



TETRA TECH

May 30, 2014

Jerry Lein
North Dakota Public Service Commission
600 E. Blvd. Dept. 408
Bismarck, ND 58505-0480

SUBJECT: Thunder Spirit Wind Energy Project, Adams County, ND (Case No. PU-11-601)

Dear Mr. Lein,

On behalf of Thunder Spirit Wind, LLC, Tetra Tech is pleased to provide you one original and ten copies of the Amendment to the Application for a Certificate of Site Compatibility for the Thunder Spirit Wind Energy Project. A CD with electronic copy is also enclosed for your convenience.

As discussed with you on the phone, and as explained within the text of the Amendment, the necessity of these proposed modifications are attributable to three principal developments since the PSC issued the original Certificate of Site Compatibility in October 2013:

- In October 2013 Thunder Spirit Wind, LLC signed a power purchase agreement for 107.5 MW of the overall Project nameplate of 150 MW;
- In October 2013 Thunder Spirit Wind, LLC selected the Nordex N100/2500 turbine for the Project; and
- In December 2013 the FAA responded favorably to an appeal by Thunder Spirit to open up a portion of the Project area previously judged to have airspace obstruction conflicts.

As such, it is Thunder Spirit's objective to utilize the Nordex 2.5 MW turbine and the newly freed-up wind resource area to construct the most cost-efficient and environmentally benign 107.5 MW project possible within the originally permitted Project area. Thunder Spirit refers to the footprint of this revised Project as the Optimized Layout.

Various environmental studies have been completed for this Optimized Layout. Summaries have been included in this Amendment including a summary of cultural findings (the full cultural report will not be submitted to the PSC as it contains sensitive information). Additionally, Thunder Spirit is preparing a Bird and Bat Conservation Strategy. This report will be submitted to the PSC upon completion.

Please feel free to contact me at (617) 443-7552 or Tracey.Dubuque@tetrattech.com if you have any questions. We look forward to your comments.

Sincerely,

TETRA TECH, INCORPORATED

Tracey M. Dubuque, P.E.
Senior Project Manager

**Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota**

**AMENDMENT to the North Dakota Public Service Commission
for a Certificate of Site Compatibility (Updated May 30, 2014)**



Prepared for:
Thunder Spirit Wind, LLC
103 Front Street
Schenectady, NY 12305

Prepared by:
Tetra Tech, Inc.
160 Federal Street
Boston, MA 02110



THUNDER SPIRIT WIND ENERGY PROJECT

Case No.: PU-11-601

AMENDMENT to the North Dakota Public Service Commission for a Certificate of Site Compatibility

Updated May 30, 2014

Prepared for:

Thunder Spirit Wind, LLC
103 Front Street
Schenectady, NY 12305

Prepared by:

Tetra Tech, Inc.
160 Federal Street
Boston, MA 02110



TABLE OF CONTENTS

1.	INTRODUCTION	1
1.1	Proposed Project Details	3
1.1.1	Proposed Project Area.....	3
1.1.2	Proposed Turbine Type	4
1.1.3	Projected Output	4
1.1.4	Proposed Technology and Associated Facilities	4
1.2	Project Schedule.....	4
1.3	Proposed Project Impacts	5
2.	PSC SITING CRITERIA	7
2.1	Exclusion Areas	7
2.2	Avoidance Areas	8
2.3	Selection Criteria.....	10
2.4	Policy Criteria	13
3.	ENVIRONMENTAL ANALYSIS - UPDATE.....	14
3.1	Air Traffic	14
3.2	Communications.....	15
3.3	Eagles.....	15
3.3.1	Impacts	15
3.3.2	Mitigative Measures.....	15
3.4	Shadow flicker.....	15
3.4.1	Impacts	15
3.4.2	Mitigative Measures.....	16
3.5	Noise.....	16
3.5.1	Impacts	17
3.5.2	Mitigative Measures.....	17
3.6	Cultural and Archaeological Impacts.....	18
3.6.1	Description of Resources	18
3.6.2	Impacts	19
3.6.3	Mitigative Measures.....	20
3.6.4	Effect of Project on Cultural Resources	21
3.7	Historic Architectural Impacts	21
3.8	Wetlands, Surface Water and Floodplain Resources.....	21
3.8.1	Impacts	22
3.8.2	Mitigative Measures.....	22
3.9	Summary of Impacts	23
4.	POTENTIAL PERMITS AND APPROVALS	26

REVISED FIGURES (FIGURE NUMBERS WERE NOT CHANGED)

Figure 1	Project Location
Figure 2	Project Area (Aerial) Optimized Layout
Figure 3	Project Area (Topographical) Optimized Layout
Figure 4	Project Impact Assumptions
Figure 5	Exclusion and Avoidance Areas
Figure 10	Public Lands and Easements
Figure 13	Land Cover Map
Figure 14	Prime Farmland Soil Distribution Map
Figure 15	State Soils Association Map
Figure 16	National Wetlands Inventory and Surface Waters Map
Figure 17	Residential Receptor Distances to Closest Wind Turbine
Figure 18	Project Layout with Adams County Zoning Setbacks
Figure 19 (new)	Permitted Turbine Locations Compared to Optimized Layout

REVISED TABLES

Table 1.	Turbine Shifts and Added Turbines – 43 Turbine Optimized Case	2
Table 2.	Project Area Location.....	3
Table 3.	Project Area Descriptions.....	4
Table 4.	The Nordex N100/2500 IEC II Turbine.....	4
Table 5.	Assumptions For Overall Ground-Disturbing Impacts.....	5
Table 6.	Estimated Project Impacts - Comparison	6
Table 7.	Exclusion Areas.....	7
Table 8.	Avoidance Areas.....	8
Table 9.	Selection Criteria	10
Table 10.	Policy Criteria	13
Table 11.	Comparison of Modeled Shadow Flicker Impacts for Original and Optimized Turbine Layout Design for the Top Ten Predicted Impact Receptors	16
Table 12.	Noise Modeling Results	17
Table 13.	Results of Supplemental Wetland Delineations.....	21
Table 14.	Summary of Impacts and Mitigation.....	23
Table 15.	Potential Permits and Approvals	26

REVISED APPENDICES

Appendix A	Studies and Assessments (Only those that were revised or were not provided in Certificate)
	<ul style="list-style-type: none">• Supplemental Wetland Delineation Summary• Revised Shadow Flicker Analysis• Revised Acoustic Analysis
Appendix B	Additional Agency Correspondence
Appendix C	Nordex Turbine Specifications
Appendix D	Distance from Receptors to Turbines

1. INTRODUCTION

On June 4, 2013, Thunder Spirit Wind, LLC (Thunder Spirit), an affiliate of Wind Works Power Corp., submitted an application for a Certificate of Site Compatibility (Application) to construct the Thunder Spirit Wind Energy Project (the Project). Since the submission of the Application, although the Project Area has not changed, there were some modifications to some turbine locations (Figure 1 and Figure 19). In July, some turbines were further microsited or removed to avoid environmentally sensitive areas and meet setback requirements. In August, further micrositing occurred to account for landowner requests, to avoid environmentally sensitive areas, and to meet county setback requirements. A total of 29 turbines were microsited after the layout dated April 26, 2013. Details of these adjustments were described an Amendment filed in September, 2013. Thunder Spirit received the Findings of Fact, Conclusions of Law and Order on October 9, 2013. Thunder Spirit held the required pre-construction meeting with the North Dakota Public Service Commission on 24 October 2013.

In October 2013, Thunder Spirit signed a power purchase agreement with Montana Dakota Utilities (MDU) to supply 107.5 MW of power from the Project for a 25 year period. This output represents just over two-thirds of the overall Project nameplate capacity of 150 MW. The remaining approximately 42.5 MW of this nameplate capacity are currently being marketed and could potentially represent a second phase of Project construction.

In December 2013, Thunder Spirit received notification from the Federal Aviation Administration (FAA) that a portion of the Project area previously precluded from development due to airspace constraints could now be used (See further discussion in Section 3). In May of 2014, Thunder Spirit revised the project layout a) to accommodate a 107.5 MW Phase I, and b) to include the use of the area recently approved for turbine erection by the FAA. The area originally precluded has an excellent wind resource. Thunder Spirit is now requesting that the ND PSC review and approve these changes as described in this Revised Application.

In December 2013 Thunder Spirit also signed a turbine supply agreement with Nordex, to provide 43 turbines for the 107.5 MW initial phase of the Project. This turbine, the 2.5 MW Nordex N100/2500 IEC II, is described in this Application (Thunder Spirit initially notified the PSC of this turbine selection in a Notice of Intent to begin construction on December 6, 2013). It should be noted that while this specific turbine was not described in the June, 2013 Application, its size, output, and thus range of potential environmental effects fall well within the range of turbines and associated potential impacts evaluated in the original Application approved in October 2013.

Two versions of the Phase I 107.5 MW layout have been developed with this turbine within the original Thunder Spirit project area, a Base Case layout and an Optimized Case layout:

- The Base Case includes a total of 43 turbines. This is primarily a subset of the locations that were permitted in October 2013 as presented in the previous Application, with minor changes to access roads which have required additional wetland and cultural surveys. As such, this case will be the subject of an administrative update with the North Dakota Public Service Commission, in June 2014.

- The Optimized Case also includes a total of 43 turbines, along with associated access roads and electrical collection lines. Approximately 58% of the turbines in this Optimized Case are sited in locations previously approved by the PSC, while the remaining locations have not yet been approved (again, because at the time of the PSC’s original review of the Project, these locations were not yet cleared by the FAA). It is important to note that while the PSC has yet to approve the specific siting attributes of the new locations, all these locations occur within the same overall Project area that was extensively reviewed by the PSC for potential environmental impacts in 2013. The specific environmental attributes of these new locations, and those cumulative potential impacts of the overall Optimized Case layout are the subjects of this Revised Application.

Of the 43 turbine locations in the Optimized Case, 18 are new and 25 are within the areas surveyed for the June 2013 Application. Of the 25 turbines within already-surveyed areas, turbine locations have been adjusted to optimize production and avoid resource impacts, resulting in shifts of under 1 foot to approximately 792 feet. Where this resulted in a turbine being shifted out of a previous survey corridor, additional surveys were performed. This additional field survey work was limited to wetlands and cultural resources, as previously-performed surveys covered the entire Project Area. In addition, some desktop analyses were conducted. These include a revised sound analysis, revised shadow flicker analysis, and impact calculations. **Table 1** shows the turbine shifts and the new turbines used in the Optimized Case; Figures 2 and 3 shows the proposed locations for the turbines, access roads and underground collection lines for the Optimized Case.

Table 1. Turbine Shifts and Added Turbines – 43 Turbine Optimized Case

Optimized Turbine #	Distance to Nearest Permitted Turbine	Permitted Turbine #
1	ADDED TURBINE	N/A
2	329.33	9
3	403.19	10
4	255.79	11
5	138.30	12
6	108.05	13
7	452.23	14
8	0.82	15
9	0.33	16
10	1.54	17
11	139.82	18
12	205.60	19
13	134.80	20
14	ADDED TURBINE	N/A
15	ADDED TURBINE	N/A
16	ADDED TURBINE	N/A
17	No turbine #17	N/A
18	No turbine #18	N/A
19	ADDED TURBINE	N/A
20	395.01	35
21	393.40	36
22	ADDED TURBINE	N/A

Optimized Turbine #	Distance to Nearest Permitted Turbine	Permitted Turbine #
23	ADDED TURBINE	N/A
24	ADDED TURBINE	N/A
25	ADDED TURBINE	N/A
26	ADDED TURBINE	N/A
27	415.46	38
28	ADDED TURBINE	N/A
29	ADDED TURBINE	N/A
30	ADDED TURBINE	N/A
31	ADDED TURBINE	N/A
32	ADDED TURBINE	N/A
33	ADDED TURBINE	N/A
34	ADDED TURBINE	N/A
35	ADDED TURBINE	N/A
36	ADDED TURBINE	N/A
37	792.59	A29
38	332.91	A28
39	98.28	54
40	181.88	55
41	492.22	A19
42	0.21	57
43	1.11	58
44	0.73	59
45*	462.05	60

* There are a total of 43 turbines. There is no Turbine 17 or 18.

1.1 Proposed Project Details

1.1.1 Proposed Project Area

Thunder Spirit is located approximately two to five miles northeast of Hettinger, North Dakota in Adams County. The Project Area was selected to include all areas necessary for Thunder Spirit to optimize the wind resource while avoiding and minimizing impacts to environmental resources (Table 2).

Table 1. Project Area Location

County	Civil Township	Township	Range	Sections
Adams County	Duck Creek	130N	95W	1-36
	Holt	130N	96W	13, 14, 23, 24, 25, 26

For purposes of this Revised Application, a subset of the Project Area referred to as the Wind Energy Facility Perimeter (WEFP) as defined in the Adam’s County regulations will be used to describe the existing environmental conditions (Figure 1 and Table 3). This WEFP is comprised of all lands under easement agreements with Thunder Spirit, but not all these lands will ultimately host Project infrastructure.

Table 3. Project Area Descriptions

Area Descriptions	Area
Project Area Boundary	26,867 acres
WEFP	14,881 acres

1.1.2 Proposed Turbine Type

Table 4 presents details about the 2.5 MW Nordex N100/2500 IEC II turbine. Appendix C shows the Nordex Turbine Specification Sheet:

Table 4. The Nordex N100/2500 IEC II Turbine

Factor	Value
Total number of turbines	43
Rated Power	2.5 MW
Rotor Diameter	100 m
Rotor Swept Area	7,854 m ²
Blade length	49 m
Hub height	80 m
Operating Range Rotor Speed	9.6 to 16.8 rpm
Cut-in Speed	3 m/s
Rated Wind Speed	14.9 m/s
Cut-out speed	25 m/s

1.1.3 Projected Output

The Project will have a nameplate (gross) capacity of approximately 107.5 MW. Assuming a net capacity factor of approximately 45.9 percent (GWH, 2013), the projected average annual output is estimated at approximately 485,900 megawatt hours (MWh) per year. As with all wind projects, output is dependent upon wind resource, final design, site-specific features, and equipment performance.

1.1.4 Proposed Technology and Associated Facilities

As mentioned, although the Nordex turbine technology ultimately selected for the initial 107.5 MW of the Thunder Spirit Project was not specifically discussed in the original Application submitted in June 2013, the size and output of this technology is well within the range of potential impacts already examined. This fact will be supported within this application by reference to both field and desktop impact analyses. The design and construction of associated facilities, including turbine foundations, access roads, underground collection lines, the transmission line, as well as potential off-site civil works, will be carried out as described in the June, 2013 Application. The substation was shifted approximately 450 feet to the west in an effort to mitigate potential impacts as well as alleviate the concern posed at the hearing in September 2013 by the closest non-participating landowner.

1.2 Project Schedule

After all local and state permits required to construct the Project were obtained in October 2013, and a power purchase agreement was signed, Thunder Spirit began construction of part of its access road network in December 2013. Approximately two miles of access road were constructed before inclement weather forced work to stop for the winter. Thunder Spirit is targeting August 2014 for

the resumption of construction provided all pre-construction permits and approvals have been obtained. The target date for commercial operation is October 2015, however this date is dependent upon permitting, equipment deliveries, and other development activities.

- a. Certificate of Site Compatibility: Thunder Spirit anticipates the Amended Order will be approved prior to August 2014.
- b. Land Acquisition: Thunder Spirit has completed all land acquisition.
- c. Permits: Thunder Spirit will obtain all permits and licenses that are required following issuance of the Certificate. Completing permits is on the “critical path” for the Project and will allow Thunder Spirit to move forward with other commitments on the Project.
- d. Equipment Procurement, Manufacture and Delivery: Thunder Spirit has signed a turbine supply agreement with Nordex and expects to begin receiving initial component deliveries prior to turbine erection beginning in May 2015.
- e. Construction: Construction is scheduled to resume in August 2014, subject to road restrictions and weather. The engineering, procurement, and construction (EPC) contractor will be responsible for completing all project construction, including roads, wind turbine assembly, electrical, and communications work.
- f. Test and Operations: Thunder Spirit anticipates testing and operation to begin around July-August 2015.
- g. Commercial Operation: Thunder Spirit anticipates a Commercial Operation Date (COD) in October 2015.

1.3 Proposed Project Impacts

The Application for a Certificate of Site Compatibility submitted in June 2013 included impact calculations for up to 85 turbines. The current Phase I optimized layout (dated May 27, 2014) will utilize 43 turbines. Assumptions for overall ground disturbance are presented in **Table 5**, and **Table 6** presents a comparison of the permitted impacts from the June 2013 Application with the proposed impacts for this revised Application. Refer to Figure 4 for the Project Impact Assumptions.

Table 5. Assumptions For Overall Ground-Disturbing Impacts

Project Component	Total Disturbance (Temporary and Permanent)	Permanent Disturbance	Temporary Disturbance
Wind Turbines a/	4.5 acres per turbine	0.75 acres per turbine	3.75 acres per turbine
Access Roads b/	100 foot corridor per linear foot of road	36 foot corridor per linear foot of road	64 foot corridor per linear foot of road
Collection Lines c/	50 foot corridor per linear foot of line	0 feet	50 foot corridor per linear foot
O&M Facility d/ Collection Substation e/ Laydown Area f/	20 acres	7 acres	13 acres
Additional Construction Laydown Areas f/	Up to 10 acres	0 acres	10 acres
<p>a/ These impacts assume all 43 turbines x 4.5 acres of ground disturbance during construction, 0.75 acre/turbine of that remaining as permanent impacts.</p> <p>b/ Assumes a 100-ft wide impact area for roads during construction. Roads required to support crane access to turbines during construction would remain up to 36 feet wide; other access roads may be built at 16 feet or reduced later to 16 feet. This table estimates the worst case impacts. Access road impacts also assume that all proposed roads are new construction and do not consider improvements to existing roads.</p>			

Project Component	Total Disturbance (Temporary and Permanent)	Permanent Disturbance	Temporary Disturbance
<p>g/ The overlapping areas between the collection line corridor buffer and the access road corridor buffer were removed from impact calculation.</p> <p>d/ Acreage based on information provided by Thunder Spirit. Estimated temporary disturbance for the O&M facility is between 4-7 acres.</p> <p>e/ Thunder Spirit will attempt to construct substation near the O&M Facility. Estimated temporary disturbance for the Substation is between 3-6 acres.</p> <p>f/ There will be up to two laydown areas (up to 5-10 acres each). One laydown area will be located near the O&M/Substation area. The locations and sizes will be determined early in the engineering and project management review of the project.</p>			

Table 6. Estimated Project Impacts - Comparison

Project Component	Total Disturbance (Temporary and Permanent) *		Permanent Disturbance (Operation)		Temporary Disturbance (Construction Only)	
	Permitted	Optimized Phase I	Permitted	Optimized Phase I	Permitted	Optimized Phase I
Wind Turbines <u>a/</u>	323 acres	152 acres	56 acres	27 acres	267 acres	125 acres
Access Roads <u>b/</u>	309 acres	194 acres	113 acres	71 acres	196 acres	123 acres
Collection Lines <u>c/</u>	155 acres	96 acres	0	0 acres	155 acres	96 acres
O&M Facility <u>d/</u> Collection Substation <u>e/</u> Laydown Area <u>f/</u>	20 acres	20 acres	7 acres	7 acres	13 acres	13 acres
Additional Construction Laydown Area <u>f/</u>	5-10 acres	5-10 acres	0 acres	0 acres	5-10 acres	5-10 acres
Totals	817 acres	472 acres	176 acres	105 acres	641 acres	367 acres
<p>*Permitted assumes the layout presented in the June 2013 Application. Optimized assumes the layout proposed in this Application.</p> <p><u>a/</u> These impacts assume all 43 turbines x 4.5 acres of ground disturbance during construction, 0.75 acre/turbine of that remaining as permanent based on the layout dated May 27, 2014.</p> <p><u>b/</u> Assumes a 100-ft wide impact area for roads during construction, 36 feet of that remaining during operation. Assumes total of approximately 17 linear miles of service roads. The overlapping area for turbines and substation were excluded from the impact calculations.</p> <p><u>c/</u> The overlapping areas between the collection line corridor buffer and the access road corridor buffer were removed from impact calculation. Approximately 25 miles of collection lines were used to calculate impacts. The impacts also include approximately 22 miles of collection lines not co-located with access roads.</p> <p><u>d/</u> Acreage based on information provided by Thunder Spirit. Estimated temporary disturbance for the O&M facility is between 4-7 acres.</p> <p><u>e/</u> Thunder Spirit will attempt to construct substation near the O&M Facility. Estimated temporary disturbance for the Substation is between 3-6 acres.</p> <p><u>f/</u> There will be up to two laydown areas (up to 5-10 acres each). One laydown area will be located near the O&M/Substation area. The locations and sizes will be determined early in the engineering and project management review of the project.</p>						

2. PSC SITING CRITERIA

2.1 Exclusion Areas

In accordance with NDAC Section 69-06-08-01-1, the geographical areas listed in the following table shall be excluded in the consideration of a site for an energy conversion facility. Refer to the last column in **Table 7** for any changes to Exclusion Areas for Phase I and Figure 5 for the Exclusion Areas and Figure 14 for Prime Farmland and Figure 17 which shows the receptor distances to the closest turbine.

Table 7. Exclusion Areas

Exclusion Area	Present within Project Area?	Description	Impacts of Revised Layout
Designated or registered national areas: 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	N/A	No change* (*See Note in footer of table)
Designated or registered state areas: 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.	Present	Cultural sites that are potentially eligible for the historic register will be avoided.	No change
County parks and recreational areas; municipal parks; parks owned or administered by other governmental subdivisions; hardwood draws; and enrolled woodlands.	None	N/A	No change
Prime farmland and unique farmland, as defined by the land inventory and monitoring division of the soil conservation service, United States department of agriculture, in 7 C.F.R. part 657; provided, however, that if the Commission finds that the prime farmland and unique farmland that will be removed from use for the life of the facility is of such small acreage as to be of negligible impact on agricultural productions, such exclusion shall not apply.	Present	Prime farmland has been avoided to the extent practical. Permanent impacts to prime farmland soils from turbine placement and access roads are expected to be approximately 2.3 acres, which is a negligible percentage of the Project Area.	No change* (*See Note in footer of table)
Irrigated land	None	No agricultural irrigation is currently known to take place within the Project Area.	No change
Areas critical to threatened or endangered animal or plant species	None	N/A	No change
Areas where animal or plant species that are unique or rare to this state would be irreversibly damaged.	None	N/A	No change

Exclusion Area	Present within Project Area?	Description	Impacts of Revised Layout
Areas within 1,200 feet of the geographic center of an intercontinental ballistic missile (ICBM) launch or launch control facility	None	N/A	No change
Setbacks from Interstate or state roadways ROW, railroads, transmission lines, non-participating landowners, and county or township roadways.	Present	<ul style="list-style-type: none"> • 1.1 x height of turbine from interstate or state roadways ROW • 1.1 x height of turbine from railroads • 1.1 x height of turbine from transmission lines (over 115 kV) • 1.1 x height of turbine from non-participating landowners • 1.1 x height of turbine plus 75' from centerline of any county or maintained township roadways 	All turbines have been located so as to meet these setbacks.
<p>Note: The Certificate of Site Compatibility Application Amendment submitted in September 2013 included impact calculations for up to 85 turbines. The current Phase I optimized layout (dated May 27, 2014) will utilize 43 turbine locations. Since the total number of turbines was not increased, rather it was decreased, there is no additional impact to those originally presented for native prairie, prime farmland, agricultural production and plant life and this total impact would be less than what was presented previously. Should a second phase of the project be built (~ 42.5 MW), the total impacts are expected to approximate those originally presented for an overall 150 MW project.</p>			

2.2 Avoidance Areas

In accordance with NDAC Section 69-06-08-01-2, the geographical areas listed in the following table shall not be approved as a site for an energy conversion facility unless the applicant shows that, under the circumstances, there is no reasonable alternative. Refer to the last column in **Table 8** for any changes to Avoidance Areas and Figure 5 for the Avoidance Areas for Phase I and Figure 10 for Public Lands and Easements.

Table 8. Avoidance Areas

Avoidance Areas	Present within Project Area?	Description and Proposed Buffer	Impacts of Revised Layout
Historical resources which are not designated as exclusion areas	Present	A Class III cultural resources survey was completed for the new turbines, access roads, electrical collection lines, and associated facilities. Sites with potential cultural significance have been avoided.	Turbines have been relocated to ensure avoidance.
Areas within the city limits of a city or the boundaries of a military installation	None	N/A	No change
Areas within known floodplains as defined by the geographical boundaries of the 100-year flood	None	The Project Area is located in Flood Hazard Zone D: Areas in which flood hazards are undetermined, but possible.	No change
Areas that are geologically unstable	Present	Evidence exists that a single abandoned coal mine is present within the Project Area. Subsidence hazards related to the potential	No change

Avoidance Areas	Present within Project Area?	Description and Proposed Buffer	Impacts of Revised Layout
		presence of abandoned underground coal mines will be mitigated through field studies and geotechnical analyses and subsequent micrositing.	
Wetlands	Present	Additional wetland delineations have been conducted for the new turbines, access roads electrical collection lines, and associated facilities. Permanent impacts to wetlands have been avoided.	No change
Woodlands	None	The Project Area contains approximately 15 acres of deciduous forest mostly comprised of windbreaks around farming facilities. Impacts to woodlands have been avoided to the extent practical.	No change
Native Prairie	Present	The Project Area contains approximately 4,527 acres of native prairie (16% of the Project Area). Native Prairie has been avoided to the extent practical, with approximately 46 acres of permanent impact and 151 acres of temporary impact.	No change* (*See Note in footer of table)
Areas of recreational significance which are not designated as exclusion areas	None	N/A	No change
Sound levels within 100' of an inhabited residence or a community building cannot exceed 50 dBA	None	The sound analysis showed no exceedances of this standard.	No impacts
<p>Note: The Certificate of Site Compatibility Application Amendment submitted in September 2013 included impact calculations for up to 85 turbines. The current layout (dated May 27, 2014) will utilize 43 turbine locations. Since the total number of turbines was not increased, rather it was decreased, there is no additional impact to those originally presented for native prairie, prime farmland, agricultural production and plant life and this total impact would be less than what was presented previously. Should a second phase of the project be built (~ 42.5 MW), the total impacts are expected to approximate those originally presented for an overall 150 MW project.</p>			

2.3 Selection Criteria

In accordance with NDAC Section 69-06-08-01-3, a site shall be approved in an area only when it is demonstrated to the PSC by the applicant that any significant adverse effects resulting from the location, construction, and operation of the facility in that area, as they relate to the criteria listed in the following table. Refer to the last column in **Table 9** for any changes to Selection Criteria for Phase I and Figures 13 and 15.

Table 9. Selection Criteria

Selection Criteria	Potential Adverse Effects	Impact of Revised Layout
The impact upon agriculture:		
Agricultural production	The Project will result in approximately 38 acres of permanent impact and 116 acres of temporary impact to agricultural land. Temporary impacts will be limited to the period of construction. These impacts represent a minor portion of the land area within the Project Area that is available for agricultural production. As a result, no adverse effects are expected.	No change* (*See Note in footer of table)
Family farms and ranches	The Project will comply with local setbacks as stipulated in the Adams Co. wind ordinance. Although some land area will be permanently converted to wind turbine foundations and pads, access roads, and a substation, wind lease payments to farmers will provide a compensatory source of income, and no adverse effect are expected.	No change
Land which the owner demonstrates has soil, topography, drainage, and an available water supply that cause the land to be economically suitable for irrigation	N/A. No agricultural irrigation is currently known to occur within the Project Area. No adverse effects are expected.	No change
Surface drainage patterns and ground water flow patterns	No adverse effects are expected.	No change
The agricultural quality of the cropland	No impacts to the agricultural quality of the cropland are anticipated (except for areas converted to wind energy facility use). Thunder Spirit will work with the landowners to alleviate the compaction of any soils which occurs during construction,	No change
The impact upon the availability and adequacy of:		
Law enforcement	No adverse effects are expected.	No change
School systems and education programs	No adverse effects are expected.	No change
Governmental services and facilities	No adverse effects are expected.	No change
General and mental health care facilities	No adverse effects are expected.	No change
Recreational programs and facilities	No adverse effects are expected.	No change
Transportation facilities and networks	During construction, an increase in vehicle trips per day is anticipated for the duration of the Project construction. During facility operation, no significant impacts are anticipated.	No change
Retail service facilities	Local services such as motels, restaurants, and convenience stores are likely to experience an increase in business during Project construction. During facility operation, no significant impacts are anticipated.	No change

Selection Criteria	Potential Adverse Effects	Impact of Revised Layout
Utility services	No significant impacts are anticipated. Thunder Spirit will purchase station service from both MDU (to satisfy power requirements at the turbines and substation) and from Slope Electric (for requirements at O&M offices). Utilities will suggest appropriate configurations for the electrical system, and Thunder Spirit will abide by the recommendations to prevent impacts to the transmission system.	No change
The impact upon:		
Local institutions	No impacts are anticipated.	No change
Noise sensitive land uses	The only noise sensitive land uses within the Project Area are the residences near turbine locations. The acoustic modeling analysis, demonstrates the Project has been adequately designed inclusive of a number of conservative assumptions to generate sound levels below the EPA guidelines, the North Dakota noise limit, and the Adams County zoning ordinance at all occupied receptors.	See attachment for details
Rural residences and businesses	The Project will comply with local setback regulations, in accordance with the Adams Co. wind ordinance. No significant impacts are anticipated.	No change
Aquifers	No adverse effects are expected.	No change
Human health and safety	No impacts to human health and safety are anticipated based on the implementation of the mitigative measures discussed in Section 5.5.3 of the original Certificate.	No change
Animal health and safety	No impacts to livestock are anticipated from construction or operation of the facility. Based on avian and bat surveys performed to date, mean avian raptor and non-raptor and bat use was generally low to low-moderate compared to other wind facilities. Thunder Spirit will implement measures to avoid and minimize impacts to wildlife by siting facilities away from active raptor nests and wetlands to the extent practicable. There will be no permanent impacts to wetlands, further reducing impacts to migratory birds. In addition, Thunder Spirit will implement a minimum of one year of post-construction mortality monitoring for birds and bats.	No change
Plant life	The Project will result in approximately 105 acres of permanent impact and 367 acres of temporary impact to plant life. This is a negligible percentage of the entire Project area, and no significant impacts are anticipated. Project layout would permanently impact approximately 62 acres of grasslands and 232 acres of temporary impacts.	No change* (*See Note in footer of table)
Temporary and permanent housing	No adverse impacts are anticipated. Temporary housing may be utilized during construction. The EPC contractor will be responsible for housing for their employees.	No change
Temporary and permanent skilled and unskilled labor	No adverse impacts are anticipated. Local contractors employed for construction will result in increased wages.	No change
The cumulative effect of the location of the facility in relation to existing and planned facilities and other industrial development	Wind energy development is anticipated to have a positive cumulative impact on air quality and minimal impacts to geology, soils, water, noise, safety and health issues, and cultural resources. Socioeconomic impacts are anticipated to be positive, as the rural economy and energy production is diversified. Wind energy development removes less total land from agricultural use than other forms of development. Cumulative impacts to wildlife will be minimized through the measures listed in the Animal health and safety section, above.	No change

Selection Criteria	Potential Adverse Effects	Impact of Revised Layout
<p>Note: The Certificate of Site Compatibility Application Amendment submitted in September 2013 included impact calculations for up to 85 turbines. The current layout (dated May 27, 2014) will utilize 43 turbine locations. Since the total number of turbines was not increased, rather it was decreased, there is no additional impact to those originally presented for native prairie, prime farmland, agricultural production and plant life and this total impact would be less than what was presented previously. Should a second phase of the project be built (~ 42.5 MW), the total impacts are expected to approximate those originally presented for an overall 150 MW project.</p>		

2.4 Policy Criteria

Refer to the last column in **Table 10** for any changes to Policy Criteria.

