32BAx84	Grand Prairie Free Methodist (Destroyed)	Unevaluated
32BAx304	Historic-aged Farmstead	Recommended Not Eligible
32BA174	Historic Windmill and Scatter (Destroyed)	Recommended Not Eligible

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

As a result of the literature review, Atwell has reached the following conclusions:

- One previously identified archaeological site lead is in the Study Area.
- One previously identified archaeological site is in the Study Area.
- No previously documented architectural resources are in the Study Area.
- No architectural or archaeological resources listed on the National Register of Historic Places are in the Study Area.
- No cemeteries are located within the Study Area.

Currently, no federal trigger has been identified for this project; therefore, Section 106 regulations do not apply. Should Section 106 be triggered, methods for archaeological pedestrian survey and aboveground architectural survey should be determined through consultation with the lead federal agency and the SHSND.

5.2 RECOMMENDATIONS

Based on a review of the data presented above in conjunction with the fact that the Project's Disturbance Area has largely been previously surveyed (approximately 93%) and disturbed by the original construction of the wind farm, Atwell makes the following recommendations:

- The Project proceed as planned without additional archaeological resource work prior to construction.
- Provided that 32BA172 is still extant, Atwell recommends a 30 meter buffer area placed around the resource for the duration of construction to prevent disturbances as originally recommended by Beaver Creek Inc. in the 2008 report (Grimsrud Burns 2008).

- An Unanticipated Discovery Plan should be developed to establish procedures and relevant contact information in the event that human remains or archaeological deposits are discovered during the construction, operational, and decommission phases of the Project. See Unanticipated Discovery Plan in **Appendix A**.
    - If buried archaeological resources are encountered, all activity should cease in the immediate area and within a 100-foot buffer area and the artifacts should be left in place. Otter Tail's archaeologist should be contacted immediately, and unanticipated discovery procedures should be initiated.
    - If human remains are encountered, construction should stop in the immediate area of discovery and within a 100-foot buffer area, and law enforcement should be notified immediately. Law enforcement officials should determine whether the discovery is a crime scene and whether the remains are prehistoric or historic Native American remains. The SHSND should be contacted immediately if the human remains are determined to be prehistoric or historic in nature and/or Native American remains.

6 REFERENCES

Brooks B. 2015. BEK Communication Buried Fiber Optic Line - Valley City North: A Class II Reconnaissance and Class III Intensive Cultural Resources Inventory in Barnes County, North Dakota. Bismarck, North Dakota: Beaver Creek Archaeology, Inc. Report No.: 015989.

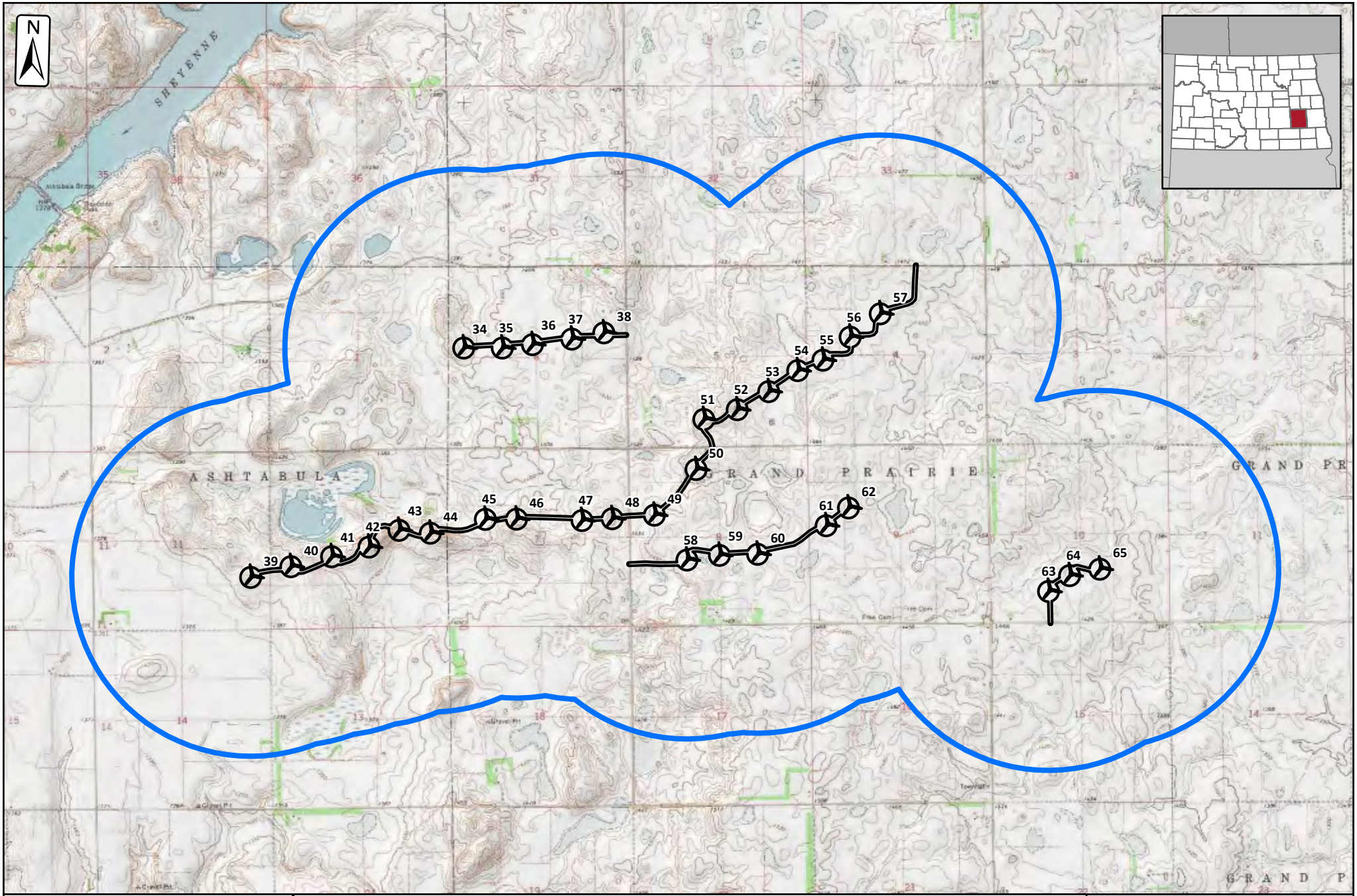
Bryce SA, Omernik JM, Pater DA, Ulmer M, Schaar J, Freeouf J, Johnson P, Kuck P, Azevedo SH. 1996. Ecoregions of North Dakota and South Dakota. Reston, Virginia: U.S. Geological Survey.