Table 10. Policy Criteria

Policy Criteria	Suitable Policy or Practice of Applicant	Turbine adjustment impacts?
Recycling of the conversion byproducts and effluents	N/A The Project would not create byproducts or effluent.	No change
Energy conservation through location, process, and design	Thunder Spirit is developing the site to maximize energy output and will develop a site layout that optimizes wind resources while minimizing the impact on land resources and any potentially sensitive areas.	No change
Training and utilization of available labor in this state for the general and specialized skills required	Thunder Spirit will use local labor to the extent practicable.	No change
Use of a primary energy source or raw material located within the state	The energy generated at the site will utilize the wind resources of the State of North Dakota.	No change
Non-relocation of residents	No residents will be relocated as a result of the Project.	No change
The dedication of an area adjacent to the facility to land uses such as recreation, agriculture, or wildlife management	The Project will not interfere with adjacent land uses. As such, it is not anticipated that areas adjacent will be dedicated to recreation, agriculture, or wildlife management issues.	No change
Economies of construction and operation	Thunder Spirit will utilize local contractors to the extent practicable.	No change
Secondary uses of appropriate associated facilities for recreation and enhancement of wildlife	None.	No change
Use of citizen coordinating committees	Thunder Spirit will continue to work with landowners of properties for the Project.	No change
A commitment of a portion of the energy produced for use in this state	Energy produced will be injected into the MDU 230 kV line at the Hettinger Substation. MDU serves the majority of Western North Dakota with retail electric power service, and a portion of the energy produced will be used in North Dakota,	No change
Labor relations	No labor relations will be affected.	No change
The coordination of facilities	Existing facilities and facility corridors were considered in the location of the wind farm and associated facilities.	No change
Monitoring of impacts	Thunder Spirit and the EPC contractor will employ best management practices (BMPs) during construction to monitor soil impacts and to segregate topsoil. Storm water prevention plans will be prepared for all disturbance sites exceeding size thresholds. Environmental monitors will be onsite during construction to ensure there will be no impacts to wetlands and documented archeological sites that require avoidance as required by applicable agencies.	No change

3. ENVIRONMENTAL ANALYSIS - UPDATE

This section presents the results of supplemental or updated environmental analyses conducted for the Optimized Case. Please refer to Section 5 of the original Application submitted in June 2013 titled “Thunder Spirit Wind Energy Project, Application to the North Dakota Public Service Commission for a Certificate of Site Compatibility” for details on other environmental conditions which have not changed.

3.1 Air Traffic

The installation of wind turbines creates a potential for air traffic collision. However, the wind turbines and meteorological towers will have lighting and markings that comply with Federal Aviation Administration (FAA) requirements. In addition, the FAA’s review will include the evaluation of any potential interference with air traffic and requirements for lighting and marking of the turbines and meteorological towers.

In June 2013 Thunder Spirit submitted all locations included in the original June 2013 PSC Application to the FAA for airspace evaluation. In late July 2013 the FAA issued determinations for these locations – with approximately 2/3 of the locations receiving Presumed Hazard Determinations and the remainder receiving Determinations of No Hazard. This result was a surprise to Thunder Spirit, as previous airspace constraints studies conducted by a private aviation consultant did not anticipate any violations of existing airspace regulations. Upon further inquiry, it was learned that in making its determinations, the FAA had referenced an unpublished plan for future expansion by the Hettinger Airport and it was the potential constraints imposed by this expansion that resulted in the FAA’s issuance of Presumed Hazard Determinations. With the cooperation of the Hettinger Airport, Thunder Spirit appealed the FAA’s decision to evaluate its turbine locations based on these potential future constraints (primarily because the size aircraft protected by these constraints are not appropriate for either existing or future Hettinger Airport runways/facilities). In December 2013 the FAA formally concurred with this appeal and issued Determinations of No Hazard for all turbine locations. Given this decision, and its resulting liberation of a high-wind-resource portion of the Project area previously thought to be constrained by airspace constraints, Thunder Spirit now seeks to include locations from this area in its Optimized Layout (i.e., “optimized” to include higher wind resource locations, as well as already-permitted locations). Thunder Spirit submitted these locations to the FAA for determinations and lighting design approval in late May 2014.

As another component of Thunder Spirit’s airspace obstruction due diligence, Thunder Spirit contacted the US Air Force to verify that the Project would have no impacts to recently-proposed modifications to the USAF’s Powder River Training Complex, located approximately 160 miles south of Hettinger, ND. Lt Col Richard C. Miller, Air Force Representative to the FAA, referred Thunder Spirit to Terri Johnson, USAF OE/AAA Program Manager, and after reviewing the case Ms. Johnson verified that no impacts would occur. The USAF thus affirmed the FAA’s determinations of no hazard for wind turbines sited within the Thunder Spirit Project area.

3.2 Communications

Significant changes are not expected due to the modifications to the turbine locations. But since the studies were conducted in 2013, Thunder Spirit is currently updating the relevant communications studies. These results will be submitted once they are received.

3.3 Eagles

Thunder Spirit and WEST undertook a dedicated eagle nest survey in May 2013 using a helicopter within the Project area and a surrounding 10-mile buffer area. Detection levels can be higher using this type of aircraft compared to a fixed-wing. During this survey, a single golden eagle nest was found adjacent to the project area and a minimum 2 mile buffer has been instituted while ongoing behavioral observations are conducted to evaluate potential eagle use of the Project Area.

3.3.1 Impacts

Although WEST observed the 2013 golden eagle nest and representative portions of the Project area for 1 month in June 2013, it became clear after approximately 2 weeks that the nest had failed. A WEST biologist subsequently visited the nest and confirmed that it was empty. No evidence of nestlings was observed in the nest or on the ground below.

In early May 2014 WEST visited the nest and found that a pair of golden eagles was once again nesting in the same tree.

3.3.2 Mitigative Measures

Given this information, Thunder Spirit remains intent on minimizing risks to local eagles and has thus maintained its self-imposed 2 mile buffer from the nest and updated its Bird and Bat Conservation Strategy and Eagle Management Plan to include consideration of the ongoing nesting activity. This BBCS and EMP will be provided to the PSC upon its completion.

3.4 Shadow flicker

A revised shadow flicker analysis was conducted for the entire 43 turbines proposed as part of the Optimized Case. Table 11 presents the top ten worst case modeled shadow flicker impacts for the original and Optimized turbine layouts. The Siemens 2.3 MW turbine (as presented in the original application), is the closest in size to the Nordex turbine ultimately selected.

3.4.1 Impacts

Based on this analysis, none of the 35 receptors modeled had an expected shadow flicker impact of more than 30 hours/year.

Table 11. Comparison of Modeled Shadow Flicker Impacts for Original and Optimized Turbine Layout Design for the Top Ten Predicted Impact Receptors

Original Turbine Layout Design			Optimized Turbine Layout Design		
Receptor ID*	Receptor Description	Shadow Hours per Year (expected) [hh:mm / year]	Receptor ID*	Receptor Description	Shadow Hours per Year (expected) [hh:mm / year]
28	Participating Landowner	65:20	2	Non-participating Receptor	15:20
67	Abandoned/Participating	30:25	15	Participating Landowner	10:39
23	Non-participating Receptor	19:03	14	Non-participating Receptor	8:43
2	Non-participating Receptor	14:32	10	Participating Landowner	7:57
10	Participating Landowner	11:07	11	Participating Landowner	7:26
14	Non-participating Receptor	10:59	30	Participating Landowner	5:11
11	Participating Landowner	9:42	28	Participating Landowner	4:24
7	Non-participating Receptor	9:23	1	Participating Landowner	4:09
9	Non-participating Receptor	8:27	6	Participating Landowner	1:29
8	Participating Landowner	8:15	3	Non-participating Receptor	1:28

The analysis of potential shadow flicker impacts from the Project on nearby receptors shows that shadow flicker impacts within the area of study are expected to be minor and well within acceptable ranges for avoiding nuisance and/or health hazards. All receptor locations had modeled shadow flicker impact below the target of 30 hours per year under conservative conditions. The analysis assumes that the receptors all have a direct in-line view of the incoming shadow flicker sunlight and does not account for trees or other obstructions which may block sunlight. In reality, the windows of many houses will not face the sun directly for the key shadow flicker impact times. For these reasons, shadow flicker impacts are expected to be considerably less than estimated in this conservative analysis, and shadow flicker is not expected to be a significant environmental impact.

3.4.2 Mitigative Measures

Mitigation measures such as strategic vegetative screening and/or installation of curtains and blinds on the windows facing the turbine casting the shadows are effective and economically viable options that Thunder Spirit could consider on an individual basis with landowners, if necessary. The primary mitigation measure used for wind turbines is setback distance. Thunder Spirit is committed to a minimum 2,640-foot setback distance from all non-participating existing occupied residential structures. Because no significant impacts are anticipated, no additional mitigation is proposed at this time.

3.5 Noise

A revised acoustic analysis was conducted using the 43 Nordex turbines for the Optimized Case layout. This section provides the results of this evaluation and an assessment of Project compliance with the U.S. Environmental Protection Agency (EPA) noise guidelines used in the previous analysis as well as the current State of North Dakota noise regulations for wind energy projects. The primary mitigative measure used for wind turbines is setback distance. As stated in the Certificate, to meet

county zoning setbacks, Thunder Spirit is committed to a minimum 2,640-foot setback distance from all occupied residential structures. Refer to Figure 18 for the Adams County Setbacks.

3.5.1 Impacts

Table 12 presents the modeling results. The State of North Dakota standard of 50 dBA was not exceeded at any of the 35 receptors modeled. Sound levels under maximum rotation and maximum rotation during anomalous events may potentially exceed the EPA 48.6 dBA guideline at one receptor. However, this exceedance occurred at a receptor, which has been identified as an abandoned residence and a vacant farm, which is situated near a transmission line. Also, the EPA guidelines are not regulatory limits; however, and the EPA threshold exceedances are only provided for comparative purposes to the results in the September 10, 2013 memo. With respect to the North Dakota Adams County Zoning Ordinance, there are no exceedances of the noise limits.

Table 12. Noise Modeling Results

Sound Level (dBA)	Nordex N100/2500 IEC II		
	Number of NSRs Exceeding Sound Level Ranges		
	Cut-in	Maximum	Maximum - Anomalous
> 70 Adams County	0	0	0
> 50 North Dakota	0	0	0
> 48.6 EPA	0	0	1
>= 50	0	0	0
45 to 50	0	2	3
40 to 45	0	12	12
35 to 40	1	5	4
< 35	34	16	16

Also, as mentioned earlier in this Amendment, the substation was shifted approximately 450 feet to the west. This shift resulted in a decrease in the received sound level for the closest non-participating landowner who voiced concern during the September 2013 hearing.

3.5.2 Mitigative Measures

The acoustic modeling analysis demonstrates the Project has been adequately designed to generate sound levels below the North Dakota noise standard at all occupied receptors. If a complaint is registered and sound is measured above the 50 dBA level on more than a rare occasion, Thunder Spirit will work with the landowner to determine the best action to proceed. It should be noted that the acoustic model conservatively predicts outdoor sound levels and assumes no shielding or attenuation by trees or other vegetation.

3.6 Cultural and Archaeological Impacts

3.6.1 Description of Resources

Tetra Tech provided the necessary information for the State Historical Society of North Dakota (SHSND) review by performing a Class III Cultural Resources Inventory. The Class III Cultural Resources Inventory included a pedestrian survey of the Area of Potential Effects (APE) developed from layouts created in 2014.

Previous Investigations at the Thunder Spirit Wind Energy Center

From May 4 to 14, 2013, Tetra Tech performed a Class III pedestrian survey of the Project layout dated April 26, 2013. During the pedestrian survey of the APE, Tetra Tech documented 23 new archaeological sites. Of these sites, Tetra Tech recommended avoidance for 18 of these sites:

- seven Native American stone feature sites;
- four lithic scatters;
- three quarry/lithic workshop sites;
- one Euro-American artifact scatter and foundation;
- one artifact scatter;
- one former clay pit; and
- one stone pile of indeterminate cultural affiliation.

Tetra Tech also recommended the creation of avoidance buffers for Native American stone cairns (100 feet), Native American tipi rings and alignment (50 feet), the quarry/lithic workshop sites and lithic scatters (50 feet), the site with indeterminate cultural affiliation (50 feet), and the Euro-American artifact scatters and former clay pit (16 feet). If these sites and their associated avoidance buffers can be avoided during construction, then Tetra Tech recommended a determination of No Historic Properties Affected. The remaining sites, including the Euro-American stone pile site and the Native American isolated finds, are not considered eligible for inclusion in the National Register; therefore, avoidance is not recommended.

If avoidance was not possible for the Native American lithic scatter sites or the Euro-American artifacts scatters, then subsurface testing was recommended to determine if intact archaeological materials were present below the surface. If avoidance is not possible for Native American quarry/lithic workshop sites or the former Euro-American clay pit site, then consultation with the SHPO is recommended to determine an appropriate scope of work for evaluating these sites.

Tetra Tech submitted the Class III Cultural Resource Inventory for the Thunder Spirit Wind Energy Center on August 8, 2013, and received a provisional “*No Significant Sites Affected*” from the SHPO on August 14, 2013, on the condition that the proposed project is of the nature stated, it takes place in the location described, and avoids impacted as stipulated on pages i-ii of the report, as reported and discussed in Section 7 and summarized in Table 8 of the report, and as buffered and mapped in the project documentation.

2014 Class III Pedestrian Survey – Optimized Case Layout

Tetra Tech conducted a Class III Pedestrian Survey of the Optimized Case Layout APE based on the May 5, 2014 Project layout. The Optimized Case Layout included areas surveyed in May 2013 and new areas not included in the May 2013 survey. The Optimized Case Layout included surveying the locations for:

- the 43 locations for wind turbine generators;
- the approximately 16.9 miles of access roads;
- the approximately 24.9 miles of the electrical collection system;
- the approximately 0.64 miles of the overhead transmission line;
- the 20-acre substation; and
- the 10-acre temporary laydown area.

To provide some additional laydown areas and allow for some flexibility in construction, Tetra Tech surveyed a 250-ft radius for each of the proposed turbine locations; a 250-ft corridor for service roads, a 100-ft corridor for collection line routes, and a 250-ft corridor for the overhead transmission line.

The Class III pedestrian survey was conducted from May 7 to 13, 2014. During the pedestrian survey of the Optimized Case Layout APE, Tetra Tech documented 30 archaeological sites including the following:

- 10 prehistoric stone feature sites;
- Two lithic scatters;
- Two site leads;
- One historic foundation;
- One foundation with depressions;
- One dump;
- Five pile sites of indeterminate cultural affiliation; and
- Eight Euro-American stone pile sites.

In addition to documenting new archaeological sites, the boundaries of four previously documented sites were expanded into the Optimized Case Layout APE during the May 2014 survey.

3.6.2 Impacts

Based on the Optimized Case Layout, there are 14 previously documented sites and 11 avoidance buffers, and 30 newly documented cultural resources within the Optimized Case Layout APE. A total of 10 sites documented during the May 2013 where avoidance was recommended are located within the Optimized Case Layout APE. Additionally, 11 avoidance buffers created in 2013 are located with Optimized Case Layout APE. The SHPO's concurrence letter was provisional on the

avoidance of these sites and avoidance buffers and the Optimized Case Layout have been redesigned to comply with the SHPO's conditions.

At this time, the newly documented Native American stone feature sites and lithic scatters and stone piles of indeterminate cultural affiliation have not been evaluated for their eligibility for inclusion to the National Register of Historic Places (NRHP); however, these sites may contain intact archaeological features and may also hold traditional religious and cultural importance to regional Native American tribes and therefore may meet the criteria for inclusion in the NRHP (36 CFR 800.16[I][1]). Tetra Tech recommends that these sites be avoided during construction.

The newly identified Euro-American foundation sites and stone pile/dump has not been evaluated for their potential eligibility for inclusion to the NRHP; however, these sites may contain intact archaeological features. Tetra Tech recommends that these sites be avoided during construction.

The two site leads consisted of non-diagnostic artifacts located in upland settings (i.e., non-depositional settings) with very little soil accumulation. It is Tetra Tech's opinion that these site leads are not eligible for inclusion to the NRHP.

At this time, Tetra Tech recommends avoidance of the Euro-American rock piles.

3.6.3 Mitigative Measures

It is recommended that previously documented and newly documented archaeological sites and associated avoidance buffers be avoided during construction and snow fencing be placed around the avoidance buffer to reduce the potential that they will be inadvertently disturbed.

If areas beyond the currently surveyed APE for direct effects are to be utilized during construction, then Tetra Tech recommends that a supplemental Class III cultural resource survey be conducted to determine the presence of cultural resources within these areas. Tetra Tech has prepared an unanticipated discoveries plan to accommodate any archaeological materials that may be exposed during project construction.

If archaeological resources should be encountered during Project construction and/or operation, work in the area should stop and the discoveries should be reported to the Tetra Tech Project Manager and Archaeologist. Tetra Tech will work with the SHPO and the client to document the resource and mitigate impacts in a timely manner. If human remains are inadvertently disturbed or exposed during construction, all work within the vicinity of the discovery should be halted and the local law enforcement agency shall be notified immediately. The local law enforcement agency shall, as soon as practicable, report the receipt of such notification to SHPO and the North Dakota State Department of Health and Consolidated Laboratories (NDS DHCL).

The Native American Graves Protection and Repatriation Act of 1990 allow tribes to protect American Indian graves and to repatriate human remains. The proponent must comply with this act if a burial site is encountered during construction, as the aforementioned act applies to all developments regardless of the funding source. Any burial site identified, including tribal or pioneer, must be referred to the North Dakota Intertribal Reinterment Committee and the SHSND.

3.6.4 Effect of Project on Cultural Resources

Tetra Tech conducted a Class III Pedestrian Survey for archeological resources. Based on the Optimized Case Layout dated May 5, 2014, 14 previously documented sites and 11 avoidance buffers, and 30 newly documented cultural resources within the Optimized Case Layout APE. The cultural resources inventory report will be submitted to the SHPO for comment once it is complete.

Thunder Spirit is committed to minimize impacts to these resources and will avoid these resources and any additional resources identified throughout the life of the Project. If avoidance is not possible, Thunder Spirit will work with the North Dakota SHPO to mitigate potential impacts.

3.7 Historic Architectural Impacts

In Spring 2013, a Class II Historic Architecture Survey was conducted. The results were summarized in a report dated August 2013. Results and recommendations were submitted to SHPO for review and acceptance. On August 20, 2013, a response was received which stated that the SHPO concurs with “*No Significant Sites Affected*” or “*No Historic Properties Affected*” provided that the project is of the nature stated and it takes place in the location plotted and described in the project documentation, and avoidance procedures are maintained (See attached letter).

The architectural historian submitted a summary of the changes to the SHPO who determined that the revisions to the layout did not add or subtract properties from the Area of Potential Effect (APE), therefore, the concurrence is still valid.

3.8 Wetlands, Surface Water and Floodplain Resources

A supplemental delineation was conducted of wetlands and other Waters of the United States (WoUS); field work took place in early May, 2014. All wetlands and potentially jurisdictional streams which would be impacted by the Optimized Layout were delineated. Results of this delineation are presented in Table 13. Refer to Figure 16 and the Supplemental Delineation Memo Figure for wetlands.

Table 13. Results of Supplemental Wetland Delineations

Feature ID	Feature Description	Impact Assessment	Preliminary Jurisdictional Determination	Potential Impact from Project Component*	
				Permanent	Temporary
TS-WET-7	Palustrine, emergent, temporarily flooded	This is a fringe wetland that lines a potentially perennial stream that ultimately flows to Duck Creek. This wetland would be crossed by an electrical collection line in the optimized Project layout. No impacts would occur if horizontal directional drilling was utilized to place the collection line under the wetland.	Jurisdictional	0	0
Total potential Project impacts				0	0
Notes:					
a/ Jurisdictional status of features was based on nexus determination completed during the field evaluation, but would require final decision of significant nexus from USACE.					
b/ Impacts were based on the layout from May, 2014 and the impact assumptions in Table 13, above.					
c/ Impact calculations are rounded to two significant digits.					
d/ Impacts were not calculated for drainage swales, which are not considered to be jurisdictional Waters of the US.					

3.8.1 Impacts

Only one wetland or other WoUS was identified that appears likely to be crossed and potentially impacted by Project components associated with the Optimized Layout. This wetland does appear to maintain surface inundation for more than just the spring season, and may in fact be perennial. It was vegetated with prairie cordgrass and cattail, as well as various species of rushes and sedges. Impacts to this wetland could be avoided completely by using horizontal directional drilling to place the collection line under the wetland. The bore would be relatively short and would allow for the avoidance of any adverse impacts to this wetland ecosystem.

3.8.2 Mitigative Measures

Thunder Spirit has committed to avoiding all permanent impacts to wetlands and other WoUS. If temporary impacts cannot be avoided, proper permits will be obtained and notifications made as required.

3.9 Summary of Impacts

Table 14 summarizes the resource impacts due to the revisions to the Project layout.

Table 14. Summary of Impacts and Mitigation

Resource	Impact	Mitigation
Demographics	Primarily positive due to increased expenditures during construction and the long term benefits of lease payments and an increased tax base of the county due to property taxes. <i>No change from original application.</i>	N/A
Land Use	Approximately 105 acres of land will be affected by turbines, associated access roads, and O&M facility, and the substation during operation. Temporary impacts during construction for turbine installation, road construction, cable trenching, and laydown and contractor staging are estimated at 367 acres.	Thunder Spirit will work with landowners to minimize impacts of the Project to agricultural resources. The substation was shifted approximately 450 feet to the west in an effort to mitigate potential impacts as well as alleviate the concern posed by the closest non-participating landowner at the hearing in September 2013.
Public Services	No impacts are anticipated. <i>No change from original application.</i>	Thunder Spirit will utilize station service from the local electrical utility and will abide by the utility's recommendations to prevent impacts to the transmission system.
Human Health and Safety	No impacts are anticipated. <i>No change from original application.</i>	Turbines will be lighted to comply with FAA requirements. A variety of security measures will be implemented to reduce the chance of physical and property damage.
Noise	No impacts are anticipated to noise-sensitive resources (occupied residences).	No mitigative measures are anticipated to be needed, as Thunder Spirit will comply with the North Dakota 50 dBA standard at all occupied residences. Also, the substation was shifted approximately 450 feet to the west which resulted in a decrease in the received sound level for the closest non-participating landowner who voiced concern during the September 2013 hearing.
Shadow Flicker	Shadow flicker impacts within the area of study are expected to be minor and well within acceptable ranges for avoiding nuisance and/or health hazards	No mitigative measures are anticipated to be needed, as Thunder Spirit will place all turbines sufficiently far from occupied residences to reduce shadow flicker impacts to insignificant levels.
Visual	Visual impacts will occur. The impacts are based on a subjective human response, and there are existing wind energy facilities in the Project vicinity. <i>No change from original application.</i>	Thunder Spirit will work with landowners to site turbines. They will not be located in environmentally sensitive areas. Existing infrastructure will be used where possible. Cut and fill areas will be minimized and mitigated as appropriate.

Resource	Impact	Mitigation
Cultural, Archaeological, and Historic Architecture	No impacts to previously identified cultural resources are anticipated.	Thunder Spirit has conducted a supplemental Class III inventory for the proposed Project. Turbines and other Project facilities will be microsituated to avoid impacts to newly documented archaeological sites that are potentially eligible to the NHRP. The sites that were identified during Project surveys will be evaluated for significance in consultation with SHPO and avoided as necessary.
Recreational Resources	No impacts are anticipated. <i>No change from original application.</i>	Since no significant recreational resources will be removed from service due to the Project, no mitigative measures are proposed.
Land Based Economies	The agricultural economy would have up to 38 acres of land permanently affected. In addition, approximately 116 acres would be impacted temporarily due to construction activities.	These impacts represent a minor portion of the land area within the Project Area that is available for agricultural production. Lease payments to landowners will provide a supplemental source of income which will mitigate for these impacts. As a result, no adverse effects are expected. Thunder Spirit will work with landowners to minimize impact to their agricultural lands.
Soils	Approximately 105 acres of land will be permanently affected. Temporary impacts include 367 acres for turbine installation, road construction, cable trenching, O&M facility construction, and laydown and contractor staging. Also, Thunder Spirit will work with the landowners to alleviate the compaction of any soils which occurs during construction.	BMPs for erosion and sediment control will be utilized to minimize wind and water erosion at the site. Only land needed for the facility will be permanently affected. Temporarily disturbed areas will be restored.
Geologic and Groundwater Resources	No impacts to geologic or groundwater resources are anticipated. <i>No change from original application.</i>	Geotechnical surveys will be conducted to evaluate the subsurface conditions at the location of each turbine and other significant Project structures
Surface Water and Floodplain Resources	Access roads and turbines will be located and constructed in such a manner that impacts to surface waters will be avoided to the greatest extent practicable. <i>No change from original application.</i>	Thunder Spirit will implement BMPs to minimize erosion and sedimentation at the site.
Wetlands	As currently designed, no permanent impacts are anticipated. Temporary impacts will be avoided to the greatest extent practicable.	Horizontal directional drilling will be used where necessary to avoid impacts to wetlands from collection line trenching during construction.
Vegetation	Approximately 105 acres of land will be permanently affected; an additional 367 acres will be temporarily disturbed during construction.	Thunder Spirit will avoid existing trees and shrubs as practicable and will use BMPs during construction and operation to minimize impacts. If trees are removed as part of the Project, they will be replaced per PSC's Tree and Shrub Mitigation Specifications. Temporarily disturbed areas will be reseeded per USFWS and NRCS recommendations. Native prairie will be avoided to the extent practicable and will be reseeded using native prairie mix.

Resource	Impact	Mitigation
Wildlife	<p>Potential avian and bat collisions may occur, but are anticipated to be relatively few.</p> <p>Two active raptor nests were identified within the Project area.</p> <p>Also, five sharp-tailed grouse leks were observed during lek surveys.</p>	<p>In addition to developing the BBCS, a variety of mitigative measures will be implemented, as discussed in Section 5.15.3 of the original Application. In addition to the BMPs described throughout this Application, Thunder Spirit will conduct one-year of post-construction mortality monitoring as described in Section 5.15.3 of the original Application.</p>
Rare and Unique Natural Resources	<p>The 2013 golden eagle nest and representative portions of the Project area were observed for 1 month in June 2013. After approximately 2 weeks, it was concluded that the nest had failed. A biologist subsequently visited the nest and confirmed that it was empty. No evidence of nestlings was observed in the nest or on the ground below.</p> <p>In early May 2014 the nest was visited again. A pair of golden eagles were once again nesting in the same tree.</p>	<p>Given this information, Thunder Spirit remains intent on minimizing risks to local eagles and has thus maintained its self-imposed 2 mile buffer from the nest and updated its Bird and Bat Conservation Strategy (BBCS) and Eagle Management Plan (EMP) to include consideration of the ongoing nesting activity. This BBCS and EMP will be provided to the PSC upon its completion.</p> <p>Additional mitigative measures will be implemented, as discussed in Section 5.15.3 of the original Application.</p>

4. POTENTIAL PERMITS AND APPROVALS

Table 15 presents an update to the potential permits and approvals required for construction and operation of the proposed facility.

Table 15. Potential Permits and Approvals

Agency	Type of Approval	Status*	Need and Further Details
Federal Approvals			
U.S. Army Corps of Engineers	Nationwide Permit	3	A supplemental wetland delineation was completed in May 2014. Thunder Spirit has committed to no permanent impacts. If temporary impacts cannot be avoided, proper permits will be obtained and notifications will be made, as required.
Federal Aviation Administration	Determination of No Hazard to Air Navigation - Notice and approval are required for structures over 200 feet in height. FAA approval of lighting and marking of turbines is required.	1	Awaiting final FAA evaluation.
State of North Dakota			
Public Service Commission	Certificate of Site Compatibility	1	Order received in October 2013. This Amendment has been submitted to discuss some variations.
North Dakota State Historic Preservation Office	Concurrence on results of Cultural Resources Inventory	1	Class I, Class II, and Class III surveys were completed May 2013 and updated in May 2014; SHPO concurrence received for original filing. May 2014 report will be submitted when complete. See attached concurrence letters.
North Dakota Department of Health	NPDES Permit: General Construction Storm Water	2	Will be prepared by Thunder Spirit or their contractor.
North Dakota Highway Patrol	Overheight/ Overweight Permit	2	Will be prepared by Thunder Spirit or their contractor.
North Dakota Department of Transportation	Road Approach/Access Permit	3	Will be prepared by Thunder Spirit or their contractor if necessary.
	Utility Permit/Risk Management Documents	3	Will be prepared by Thunder Spirit or their contractor if necessary.
Local Permits			
Adams County	Wind Energy Facility Siting Permit	1	Permit granted on September 9, 2013. Will be revised to correspond to this Application.
	Building Permits	1	Permit granted. Adams County has determined that a single building permit will be issued for the entire proposed facility.
* Status Explanation: 1 Applied and/or Decision Pending 2 Will Apply Once Certificate is Received 3 Final Layout will Determine Whether Permit/Approval is Needed			








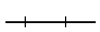
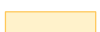


FIGURES

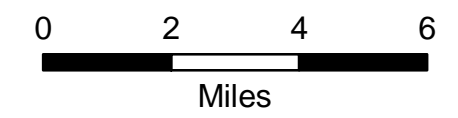
Figure 1

Project Location

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

June 2014

-  Project Area
-  WEFP
-  Primary Limited Access or Interstate
-  Primary US and State Highway
-  Secondary State and County
-  Local -Rural
-  Railroad
-  Populated Place
-  County Boundary
-  Township Boundary
-  Waterbody



REFERENCE MAP

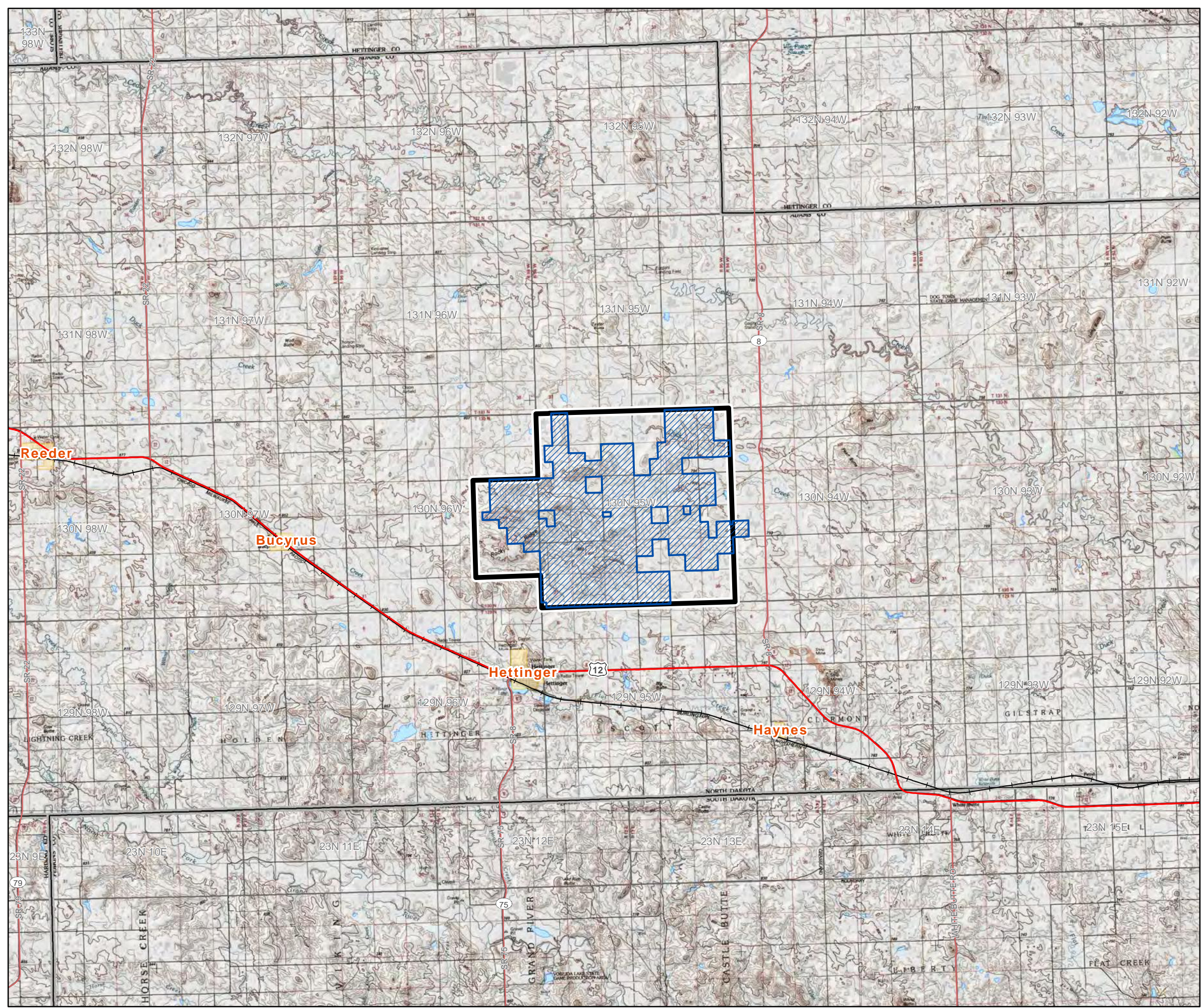
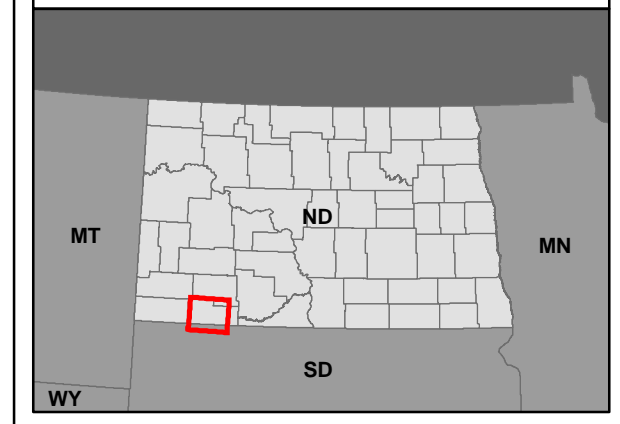
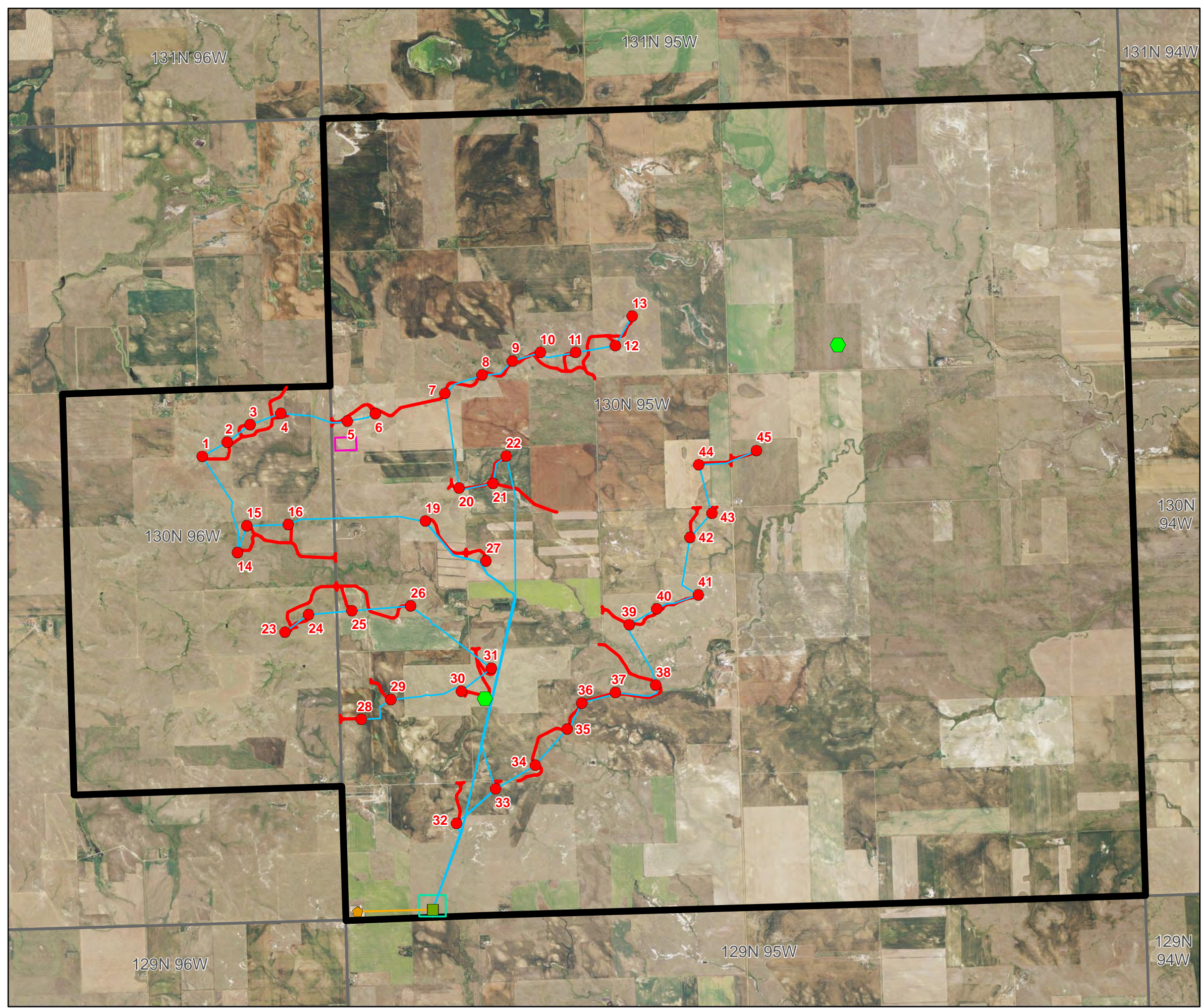


Figure 2
 Project Area
 (Aerial)
 Optimized Layout
 Thunder Spirit Wind Energy Project
 Thunder Spirit Wind, LLC
 Adams County, North Dakota
 June 2014



- Met Tower Location
- Approximate POI
- Optimized Turbine Location (5/27/2014)
- Proposed Collector Substation (5/27/2014)
- Overhead Line (5/27/2014)
- Collection Line (5/27/2014)
- Access Road (5/27/2014)
- Construction Laydown Area (10 Acres)
- Collection Substation, O&M Facility, and Additional Laydown Area
- Project Area (4/26)
- Township Boundary

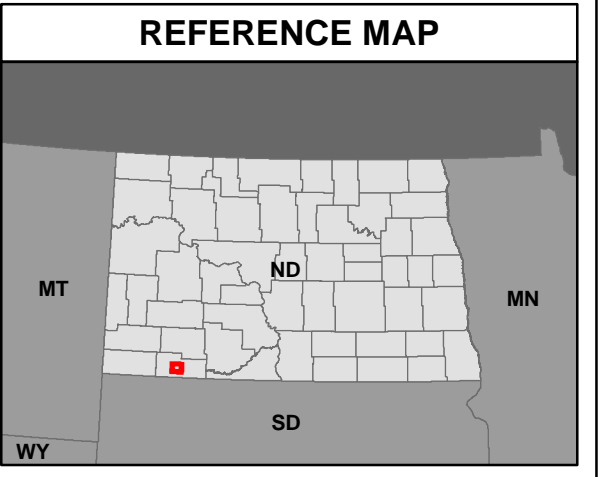
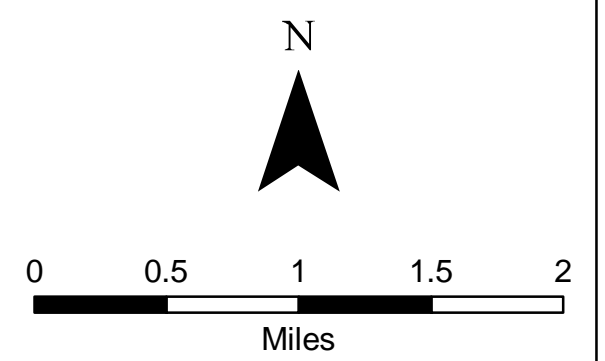
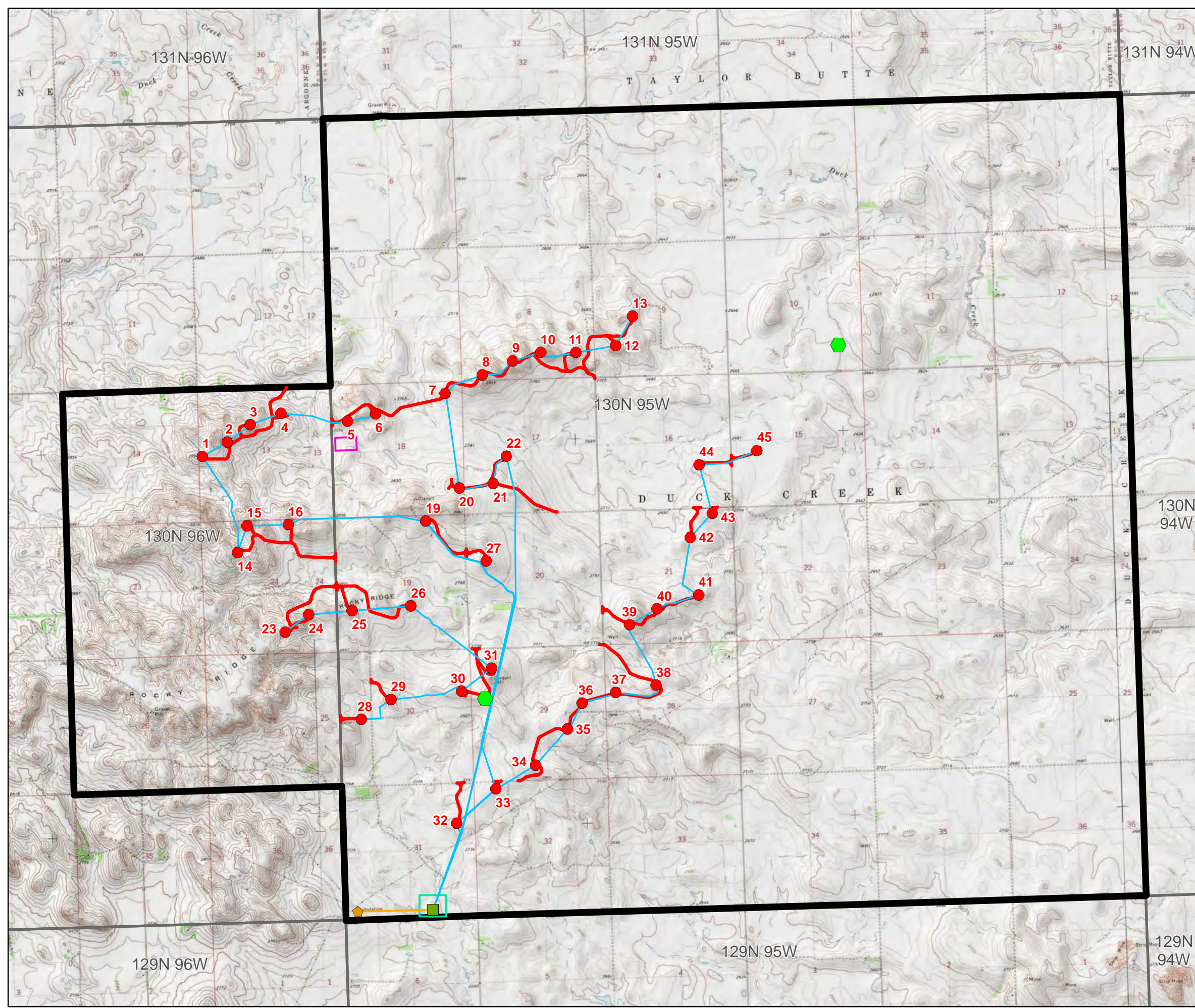
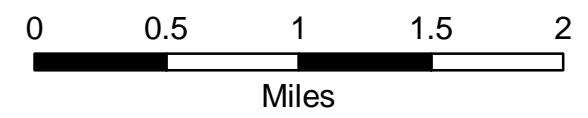


Figure 3
 Project Area
 (Topo)
 Optimized Layout
 Thunder Spirit Wind Energy Project
 Thunder Spirit Wind, LLC
 Adams County, North Dakota
 June 2014



- ◆ Met Tower Location
- ◆ Approximate POI
- Optimized Turbine Location (5/27/2014)
- Proposed Collector Substation (5/27/2014)
- Overhead Line (5/27/2014)
- Collection Line (5/27/2014)
- Access Road (5/27/2014)
- Construction Laydown Area (10 Acres)
- Collection Substation, O&M Facility, and Additional Laydown Area
- Project Area (4/26)
- Township Boundary



REFERENCE MAP

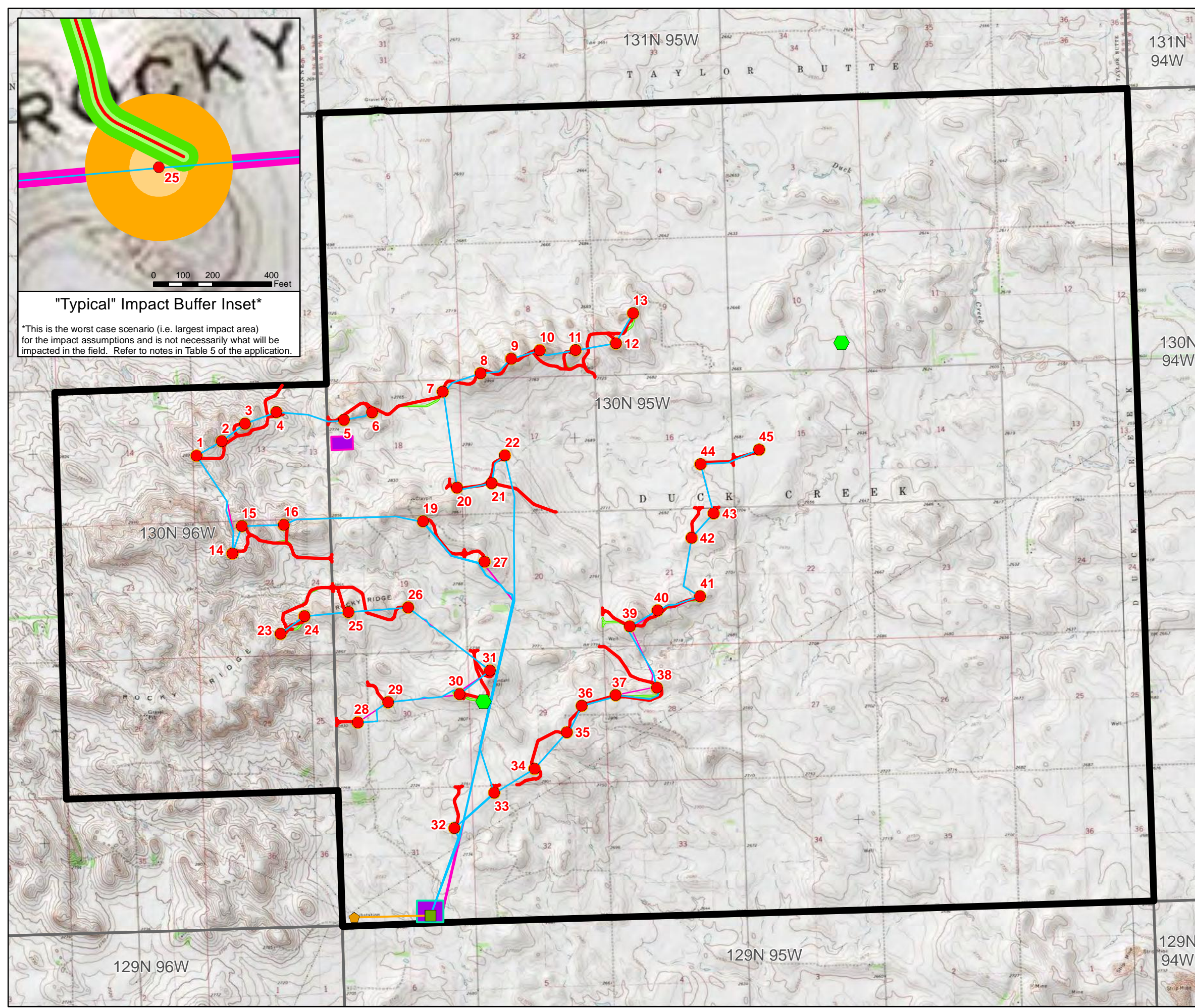


Figure 4

Project
Impact Assumptions

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

June 2014



"Typical" Impact Buffer Inset*
*This is the worst case scenario (i.e. largest impact area) for the impact assumptions and is not necessarily what will be impacted in the field. Refer to notes in Table 5 of the application.

- Met Tower Location
- Approximate POI
- Optimized Turbine Location (5/27/2014)
- Proposed Collector Substation (5/27/2014)
- Overhead Line (5/27/2014)
- Collection Line (5/27/2014)
- Access Road (5/27/2014)
- Construction Laydown Area (10 Acres)
- Collection Substation, O&M Facility, and Additional Laydown Area
- Permanent Access Road Impact Buffer
- Temporary Access Road Impact Buffer
- Permanent Turbine Impact Buffer
- Temporary Turbine Impact Buffer
- Temporary Collection Line Impact Buffer
- Project Area (4/26)
- Township Boundary

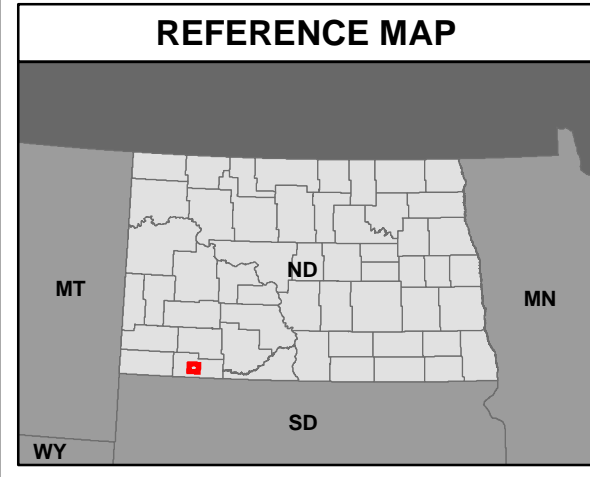
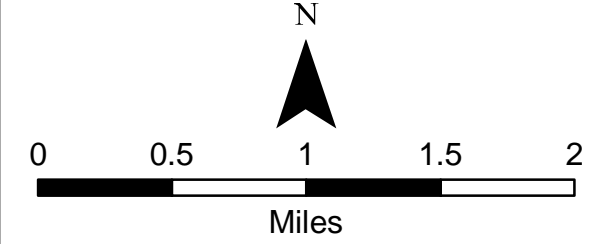
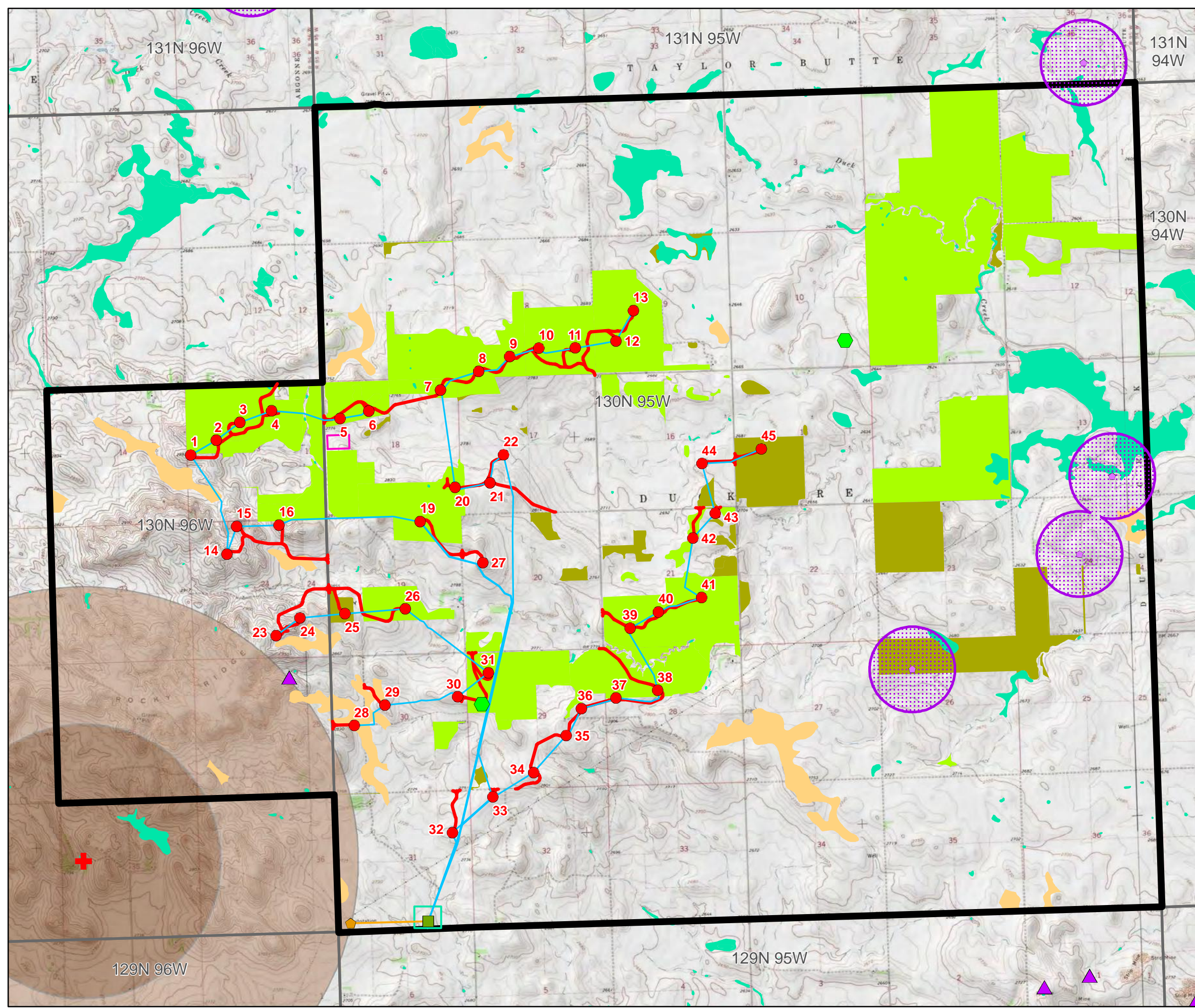


Figure 5

Exclusion and Avoidance Areas

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

June 2014



- Lek Location
- Abandoned Mine
- Buffer of Lek (0.5 mi)
- Approximate Eagle Nest (2013-2014)
- 0-1 mi
- 1-2 mi
- Met Tower Location
- Approximate POI
- Optimized Turbine Location (5/27/2014)
- Proposed Collector Substation (5/27/2014)
- Overhead Line (5/27/2014)
- Collection Line (5/27/2014)
- Access Road (5/27/2014)
- Construction Laydown Area (10 Acres)
- Collection Substation, O&M Facility, and Additional Laydown Area
- Project Area (4/26)
- Township Boundary
- NWI Wetland
- Native Prairie
- Native Prairie/Hayfields
- Prime Farmland

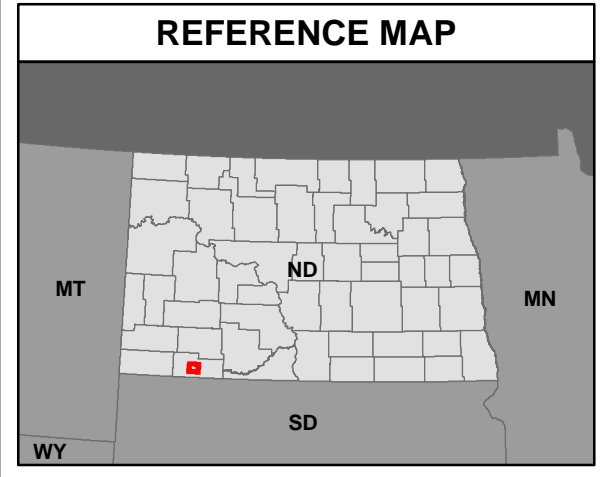
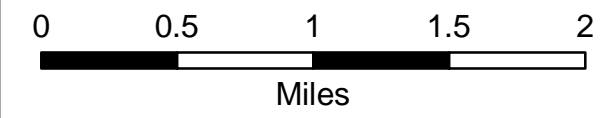














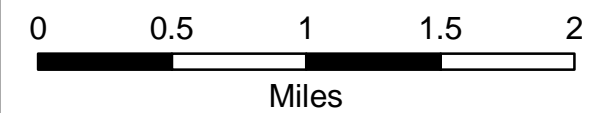
Figure 10

Public Lands and Easements

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

June 2014

-  Met Tower Location
-  Approximate POI
-  Optimized Turbine Location (5/27/2014)
-  Proposed Collector Substation (5/27/2014)
-  Overhead Line (5/27/2014)
-  Collection Line (5/27/2014)
-  Access Road (5/27/2014)
-  Construction Laydown Area (10 Acres)
-  Collection Substation, O&M Facility, and Additional Laydown Area
-  ND PLOTS Data*
-  Project Area (4/26)
-  Township Boundary



REFERENCE MAP

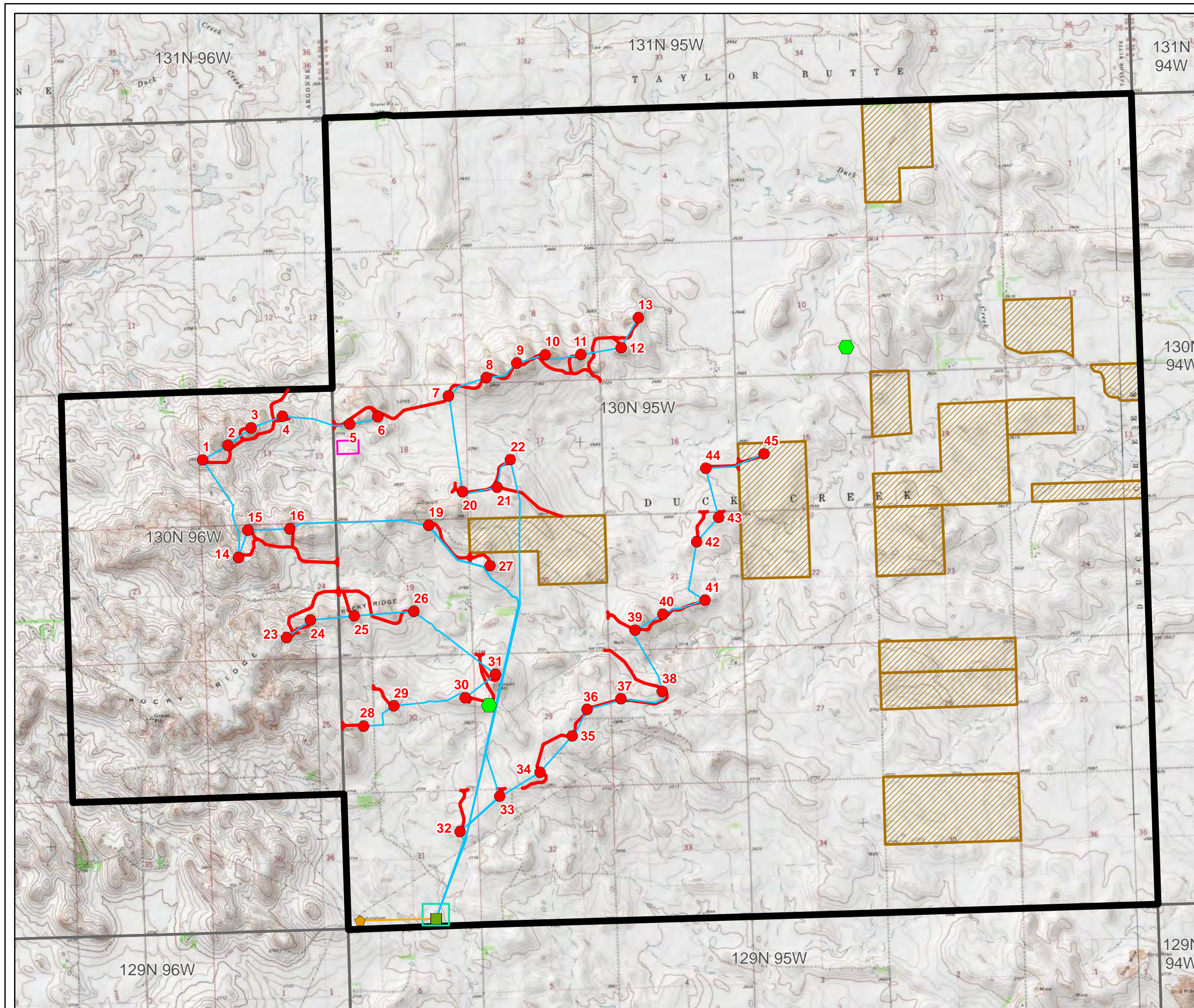













Figure 13











Land Cover Map

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

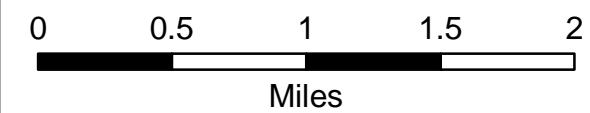
June 2014

-  Met Tower Location
-  Approximate POI
-  Optimized Turbine Location (5/27/2014)
-  Proposed Collector Substation (5/27/2014)
-  Overhead Line (5/27/2014)
-  Collection Line (5/27/2014)
-  Access Road (5/27/2014)
-  Construction Laydown Area (10 Acres)
-  Collection Substation, O&M Facility, and Additional Laydown Area
-  Project Area (4/26)
-  Township Boundary