Grimsrud Burns C. 2008. Ashtabula Wind Farm Project: A Class III Cultural Resource Inventory, Barnes County, North Dakota. Linton, North Dakota: Beaver Creek Archaeology, Inc. Report No.: 10502.

USDA [U.S. Department of Agriculture]. 2017. Web Soil Survey. US Department of Agriculture, Natural Resources Conservation Service.
http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm.

FIGURES

PUBLIC DOCUMENT - NONPUBLIC DATA HAS BEEN EXCISED



Ashtabula Wind Upgrade Project

Figure 1 – Site Location

Barnes County, North Dakota

Issue Date: 3/7/2023

Existing Turbine Locations

Study Area

1 mile Buffer

SOURCE: USGS Topo Map

ATWELL

0 0.75 Miles

Ashtabula Wind Upgrade Project

Figure 2 – Known Cultural Resources Index

Barnes County, North Dakota

Issue Date: 3/7/2023

- Architectural Site (Point)
- Archeological Site (Point)
- Architectural Site (Poly)
- Archeological Site (Poly)
- Archeological Survey
- Existing Turbine Locations
- Existing Access Roads
- Disturbance Area (~77 acres)
- Study Area
- Mapbook Page
- 1 mile Buffer

SOURCE: USGS Topo Map

ATWELL

0 1 Miles

Ashtabula Wind Upgrade Project

Figure 2 – Known Cultural Resources Index

Barnes County, North Dakota

Issue Date: 5/16/2023

- Architectural Site (Point)
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- Architectural Site (Poly)
- Archeological Site (Poly)
- Archeological Survey
- Existing Turbine Locations
- Existing Access Roads
- Disturbance Area (~77 acres)
- Study Area
- Township

SOURCE: Esri World Imagery (2021)

1

ATWELL

0 500 Feet

PUBLIC DOCUMENT - NONPUBLIC DATA HAS BEEN EXCISED

[redacted]

Ashtabula Wind Upgrade Project

Figure 2 – Known Cultural Resources Index

Barnes County, North Dakota

Issue Date: 5/16/2023

- Architectural Site (Point)
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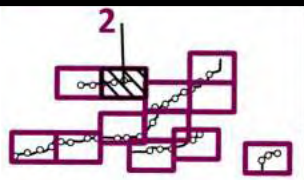
- Archeological Survey
- Existing Turbine Locations
- Existing Access Roads
- Disturbance Area (~77 acres)
- Study Area
- Township

SOURCE: Esri World Imagery (2021)



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Ashtabula Wind Upgrade Project

Figure 2 – Known Cultural Resources Index

Barnes County, North Dakota

Issue Date: 5/16/2023

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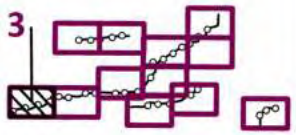
SOURCE: Esri World Imagery (2021)



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Ashtabula Wind Upgrade Project

Figure 2 – Known Cultural Resources Index

Barnes County, North Dakota

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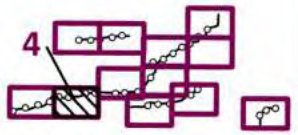

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Ashtabula Wind Upgrade Project

Figure 2 – Known Cultural Resources Index

Barnes County, North Dakota

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SOURCE: Esri World Imagery (2021)

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ATWELL

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Ashtabula Wind Upgrade Project

Figure 2 – Known Cultural Resources Index

Barnes County, North Dakota

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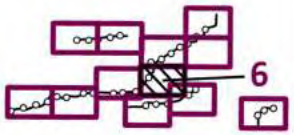

ATWELL

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Ashtabula Wind Upgrade Project

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Barnes County, North Dakota

Issue Date: 5/16/2023

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- Study Area
- Township

SOURCE: Esri World Imagery (2021)