NLCD 2006 Land Cover Type

- | | |
|--|--|
|  Barren Land |  Pasture/Hay |
|  Developed, Low Intensity |  Shrub/Scrub |
|  Developed, Open Space |  Deciduous Forest |
|  Cultivated Crops |  Woody Wetlands |
|  Grassland/Herbaceous |  Open Water |

N



REFERENCE MAP
















Figure 14

Prime Farmland
Soil Distribution Map

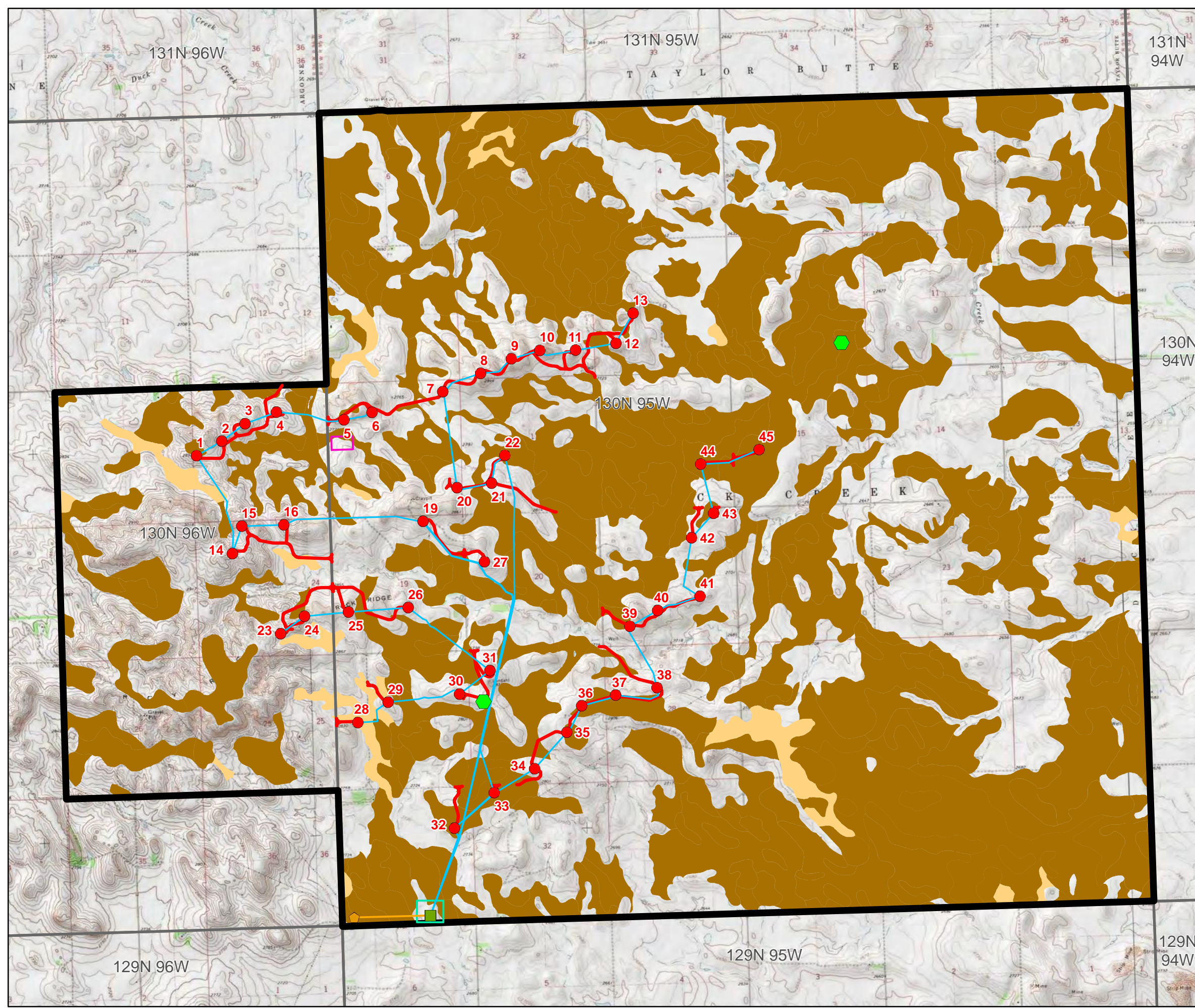
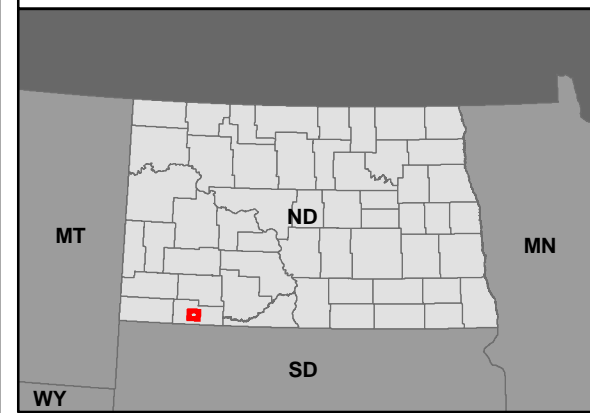
Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

June 2014

-  Met Tower Location
-  Approximate POI
-  Optimized Turbine Location (5/27/2014)
-  Proposed Collector Substation (5/27/2014)
-  Overhead Line (5/27/2014)
-  Collection Line (5/27/2014)
-  Access Road (5/27/2014)
-  Construction Laydown Area (10 Acres)
-  Collection Substation, O&M Facility, and Additional Laydown Area
-  Project Area (4/26)
-  Township Boundary
-  Prime farmland
-  Farmland of statewide importance



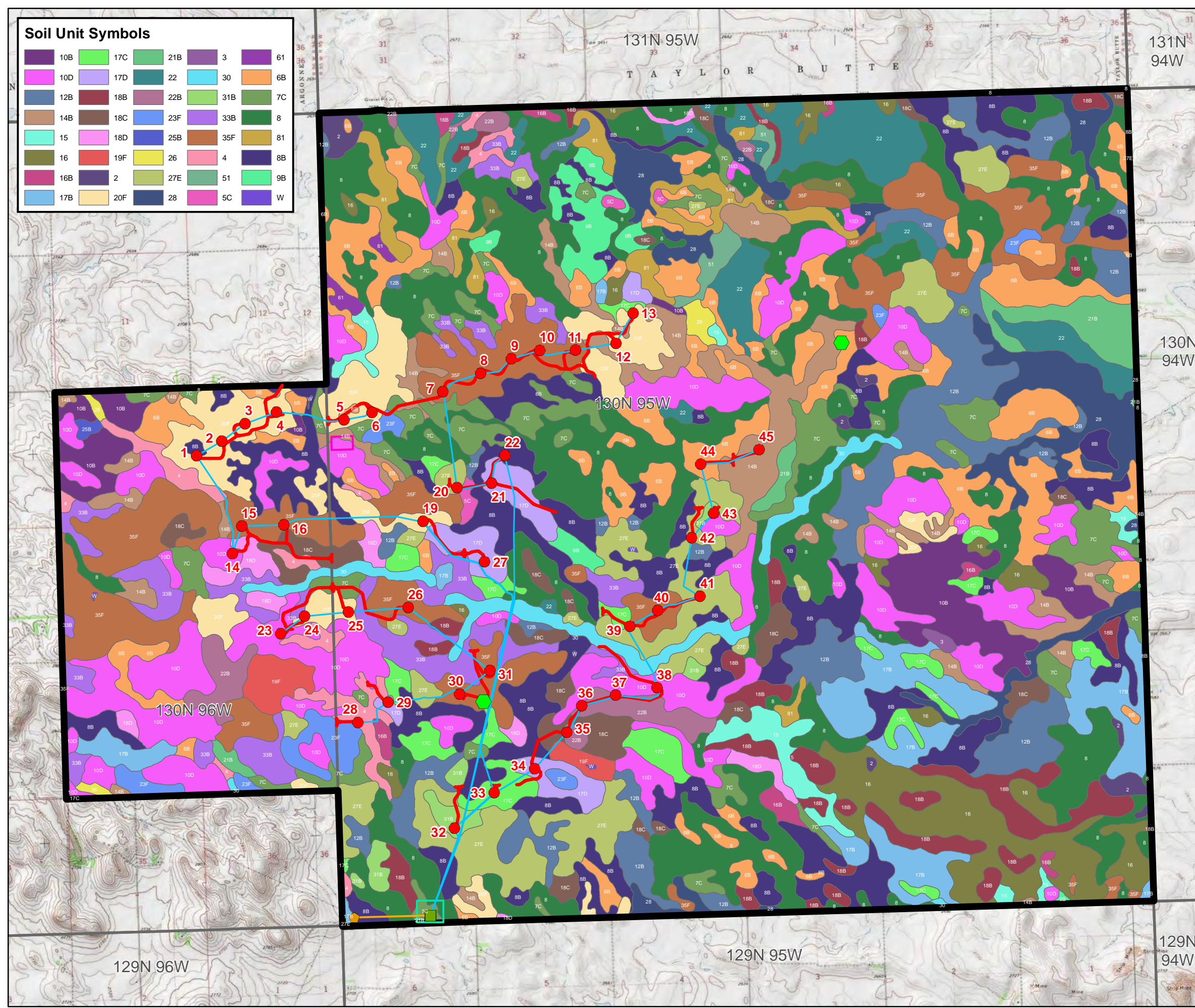
REFERENCE MAP



Soil Unit Symbols

10B	17C	21B	3	61
10D	17D	22	30	6B
12B	18B	22B	31B	7C
14B	18C	23F	33B	8
15	18D	25B	35F	81
16	19F	26	4	8B
16B	2	27E	51	9B
17B	20F	28	5C	W

Figure 15
 State Soils Association Map
 Thunder Spirit Wind Energy Project
 Thunder Spirit Wind, LLC
 Adams County, North Dakota
 June 2014



- Met Tower Location
- Approximate POI
- Optimized Turbine Location (5/27/2014)
- Proposed Collector Substation (5/27/2014)
- Overhead Line (5/27/2014)
- Collection Line (5/27/2014)
- Access Road (5/27/2014)
- Construction Laydown Area (10 Acres)
- Collection Substation, O&M Facility, and Additional Laydown Area
- Project Area (4/26)
- Township Boundary

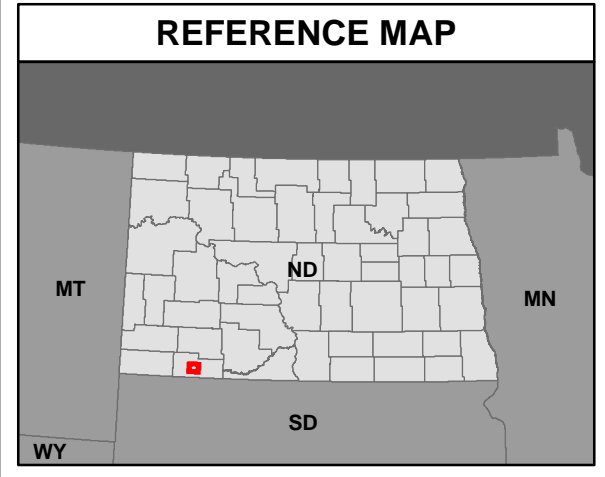
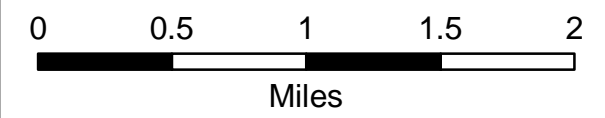


Figure 16

National Wetlands Inventory and
Surface Waters Map

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

June 2014

-  Met Tower Location
-  Approximate POI
-  Optimized Turbine Location (5/27/2014)
-  Proposed Collector Substation (5/27/2014)
-  Overhead Line (5/27/2014)
-  Collection Line (5/27/2014)
-  Access Road (5/27/2014)
-  Construction Laydown Area (10 Acres)
-  Collection Substation, O&M Facility, and Additional Laydown Area
-  River/Stream
-  Open Water
-  NWI Wetland
-  Project Area (4/26)
-  Township Boundary

N



Miles

REFERENCE MAP

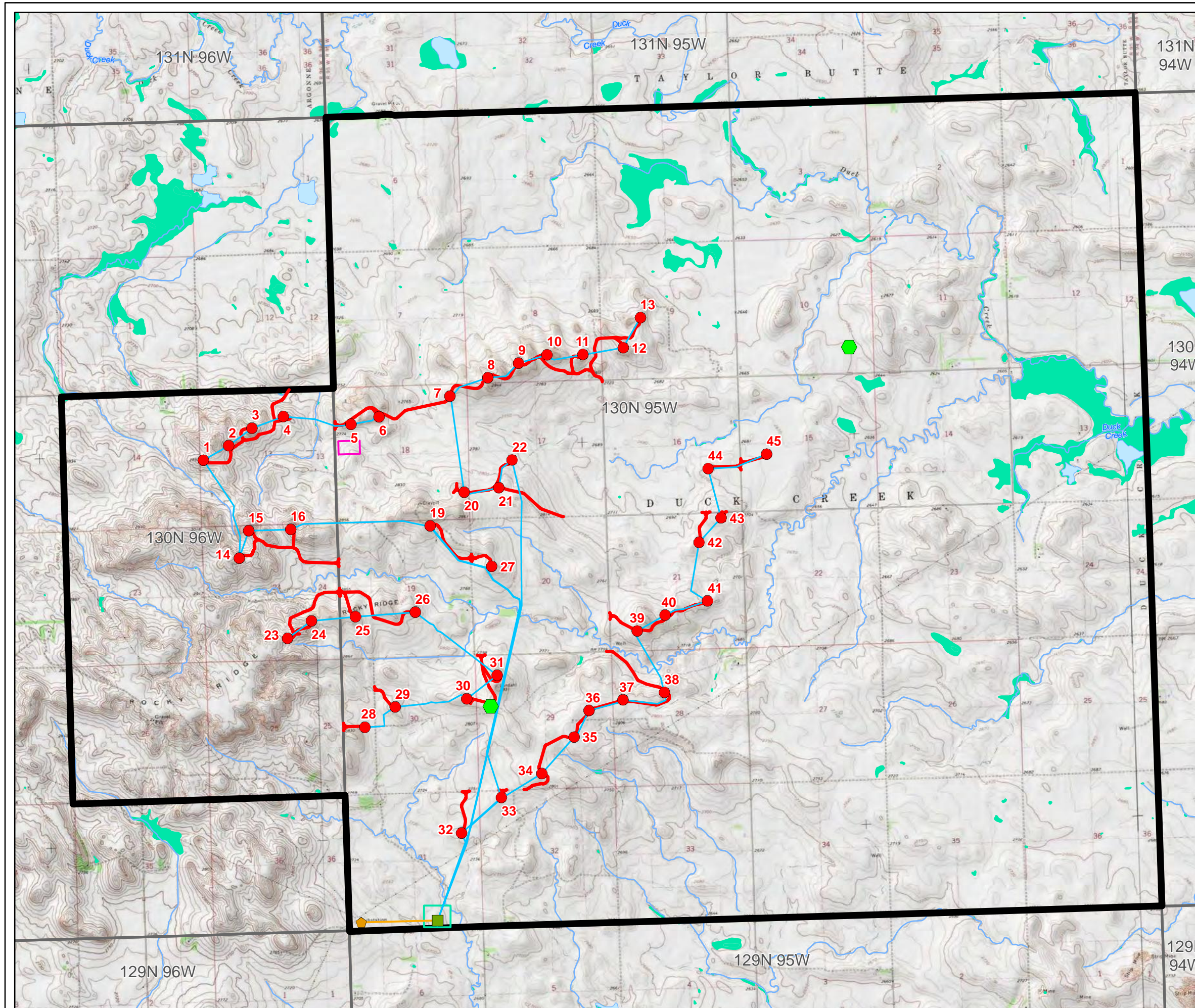
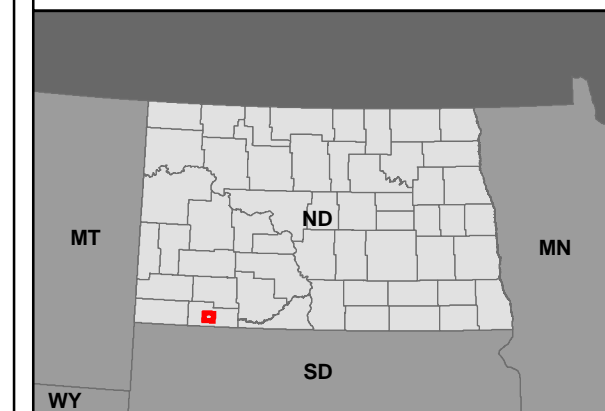











Figure 17

Residential Receptor Distances to Closest Wind Turbine

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

June 2014

-  Optimized Turbine Location (5/27/2014)
-  Signed Easement (Occupied)
-  Signed Easement (Unoccupied)
-  Not Signed (Occupied)
-  Not Signed (Unoccupied)
-  Distance Dimension (Residence to nearest turbine)
-  Collector Substation Construction Footprint (20 Acres)
-  Project Area (4/26)
-  Township Boundary



REFERENCE MAP

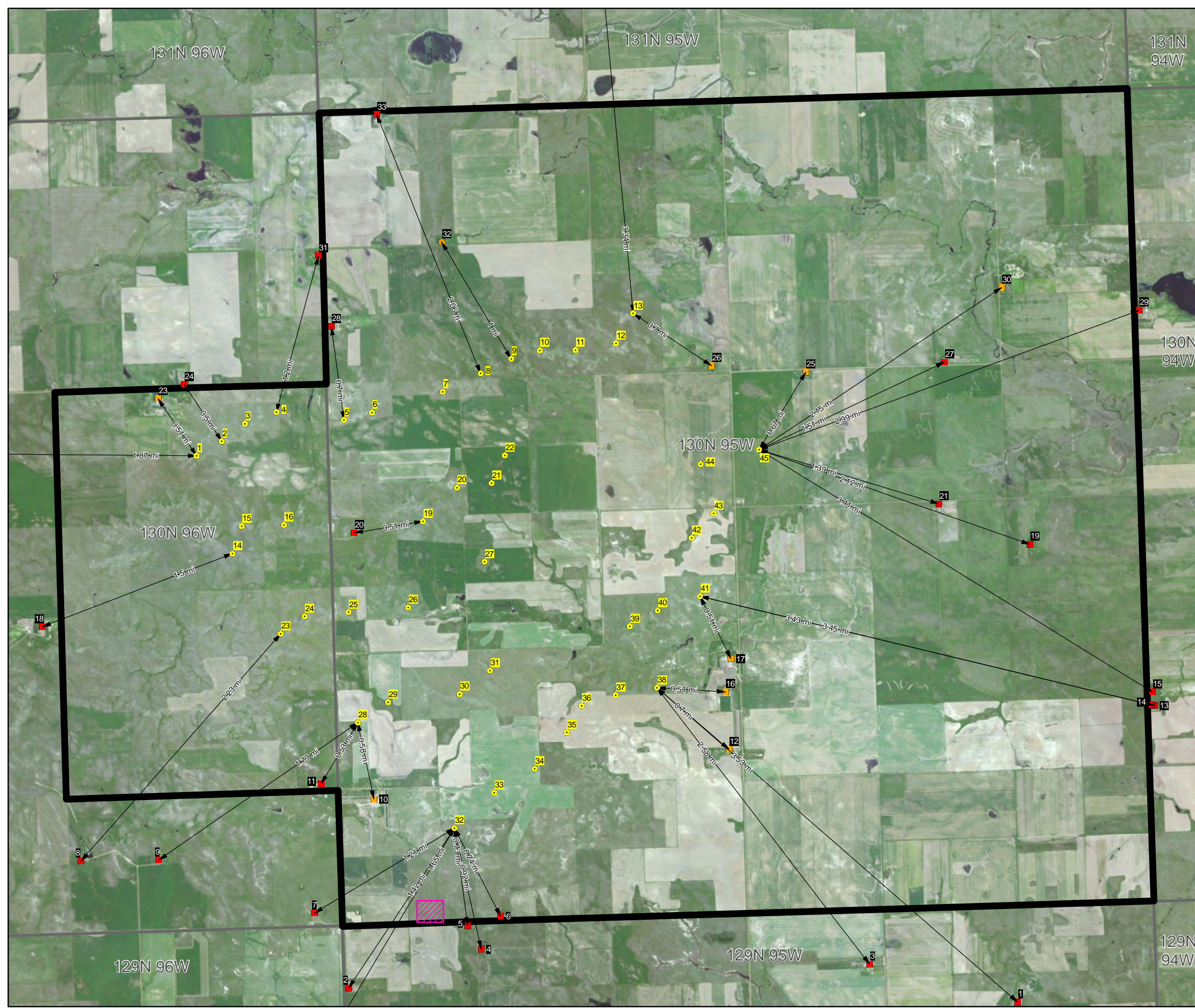
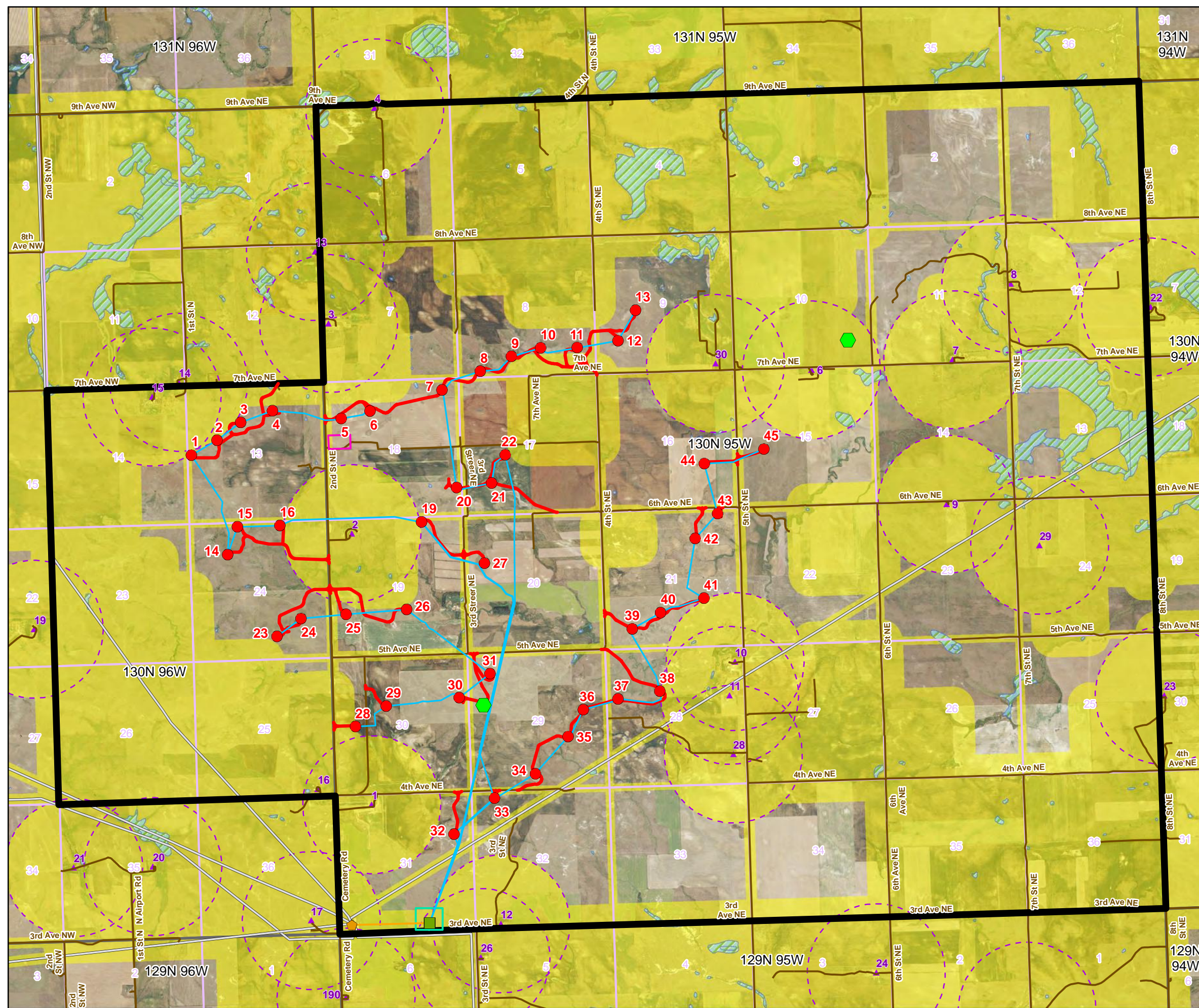


Figure 18
 Project Layout with
 Adams County Zoning Setbacks
 Thunder Spirit Wind Energy Project
 Thunder Spirit Wind, LLC
 Adams County, North Dakota
 June 2014



- ◆ Met Tower Location
- ◆ Approximate POI
- Optimized Turbine Location (5/27/2014)
- Proposed Collector Substation (5/27/2014)
- Overhead Line (5/27/2014)
- Collection Line (5/27/2014)
- Access Road (5/27/2014)
- Construction Laydown Area (10 Acres)
- Collection Substation, O&M Facility, and Additional Laydown Area
- Existing Road
- Existing Transmission Line
- ▲ Occupied Residence
- Occupied Residence Buffer (0.5 miles)
- NWI Wetland
- Setbacks (See Table 12 in PSC Application)
- Project Area (4/26)
- PLSS Township
- PLSS Section Boundary

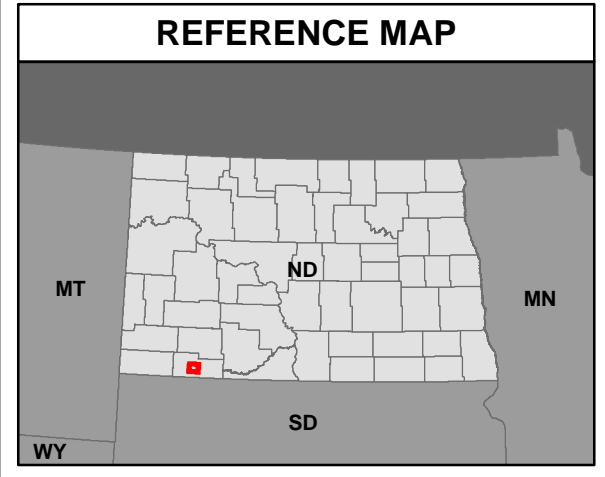
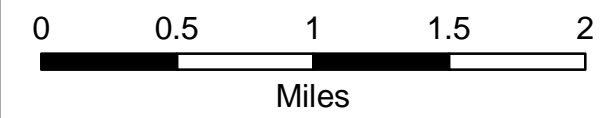
















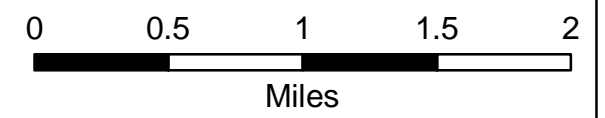
Figure 19

Permitted Turbine Locations
Compared to Optimized
Layout

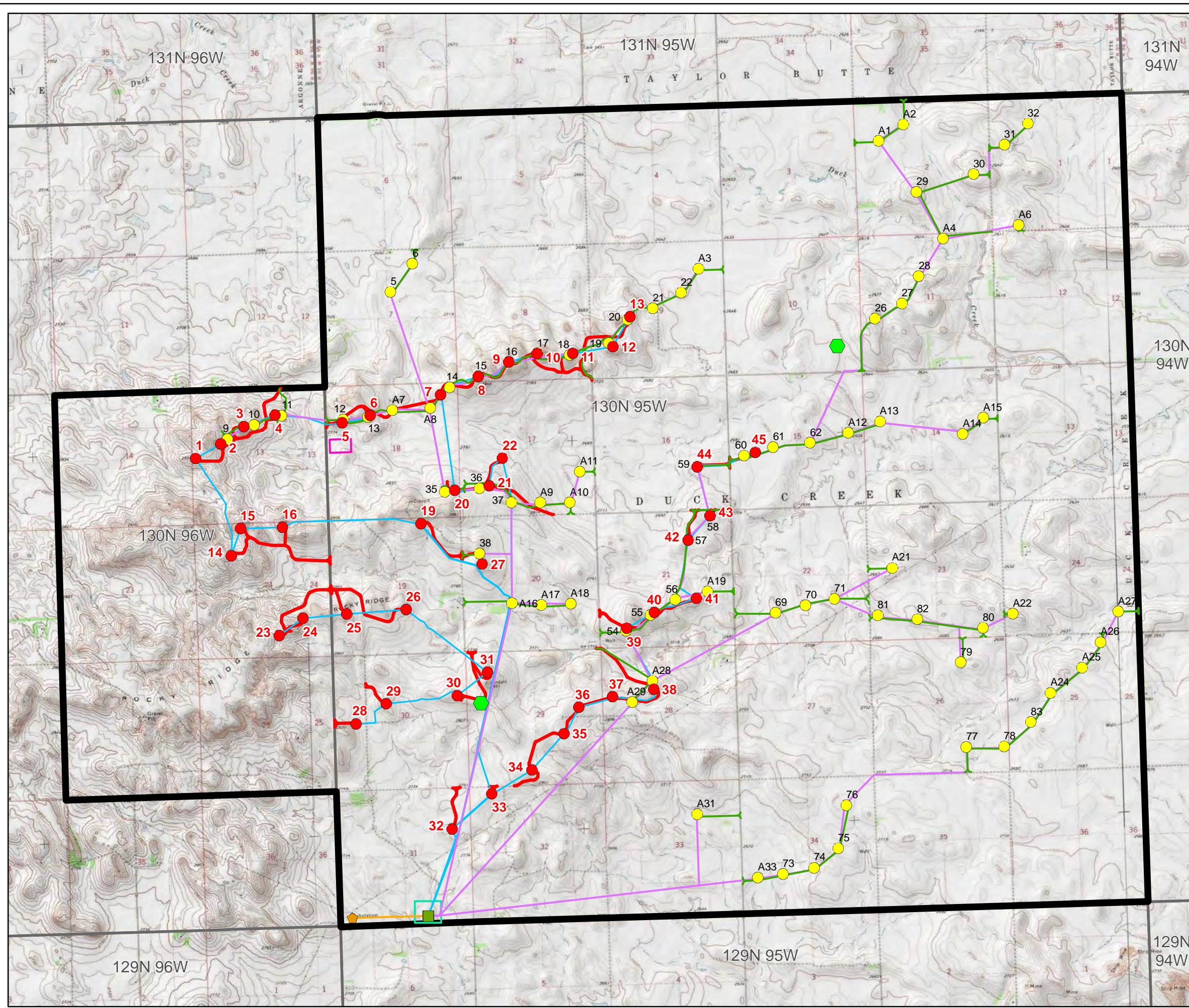
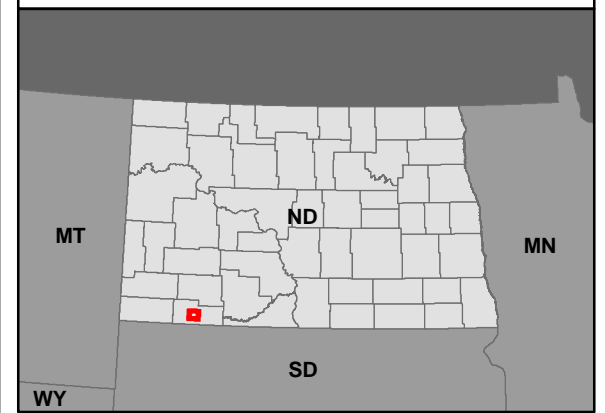
Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

June 2014

-  Met Tower Location
-  Approximate POI
-  Proposed Collector Substation (5/27/2014)
-  Optimized Turbine Location (5/27/2014)
-  Proposed Turbine Layout
-  Access Road (5/27/2014)
-  Proposed Access Road
-  Collection Line (5/27/2014)
-  Proposed Collection Line
-  Overhead Line (5/27/2014)
-  Construction Laydown Area (10 Acres)
-  Collection Substation, O&M Facility, and Additional Laydown Area
-  Project Area (4/26)
-  Township Boundary



REFERENCE MAP



Appendix A
Studies and Assessments
*Those that were revised or not submitted with Original
Application*



May 28, 2014

Tracey Dubuque, P.E.
 Tetra Tech Project Manager
 160 Federal Street, 3rd Floor
 Boston, MA 02110

Dear Tracey:

This memorandum is intended to document delineation of wetlands and other waters of the United States (WoUS) in the Thunder Spirit Wind Energy Project (Project) optimized layout for the Project. Field work was conducted on Thursday, May 8, 2014. The field work followed wetlands delineation methodology contained in the USACE *Wetland Delineation Manual* (1987) and the *Regional Supplement to the USACE Wetland Delineation Manual: Great Plains Region* (Version 2.0, 2010).

The weather conditions during the delineation were overcast and cool. Moderate precipitation had occurred in Hettinger, North Dakota for the two days prior to the delineation effort. Ambient conditions verified that it had been a wet start to the spring. This assessment was based on the fact that the site was observed to have significantly more standing surface water present than at the same time last year when the initial phase of wetland delineation for this Project had occurred (May 2013).

Results

Table 1 provides data on the only wetland or other WoUS that appears likely to be crossed and potentially impacted by the optimized layout of Project infrastructure. Table 1 also provides a brief assessment of whether the delineated feature is jurisdictional water. It should be stressed that the U.S. Army Corps of Engineers (USACE) Bismarck Regulatory Office must make formal jurisdictional determinations for this Project site.

Table 1: Wetlands and Other Waters of the U.S., Thunder Spirit Wind Energy Project Site, May 2014.				
Feature ID	Feature Description	Latitude-Longitude	Probable Jurisdictional Status	Impact Assessment
TS-WET-7	palustrine, emergent, temporarily flooded	46.0614 / -102.6027	Jurisdictional	This is a fringe wetland that lines a potentially perennial stream that ultimately flows to Duck Creek. This wetland would be crossed by an electrical collection line in the optimized Project layout. Impacts would be avoided with use of horizontal directional drilling.

Attachment 1 is a field photo log with pictures of wetland TS-WET-7, along with views of the upland sample plot (and close-ups of wetland soils from the wetland sample plot. Attachment 2 is the wetland determination data forms. Figure 1 depicts the location of wetland TS-WET-7 within the optimized layout for the Thunder Spirit Project.

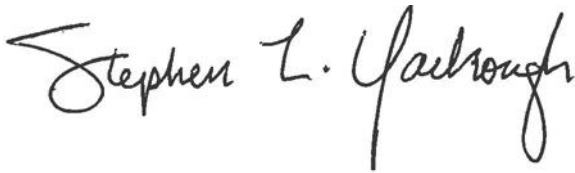
Recommendations

Our recommendation for TS-WET-7 is to utilize directional drilling to bore underneath this wetland. This wetland does appear to maintain surface inundation for more than just the spring season, and may in fact be perennial. It was vegetated with prairie cordgrass and cattail, as well as various species of rushes and sedges. The bore would be relatively short and would allow for the avoidance of any adverse impacts to this wetland ecosystem.

Please feel free to call (303-291-6288) or email me (steve.yarbrough@tetrattech.com) with any questions that you may have regarding the findings of this latest delineation effort.

Sincerely,

TETRA TECH, INCORPORATED

A handwritten signature in black ink that reads "Stephen L. Yarbrough". The signature is written in a cursive style with a large, looped initial 'S'.

Steve Yarbrough
Professional Wetland Scientist (PWS)

steve.yarbrough@tetrattech.com
303-291-6288

**Attachment 1:
Field Photo Log**



Photo 1: View of wetland TS-WET-7, looking north. Wetland conditions were determined to exist left of the shovel – upland conditions are to the right. This wetland may best be described as a palustrine emergent fringed wetland. The matted vegetation in the foreground is prairie cordgrass (*Spartina pectinanta*) which is a facultative wetland (FACW) species, which occur in wetlands 67–99 percent of the time. Cattails (*Typha latifolia* [OBL]) are dominant 50 yards downstream to the north.



Photo 2: View of the sample plot that documents upland conditions immediately east of wetland TS-WET-7, looking south. Vegetation at this location is dominated by the upland grass smooth brome (*Bromus inermis* [UPL]). The soils at this location were dark (10 YR, 3/2), but they lacked any evidence of redoximorphic features or other characters that would identify this soil as hydric.



Photo 3: Close-up view of soil from the wetland sample plot, with oxidized root channels visible in this sample.



Photo 4: Another close-up view of soil from the wetland sample plot. The matrix is a reduced color (10YR 2/1) and there are obvious concentrations in this matrix of soils with redoximorphic color (10YR 6/6).

**Attachment 2:
Wetland Determination Data Forms**

WETLAND DETERMINATION DATA FORM—Great Plains Region

Project/Site: Thunder Spirit Wind Farm		City/County: Hettinger	Sampling Date: 5/8/14
Applicant/Owner: Thunder Spirit/Global Wind LLC		State: North Dakota	Sampling Point: TS-WT-7
Investigator(s): Steve Yarbrough		Section, Township, Range: Sec 19, T130N, R96W	
Landform (hillslope, terrace, etc.): stream margin		Local relief (concave, convex, none) concave	Slope (%): 2
Subregion (LRR): F	Lat:	Long:	Datum: WGS 84
Soil Map Unit Name: Korchea-Fluvaquents Complex		NWI Classification: Not mapped by NWI	
Are climatic/hydrologic conditions on the site typical for this time of year? Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> (if no, explain in Remarks) Cold 40°F			
Are Vegetation <input type="checkbox"/> , Soil <input type="checkbox"/> , or Hydrology <input type="checkbox"/> significantly disturbed? Are "normal circumstances" present? Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>			
Are Vegetation <input type="checkbox"/> , Soil <input type="checkbox"/> , or Hydrology <input type="checkbox"/> naturally problematic? (If necessary, explain any answers in Remarks) Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>			
SUMMARY OF FINDINGS—Attach site map showing sampling point locations, transects, important features, etc.			
Hydrophytic Vegetation Present? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		Is the Sampled Area within a Wetland?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Hydric Soil Present? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No			
Wetland Hydrology Present? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No			
Remarks: Wetland #7			

VEGETATION—Use scientific names of plants.

Tree Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status	Dominance Test worksheet:	
1. No tree stratum				Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC-):	(A)
2.				Total Number of Dominant Species Across All Strata:	(B)
3.				Percent of Dominant Species That Are OBL, FACW, or FAC:	(A/B)
4.				Prevalence Index worksheet:	
		= Total Cover		Total % Cover of:	Multiply by:
Sapling/Shrub Stratum (Plot size:)				OBL species	x 1 =
1. No shrub stratum				FACW species	x 2 =
2.				FAC species	x 3 =
3.				FACU species	x 4 =
4.				UPL species	x 5 =
5.				Column Totals: (A)	(B)
		= Total Cover		Prevalence Index = B/A =	
Herb Stratum (Plot size: 5')				Hydrophytic Vegetation Indicators:	
1. <i>Spartina pectinata</i>	yes	80	FACW	<input type="checkbox"/>	1. Rapid Test for Hydrophytic Vegetation
2.				<input type="checkbox"/>	2. Dominance Test is >50%
3.				<input type="checkbox"/>	3. Prevalence Index is ≤3.0 ¹
4.				<input type="checkbox"/>	4. Morphological Adaptations ¹ (Provide supporting data in Remarks or on a separate sheet)
5.				<input type="checkbox"/>	Problematic Hydrophytic Vegetation ¹ (Explain)
6.				¹ Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.	
7.					
8.					
9.					
		= Total Cover			
Woody Vine Stratum (Plot size:)				Hydrophytic Vegetation Present?	
1. No woody vine stratum				<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	
Open water		= Total Cover			
% Bare Ground in Herb Stratum: 20					
Remarks: There is <i>Typha latifolia</i> at a distance of 75' downstream. LOTS of chorus frogs here.					

WETLAND DETERMINATION DATA FORM—Great Plains Region

SOIL

Sampling Point: TS-WT-7

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)								
Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type ¹	Loc ²		
0-6	10 YR 2/1	99	10 YR 7/4	1	C	M	silt loam	
6-20	10 YR 2/1	95	10 YR 6/6	5	C	M	silt loam	
¹ Type: C=Concentration; D=Depletion; RM=Reduced Matrix; CS=Covered or Coated Sand Grains ² Location: PL=Pore Lining; M=Matrix								
Hydric Soil Indicators: (applicable to all LRRs, unless otherwise noted.)						Indicators for Problematic Hydric Soils ³ :		
<input type="checkbox"/>	Histosol (A1)			<input type="checkbox"/>	Sandy Gleyed Matrix (S4)		<input type="checkbox"/>	1 cm Muck (A9) (LRR I, J)
<input type="checkbox"/>	Histic Epipedon (A2)			<input type="checkbox"/>	Sandy Redox (S5)		<input type="checkbox"/>	Coast Prairie Redox A16) (LRR F, G, H)
<input type="checkbox"/>	Black Histic (A3)			<input type="checkbox"/>	Stripped Matrix (S6)		<input type="checkbox"/>	Dark Surface (S7) (LRR G)
<input type="checkbox"/>	Hydrogen Sulfide (A4)			<input type="checkbox"/>	Loamy Mucky Mineral (F1)		<input type="checkbox"/>	High Plains Depressions (F16) (LRR H outside of MLRA 72 and 73)
<input type="checkbox"/>	Stratified Layers (A5) (LRR F)			<input type="checkbox"/>	Loamy Gleyed Matrix (F2)		<input type="checkbox"/>	Reduced Vertic (F18)
<input type="checkbox"/>	1 cm Muck (A9) (LRR F, G, H)			<input type="checkbox"/>	Depleted Matrix (F3)		<input type="checkbox"/>	Red Parent Material (TF2)
<input type="checkbox"/>	Depleted Below Dark Surface (A11)			<input checked="" type="checkbox"/>	Redox Dark Surface (F6)		<input type="checkbox"/>	Very Shallow Dark Surface (TF12)
<input type="checkbox"/>	Thick Dark Surface (A12)			<input type="checkbox"/>	Depleted Dark Surface (F7)		<input type="checkbox"/>	Other (Explain in Remarks)
<input type="checkbox"/>	Sandy Mucky Mineral (S1)			<input type="checkbox"/>	Redox Depressions (F8)		³ Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.	
<input type="checkbox"/>	2.5 cm Mucky Peat or Peat (S2) (LRR G, H)			<input type="checkbox"/>	High Plains Depressions (F16) (MLRA 72 and 73 of LRR H)			
<input type="checkbox"/>	5 cm Mucky Peat or Peat (S3) (LRR F)							
Restrictive Layer (if present):				Hydric Soil Present?			<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	
Type:								
Depth (inches):				Remarks:				

HYDROLOGY

Wetland Hydrology Indicators:										
Primary Indicators (minimum of one required; check all that apply)					Secondary Indicators (minimum of two required)					
<input checked="" type="checkbox"/>	Surface Water (A1)			<input type="checkbox"/>	Salt Crust (B11)		<input type="checkbox"/>	Surface Soil Cracks (B6)		
<input checked="" type="checkbox"/>	High Water Table (A2)			<input type="checkbox"/>	Aquatic Invertebrates (B13)		<input type="checkbox"/>	Sparsely Vegetated Concave Surface (B8)		
<input checked="" type="checkbox"/>	Saturation (A3)			<input type="checkbox"/>	Hydrogen Sulfide Odor (C1)		<input checked="" type="checkbox"/>	Drainage Patterns (B10)		
<input type="checkbox"/>	Water Marks (B1)			<input type="checkbox"/>	Dry-Season Water Table (C2)		<input type="checkbox"/>	Oxidized Rhizospheres on Living Roots (C3) (where tilled)		
<input type="checkbox"/>	Sediment Deposits (B2)			<input type="checkbox"/>	Oxidized Rhizospheres on Living Roots (C3) (where not tilled)		<input type="checkbox"/>	Crayfish Burrows (C8)		
<input type="checkbox"/>	Drift Deposits (B3)			<input type="checkbox"/>	Presence of Reduced Iron (C4)		<input checked="" type="checkbox"/>	Saturation Visible on Aerial Imagery (C9)		
<input type="checkbox"/>	Algal Mat or Crust (B4)			<input type="checkbox"/>	Thin Muck Surface (C7)		<input checked="" type="checkbox"/>	Geomorphic Position (D2)		
<input type="checkbox"/>	Iron Deposits (B5)			<input type="checkbox"/>	Other (Explain in Remarks)		<input type="checkbox"/>	FAC-Neutral Test (D5)		
<input type="checkbox"/>	Inundation Visible on Aerial Imagery (B7)								<input type="checkbox"/>	Frost-Heave Hummocks (D7) (LRR F)
<input checked="" type="checkbox"/>	Water-Stained Leaves (B9)									
Field Observations:				Water Hydrology Present?			<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No			
Surface Water Present?		<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	Depth (inches): 1							
Water Table Present?		<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	Depth (inches): 0							
Saturation Present? (includes capillary fringe)		<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	Depth (inches): 0							
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:										
Remarks:										

WETLAND DETERMINATION DATA FORM—Great Plains Region

Project/Site: Thunder Spirit Wind Farm		City/County: Hettinger	Sampling Date: 5/8/14
Applicant/Owner: Thunder Spirit/Global Wind LLC		State: North Dakota	Sampling Point: TS-UP-7
Investigator(s): Steve Yarbrough		Section, Township, Range: Sec 19, T130N, R96W	
Landform (hillslope, terrace, etc.): hillslope		Local relief (concave, convex, none) none	Slope (%): 5–10
Subregion (LRR): F	Lat:	Long:	Datum: WGS-84
Soil Map Unit Name: Korchea-Flavaquents Complex		NWI Classification:	
Are climatic/hydrologic conditions on the site typical for this time of year? Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> (if no, explain in Remarks)			
Are Vegetation <input type="checkbox"/> , Soil <input type="checkbox"/> , or Hydrology <input type="checkbox"/> significantly disturbed? Are "normal circumstances" present? Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>			
Are Vegetation <input type="checkbox"/> , Soil <input type="checkbox"/> , or Hydrology <input type="checkbox"/> naturally problematic? (If necessary, explain any answers in Remarks) Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>			
SUMMARY OF FINDINGS—Attach site map showing sampling point locations, transects, important features, etc.			
Hydrophytic Vegetation Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		Is the Sampled Area within a Wetland?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
Hydric Soil Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No			
Wetland Hydrology Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No			
Remarks:			

VEGETATION—Use scientific names of plants.

Tree Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status	Dominance Test worksheet:	
1. No tree stratum				Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC-):	(A)
2.				Total Number of Dominant Species Across All Strata:	(B)
3.				Percent of Dominant Species That Are OBL, FACW, or FAC:	(A/B)
4.				Prevalence Index worksheet:	
		= Total Cover		<u>Total % Cover of:</u>	<u>Multiply by:</u>
Sapling/Shrub Stratum (Plot size:)				OBL species	x 1 =
1. No shrub stratum				FACW species	x 2 =
2.				FAC species	x 3 =
3.				FACU species	x 4 =
4.				UPL species	x 5 =
5.				Column Totals: (A)	(B)
		= Total Cover		Prevalence Index = B/A =	
Herb Stratum (Plot size: 5')				Hydrophytic Vegetation Indicators:	
1. Bromus inermis	90	yes	UPC	<input type="checkbox"/>	1. Rapid Test for Hydrophytic Vegetation
2. Medicago lupulina	10	no	FACU	<input type="checkbox"/>	2. Dominance Test is >50%
3.				<input type="checkbox"/>	3. Prevalence Index is ≤3.0 ¹
4.				<input type="checkbox"/>	4. Morphological Adaptations ¹ (Provide supporting data in Remarks or on a separate sheet)
5.				<input type="checkbox"/>	Problematic Hydrophytic Vegetation ¹ (Explain)
6.				¹ Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.	
7.					
8.					
9.					
	100	= Total Cover			
Woody Vine Stratum (Plot size:)				Hydrophytic Vegetation Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	
1. No woody vine stratum					
		= Total Cover			
% Bare Ground in Herb Stratum: 0					
Remarks:					

WETLAND DETERMINATION DATA FORM—Great Plains Region

SOIL

Sampling Point: TS-UP-7

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)								
Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type ¹	Loc ²		
0-12	10 YR 3/2	100					silt loam	
12	2.5 YR 6/4	100					silt loam	
¹ Type: C=Concentration; D=Depletion; RM=Reduced Matrix; CS=Covered or Coated Sand Grains ² Location: PL=Pore Lining; M=Matrix								
Hydric Soil Indicators: (applicable to all LRRs, unless otherwise noted.)						Indicators for Problematic Hydric Soils ³ :		
<input type="checkbox"/>	Histosol (A1)		<input type="checkbox"/>	Sandy Gleyed Matrix (S4)		<input type="checkbox"/>	1 cm Muck (A9) (LRR I, J)	
<input type="checkbox"/>	Histic Epipedon (A2)		<input type="checkbox"/>	Sandy Redox (S5)		<input type="checkbox"/>	Coast Prairie Redox A16) (LRR F, G, H)	
<input type="checkbox"/>	Black Histic (A3)		<input type="checkbox"/>	Stripped Matrix (S6)		<input type="checkbox"/>	Dark Surface (S7) (LRR G)	
<input type="checkbox"/>	Hydrogen Sulfide (A4)		<input type="checkbox"/>	Loamy Mucky Mineral (F1)		<input type="checkbox"/>	High Plains Depressions (F16) (LRR H outside of MLRA 72 and 73)	
<input type="checkbox"/>	Stratified Layers (A5) (LRR F)		<input type="checkbox"/>	Loamy Gleyed Matrix (F2)		<input type="checkbox"/>	Reduced Vertic (F18)	
<input type="checkbox"/>	1 cm Muck (A9) (LRR F, G, H)		<input type="checkbox"/>	Depleted Matrix (F3)		<input type="checkbox"/>	Red Parent Material (TF2)	
<input type="checkbox"/>	Depleted Below Dark Surface (A11)		<input type="checkbox"/>	Redox Dark Surface (F6)		<input type="checkbox"/>	Very Shallow Dark Surface (TF12)	
<input type="checkbox"/>	Thick Dark Surface (A12)		<input type="checkbox"/>	Depleted Dark Surface (F7)		<input type="checkbox"/>	Other (Explain in Remarks)	
<input type="checkbox"/>	Sandy Mucky Mineral (S1)		<input type="checkbox"/>	Redox Depressions (F8)		<input type="checkbox"/>	³ Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.	
<input type="checkbox"/>	2.5 cm Mucky Peat or Peat (S2) (LRR G, H)		<input type="checkbox"/>	High Plains Depressions (F16) (MLRA 72 and 73 of LRR H)				
<input type="checkbox"/>	5 cm Mucky Peat or Peat (S3) (LRR F)							
Restrictive Layer (if present):								
Type:			Hydric Soil Present?			<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		
Depth (inches):								
Remarks: No indication of hydric soils								

HYDROLOGY

Wetland Hydrology Indicators:								
Primary Indicators (minimum of one required; check all that apply)						Secondary Indicators (minimum of two required)		
<input type="checkbox"/>	Surface Water (A1)		<input type="checkbox"/>	Salt Crust (B11)		<input type="checkbox"/>	Surface Soil Cracks (B6)	
<input type="checkbox"/>	High Water Table (A2)		<input type="checkbox"/>	Aquatic Invertebrates (B13)		<input type="checkbox"/>	Sparsely Vegetated Concave Surface (B8)	
<input type="checkbox"/>	Saturation (A3)		<input type="checkbox"/>	Hydrogen Sulfide Odor (C1)		<input type="checkbox"/>	Drainage Patterns (B10)	
<input type="checkbox"/>	Water Marks (B1)		<input type="checkbox"/>	Dry-Season Water Table (C2)		<input type="checkbox"/>	Oxidized Rhizospheres on Living Roots (C3) (where tilled)	
<input type="checkbox"/>	Sediment Deposits (B2)		<input type="checkbox"/>	Oxidized Rhizospheres on Living Roots (C3) (where not tilled)		<input type="checkbox"/>	Crayfish Burrows (C8)	
<input type="checkbox"/>	Drift Deposits (B3)		<input type="checkbox"/>	Presence of Reduced Iron (C4)		<input type="checkbox"/>	Saturation Visible on Aerial Imagery (C9)	
<input type="checkbox"/>	Algal Mat or Crust (B4)		<input type="checkbox"/>	Thin Muck Surface (C7)		<input type="checkbox"/>	Geomorphic Position (D2)	
<input type="checkbox"/>	Iron Deposits (B5)		<input type="checkbox"/>	Other (Explain in Remarks)		<input type="checkbox"/>	FAC-Neutral Test (D5)	
<input type="checkbox"/>	Inundation Visible on Aerial Imagery (B7)					<input type="checkbox"/>	Frost-Heave Hummocks (D7) (LRR F)	
<input type="checkbox"/>	Water-Stained Leaves (B9)							
Field Observations:								
Surface Water Present?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Depth (inches):	Water Hydrology Present?			<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		
Water Table Present?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Depth (inches):						
Saturation Present? (includes capillary fringe)	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Depth (inches):						
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:								
Remarks: No primary or secondary indicators of wetland hydrology.								

Figure 1

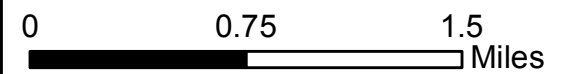
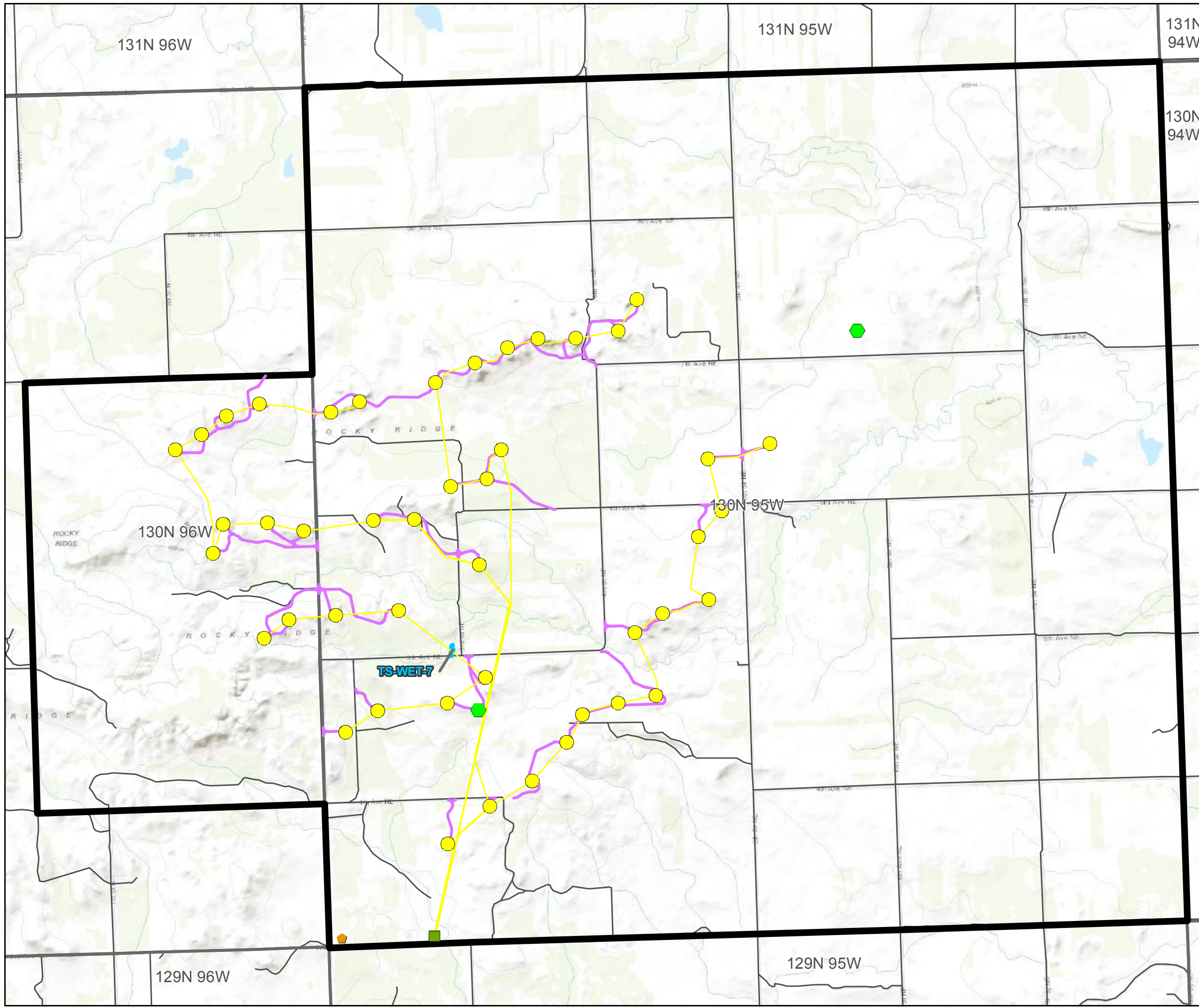
Project Area (Topographical)

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

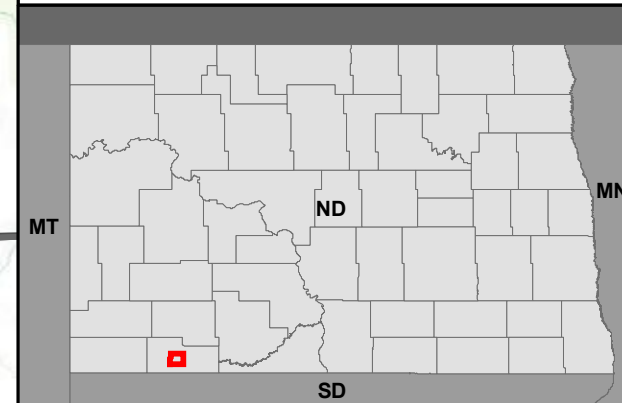
May 2013

Legend

-  Met Tower Location
-  Approximate POI
-  Proposed Collector Substation (8/15/2013)
-  Optimized Layout (4/11/2014)
-  Optimized Layout Phase 1 Electrical Alignment
-  Optimized Layout Phase 1 Road
-  Project Area (4/26)
-  Township Boundary
-  Road
-  Delineated Wetland



REFERENCE MAP



**Shadow Flicker Impact Analysis
for the
Thunder Spirit Wind Energy Project**
Adams County, North Dakota

Prepared for

Thunder Spirit Wind, LLC
103 Front Street
Schenectady, New York 12305

Prepared by



Tetra Tech, Inc.
160 Federal Street – 3rd Floor
Boston, Massachusetts 02110

May 2013
Revised September 2013
Revised May 2014

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY 1
2.0 OVERVIEW 1
3.0 WINDPRO SHADOW FLICKER ANALYSIS 3
4.0 SHADOW FLICKER ANALYSIS RESULTS 4
5.0 CONCLUSION 6
6.0 REFERENCES 7

TABLES

Table 1A. WindPro Predicted Shadow Flicker Impacts for Receptors with Maximum Expected Impacts – Turbine Scenario A (Base Case).....4
Table 1B. WindPro Predicted Shadow Flicker Impacts for Receptors with Maximum Expected Impacts – Turbine Scenario B (Optimized Case).....5
Table 2A. Statistical Summary of WindPro Predicted Shadow Flicker Impacts at Modeled Receptor Locations – Turbine Scenario A (Base Case).....5
Table 2B. Statistical Summary of WindPro Predicted Shadow Flicker Impacts at Modeled Receptor Locations – Turbine Scenario B (Optimized Case).....5

FIGURES

Figure 1. Receptors Modeled with WindPro to Predict Potential Shadow Flicker Impacts.....2
Figure 2A. WindPro Predicted Expected Shadow Flicker Impact Areas – Turbine Scenario A (Base Case).....3
Figure 2B. WindPro Predicted Potential Shadow Flicker Impact Areas – Turbine Scenario B (Optimized Case).....4

ATTACHMENT

Attachment A. Detailed Summary of WindPro Shadow Flicker Analysis Results

1.0 EXECUTIVE SUMMARY

Wind Works Power Corporation and Thunder Spirit Wind, LLC (Thunder Spirit) are proposing to construct and operate the Thunder Spirit Wind Farm (the “Project”) in Adams County, North Dakota. Tetra Tech submitted a shadow flicker impact analysis on September 10, 2013 for a Project layout consisting of 78 wind turbine generators (WTGs). Since that time the Project layout was modified to include 43 WTGs.

After consideration of several WTG types, the Nordex N100 2.5MW turbine was selected. Two layouts have been developed using this turbine, as follows. Both would have a nameplate capacity of 107.5 MW:

- The Base Case includes a total of 43 turbines. This is primarily a subset of the locations that were permitted in October 2013.
- The Optimized Case also includes a total of 43 turbines, along with associated access roads and electrical collection lines. Approximately 58% of the turbines in this Optimized Case are sited in locations previously modelled, while the remaining locations had not yet been modelled. All of these locations occur within the same overall Project area that was extensively reviewed for potential environmental impacts.

An updated shadow flicker impact analysis was completed for both the new Base Case layout and the Optimized Case layout (dated May 27, 2014). Tetra Tech evaluated the new Project layout configuration using the same methodology used in the September 10, 2013 submittal. This memo provides the results of the revised modeling efforts.

2.0 OVERVIEW

A wind turbine’s moving blades can cast a moving shadow on locations within a certain distance of a turbine. These moving shadows are called shadow flicker, and can be a temporary phenomenon experienced at nearby residences or public gathering places. The impact area depends on the time of year and day (which determine the sun’s azimuth and altitude angles) and the wind turbine’s physical characteristics (height, rotor diameter, blade width, and orientation of the rotor blades). Shadow flicker generally occurs during low angle sunlight conditions, typically during sunrise and sunset times of the day. However, when the sun angle gets very low (less than 3 degrees), sunlight passes through more atmosphere and becomes too diffused to form a coherent shadow. Shadow flicker will not occur when the sun is obscured by clouds or fog, at night, or when the source turbine(s) are not operating. In addition, shadow flicker is only an issue when at least 20% of the sun’s disc is covered by the turbine blades.

Shadow flicker intensity is defined as the difference in brightness at a given location in the presence and absence of a shadow. Shadow flicker intensity diminishes with greater receptor-to-turbine separation distance. Shadow flicker intensity for receptor-to-turbine distances beyond 2,000 meters (6,562 feet) is very low and generally considered imperceptible. In general, increasing proximity to turbines may make shadow flicker more noticeable, with the largest number of shadow flicker hours, along with greatest shadow flicker intensity, occurring nearest the wind turbines.