7

ATWELL

0 500 Feet

Ashtabula Wind Upgrade Project

Figure 2 – Known Cultural Resources Index

Barnes County, North Dakota

Issue Date: 5/16/2023

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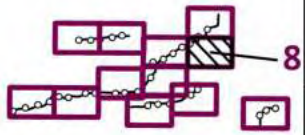

ATWELL

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Ashtabula Wind Upgrade Project

Figure 2 – Known Cultural Resources Index

Barnes County, North Dakota

Issue Date: 5/16/2023

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SOURCE: Esri World Imagery (2021)

9

ATWELL

0 500 Feet

Ashtabula Wind Upgrade Project

Figure 2 – Known Cultural Resources Index

Barnes County, North Dakota

Issue Date: 5/16/2023

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SOURCE: Esri World Imagery (2021)

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ATWELL

0 500 Feet

Ashtabula Wind Upgrade Project

Figure 2 – Known Cultural Resources Index

Barnes County, North Dakota

Issue Date: 5/16/2023

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- Archeological Survey
- Existing Turbine Locations
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- Disturbance Area (~77 acres)
- Study Area
- Township

SOURCE: Esri World Imagery (2021)

12

ATWELL

0 500 Feet

APPENDIX

UNANTICIPATED DISCOVERIES PLAN

ASHTABULA WIND UPGRADE PROJECT
BARNES COUNTY, NORTH DAKOTA

Prepared for

Otter Tail Power Company
215 S. Cascade Street
Fergus Falls, Minnesota 56537

Atwell Project No. 22007264

Submitted by Atwell, LLC

May 19, 2023

Contents

Appendices

1 Introduction

This Unanticipated Discoveries Plan (UDP) has been developed to lay out specific protocols and procedures to be taken should unanticipated archaeological resources be discovered during construction, operation, or decommission of the proposed Ashtabula Wind Upgrade Project (Project) located in Barnes County, North Dakota. The Project's Study Area comprises approximately 272 acres and encompasses a 300-foot buffer around the center point of each existing turbine and a 50-foot buffer (100-foot corridor) off the approximately 8.3 miles of existing access roads. The 80-acre Disturbance Area is the area where construction is expected to occur and includes a 150-foot buffer around the center point of each existing turbine and the footprint of the approximately 8.3 miles of existing access roads *Unanticipated Discoveries* are previously unknown or unrecorded archaeological resources, including human remains, discovered during Project activities. A series of steps to minimize physical impacts to archaeological resources is outlined in this UDP.

The protocols and procedures in the UDP outline actions to be taken if unanticipated discoveries are encountered during construction, operations, and decommission. The UDP is applicable to ground disturbing work associated with the Project during the construction, operations, and decommissioning phases. The UDP may be revised on occasion in accordance with regulatory changes, approved practices, or expansion into previous non-Project areas.

The UDP includes procedures in accordance with the State Historical Society of North Dakota (SHSND) for compliance with state requirements. In addition, general requirements for meeting the National Historic Preservation Act (NHPA) are included in the UDP.

The objectives of these procedures are to identify and promote the avoidance and/or the preservation and recording of any archaeological material discovered. A key component of the UDP is the notification of archaeological authorities to resolve any issues that may arise from unanticipated discoveries.

2 Summary of Archaeological Investigations

An archaeological literature review, completed in April of 2023, indicated that two previous archaeological surveys had been conducted within the Study Area, one of which covered nearly the entire Disturbance Area. The literature review also indicated that one archaeological site, 32BA172, has been previously recorded within the current Study Area.

Based on the literature review in conjunction with the fact that the Disturbance Area has largely been previously surveyed and disturbed by the original construction of the wind farm, Atwell makes the following recommendations:

- The Project proceed as planned without additional archaeological resource work prior to construction.
- Atwell recommends a 30m buffer area placed around 32BA172 site for the duration of construction to prevent disturbances as originally recommended by Beaver Creek Inc. in the 2008 report (Grimsrud Burns 2008).
- An UDP should be developed to establish procedures and relevant contact information in the event that human remains or archaeological deposits are discovered during the construction, operational, and decommission phases of the Project.
    - If buried archaeological resources are encountered, all activity should cease in the immediate area and within a 100-foot buffer area and the artifacts should be left in place. Otter Tail Power's archaeologist should be contacted immediately, and unanticipated discovery procedures should be initiated.
    - If human remains are encountered, construction should stop in the immediate area of discovery and within a 100-foot buffer area, and law enforcement should be notified immediately. Law enforcement officials should determine whether the discovery is a crime scene and whether the remains are prehistoric or historic Native American remains. The SHSND should be contacted immediately if the human remains are determined to be prehistoric or historic in nature and/or Native American remains.

The report was submitted to the SHSND on May 19th 2023 and concurrence is currently pending.

3 Regulatory Background and Authority

The UDP is designed to meet North Dakota and federal regulations governing the discovery of archeological materials and human remains. The applicable state and federal regulations are:

- North Dakota Century Code 55-10-11 – Recognition of Federal Historical Preservation Law;
- North Dakota Century Code 23-06-27 – Protection of human burial sites, human remains, and burial goods;
- Section 106 of the National Historic Preservation Act, (NHPA), as Amended; and

Currently, no federal trigger has been identified for this Project; therefore, Section 106 regulation do not apply. However, this UDP has been designed to comply with Section 106 should a federal trigger be identified in the future.

North Dakota has stringent state laws protecting human burials. A human burial can be marked or unmarked. An "unmarked burial" includes any location where human remains have been or may be found inadvertently and where there is no surficial evidence of a burial site (i.e., cemetery fence lines, tombstones, grave markers, etc.). This includes all prehistoric or historic Native American burials as well as all early historic-period Euro-American, African-American, and other isolated burials and abandoned cemeteries that are no longer being used for internments or being maintained in good condition. Human burials are protected under North Dakota Century Code 23-06-27. This law outlines the penalties for disturbing these resources as well and outlines the reporting protocol in the event an unmarked grave, burial, or historic cemetery is discovered.

4 Unanticipated Discovery Procedures

The general process for managing unanticipated discoveries is outlined in the following section, followed by information specific to archaeological sites and human remains or unmarked burials.

A responsible person who will be involved with all aspects of Project-related ground disturbing work during the construction, operations, and decommissioning phases should be identified. The designated responsible person (cultural liaison) should be present onsite during most Project activities and have some level of training, awareness, and sensitivity to the cultural resources that may be encountered within the Project site. This person will act as the Project liaison with the owner, Project archeologist, and cultural resources authorities in the event of unanticipated discoveries. S/he also will serve as the initial contact in the event of unanticipated discoveries during Project activities and be listed in the contacts section of this UDP.

During the Project kick-off meeting, all contractors will be made aware of the UDP and will be provided contact information for the cultural liaison, who will contact the Project archeologist to evaluate the need for further action. Whenever new personnel are brought onsite, they also will be informed of the UDP and the contact information. A copy of the UDP, including contact information, shall be posted in an accessible location onsite for reference as needed.

4.1 Archaeological Material

For purposes of the UDP, "archaeological material" could be from prehistoric or historic periods and includes, though not exclusively, the following types of materials (see Appendix A for additional examples):

- An area of charcoal or charcoal-stained soils associated with historic-period or prehistoric-period remains, such as bones, pottery sherds, shell, stone tools or chips;
- An arrowhead, pottery sherds, shell, stone tool, or stone chips;
- A historic-period bottle, old glass fragments, square nails, bricks and mortar, decorated white ware ceramics, etc.;
- A cluster of shell, sherds, and/or bones or large field stones or burned rocks in association with stone tools or chips;
- Dredging, pumping, industrial, and/or agricultural equipment older than 50 years;
- Buried structures, brick foundation piers or concrete slabs from remnant outbuildings or residences;
- A cluster of darkened soils in association with bones; and
- Undisturbed mounds of soil in areas that were once wetlands or shorelines.

The following general procedure is to be executed if archaeological material is discovered.

1. The site supervisor/foreman is informed of the discovery. The site supervisor/foreman will then contact the cultural liaison.
2. All construction activity within 100 feet of the discovery area/feature/site will cease immediately.
3. All remains or materials are to be left in place unless in jeopardy because of Project activities.
4. The area will be secured to prevent any damage or loss of removable objects. If feasible, a fence or other barrier will be erected to demarcate and protect the discovery area.
5. The cultural liaison will contact the Project archeologist, who will record the discovery location and delineate the extent of the discovery relative to planned Project activities. The Project archeologist will assess, record, and photograph the find.
6. Within 48 hours of the discovery, the Project archeologist will notify the SHSND and provide a brief written summary of the discovery that will include a recommendation on the NRHP eligibility of the resources, the effect of Project activity on historic properties, if present, and a proposed treatment to resolve adverse effects, if applicable.
7. The SHSND will review the recommendation made by the Project archaeologist and determine the appropriate course of action.
8. If cultural resources or remains have the potential to be culturally significant to a living Native American Tribe, the SHSND will notify the appropriate Tribes.
9. If human remains or unmarked burial sites are discovered, procedures in the next section should be followed.

4.2 Human Remains and Unmarked Burials

It is recommended that the Project follow the unanticipated discoveries protocol outlined in this section if any human remains or unmarked burial sites are discovered during Project activities.

Human remains may include any human body parts. Burial artifacts and burial sites are not easily recognized, but generally would include intact prehistoric pots, clusters of artifacts, or modern grave features (e.g., headstones, coffin parts, etc.). If in doubt whether the bones or other materials are human, it is best to stop work in the immediate area of the discovery and seek advice from the Project archaeologist.

Procedures for unanticipated discoveries involving human remains or unmarked burials are outlined below. In the event that human remains, an unmarked burial, or an abandoned cemetery is encountered by Project staff, the following procedures are applicable.

1. On discovery of the remains, construction activities (including excavation or any other below ground work) within 100 feet of the discovery will cease.

2. The site supervisor/foreman will be informed of the discovery. The site supervisor/foreman will then notify the cultural liaison.

3. Temporary site protection measures (e.g., high visibility warning tape and stakes, avoidance signs in language[s] understandable to the Project team, etc.) will be installed around the discovery area to prevent unintentional incursion and potential damage to the remains.