Thunder Spirit Wind, LLC (Thunder Spirit), an affiliate of Wind Works Power Corporation, is proposing to install 43 wind turbines with a maximum nameplate capacity of 107.5 MW as part of the Thunder Spirit Wind Energy Project (the Project) in Adams County, North Dakota. Because the Project is using a minimum turbine siting setback requirement of 2,640 feet (805 meters) to all occupied residences, the most sensitive receptors (potentially occupied non-participating residences) are generally not located in potential shadow flicker impact zones.

The wind turbine model that has been selected for the Project, and evaluated for potential shadow flicker impacts, has the following characteristics:

- **Nordex N100/2500 IEC II** – 3-blade 99.8-meter diameter rotor, with a hub height of 80 meters. The Nordex N100/2500 IEC II has a normal high rotor speed of 14.9 rotations per minute (rpm) which translates to a blade pass frequency of 0.7Hertz (Hz) which is less than 1 alternation per second.

Shadow flicker frequency is related to the wind turbine's rotor blade speed and the number of blades on the rotor. From a health standpoint, the low flicker frequencies associated with wind turbines, are harmless. For comparison, strobe lights used in discotheques have frequencies which range from about 3 Hz to 10 Hz (1 Hz = 1 flash per second). As a result, public concerns that flickering light from wind turbines can have negative health effects, such as triggering seizures in people with epilepsy are unfounded. Epilepsy Action (working name for the British Epilepsy Foundation) states that there is no evidence that wind turbines can cause seizures (Epilepsy Action 2008). However, they recommend that wind turbine flicker frequency be limited to 3 Hz. Since the proposed Project's wind turbine blade pass frequency is approximately 0.7 Hz (less than 1 alternation per second), no negative health effects to individuals with photosensitive epilepsy are anticipated.

Shadow flicker impacts are not regulated in applicable state or federal law, and there is no permitting threshold with regard to hours per year of anticipated impacts to a receptor from a wind energy project. Due to the significant growth of the wind energy industry in recent years, some states have published model bylaws for local governments to adopt or modify at their own discretion which sometimes include guidance and recommendations for shadow flicker levels and mitigation. In lieu of specific regulations, a general precedent has been established in the industry both abroad and in the United States that fewer than 30 hours per year of shadow flicker impacts is acceptable to receptors in terms of nuisance and well below health hazard concerns. In a German court case, for example, a judge found 30 hours of actual shadow flicker per year at a certain neighbor's property to be tolerable (WindPower 2003). The 30 hours per year threshold value has been widely used in the industry as a target value in the absence of formal guidelines. However, predicted shadow flicker greater than this threshold does not necessarily create a nuisance and is still well below concerns for impacts to health.

3.0 WINDPRO SHADOW FLICKER ANALYSIS

An analysis of potential shadow flicker impacts from the Project was conducted using the WindPro software package. The turbine layouts provided by Thunder Spirit (dated May 20, 2014 for the Base case, and dated May 27, 2014 for the Optimized case), both consist of 43 turbines, and were included in the WindPro analysis. The analysis evaluated the following two turbine layout scenarios:

- Scenario A – Base Case: 43 Nordex N100/2500 turbines (primarily a subset of the locations that were previously modelled)
- Scenario B – Optimized Case: 43 Nordex N100/2500 turbines (this layout includes some turbines whose locations were not included in the previous modelling effort)

The WindPro analysis was conducted to determine shadow flicker impacts under realistic impact conditions (actual expected shadow). This analysis calculated the total amount of time (hours and minutes per year) that shadow flicker could occur at receptors out to one mile (5,280 feet). The realistic impact condition scenario is based on the following assumptions:

- The elevation and position geometries of the wind turbines and surrounding receptors (potentially occupied residences). Elevations were determined using United States Geological Survey (USGS) digital elevation model (DEM) data. Positions geometries were determined using geographic information system (GIS) and referenced to Universal Transverse Mercator (UTM) Zone 13 (NAD83).
- The position of the sun and the incident sunlight relative to the wind turbine and receptors on a minute-by-minute basis over the course of a year.
- Historical sunshine availability (percent of total hours available). Historical sunshine rates for the area (as summarized by the National Climatic Data Center (NCDC 2008) for nearby Bismarck, North Dakota) used in this analysis are as follows:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
53%	53%	58%	58%	61%	64%	73%	72%	65%	58%	43%	47%

- Estimated wind turbine operations and orientation (based on approximately 1 year of wind data from June 2011 through May 2012 (wind speed / wind direction frequency distribution) measured at on-site meteorological towers).
- Receptor viewpoints (i.e., house windows) are assumed to always be directly facing turbine to sun line of sight (“greenhouse mode”).

WindPro incorporates terrain elevation contour information and the analysis accounts for terrain elevation differences. The sun’s path with respect to each turbine location is calculated by the software to determine the cast shadow paths every minute over a full year. Sun angles less than 3 degrees above the horizon were excluded, for the reasons identified earlier in this section. Since shadow flicker is only an issue when at least 20% of the sun disc is covered by the

blades, WindPro uses blade width dimension data to calculate the maximum distance from the turbine where shadow flicker must be calculated. Beyond this distance, the turbine will not contribute to the shadow flicker impact.

It should be noted however, that WindPro provides a conservative estimate of shadow flicker as obstacles such as trees, haze, and visual obstructions (window facing, coverings) are not fully accounted despite the likelihood of their reducing or eliminating shadow flicker impacts to receptors. A total of 35 receptor locations were identified within one mile of proposed Project turbines. A receptor in the model is defined as a 1 meter squared area (approximate size of a typical window), 1 meter (3.28 feet) aboveground level. Approximate eye level is set at 1.5 meters (4.94 feet). Figure 1 shows the receptor locations and proposed Project turbines considered for Scenarios A and B.

4.0 SHADOW FLICKER ANALYSIS RESULTS

As expected, WindPro predicts that shadow flicker impacts will be greatest at locations nearer to the wind turbines. Figures 2A and 2B describe the WindPro predicted shadow flicker impact areas for turbine Scenarios A and B, respectively. A detailed WindPro shadow flicker analysis summary, for each of the turbine layout scenarios and modeled receptor locations, is provided in Attachment A. Tables 1A and 1B present the WindPro predicted shadow flicker impacts for the top ten worst case receptors for turbine Scenarios A and B, respectively. Considering both turbine scenarios, none of the 35 receptors modeled had expected shadow flicker impacts of more than 20 hours per year. The maximum predicted shadow flicker impact at a receptor is 15 hours, 20 minutes per year (layout scenario B, receptor 2), which is approximately 0.3 percent of the potential available daylight hours.

Table 1A. WindPro Predicted Shadow Flicker Impacts for Receptors with Maximum Expected Impacts – Turbine Scenario A (Base Case)

Receptor ID*	Receptor Description	Shadow Hours per Year (expected) [hh:mm / year]
10	Participating Landowner	9:21
14	Non-participating Receptor	9:11
11	Participating Landowner	8:33
15	Participating Landowner	7:55
28	Participating Landowner	7:14
30	Participating Landowner	4:45
8	Participating Landowner	3:35
2	Non-participating Receptor	2:28
6	Participating Landowner	1:29
3	Non-participating Receptor	1:17

Table 1B. WindPro Predicted Shadow Flicker Impacts for Receptors with Maximum Expected Impacts – Turbine Scenario B (Optimized Case)

Receptor ID*	Receptor Description	Shadow Hours per Year (expected) [hh:mm / year]
2	Non-participating Receptor	15:20
15	Participating Landowner	10:39
14	Non-participating Receptor	8:43
10	Participating Landowner	7:57
11	Participating Landowner	7:26
30	Participating Landowner	5:11
28	Participating Landowner	4:24
1	Participating Landowner	4:09
6	Participating Landowner	1:29
3	Non-participating Receptor	1:28

The shadow flicker impact prediction statistics are summarized in Tables 2A and 2B.

Table 2A. Statistical Summary of WindPro Predicted Shadow Flicker Impacts at Modeled Receptor Locations – Turbine Scenario A (Base Case)

Cumulative Shadow Flicker Time (expected)	Number of Receptors
Total	35
= 0 Hours	24
> 0 Hours < 10 Hours	11
≥ 10 Hours < 20 Hours	0
≥ 20 Hours < 30 Hours	0
≥ 30 Hours	0

Table 2B. Statistical Summary of WindPro Predicted Shadow Flicker Impacts at Modeled Receptor Locations – Turbine Scenario B (Optimized Case)

Cumulative Shadow Flicker Time (expected)	Number of Receptors
Total	35
= 0 Hours	24
> 0 Hours < 10 Hours	9
≥ 10 Hours < 20 Hours	2
≥ 20 Hours < 30 Hours	0
≥ 30 Hours	0

5.0 CONCLUSION

The analysis of potential shadow flicker impacts from the Project on nearby receptors shows that shadow flicker impacts within the area of study are expected to be minor and well within acceptable ranges for avoiding nuisance and/or health hazards. All receptor locations had modeled shadow flicker impact below the target of 30 hours per year under conservative conditions. The analysis assumes that the receptors all have a direct in-line view of the incoming shadow flicker sunlight and does not account for trees or other obstructions which may block sunlight. In reality, the windows of many houses will not face the sun directly for the key shadow flicker impact times. For these reasons, shadow flicker impacts are expected to be considerably less than estimated in this conservative analysis, and shadow flicker is not expected to be a significant environmental impact. Mitigation measures such as strategic vegetative screening and/or installation of curtains and blinds on the windows facing the turbine casting the shadows are effective and economically viable options that Thunder Spirit could consider on an individual basis with landowners, if necessary.

6.0 REFERENCES

Epilepsy Action. 2008. British Epilepsy Association.

http://www.epilepsy.org.uk/info/photo_other.html. Accessed 3/1/10.

National Climatic Data Center (NCDC). 2008. Sunshine Average Percent of Possible.

<http://www.ncdc.noaa.gov/oa/climate/online/ccd/pctpos.txt>. Accessed 3/1/10

WindPower. 2003. Danish Wind industry Association. Shadow Casting From Wind Turbines.

<http://guidedtour.windpower.org/en/tour/env/shadow/index.htm>, Accessed 4/28/10

FIGURES

Figure 1

Receptors Modeled
With WindPro to Predict Potential
Shadow Flicker Impacts

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

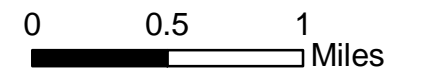
June 2014

Legend

- Base Case Turbine Location (5/20/2014)
- Optimized Turbine Location (5/27/2014)
- ▨ Collector Substation Construction Footprint (20 Acres)
- ▭ Project Area

Receptor

- Signed Easement (Occupied)
- Signed Easement (Unoccupied)
- Not Signed (Occupied)
- Not Signed (Unoccupied)



REFERENCE MAP

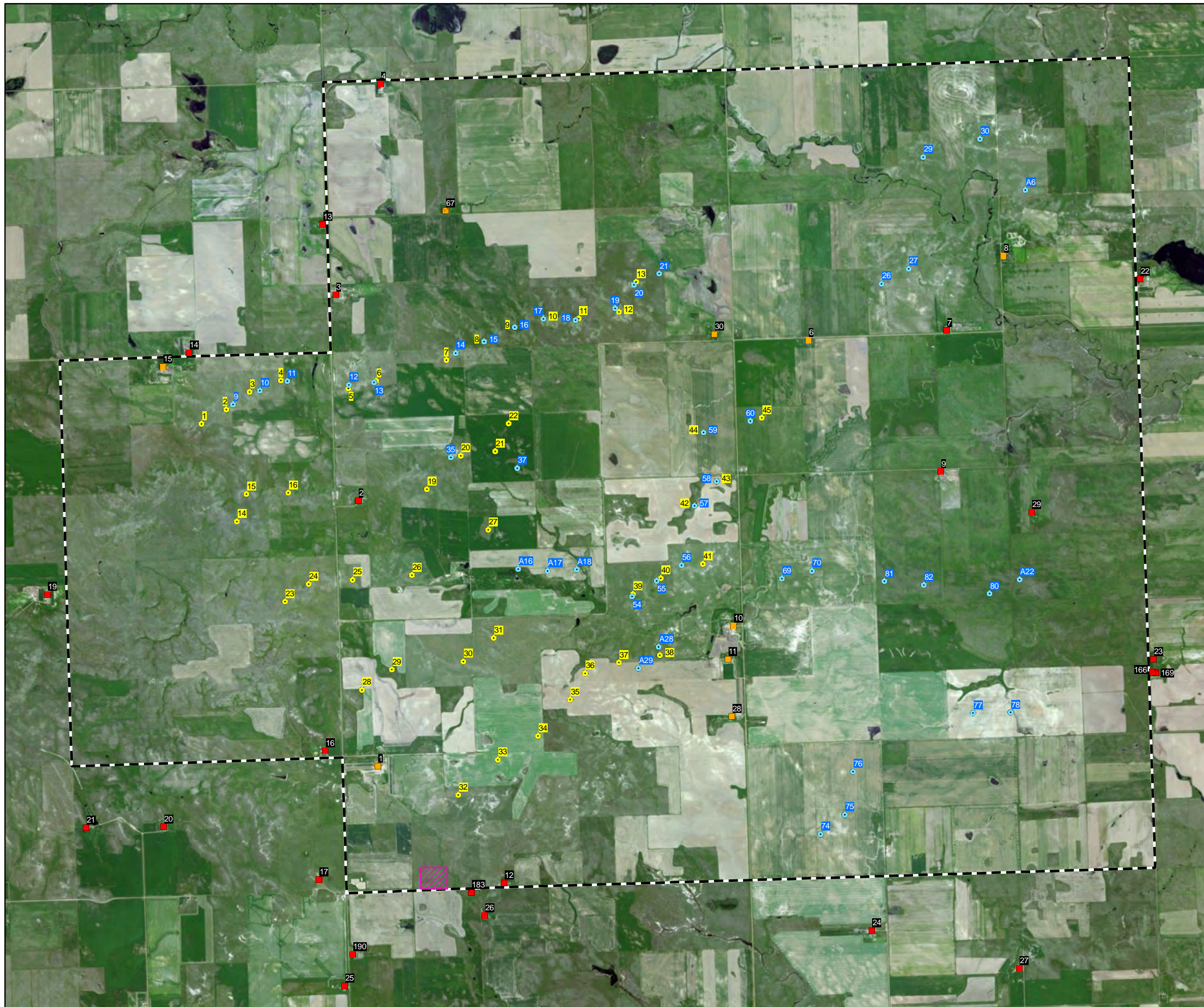
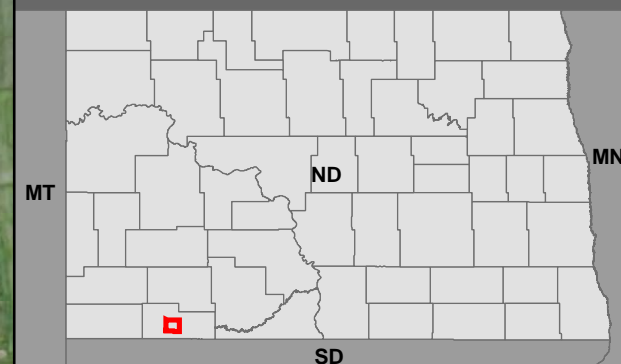


Figure 2A

WindPro Predicted Expected
Shadow Flicker Impact Areas:
Turbine Scenario A (Base Case)

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

June 2014

Legend

● Base Case Turbine Location (5/20/2014)

Receptor

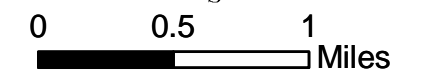
- Signed Easement (Occupied)
- Signed Easement (Unoccupied)
- Not Signed (Occupied)
- Not Signed (Unoccupied)

▨ Collector Substation
Construction Footprint (20 Acres)

Shadow Flicker Iso Line (Base Case)

- 15 hrs/yr
- 30 hrs/yr
- 50 hrs/yr
- 75 hrs/yr
- 100 hrs/yr

▭ Project Area



REFERENCE MAP

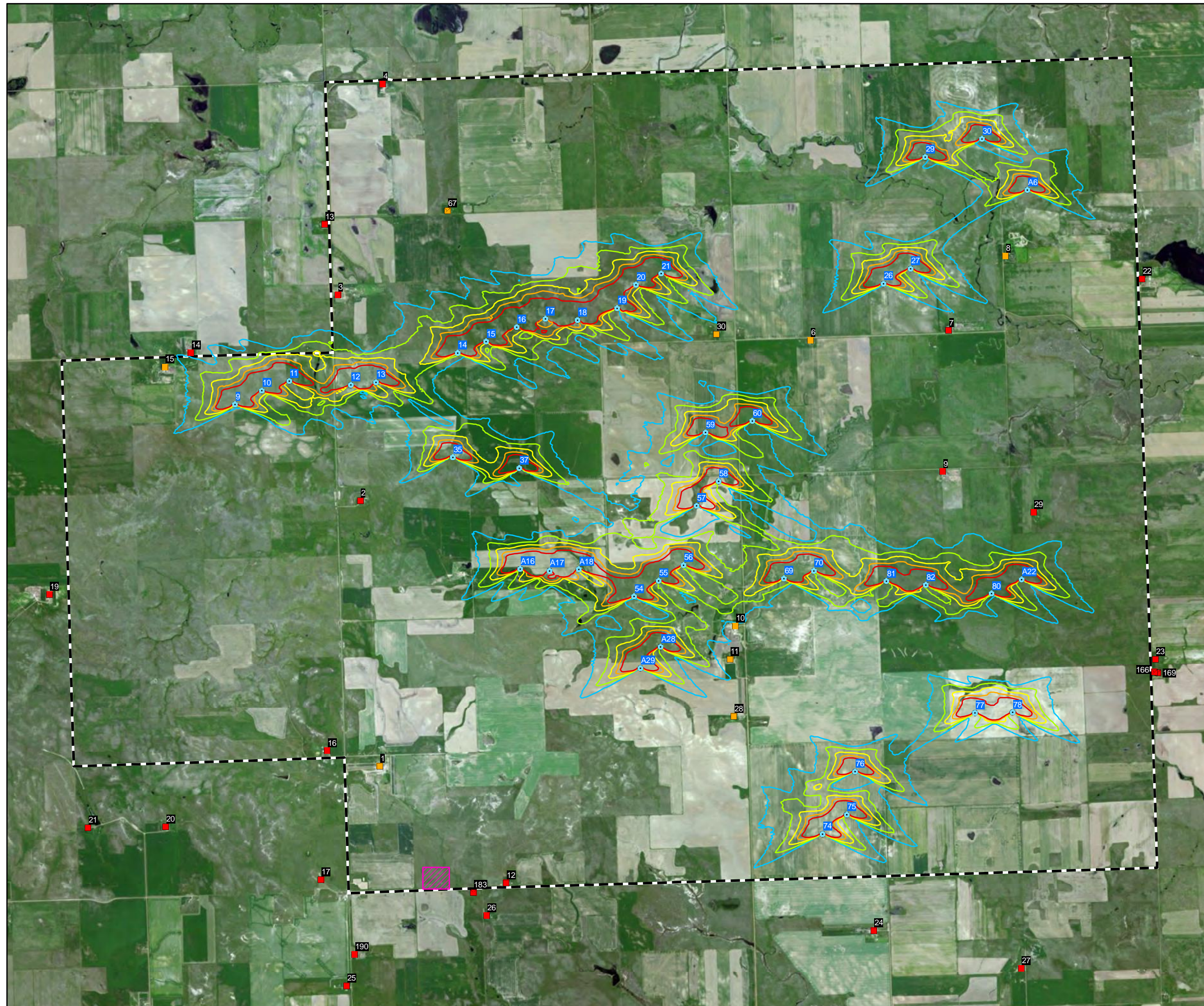
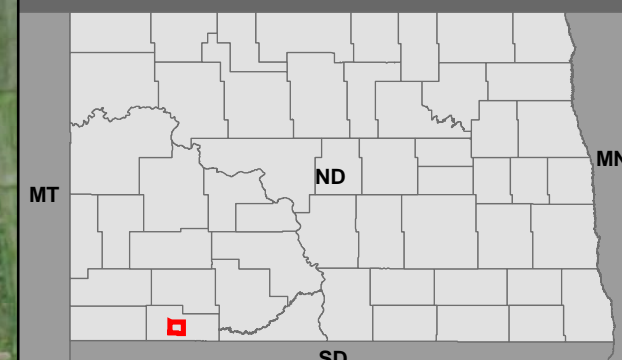


Figure 2B

WindPro Predicted Expected
Shadow Flicker Impact Areas:
Turbine Scenario B (Optimized)

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

June 2014

Legend

● Optimized Turbine Location (5/27/2014)

Receptor

- Signed Easement (Occupied)
- Signed Easement (Unoccupied)
- Not Signed (Occupied)
- Not Signed (Unoccupied)

▨ Collector Substation
Construction Footprint (20 Acres)

Shadow Flicker Iso Line (Optimized)

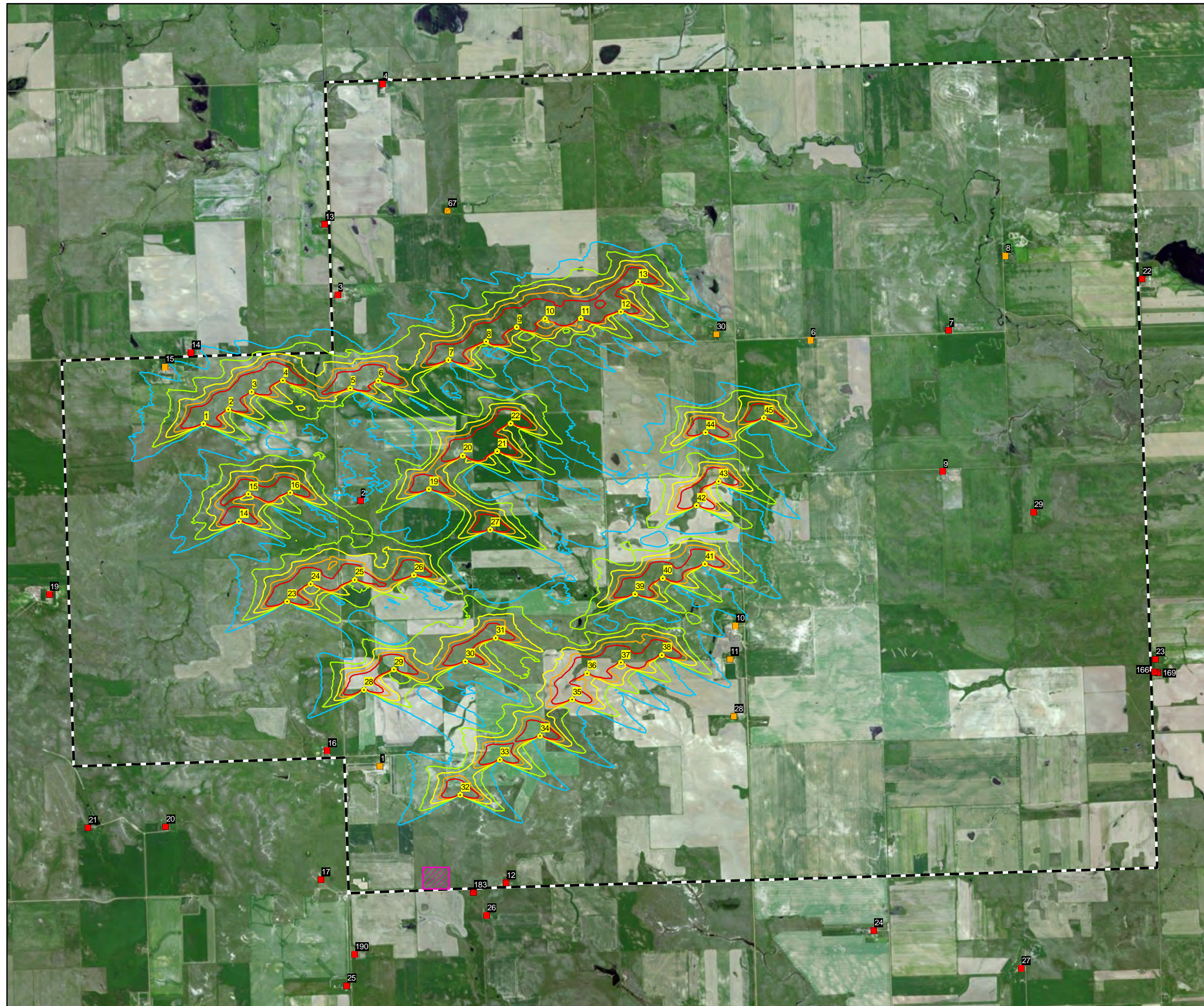
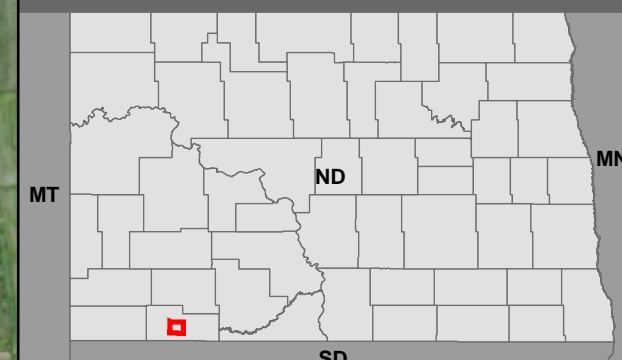
- 15 hrs/yr
- 30 hrs/yr
- 50 hrs/yr
- 75 hrs/yr
- 100 hrs/yr

▭ Project Area



0 0.5 1 Miles

REFERENCE MAP



ATTACHMENT A.

Detailed Summary of WindPro Shadow Flicker Analysis Results

**Thunder Spirit Wind Energy Project
WindPro Shadow Flicker Analysis Results Summary
Turbine Scenario A (Base Case)**

Thunder Spirit Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (Hours per Year)	Residence Status	Project Participation Status
1	684,417	5,101,848	0:00	Occupied	Signed Easement
2	684,186	5,105,014	2:28	Occupied	Not Signed
3	683,913	5,107,467	1:17	Occupied	Not Signed
4	684,451	5,109,984	0:00	Occupied	Not Signed
5	687,009	5,112,982	0:00	Occupied	Not Signed
6	689,550	5,106,924	1:29	Occupied	Signed Easement
7	691,200	5,107,045	0:00	Occupied	Not Signed
8	691,878	5,107,932	3:35	Occupied	Signed Easement
9	691,131	5,105,359	0:00	Occupied	Not Signed
10	688,659	5,103,520	9:21	Occupied	Signed Easement
11	688,595	5,103,125	8:33	Occupied	Signed Easement
12	685,925	5,100,457	0:00	Occupied	Not Signed
13	683,758	5,108,307	0:00	Occupied	Not Signed
14	682,164	5,106,780	9:11	Occupied	Not Signed
15	681,853	5,106,609	7:55	Occupied	Signed Easement
16	683,789	5,102,031	0:00	Occupied	Not Signed
17	683,711	5,100,496	0:00	Occupied	Not Signed
18	679,297	5,105,954	0:00	Occupied	Not Signed
19	680,477	5,103,897	0:00	Occupied	Not Signed
20	681,862	5,101,126	0:00	Occupied	Not Signed
21	680,937	5,101,114	0:00	Occupied	Not Signed
22	693,510	5,107,659	0:00	Occupied	Not Signed
23	693,669	5,103,124	0:00	Occupied	Not Signed
24	690,307	5,099,887	0:00	Occupied	Not Signed
25	684,022	5,099,229	0:00	Occupied	Not Signed
26	685,692	5,100,065	0:00	Occupied	Not Signed
27	692,068	5,099,438	0:00	Occupied	Not Signed
28	688,638	5,102,441	7:14	Occupied	Signed Easement
29	692,214	5,104,878	1:06	Occupied	Not Signed
30	688,431	5,107,000	4:45	Occupied	Signed Easement
67	685,223	5,108,470	0:00	Abandoned	Signed Easement
166	693,657	5,102,971	0:00	Abandoned	Not Signed
169	693,696	5,102,962	0:00	Abandoned	Not Signed
183	685,531	5,100,343	0:00	Abandoned	Not Signed
190	684,117	5,099,602	0:00	Occupied	Not Signed

**Thunder Spirit Wind Energy Project
WindPro Shadow Flicker Analysis Results Summary
Turbine Scenario B (Optimized Case)**

Thunder Spirit Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (Hours per Year)	Residence Status	Project Participation Status
1	684,417	5,101,848	4:09	Occupied	Signed Easement
2	684,186	5,105,014	15:20	Occupied	Not Signed
3	683,913	5,107,467	1:28	Occupied	Not Signed
4	684,451	5,109,984	0:00	Occupied	Not Signed
5	687,009	5,112,982	0:00	Occupied	Not Signed
6	689,550	5,106,924	1:29	Occupied	Signed Easement
7	691,200	5,107,045	0:00	Occupied	Not Signed
8	691,878	5,107,932	0:00	Occupied	Signed Easement
9	691,131	5,105,359	0:00	Occupied	Not Signed
10	688,659	5,103,520	7:57	Occupied	Signed Easement
11	688,595	5,103,125	7:26	Occupied	Signed Easement
12	685,925	5,100,457	0:00	Occupied	Not Signed
13	683,758	5,108,307	0:00	Occupied	Not Signed
14	682,164	5,106,780	8:43	Occupied	Not Signed
15	681,853	5,106,609	10:39	Occupied	Signed Easement
16	683,789	5,102,031	0:24	Occupied	Not Signed
17	683,711	5,100,496	0:00	Occupied	Not Signed
18	679,297	5,105,954	0:00	Occupied	Not Signed
19	680,477	5,103,897	0:00	Occupied	Not Signed
20	681,862	5,101,126	0:00	Occupied	Not Signed
21	680,937	5,101,114	0:00	Occupied	Not Signed
22	693,510	5,107,659	0:00	Occupied	Not Signed
23	693,669	5,103,124	0:00	Occupied	Not Signed
24	690,307	5,099,887	0:00	Occupied	Not Signed
25	684,022	5,099,229	0:00	Occupied	Not Signed
26	685,692	5,100,065	0:00	Occupied	Not Signed
27	692,068	5,099,438	0:00	Occupied	Not Signed
28	688,638	5,102,441	4:24	Occupied	Signed Easement
29	692,214	5,104,878	0:00	Occupied	Not Signed
30	688,431	5,107,000	5:11	Occupied	Signed Easement
67	685,223	5,108,470	0:00	Abandoned	Signed Easement
166	693,657	5,102,971	0:00	Abandoned	Not Signed
169	693,696	5,102,962	0:00	Abandoned	Not Signed
183	685,531	5,100,343	0:00	Abandoned	Not Signed
190	684,117	5,099,602	0:00	Occupied	Not Signed



To: Wind Works Power Corporation and Thunder Spirit Wind, LLC
From: Tetra Tech, Inc.
Subject: Thunder Spirit Wind Farm – Revised Acoustic Modeling Analysis (Optimized)
Date: May 29, 2014

Wind Works Power Corporation and Thunder Spirit Wind, LLC (Thunder Spirit) are proposing to construct and operate the Thunder Spirit Wind Farm (the “Project”) in Adams County, North Dakota. Tetra Tech submitted an acoustic analysis on September 10, 2013 for a Project layout consisting of 78 wind turbine generators (WTGs) and a supporting collector substation. Since that time the Project layout was modified to include 43 WTGs (i.e., the Optimized layout) and a new collector substation layout. An updated acoustic analysis was completed to include the new Optimized layout and the new collector substation layout (both dated May 27, 2014). The most recent noise sensitive receptor (NSR) locations were incorporated in the updated analysis, which included 35 residences surrounding the Project area. After consideration of several WTG types the Nordex N100 2.5MW turbine was selected and used in the updated acoustic analysis. Tetra Tech evaluated the new Project layout configuration using the same methodology used in the September 10th, 2013 submittal. This memo provides the results of the revised modeling analysis and an assessment of Project compliance with the U.S. Environmental Protection Agency (EPA) noise guidelines used in the previous analysis as well as the North Dakota noise regulations for wind energy projects and the Adams County Zoning Ordinance requirements.