4. The cultural liaison will contact local law enforcement (e.g., police department, county sheriff) within 24 hours. Local law enforcement will notify the appropriate medical examiner's office.

5. The cultural liaison will contact the Project archaeologist, who will be or will engage a qualified professional archaeologist who is permitted in North Dakota and who has a background in osteology, forensic anthropology, physical anthropology, or equivalent.

6. The Project archaeologist will notify the SHSND within 48 hours of the discovery and provide the SHSND with a brief summary of the findings and recommendations.

7. The local law enforcement officials must be given site access to assess the nature and age of the remains. If the medical examiner's office determines that the human remains are older than 50 years of age and there is no need for a legal inquiry or criminal investigation, the SHSND will have jurisdiction over the remains.

8. If the SHSND believes the remains may have ethnic affinity with a living Native American Tribe, the SHSND will notify the appropriate Tribal representative(s) of the discovery.

9. Consultation will be initiated between the Project personnel (consisting of Otter Tail Power or their agent, the Project archaeologist or qualified professional archaeologist, and the cultural liaison) and the SHSND to determine the final disposition of the human remains. The information listed below will be considered during consultation if the remains are determined to be Native American:

    a. The National Park Services' Native American Graves Protection and Repatriation Act (NAGPRA) (U.S. Code 25, §3001, et seq.) database and Tribal websites

    b. Information available at the Great Plains Regional Office of the Bureau of Indian Affairs

    c. The potential interest of additional state-recognized Tribes

10. No work that will cause a direct effect to the discovery area will proceed until all human remains and associated artifacts have been recovered, and, where applicable, the appropriate regulatory agencies have given clearance for the Project work to proceed.

5 Key Personnel and Officials

In the event of an unanticipated discovery, the key personnel and agency officials listed below should be contacted consistent with the steps outlined above.

Cultural Liaison
Bryce Haugen
Energy Supply
215 S. Cascade St.
Fergus Falls, MN 56537
(701) 739-8385
bhaugen@otpco.com

Project Archaeologist
Matthew Chouest
2 Towne Square
Southfield, MI 48076
(517) 231-2053
mchouest@atwell-group.com

State Historical Society of North Dakota (SHSND)
Andrew J. Robinson
State Archaeologist
State Historical Society of North Dakota
Archaeology and Historic Preservation
612 East Boulevard Avenue
Bismarck, ND 58505-0830
Phone: (701) 328-3575
Email: andrewrobinson@nd.gov

Barnes County Sheriff's Office
57510th St. SW Suite 4
Valley City, ND 58072
Phone: (701) 845-8530

Barnes County Coroner's Office
520 Chautauqua Boulevard
Valley City, ND 58072
Phone: (701) 845-6000

APPENDIX A - EXAMPLES OF ARCHAEOLOGICAL RESOURCES

Surface or subsurface structures, shelters, facilities, or features, including, but not limited to

- domestic structures
- storage structures
- cooking structures
- ceremonial structures
- artificial mounds
- earthworks
- fortifications
- canals
- reservoirs
- gardens or fields
- bedrock mortars
- grinding surfaces
- rock alignments
- cairns
- trails
- borrow pits
- cooking pits
- refuse pits
- burial pits or graves
- hearths
- kilns
- post molds
- wall trenches

- middens
- Surface or subsurface artifact concentrations or scatters
- Whole or fragmentary tools, implements, containers, weapons or weapon projectiles, clothing, and ornaments, including, but not limited to:
    - pottery
    - other ceramics
    - cordage
    - basketry
    - other weaving
    - bottles
    - other glassware
    - bone
    - ivory
    - shell
    - metal
    - wood
    - hide
    - feathers
    - pigments
    - flaked stone
    - ground stone
    - pecked stone
- By-products, waste products, or debris resulting from manufacture or use of human-made or natural materials
- Organic waste, including, but not limited to: vegetal and animal remains, coprolites
- Human remains, including, but not limited to: bone, teeth, mummified flesh, burials, cremations

- Rock carvings, rock paintings, intaglios, and other works of artistic or symbolic representation
- Rock shelters and caves or portions thereof containing any of the above material remains
- All portions of shipwrecks, including, but not limited to: armaments, apparel, tackle, cargo
- Any portion or piece of any of the foregoing

Appendix F – IPaC Resource List

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IPaC **U.S. Fish & Wildlife Service**

IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Barnes County, North Dakota

Local office

North Dakota Ecological Services Field Office

(701) 250-4481
(701) 355-8513

3425 Miriam Avenue

3425 Miriam Avenue
Bismarck, ND 58501-7926

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

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1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information. IPaC only shows species that are regulated by USFWS (see FAQ).

2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
Northern Long-eared Bat Myotis septentrionalis Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/9045	Endangered

Insects

NAME	STATUS
Dakota Skipper Hesperia dacotae Wherever found There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/1028	Threatened
Monarch Butterfly Danaus plexippus Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/9743	Candidate

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

There are no critical habitats at this location.

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Birds of Conservation Concern https://www.fws.gov/program/migratory-birds/species
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide conservation measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON
American Golden-plover Pluvialis dominica This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds elsewhere
Bald Eagle Haliaeetus leucocephalus This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.	Breeds Dec 1 to Aug 31

Black Tern Chlidonias niger — Breeds May 15 to Aug 20
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/3093

Black-billed Cuckoo Coccyzus erythropthalmus — Breeds May 15 to Oct 10
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9399

Bobolink Dolichonyx oryzivorus — Breeds May 20 to Jul 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

California Gull Larus californicus — Breeds Mar 1 to Jul 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Chestnut-collared Longspur Calcarius ornatus — Breeds May 1 to Aug 10
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Chimney Swift Chaetura pelagica — Breeds Mar 15 to Aug 25
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Clark's Grebe Aechmophorus clarkii — Breeds Jun 1 to Aug 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Franklin's Gull Leucophaeus pipixcan — Breeds May 1 to Jul 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Golden Eagle Aquila chrysaetos — Breeds Jan 1 to Aug 31
This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/1680

Golden-winged Warbler Vermivora chrysoptera — Breeds May 1 to Jul 20
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/8745

Hudsonian Godwit Limosa haemastica — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Lesser Yellowlegs Tringa flavipes — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9679

Long-eared Owl asio otus — Breeds Mar 1 to Jul 15
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/3631

Marbled Godwit Limosa fedoa — Breeds May 1 to Jul 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9481

Red-headed Woodpecker Melanerpes erythrocephalus — Breeds May 10 to Sep 10
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Ruddy Turnstone Arenaria interpres morinella — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Short-billed Dowitcher Limnodromus griseus — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9480

Western Grebe aechmophorus occidentalis — Breeds Jun 1 to Aug 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/6743

Willet Tringa semipalmata — Breeds Apr 20 to Aug 5

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

Breeding Season (■)

Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

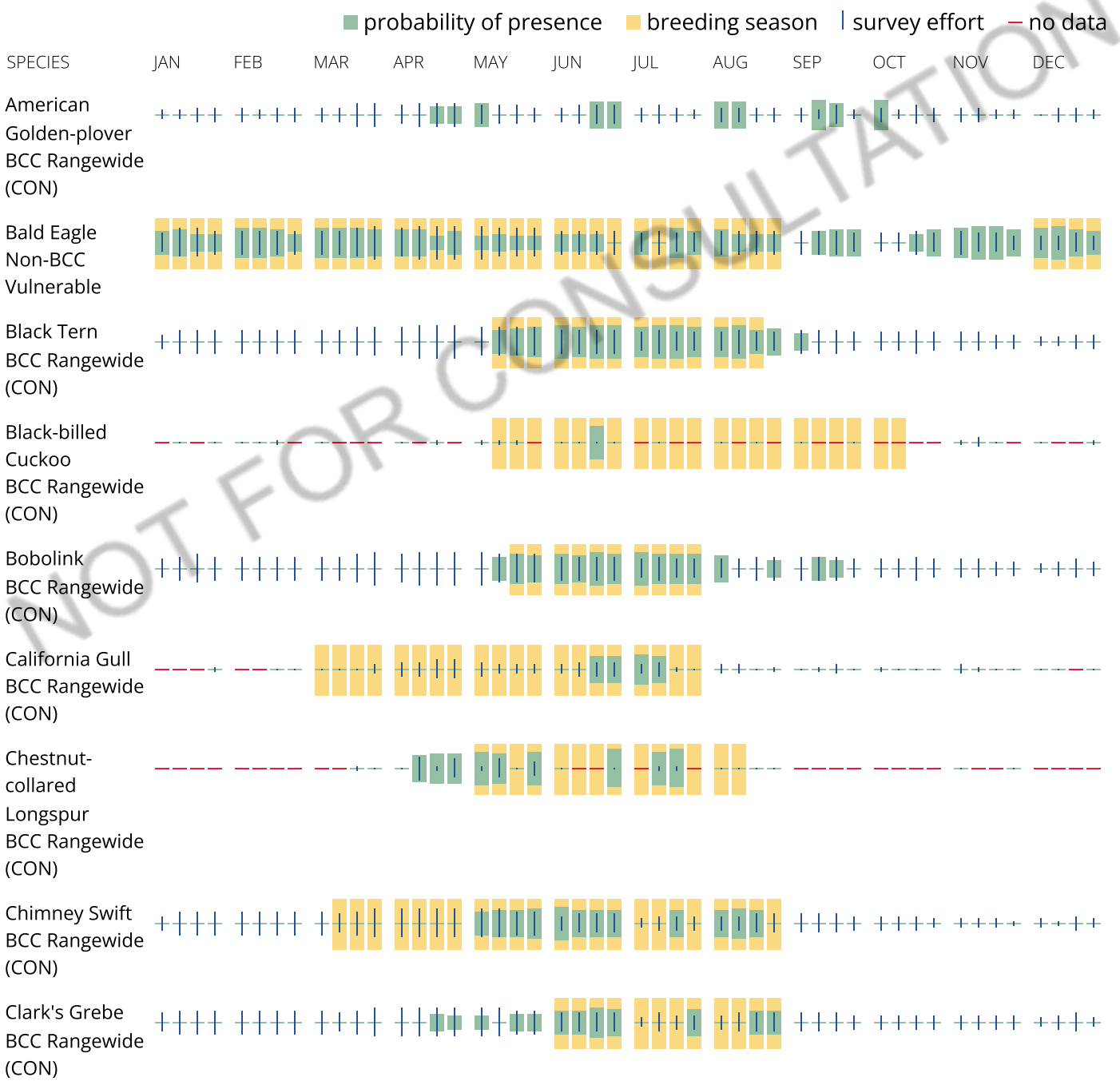
Survey Effort (|)