Applicable Noise Criteria

Tetra Tech completed a regulatory review, which identified the Adams County Zoning Ordinance noise requirements and the EPA guidelines as applicable to the Project. The Adams County Zoning Ordinance prescribes a daytime and nighttime noise limit of 80 and 70 dBA, respectively. Recently adopted at the state level, North Dakota Chapter 69-06-08-01(4) specifies noise requirements:

“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 fifty dBA. The sound level avoidance area criteria may be waived in writing by the owner of the occupied residence or the community building.”

The EPA noise guidelines are slightly more conservative than the North Dakota regulations; therefore, adherence to the EPA thresholds, or received sound levels of no more than 48.6 dBA L_{eq} at NSRs, also results in compliance with the State’s noise regulations, or 50 dBA L_{eq} at NSRs.

Acoustic Model Results

Using the Optimized Case Project layout dated May 27, 2014, acoustic modeling was completed to address multiple operating scenarios; 1) cut-in (onset of WTG operation), 2) maximum rotation (full power), and 3) maximum rotation under anomalous meteorological conditions (i.e., full power during atypical conditions that affect long range propagation). Table 1 summarizes the number of NSRs within selected sound pressure level ranges under each of the identified operational conditions. The tabulated results are independent of the existing acoustic environment, (i.e. are representative of expected Project-generated sound levels only). In

addition, in consideration of the North Dakota noise regulation, the analysis included a 100 foot buffer around each residential structure.

Table 1. Summary of Project Received Sound Levels at NSRs for the Nordex N100 2.5MW WTG

Sound Level (dBA)	Number of NSRs Exceeding Sound Level Ranges		
	Cut-in	Maximum	Maximum - Anomalous
>70 Adams County	0	0	0
> 50 North Dakota	0	0	0
> 48.6 EPA	0	0	1
>= 50	0	0	0
45 to 50	0	2	3
40 to 45	0	12	12
35 to 40	1	5	4
< 35	34	16	16

Table 1 presents the modeling results and indicates that received sound levels under maximum rotation and maximum rotation during anomalous events may potentially exceed the most stringent noise threshold for the Project (i.e., the EPA 48.6 dBA guideline) at only one NSR. There are no exceedances of the North Dakota noise regulation or the Adams County Zoning Ordinance noise limits. The EPA guidelines are just that, guidelines and not regulatory limits; however, the State's wind energy noise regulations require Project compliance. With respect to the EPA guidelines, there were no exceedances at cut-in wind speed, no exceedances at maximum rotation, and only 1 marginal exceedance at maximum rotation under anomalous meteorological condition. However, this exceedance occurred at NSR ID 183, which has been identified as an abandoned residence and a vacant farm, which is situated near a transmission line. With respect to the North Dakota regulation, all NSRs are in compliance. Attachment 1 presents the tabular results for all 35 NSRs analyzed as well as sound contour figures for the maximum rotation under anomalous meteorological condition.

In conclusion, the acoustic modeling analysis, demonstrates the Project has been adequately designed inclusive of a number of conservative assumptions to generate sound levels below the EPA guidelines, the North Dakota noise limit, and the Adams County zoning ordinance at all occupied NSRs.

ATTACHMENT 1

Tabulated Results and Sound Contour Figure

Received Sound Levels by NSR for the Nordex N100 2.5MW WTG

NSR ID	Residence Status	Landowner Status	UTM Coordinates		Received Sound Level (dBA)		
			Easting (m)	Northing (m)	Cut-in	Maximum	Anomalous Meteorological Conditions
1	Occupied	Signed Easement	684417	5101848	31.8	43.0	44.9
2	Occupied	Not Signed	684186	5105014	33.4	44.6	45.6
3	Occupied	Not Signed	683913	5107467	29.1	40.3	41.6
4	Occupied	Not Signed	684451	5109984	20.6	31.8	34.2
5	Occupied	Not Signed	687010	5112982	12.7	23.9	26.5
6	Occupied	Signed Easement	689550	5106924	26.7	37.9	39.5
7	Occupied	Not Signed	691200	5107045	20.0	31.2	33.6
8	Occupied	Signed Easement	691878	5107932	16.6	27.8	30.3
9	Occupied	Not Signed	691131	5105359	21.1	32.3	34.6
10	Occupied	Signed Easement	688659	5103520	31.3	42.5	43.4
11	Occupied	Signed Easement	688595	5103125	30.7	41.9	42.9
12	Occupied	Not Signed	685925	5100457	29.0	40.2	42.4
13	Occupied	Not Signed	683758	5108307	25.4	36.6	38.6
14	Occupied	Not Signed	682164	5106780	31.3	42.5	43.0
15	Occupied	Signed Easement	681853	5106609	30.4	41.6	42.3
16	Occupied	Not Signed	683789	5102031	29.6	40.8	42.5
17	Occupied	Not Signed	683711	5100496	29.4	40.6	43.4
18	Occupied	Not Signed	679297	5105954	18.7	29.9	32.3
19	Occupied	Not Signed	680477	5103897	20.5	31.7	34.0
20	Occupied	Not Signed	681862	5101126	19.1	30.3	32.8
21	Occupied	Not Signed	680937	5101114	15.7	26.9	29.5
22	Occupied	Not Signed	693510	5107659	10.0	21.2	23.8
23	Occupied	Not Signed	693669	5103124	13.1	24.3	26.9
24	Occupied	Not Signed	690307	5099887	17.5	28.7	31.3
25	Occupied	Not Signed	684022	5099229	25.4	36.6	39.4
26	Occupied	Not Signed	685692	5100065	34.5	45.7	48.4
27	Occupied	Not Signed	692068	5099438	11.5	22.7	25.4
28	Occupied	Signed Easement	688638	5102441	27.8	39.0	40.6
29	Occupied	Not Signed	692214	5104878	17.4	28.6	31.0
30	Occupied	Signed Easement	688431	5107000	29.3	40.5	41.8
67	Abandoned	Signed Easement	685223	5108470	26.5	37.7	39.5
166	Abandoned	Not Signed	693657	5102971	12.9	24.1	26.7
169	Abandoned	Not Signed	693696	5102962	12.8	24.0	26.6
183	Abandoned	Not Signed	685531	5100343	35.4	46.6	49.1
190	Occupied	Not Signed	684117	5099602	29.5	40.7	43.5

NOTE: Bolded value indicates an exceedance

Figure 1

Received Sound Levels –
Nordex N100 2.5MW WTG at
Maximum Rotational Wind Speed
under Anomalous Conditions

Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

June 2014

Legend

● Optimized Turbine Location (5/27/2014)

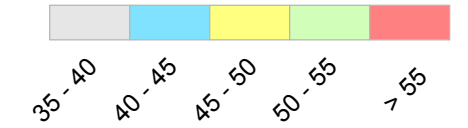
Receptor

- Signed Easement (Occupied)
- Signed Easement (Unoccupied)
- Not Signed (Occupied)
- Not Signed (Unoccupied)

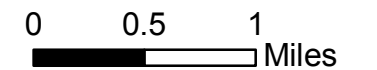
▨ Collector Substation
Construction Footprint (20 Acres)

⊞ Project Area

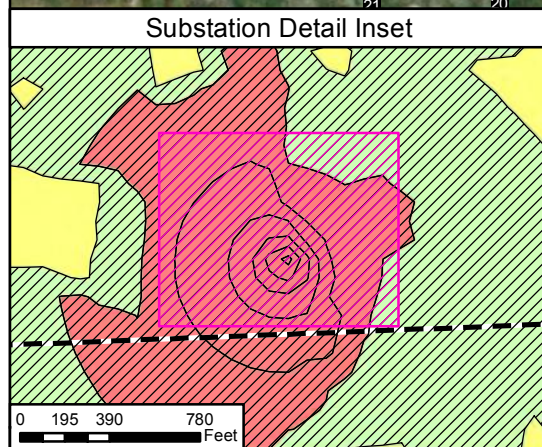
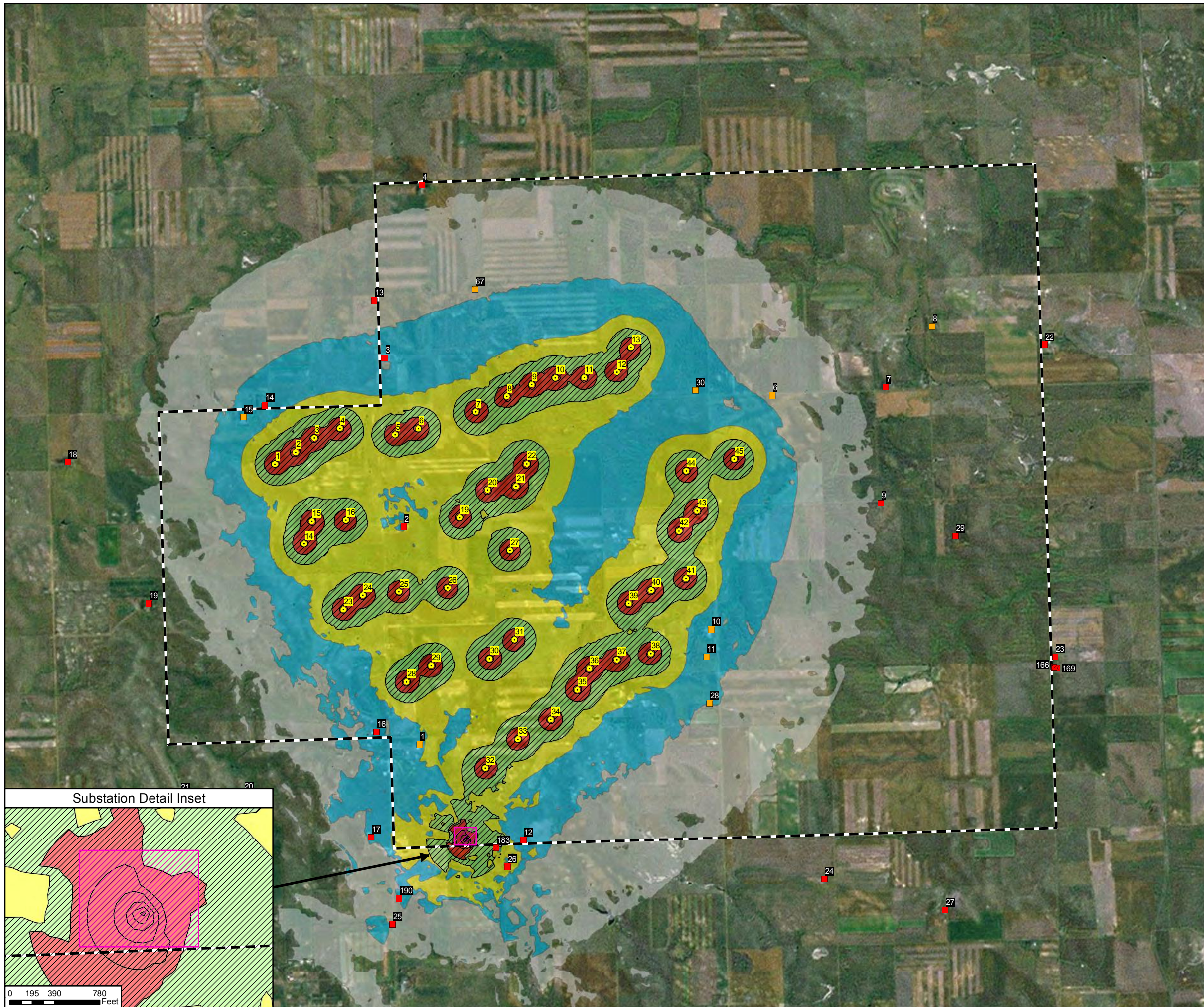
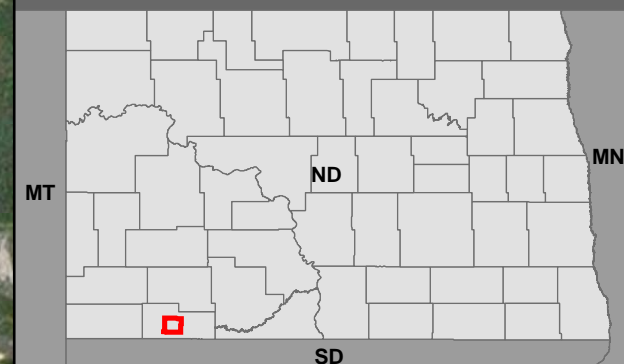
Isopleth Ranges (dBA)



▨ Isopleth Range Exceeding
EPA Guideline (>48.6 dBA)



REFERENCE MAP



Appendix B
Additional Agency Correspondence

Dubuque, Tracey

From: Sexton, James
Sent: Thursday, April 24, 2014 11:44 AM
To: Quinnell, Susan L.
Cc: Dubuque, Tracey; Bennett, Dale; Marshall, Sydne
Subject: RE: ND SHPO REF: 11-18854B PSC PU-11-601 Thunder Spirit Wind Energy Center: Class I and Class II Architectural Reconnaissance Survey in Adams County, North Dakota
Attachments: 20140422_BaseCase_Optimum_Comparison.pdf; email from SHSND re Thunder Spirit Class II HA survey - Map.pdf; email from SHSND re Thunder Spirit Class II HA survey - text.pdf

Hi Susan,

I hope this finds you well. As you may remember, Tetra Tech is supporting Thunder Spirit Wind in permitting their Thunder Spirit Wind Energy Center. In August of last year, the SHSND concurred with our Class I and Class II Survey Report and its conclusions. In the intervening months since then, our client has made minor revisions to the layout of the Project. Would you be able to look at the three attached pdfs to determine whether you are comfortable that the work done for the earlier layout will suffice for the revised one, or if further field work is needed for the Project to move forward?

I have included three attachments:

- [email from SHSND re Thunder Spirit Class II HA survey – text](#): the email which accompanied the map you returned to us with the areas for survey identified
- [email from SHSND re Thunder Spirit Class II HA survey – Map](#): the map that my colleague Adam Holven sent you last spring and your annotations to it indicating the areas to be surveyed that you were requesting
- [20140422_BaseCase_Optimum_Comparison](#): the proposed revisions to the Project layout. The yellow dots represent revised or new turbine locations

Please feel free to call me if you have any questions.

Many thanks,
James

From: Quinnell, Susan L. [<mailto:squinnell@nd.gov>]
Sent: Tuesday, August 20, 2013 3:16 PM
To: Sexton, James
Subject: ND SHPO REF: 11-18854B PSC PU-11-601 Thunder Spirit Wind Energy Center: Class I and Class II Architectural Reconnaissance Survey in Adams County, North Dakota

Hi James,

Here is our concurrence letter on this report. A copy went to Patrick Fahn at PSC.

Susan Quinnell
Review and Compliance Coordinator
ND State Historic Preservation Office
State Historical Society of North Dakota
North Dakota Heritage Center
612 East Boulevard Avenue

Bismarck ND 58505-0830

701-328-3576

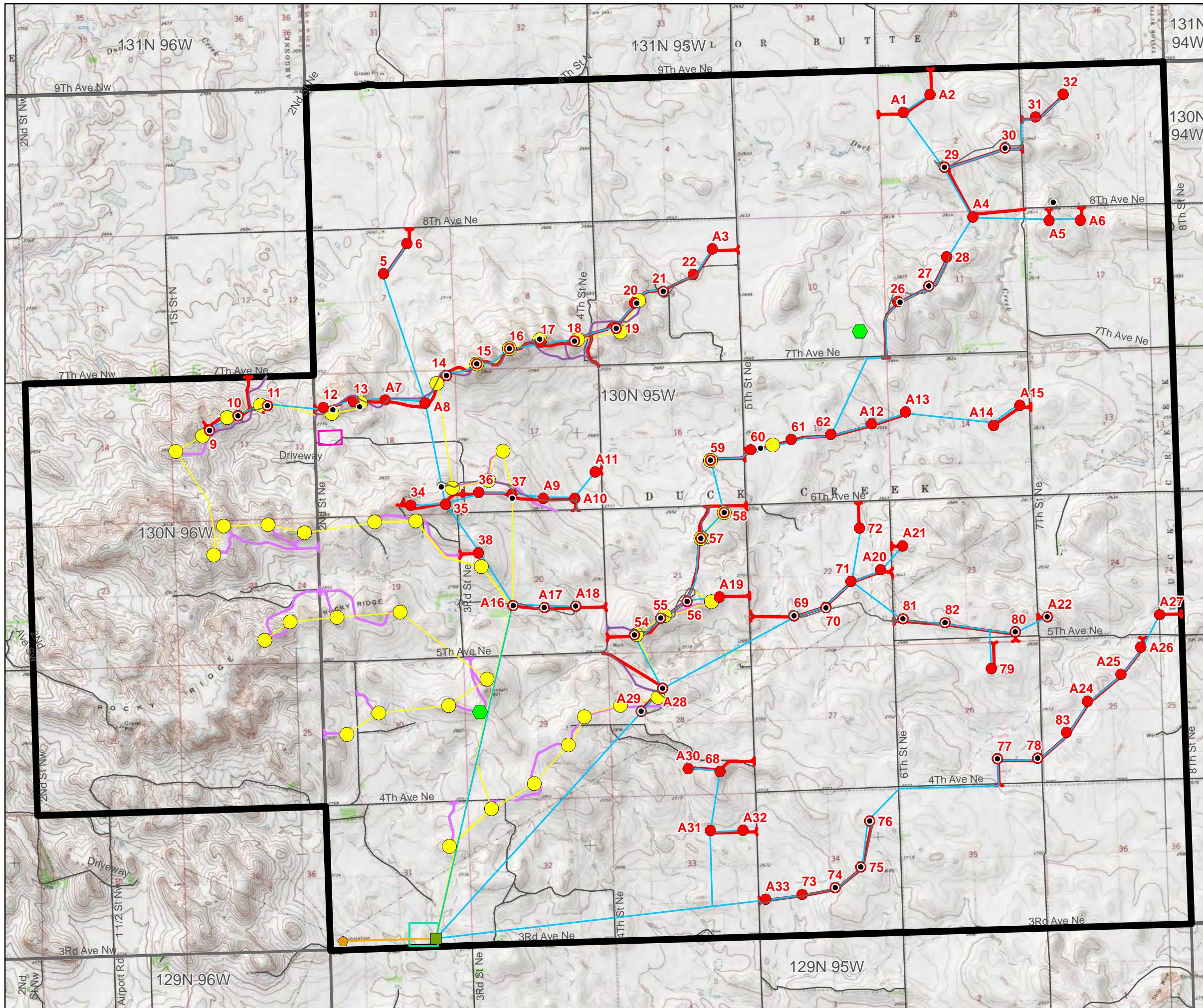
701-328-3710 FAX

Figure 3

Project Area (Topographical)

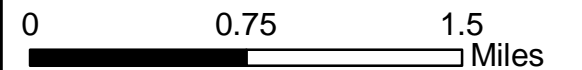
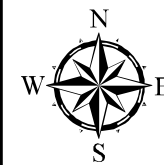
Thunder Spirit Wind Energy Project
Thunder Spirit Wind, LLC
Adams County, North Dakota

May 2013

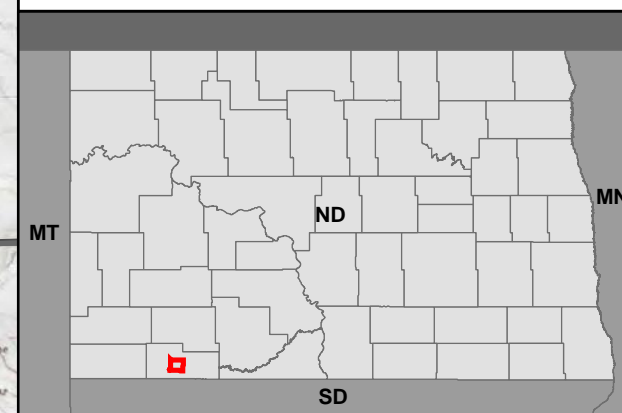


Legend

- Base Case Layout (1/15/2014)
- ◆ Met Tower Location
- ◆ Approximate POI
- Proposed Turbine Location (4/26/2013)
- Proposed Collector Substation (8/15/2013)
- Optimized Layout (4/11/2014)
- Overhead Line (4/8/2013)
- Collection Line (4/26/2013)
- Optimized Layout Phase 1 Electrical Alignment
- Access Road (4/26/2013)
- Base Case Road (Feb 2014)
- Optimized Layout Phase 1 Road
- Construction Laydown Area (10 Acres)
- Collection Substation, O&M Facility, and Additional Laydown Area
- ▭ Project Area (4/26)
- ▭ Township Boundary
- Road



REFERENCE MAP



From: Quinnell, Susan L. [<mailto:squinnell@nd.gov>]

Sent: Tuesday, April 02, 2013 11:05 AM

To: Holven, Adam

Subject: APE for Visual Effects for the Thunder Spirit wind Energy Center ND SHPO Ref: 11-1854

Hi Adam,

Here is a PDF of your map we received yesterday. I put circles or squares around the areas we would like to see a Class II (reconnaissance) survey. That means I'd like to see a photo of each of these 27 sites, keyed to a map. Then if you find any of these 27 sites that have buildings/structures 50 years or older, please fill out a site form with eligibility recommendations on the buildings/structures that are 50 years or older.

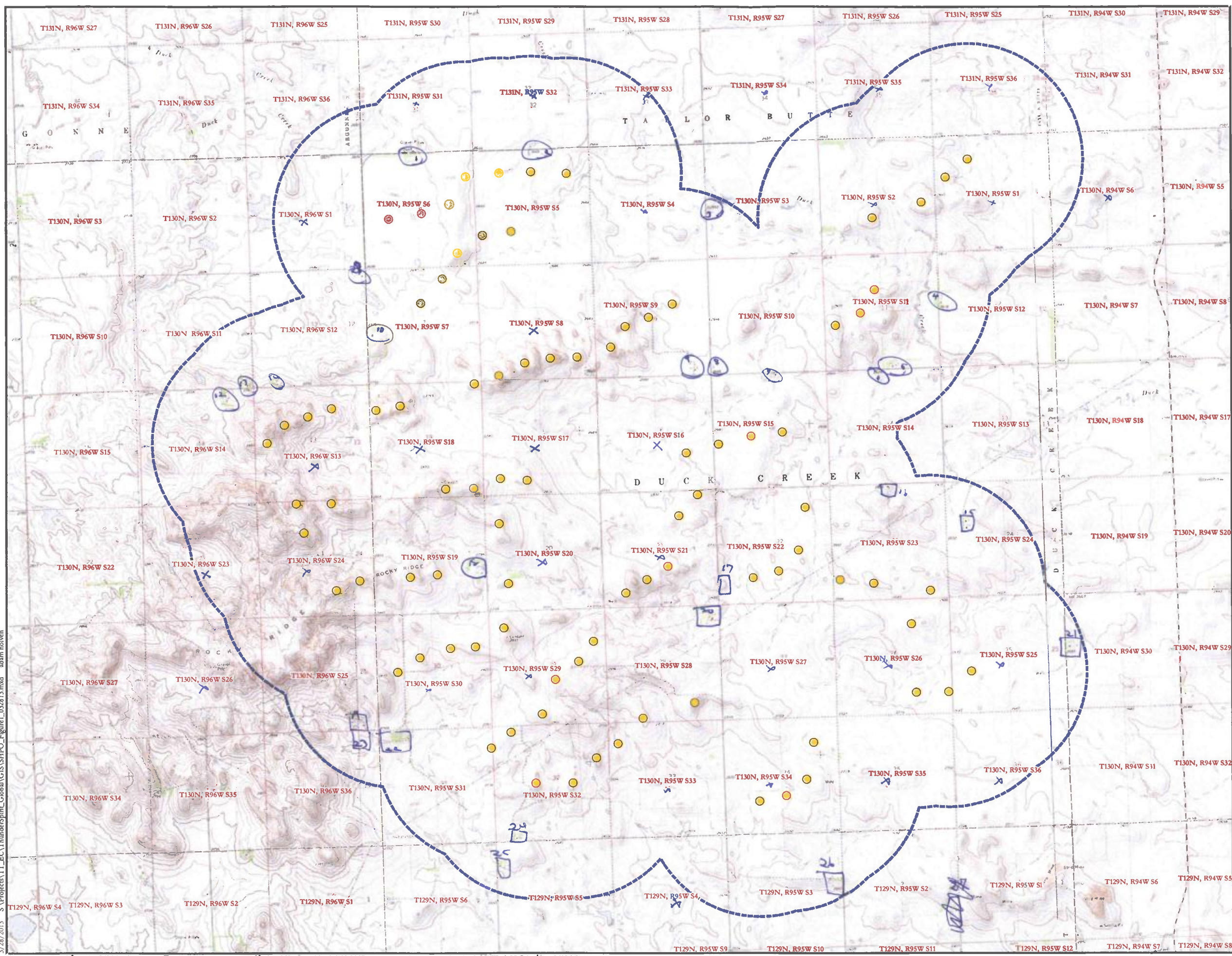
Please let me know that you received this e-mail and if you have any questions.

Thanks,

Susan Quinnell
Review and Compliance Coordinator
ND State Historic Preservation Office
State Historical Society of North Dakota
North Dakota Heritage Center
612 East Boulevard Avenue
Bismarck ND 58505-0830

701-328-3576

701-328-3710 FAX



Facility Layout 3/22/2013

- Proposed Turbine Location
- 1-mile Turbine Layout Buffer
- X = no architectural survey required in that section of land
- = Class II survey of buildings/structures w/ site plan filed out on any structures/buildings found to be 50 years+.



Figure 1:
Turbine Location
with 1-mile Buffer
Thunder Spirit Wind Energy Center
Adams County, North Dakota



3/28/2013 S:\Projects\TT_EC\ThunderSpirit_Global\GIS\SHPO_Figure_1_032813.mxd adam holven

Source: Map adapted from ArcGIS Map Server USA Topos - 24k (T3) for Butte SE [1974] and Heminger North [1974] ND); Global Winds Harvest - Thunder Spirit Wind, LLC (turbines 3/22/13)

Dubuque, Tracey

From: Sexton, James
Sent: Friday, April 25, 2014 2:44 PM
To: Dubuque, Tracey
Cc: Bennett, Dale
Subject: FW: ND SHPO Ref: 11-1854B PSC PU-11-601 Thunder Spirit Wind Energy Center: Class I and Class II Architectural Reconnaissance Survey in Adams County, North Dakota

Here is the sign-off from the SHSND.

J

From: Quinnell, Susan L. [<mailto:squinnell@nd.gov>]
Sent: Friday, April 25, 2014 2:41 PM
To: Sexton, James
Subject: RE: ND SHPO Ref: 11-1854B PSC PU-11-601 Thunder Spirit Wind Energy Center: Class I and Class II Architectural Reconnaissance Survey in Adams County, North Dakota

Hi James,

No more survey for architecture is required based on the maps you e-mailed Thursday April 24, 2014. Assume there will be some bit of additional survey for archaeology.

Thanks for the update and maps.

Susan Quinnell
Review and Compliance Coordinator
ND State Historic Preservation Office
State Historical Society of North Dakota
North Dakota Heritage Center
612 East Boulevard Avenue
Bismarck ND 58505-0830

701-328-3576
701-328-3710 FAX

From: Sexton, James [<mailto:James.Sexton@tetrattech.com>]
Sent: Thursday, April 24, 2014 12:42 PM
To: Quinnell, Susan L.
Subject: RE: ND SHPO Ref: 11-1854B PSC PU-11-601 Thunder Spirit Wind Energy Center: Class I and Class II Architectural Reconnaissance Survey in Adams County, North Dakota

Sorry about that – it's a little bit confusing. My understanding is that the "base case" shows turbine locations that have already been permitted while the "optimized case" includes both permitted and unpermitted turbines (some of these were initially removed due to some FAA issues that have since been resolved).

Hope that helps.

J

From: Quinnell, Susan L. [<mailto:squinnell@nd.gov>]
Sent: Thursday, April 24, 2014 12:34 PM
To: Sexton, James
Subject: RE: ND SHPO Ref: 11-1854B PSC PU-11-601 Thunder Spirit Wind Energy Center: Class I and Class II Architectural Reconnaissance Survey in Adams County, North Dakota

Ok, I almost understand. What does "base case" mean?

Susan Quinnell
Review and Compliance Coordinator
ND State Historic Preservation Office
State Historical Society of North Dakota
North Dakota Heritage Center
612 East Boulevard Avenue
Bismarck ND 58505-0830

701-328-3576
701-328-3710 FAX

From: Sexton, James [<mailto:James.Sexton@tetrattech.com>]
Sent: Thursday, April 24, 2014 10:44 AM
To: Quinnell, Susan L.
Cc: Dubuque, Tracey; Bennett, Dale; Marshall, Sydne
Subject: RE: ND SHPO Ref: 11-1854B PSC PU-11-601 Thunder Spirit Wind Energy Center: Class I and Class II Architectural Reconnaissance Survey in Adams County, North Dakota

Hi Susan,

I hope this finds you well. As you may remember, Tetra Tech is supporting Thunder Spirit Wind in permitting their Thunder Spirit Wind Energy Center. In August of last year, the SHSND concurred with our Class I and Class II Survey Report and its conclusions. In the intervening months since then, our client has made minor revisions to the layout of the Project. Would you be able to look at the three attached pdfs to determine whether you are comfortable that the work done for the earlier layout will suffice for the revised one, or if further field work is needed for the Project to move forward?

I have included three attachments:

- [email from SHSND re Thunder Spirit Class II HA survey – text](#): the email which accompanied the map you returned to us with the areas for survey identified
- [email from SHSND re Thunder Spirit Class II HA survey – Map](#): the map that my colleague Adam Holven sent you last spring and your annotations to it indicating the areas to be surveyed that you were requesting
- [20140422 BaseCase Optimum Comparison](#): the proposed revisions to the Project layout. The yellow dots represent revised or new turbine locations

Please feel free to call me if you have any questions.

Many thanks,
James

From: Quinnell, Susan L. [<mailto:squinnell@nd.gov>]
Sent: Tuesday, August 20, 2013 3:16 PM
To: Sexton, James
Subject: ND SHPO Ref: 11-1854B PSC PU-11-601 Thunder Spirit Wind Energy Center: Class I and Class II Architectural Reconnaissance Survey in Adams County, North Dakota

Hi James,

Here is our concurrence letter on this report. A copy went to Patrick Fahn at PSC.