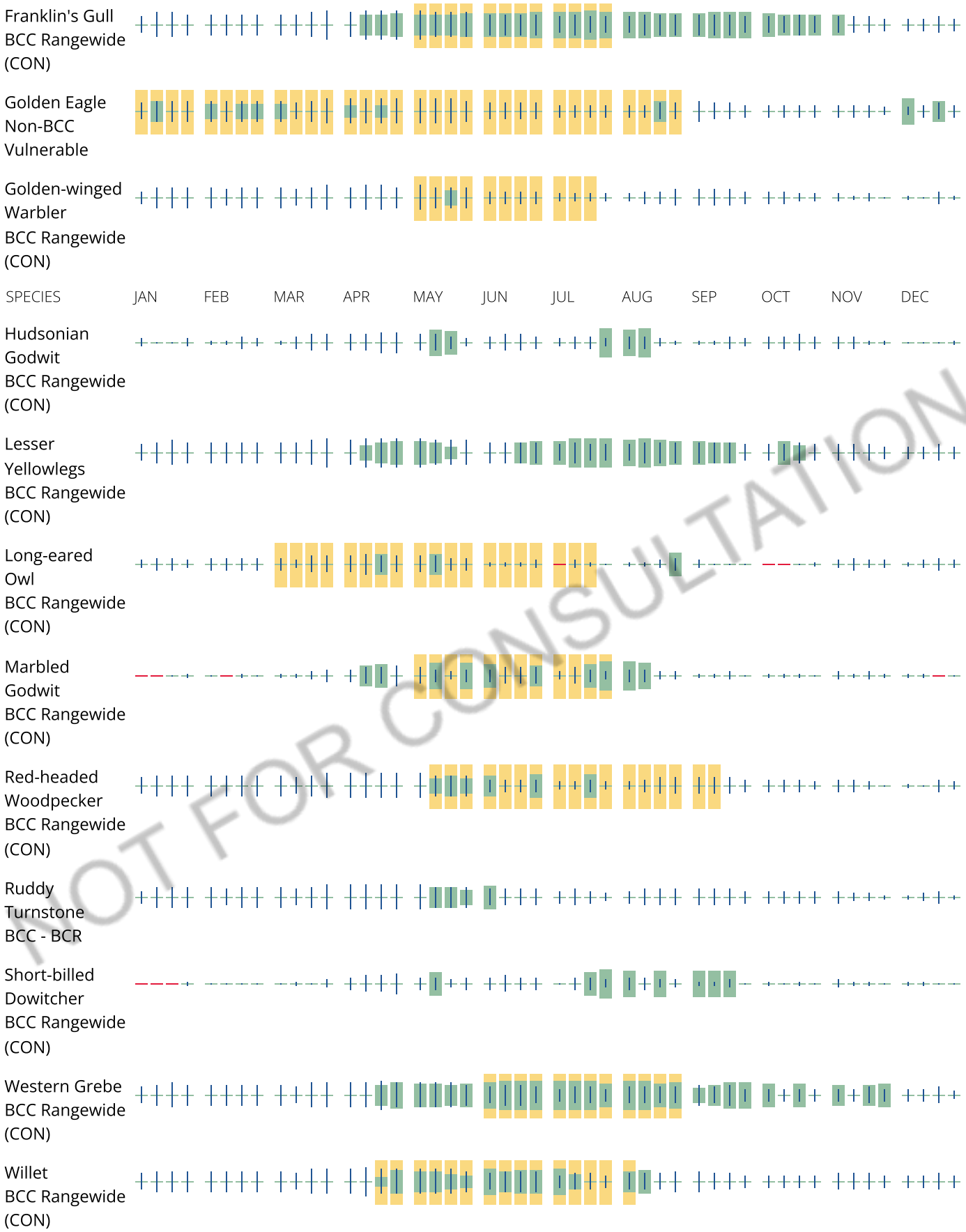
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.





Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the list of migratory birds that potentially occur in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the Rapid Avian Information Locator (RAIL) Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets.

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may query your location using the RAIL Tool and look at the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);

2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

This location overlaps the following National Wildlife Refuge lands:

LAND	ACRES
BARNES COUNTY WATERFOWL PRODUCTION AREA	13,945.83 acres
HOBART LAKE NATIONAL WILDLIFE REFUGE	2,007.05 acres
STONEY SLOUGH NATIONAL WILDLIFE REFUGE	887.02 acres
TOMAHAWK NATIONAL WILDLIFE REFUGE	438.38 acres

Fish hatcheries

This location overlaps the following National Fish Hatcheries. Please contact them for further guidance.

HATCHERY	ACRES
VALLEY CITY NATIONAL FISH HATCHERY	116.28 acres

Wetlands in the National Wetlands Inventory (NWI)

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

This location did not intersect any wetlands mapped by NWI.

NOTE: This initial screening does **not** replace an on-site delineation to determine whether wetlands occur. Additional information on the NWI data is provided below.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate Federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

STATE OF NORTH DAKOTA

PUBLIC SERVICE COMMISSION

Otter Tail Power Company **Amend – Ashtabula I Wind Energy Facility Upgrade Project** **Siting Application – Barnes County**	**Case No. PU-23-____** **OTTER TAIL POWER COMPANY'S APPLICATION TO AMEND ORDERS AND CERTIFICATE**

I. Introduction.

Pursuant to N.D.C.C. § 49-22-08(5), Otter Tail Power Company (Otter Tail) submits an application to the North Dakota Public Service Commission (Commission) requesting an amendment of the Commission's Findings of Fact, Conclusions of Law and Order, dated May 30, 2008 (Case No. PU-08-32) (2008 Order) and Order Granting Partial Certificate Transfer, dated April 13, 2009 (Case No. PU-09-53) (2009 Order), along with Certificate of Site Compatibility No. 10 (collectively, Orders and Certificate) issued to Otter Tail for its portion of the Ashtabula Wind Energy Facility (Facility). Specifically, Otter Tail requests that the Commission amend the Orders and Certificate to remove the overall 48 MW limitation.

II. Procedural History.

A brief overview of relevant procedural history is provided below:

- On May 30, 2008, the Commission issued its 2008 Order granting Certificate of Site Compatibility No. 7 to Ashtabula Wind, LLC for the Ashtabula Wind Energy Center consisting of up to 200 MW of wind turbines, electric collection and communication lines, project substation, project operations and maintenance building, meteorological towers, access roads, and other associated facilities (Case No. PU-08-32).

- On July 2, 2008, the Commission issued a Certificate of Public Convenience and Necessity (CPCN) to Otter Tail authorizing the purchase and operation of the 48 MW Facility (Case No. PU-08-200).

- On February 6, 2009, Otter Tail and Ashtabula Wind, LLC filed a Joint Application for Partial Transfer of Certificate of Site Compatibility, seeking to transfer to Otter Tail only the rights and obligations of Certificate of Site Compatibility No. 7 that coincide with the 48 MW Facility covered by the CPCN (Case No. PU-09-53).

- On April 13, 2009, the Commission issued its 2009 Order authorizing transfer of the 48 MW Facility to Otter Tail and issuing Certificate of Site Compatibility No. 10 to Otter Tail and First Amended Certificate of Site Compatibility No. 7 to Ashtabula Wind, LLC (Case No. PU-09-53). The 2009 Order amended the 2008 Order (Case No. PU-08-32) and transferred the same Facility covered by the CPCN.

- The Facility was constructed in 2008 with the Project beginning commercial operations in 2008.

- On June 28, 2023, Otter Tail filed the Certification of Timothy J. Rogelstad, with accompanying documentation, pursuant to N.D.C.C. § 49-22-03(3)(a)(4) regarding planned equipment upgrades at the Facility (Upgrade Project).

III. Planned Upgrade Project.

The Upgrade Project will consist of removing and replacing the existing General Electric (GE) 1.5 MW turbine generator technology and 77 meter (252.6 feet) rotor diameter (RD) blades, hub, and gearbox with an upgraded technology package of GE 1.6 MW generator technology and 91-meter (298.6 feet) RD blades, hub, and gearbox. The 1.6 MW technology offers more optionality and enables better, more efficient turbine operations. The Facility's total nameplate generating capacity would increase to 51.2 MW; however, the Facility's output would remain 48 MW in accordance with Otter Tail's Generator Interconnection Agreement.

IV. Amendment Request – Removal of Capacity Limitation.

In order paragraph nos. 1 and 3 of the 2008 Order, the Commission granted Certificate of Site Compatibility No. 7, which designated a site for "up to 200 MW of wind turbines" and associated facilities. In order paragraph no. 2 of the 2009 Order, the Commission issued Certificate of Site Compatibility No. 10 to Otter Tail "for the 48 MW portion of the Ashtabula Wind Energy Center for which the Commission issued Certificate of Public Convenience and

Necessity No. 5347." Likewise, Certificate of Site Compatibility No. 10 issued to Otter Tail designates a site for Otter Tail's "48 MW portion of the wind energy center".

As noted above, when repowered, the Facility's nameplate capacity would increase to 51.2 MW, even though the megawatts delivered to the grid will be limited to 48 MW. Based on review of prior repower dockets, Otter Tail understands that the Commission has previously concluded that order and certificate amendments are required where a megawatt limitation is specified.[1] Therefore, Otter Tail requests that the Commission amend the Orders and Certificates to remove the overall megawatt limitation.

V. Conclusion.

For the reasons set forth above, Otter Tail respectfully requests that its application to amend the Orders and Certificate to remove the overall capacity limitation be granted.

Dated this 28th day of June, 2023.

FREDRIKSON & BYRON, P.A.

By _____

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[1] *See* Order, dated December 3, 2019, Ashtabula Wind Energy Center Repower (Case No. PU-19-284); Order, September 5, 2018, Langdon Wind Energy Center Upgrade Project (Case No. PU-18-186); Order, dated October 27, 2022, Border Winds Energy Project Repower (Case No. PU-22-173); and Order, dated June 6, 2023, Langdon Wind Farm Upgrade Project (Case No. PU-23-86).