Susan Quinnell
Review and Compliance Coordinator
ND State Historic Preservation Office
State Historical Society of North Dakota
North Dakota Heritage Center
612 East Boulevard Avenue
Bismarck ND 58505-0830

701-328-3576

701-328-3710 FAX

dan albano

Subject: FW: Thunder Spirit wind project

From: Terri.Johnson@faa.gov [<mailto:Terri.Johnson@faa.gov>]

Sent: Thursday, May 08, 2014 8:03 AM

To: dalbano@globalwinds.com

Subject: RE: Thunder Spirit wind project

After further review, we support the FAA determination of no hazard.

v/r

Terri Johnson
USAF OE/AAA Program Manager, GS-11
A3O-BAR
Eastern Service Area
(404) 305-6920, DSN: 797-5481/5482

From: dan albano [<mailto:dalbano@globalwinds.com>]

Sent: Monday, April 28, 2014 9:39 AM

To: 'terri.johnson@faa.gov'

Subject: Thunder Spirit wind project

Hi Terri

Thanks for your call last Thursday regarding your review of the Thunder Spirit project. Although we don't anticipate any potential impacts to the Power River Training Complex operations we wanted just to be sure. We will be starting road and turbine construction this August.

To help with your review -- here is a study # from one of our turbine locations: 2013-WTE-4680-OE

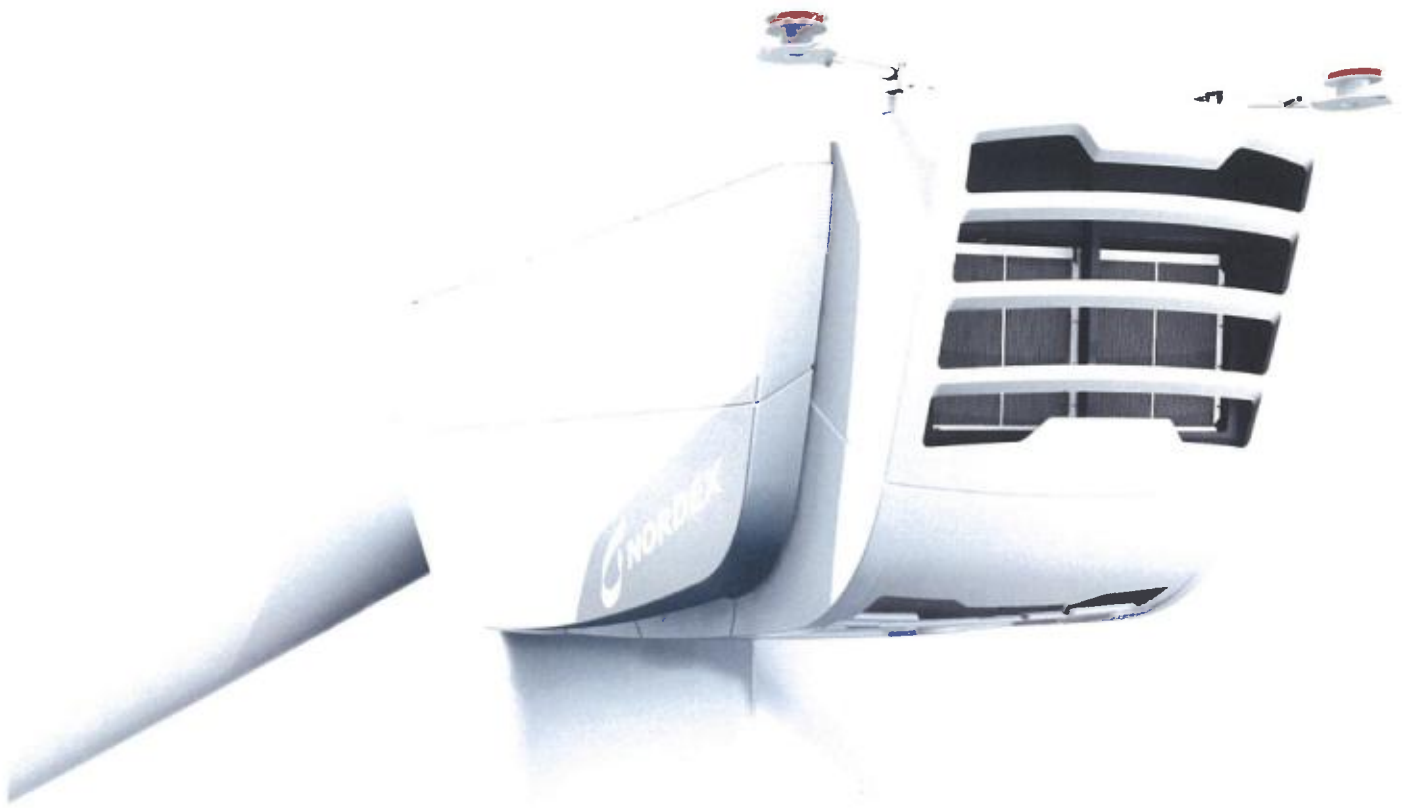
Please let me know if I can provide any other information.

thanks

Dan

Dan Albano
Global Winds Harvest
197 North Street Rd
Argyle, NY 12809
(518) 638-6938

Appendix C
Nordex Turbine Specifications



DESIGNED TO PERFORM
GENERATION GAMMA –
THE 2 MW EFFICIENCY CLASS

N90/2500
N100/2500
N117/2400

 **NORDEX**
We've got the power.

CONTENTS

- 3 NORDEX A PROFILE
Dependable power plants for a clean environment
- 4 THE EFFICIENCY CLASS
Experience puts us one step ahead
- 6 YIELD
Maximum energy yield at any location
- 8 GRID CODE COMPLIANCE
Active support for every grid
- 9 QUALITY
Top-quality engineering - simply routine for us

TURBINE PORTFOLIO AT A GLANCE

- 10 SOLUTION FOR STRONG WIND
Dependable yields in rough climates
- 12 SOLUTION FOR MODERATE WIND
Profitable at varied locations
- 14 SOLUTION FOR LIGHT WIND
Maximum economic efficiency



NORDEX – A PROFILE

Dependable power plants for a clean environment

Economic prosperity, progress and environmental protection – for Nordex these go hand in hand. Since 1985, we have been developing increasingly effective wind turbines that help meet the growing global demand for energy while reducing the impact on the environment.

As an internationally expanding company, Nordex has a footprint in all the growth markets. Our factories in Germany, China and the United States serve the markets in the core regions of Europe, Asia and the Americas. We deliver tailor-made, all-round solutions to our customers – from planning a wind farm, through turnkey installation, to maintenance and service. The “Nordex Academy” provides high quality training to all our staff, guaranteeing superior expertise as a supplier of sophisticated products and services.

Our core competence is wind turbines in the power range up to 2.5 MW. In the Gamma Generation: Efficiency Class we offer different types of machines for each wind class using a common technical platform. Nordex customers can be sure they’ll have the most effective product for every location.



THE EFFICIENCY CLASS

Experience puts us one step ahead

The Efficiency Class combines the latest research and development with know-how and experience from more than a decade of operation to meet today's market requirements. In 2000, Nordex installed the first 2.5 MW series turbine in the world and has put more than 2,100 machines of this type on grid since then. When we say that our turbines offer high quality, mature technology and dependable performance even in extreme locations, we know what we're talking about.

Nordex continues to develop the Efficiency Class. Yet we remain true to proven principles, using tried and tested series engineering and giving top priority to the dependability of all system components. We ensure that Nordex wind turbines are capital goods that generate reliable yields over a period of at least 20 years.



➤ *The Efficiency Class combines proven, reliable technology with enhanced performance.*

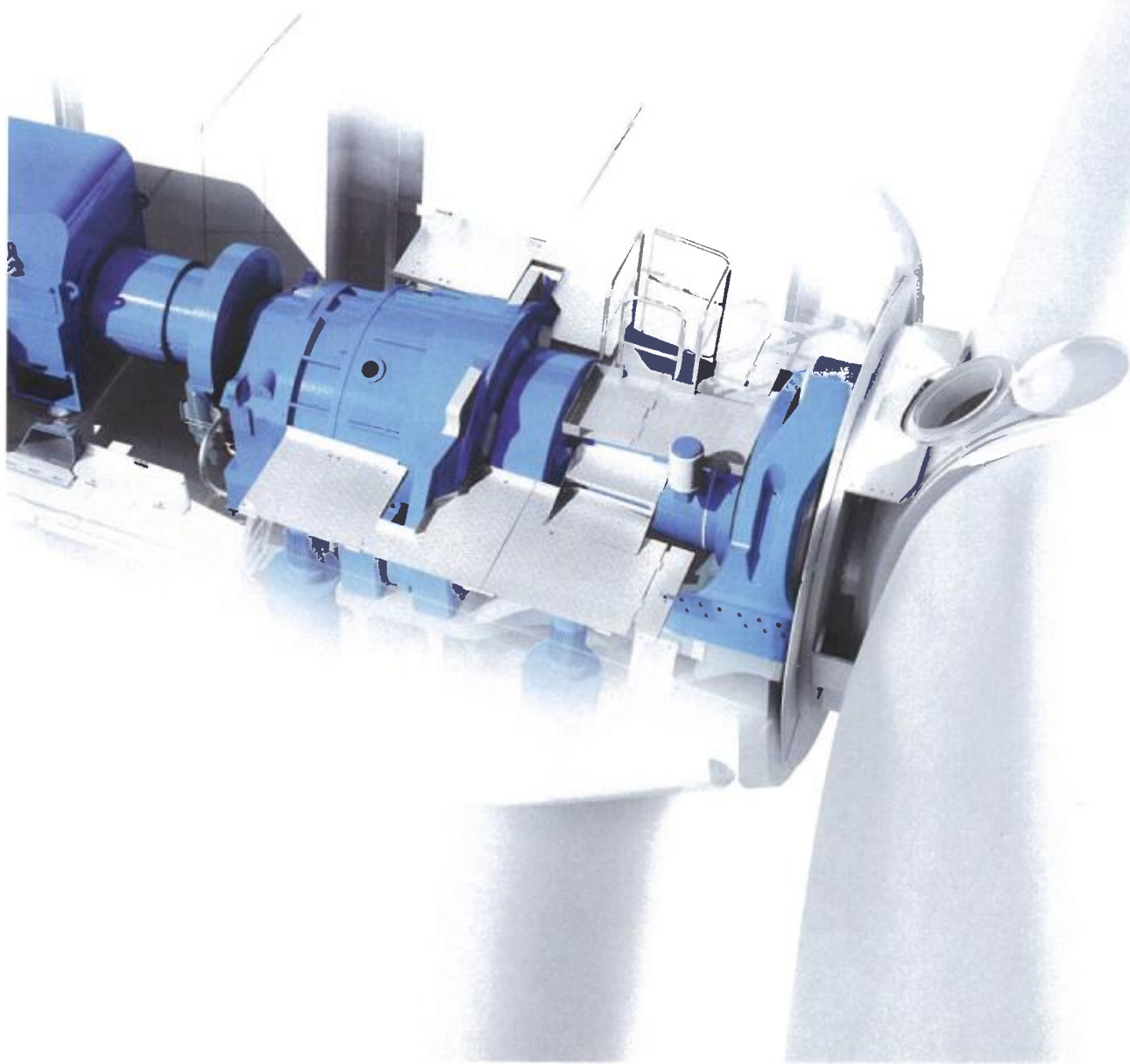
The Nordex Efficiency Class

sets the highest standards for

➤ yield

➤ grid code compliance

➤ quality



YIELD

Maximum wind yield at any location

Our commitment to continuous development ensures that Nordex wind turbines offer a high level of technical availability of more than 97 percent, making it even more worthwhile to invest in a turbine of the Efficiency Class.

The perfect machine for every type of wind

With its N90/2500, N100/2500 and N117/2400 turbines the Efficiency Class achieves the maximum yield at every site. Nordex offers the N90/2500 for regions with strong winds and the N100/2500 for areas with moderate wind conditions. The N117/2400 has been specially designed for locations with light winds and with a rotor diameter of 117 metres it is the largest turbine in its power class.

Smart options

Many good wind locations are in regions with extreme temperatures. To capitalise on the potential of these locations, Nordex offers the machines in the Efficiency Class with a hot-climate package or an anti-icing system. Turbines in the hot-climate design have an extended operating range and are available for outside temperatures up to 45 degrees Celsius. The anti-icing system is an innovative Nordex component that heats the rotor blades, freeing them from icing and preventing new ice from forming. These two options make operation of the turbines even more profitable for our customers.

➤ *The Nordex Efficiency Class also includes a 141-metre hybrid tower*



Service – simple, fast and safe

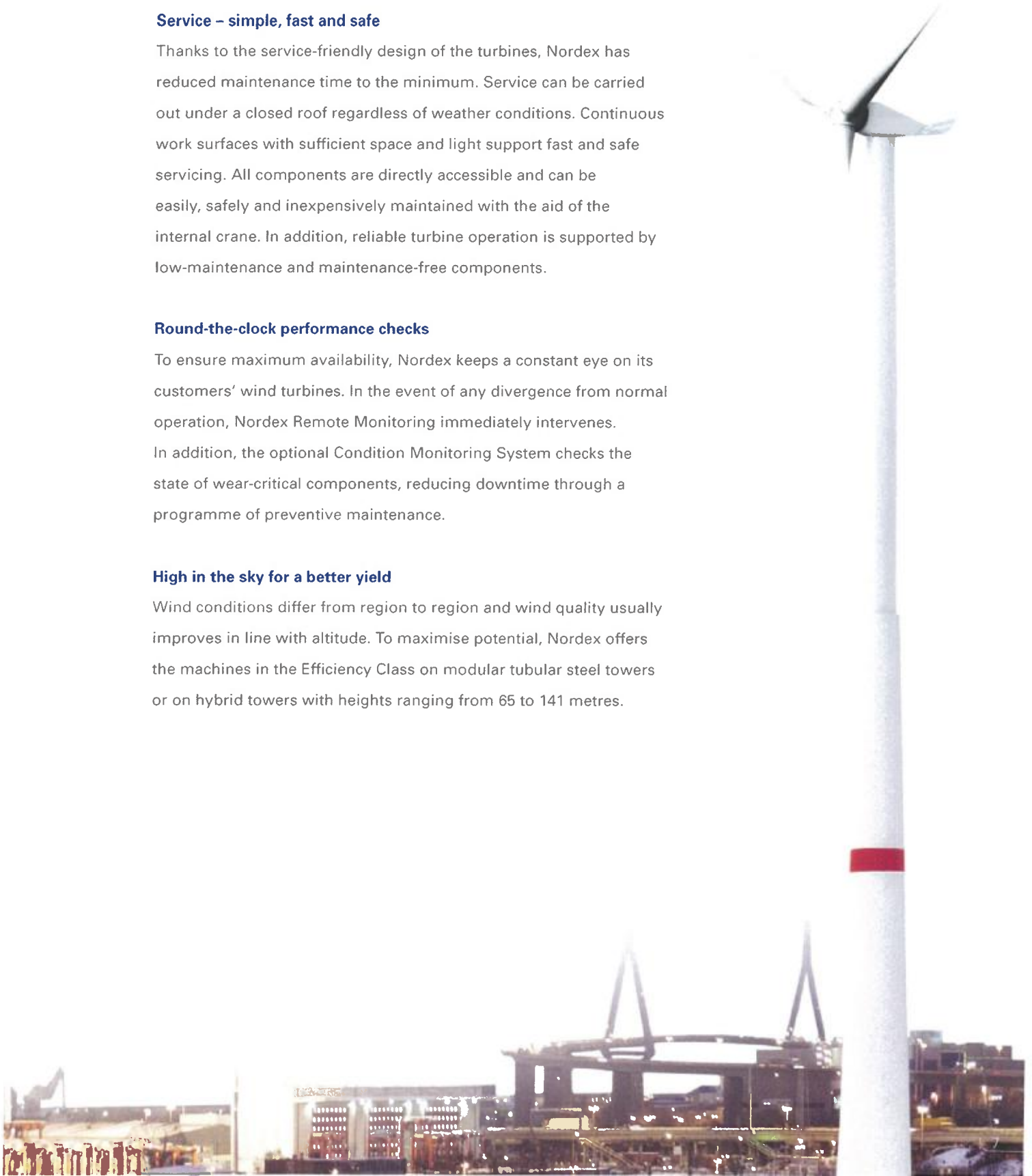
Thanks to the service-friendly design of the turbines, Nordex has reduced maintenance time to the minimum. Service can be carried out under a closed roof regardless of weather conditions. Continuous work surfaces with sufficient space and light support fast and safe servicing. All components are directly accessible and can be easily, safely and inexpensively maintained with the aid of the internal crane. In addition, reliable turbine operation is supported by low-maintenance and maintenance-free components.

Round-the-clock performance checks

To ensure maximum availability, Nordex keeps a constant eye on its customers' wind turbines. In the event of any divergence from normal operation, Nordex Remote Monitoring immediately intervenes. In addition, the optional Condition Monitoring System checks the state of wear-critical components, reducing downtime through a programme of preventive maintenance.

High in the sky for a better yield

Wind conditions differ from region to region and wind quality usually improves in line with altitude. To maximise potential, Nordex offers the machines in the Efficiency Class on modular tubular steel towers or on hybrid towers with heights ranging from 65 to 141 metres.



GRID CODE COMPLIANCE

Active support for every grid

The turbines in the Efficiency Class are characterised by excellent control capabilities for maintaining the voltage and stabilising the frequency of the public grid. They meet all the requirements for the German system service bonus (known as the SDL-Bonus).* Their fault-ride-through capability enables them to bridge effortlessly any dips in voltage. The Nordex wind farm management system allows the grid operator to directly control the rated and reactive power of the wind farm in the grid.

With these features, the turbines are certified for the grids of the most demanding international markets. They can also be adapted to new and complex connection requirements ensuring seamless integration into the local grid.

Always striving to progress

Our aim is to offer the best power quality on the market. Nordex intensively tests grid connection technology, both in the field and on the test bench. This is why our wind turbines have long been recognised for quality and dependability of supply equal to or better than those of conventional power plants.

* The requirements for the SDL bonus are regulated in Germany in the System Service Ordinance (SDLWindV). They are among the strictest grid guidelines in Europe.

➤ *Nordex makes sure that the machines in the Efficiency Class always comply with the latest grid requirements.*



QUALITY

Top-quality engineering – simply routine for us

Thanks to their sophisticated design, the wind turbines in the Efficiency Class are certified quality products. From the earliest development phase Nordex engineers check the stress levels of materials and components using advanced computer-aided calculation routines. These are followed by extensive testing in the Nordex Test Centre and in the field.

Extreme testing of hardware and software

In the Nordex Test Centre our engineers inspect the components and systems of the prototypes under simulated wind and weather conditions. By subjecting them to stress exceeding the usual specifications, such as extreme climate and vibration tests, Nordex ensures that they meet all quality criteria and that a high-quality and technically mature product goes into series production.

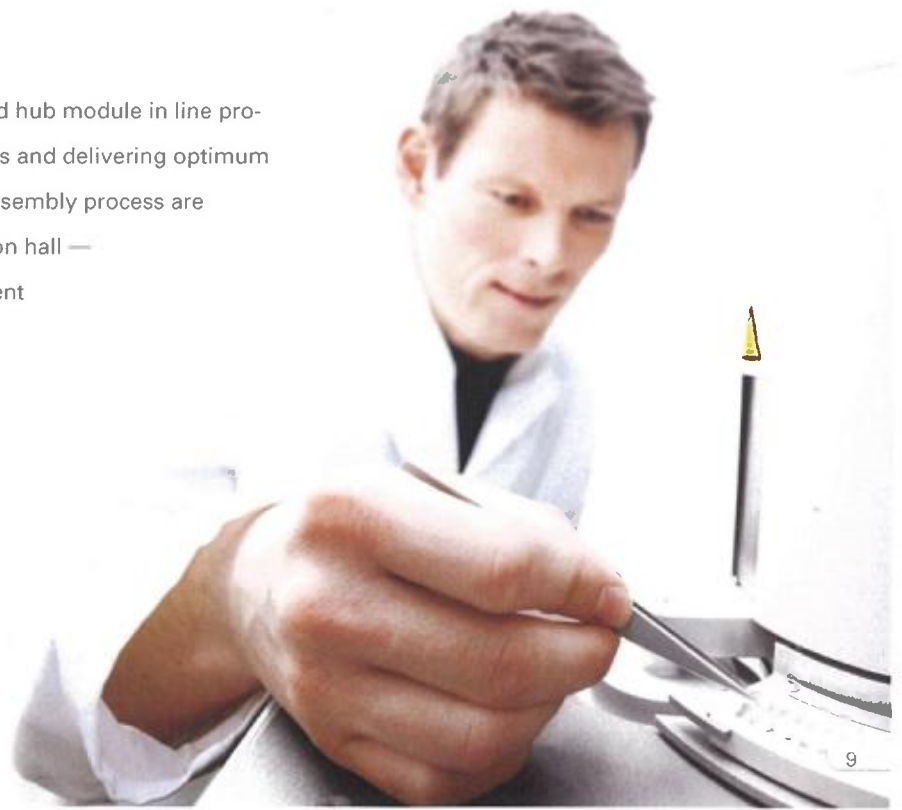
Quality-assured rotor blades

Nordex sets especially high standards when it comes to the materials used for our rotor blades, which can be up to 58 meters in length. Automated production processes, monitored by the latest measuring and testing methods, guarantee that each rotor blade works reliably.

➤ *An eye for detail: in the laboratory Nordex checks the materials for the rotor blade.*

Highest industry standards

Nordex manufactures the nacelle and hub module in line production, setting the highest standards and delivering optimum product quality. Many steps in the assembly process are performed in the protected production hall — a key prerequisite for the most efficient installation of turbines at the wind farm.





SOLUTION FOR STRONG WIND

Dependable yields in rough climates

Wind locations with rough climates require mature, robust technology. The IEC-1-certified N90/2500 has been specifically designed for these conditions. For any strong wind site, it is the first choice for its price/performance ratio.

Nordex has already connected the N90/2500 to the grid hundreds of times in Europe, Asia and North America.

➤ *The N90/2500 is the most frequently installed turbine in the Efficiency Class and has proven itself around the globe.*



FACTS AND FIGURES

N90/2500 IEC I	
Operating data	
Rated power	2,500 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	25 m/s
Rotor	
Diameter	90 m
Swept area	6,362 m ²
Operating range rotational speed	10.3 - 19.1 rpm
Rated rotational speed	16.1 rpm
Tip speed	75 m/s
Speed control	Variable via microprocessor
Overspeed control	Pitch angle
Gearbox	
Construction	Combined spur/planetary gear or differential gearbox
Generator	
Construction	Double-fed asynchronous generator
Cooling system	Liquid/air cooling
Voltage	660 V
Grid frequency	50/60 Hz
Control	
Control centre	PLC controlled
Grid connection	Via IGBT converter
Distance control	Remote controlled surveillance system
Brake system	
Main brake	Pitch angle
Secondary brake	Disk brake
Lightning protection	Fully compliant with EN 62305
Tower	
Construction	Tubular steel tower
Rotor hub height/Certification	65 m/IEC 1a
	70 m/IEC 1a
	80 m/IEC 1a





SOLUTION FOR MODERATE WIND *Profitable at varied locations*

For projects with moderate wind speeds Nordex offers the N100/2500 turbine. The N100/2500 is one of the machines with the highest yield at IEC 2 locations. For even more efficiency Nordex has raised the cut-out wind speed from 20 to 25 m/s.

Thanks to their robust technology, the N100/2500 is ideal for wind farms in the widely different climatic conditions prevailing around the world.

➤ *The N100/2500 is one of the highest yielding machines at IEC 2 locations.*



FACTS AND FIGURES

N100/2500 IEC II	
Operating data	
Rated power	2,500 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	25 m/s
Rotor	
Diameter	99.8 m
Swept area	7,823 m ²
Operating range rotational speed	9.6 – 16.8 rpm
Rated rotational speed	14.9 rpm
Tip speed	77 m/s
Speed control	Variable via microprocessor
Overspeed control	Pitch angle
Gearbox	
Construction	Combined spur/planetary gear or differential gearbox
Generator	
Construction	Double-fed asynchronous generator
Cooling system	Liquid/air cooling
Voltage	660 V
Grid frequency	50/60 Hz
Control	
Control centre	PLC controlled
Grid connection	Via IGBT converter
Distance control	Remote controlled surveillance system
Brake system	
Main brake	Pitch angle
Secondary brake	Disk brake
Lightning protection	
	Fully compliant with EN 62305
Tower	
Construction	Tubular steel tower
Rotor hub height/Certification	75 m/IEC 2a
	80 m/IEC 2a
	100 m/IEC 2a





SOLUTION FOR LIGHT WIND

Maximum economic efficiency

To make IEC 3 locations economically viable, project operators need a turbine that can exploit even low winds to the maximum. With a rotor sweep of 10,715 square metres, the N117/2400 is the IEC 3 turbine with the highest yield in its category. The maximum acoustic power level is 105 decibels, which means that the machine can be installed nearer to residential areas and that a wind farm can be optimally laid out in the available space.

With a capacity factor of 40 percent, the N117/2400 is the most profitable solution for low wind locations.

➤ *The 117-metre diameter rotor makes the N117/2400 the best solution for low wind sites.*



FACTS AND FIGURES

N117/2400 IEC III	
Operating data	
Rated power	2,400 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	20 m/s
Rotor	
Diameter	116,8 m
Swept area	10,715 m ²
Operating range rotational speed	7,5 - 13,2 rpm
Rated rotational speed	11,2 rpm
Tip speed	72 m/s
Speed control	Variable via microprocessor
Overspeed control	Pitch angle
Gearbox	
Construction	Combined spur/planetary gear or differential gearbox
Generator	
Construction	Double-fed asynchronous generator
Cooling system	Liquid/air cooling
Voltage	660 V
Grid frequency	50/60 Hz
Control	
Control centre	PLC controlled
Grid connection	Via IGBT converter
Distance control	Remote controlled surveillance system
Brake system	
Main brake	Pitch angle
Secondary brake	Disk brake
Lightning protection	
	Fully compliant with EN 62305
Tower	
Construction	Tubular steel tower, Hybrid tower (141 m)
Rotor hub height/Certification	91 m/IEC 3a, DIBt2 120 m/IEC 3a, DIBt2 141 m/IEC 3a, DIBt2



WORLDWIDE OFFICES and subsidiaries

Nordex SE

Langenhorner Chaussee 600
22419 Hamburg, Germany
Phone: +49 40 30030 1000
Fax: +49 40 30030 1101
E-Mail: info@nordex-online.com

Service

Nordex Energy GmbH

Langenhorner Chaussee 600
22419 Hamburg, Germany
Phone: +49 40 30030 1000
Fax: +49 40 30030 1101
E-Mail: info@nordex-online.com

Germany

Nordex Energy GmbH

Centroallee 263 a
46047 Oberhausen, Germany
Phone: +49 208 8241 120
Fax: +49 208 8241 105
E-Mail: SalesGermany@nordex-online.com

Denmark, Norway, Baltic countries

Nordex Energy GmbH

Niels Bohrs Vej 12 B
6000 Kolding, Denmark
Phone: +45 75 73 44 00
Fax: +45 75 73 41 47
E-Mail: SalesDenmark@nordex-online.com

UK

Nordex UK Ltd.

Suite 4, Egerton House
The Towers Business Park, Wilmslow Road
Didsbury M20 2DX, United Kingdom
Phone: +44 161 445 99 00
Fax: +44 161 445 99 88
E-Mail: SalesUK@nordex-online.com

Ireland

Nordex Energy Ireland Ltd.

Clonmel House, Forster Way
Swords, Co. Dublin, Ireland
Phone: +353 1 897 0260
Fax: +353 1 897 0299
E-Mail: SalesIreland@nordex-online.com

Austria, South-east Europe

Nordex Energy GmbH

Am Wassen 20
4755 Zell an der Pram, Austria
Phone: +43 7764 69259
Fax: +43 7764 69259 20
E-Mail: SalesAustria@nordex-online.com

France

Nordex France S.A.S.

1, Rue de la Procession
93217 La Plaine Saint-Denis, France
Phone: +33 1 55 93 43 43
Fax: +33 1 55 93 43 40
E-Mail: SalesFrance@nordex-online.com

Spain

Nordex Energy Ibérica S.A.

Pso. de la Castellana, 23 2º-A
28046 Madrid, Spain
Phone: +34 91 7000356
Fax: +34 91 3199388
E-Mail: SalesSpain@nordex-online.com

Sweden

Nordex Sverige AB

Kungsängsvägen 25
75323 Uppsala, Sweden
Phone: +46 18 185 900
Fax: +46 18 185 927
E-Mail: SalesSweden@nordex-online.com

Finland

Nordex Energy GmbH

Bulevardi 7
00120 Helsinki, Finland
Phone: +358 (50) 375 1795
E-Mail: SalesFinland@nordex-online.com

Benelux

Nordex Energy GmbH Benelux

It Reidlân 79
8502 CE Joure, Netherlands
Phone: +31 513 41 23 54
Fax: +31 513 41 85 88
E-Mail: SalesBenelux@nordex-online.com

Italy

Nordex Italia S.r.l.

Viale Città d'Europa 679
00144 Rome, Italy
Phone: +39 06 83 46 30 1
Fax: +39 06 83 46 30 60
E-Mail: SalesItaly@nordex-online.com

Poland

Nordex Polska Sp. z o.o.

Ul. Pulawska 182
02-670 Warsaw, Poland
Phone: +48 22 20 30 140
Fax: +48 22 20 30 146
E-Mail: SalesPoland@nordex-online.com

Romania

Nordex Energy Romania S.R.L.

Strada CA Rosetti nr 17
etaj 7, birou 703, sector 2
020011 Bucharest, Romania
Tel.: +40 21 527 0556
Fax: +40 21 527 0310
E-Mail: SalesRomania@nordex-online.com

Turkey

Nordex Enerji A.Ş.

Havaalanı Kavşağı EGS Business Park Blokları
B1 Blok Kat: 15 No: 451-452-453,
Yeşilköy, Istanbul, Turkey
Phone: +90 212 468 37 37
Fax: +90 212 465 36 04-05
E-Mail: SalesTurkey@nordex-online.com

Asia

Nordex China

Room 808, First Shanghai Center, No. 39
Liangmaqiao Road, Chaoyang District
Peking 100125, VR China
Phone: +86 10 84 53 51 88
Fax: +86 10 84 53 51 58
E-Mail: SalesChina@nordex-online.com

Americas

Nordex USA, Inc.

300 South Wacker Drive, Suite 1500
Chicago, Illinois 60606, USA
Phone: +1 312 386 4100
Fax: +1 312 386 4101
E-Mail: SalesUSA@nordex-online.com

Rest of the World

Nordex Energy GmbH

Langenhorner Chaussee 600
22419 Hamburg, Germany
Phone: +49 40 30030 1490
Fax: +49 40 30030 1491
E-Mail: info@nordex-online.com

© Nordex 2013. All rights reserved. The contents of this document are for informational purposes only and may be subject to change without notice. No representation or warranty, whether expressed or implied, is given or should be relied upon as to the adequacy and accuracy of the information contained herein.

Reproduction, use or disclosure to third parties, without our written consent, is not permitted.

As of: 01/2013



Appendix D
Distance from Receptors to Turbines

Distance from Receptors to Turbines (5/27/14 layout)

Receptor ID	Type	Signed Status	Parcel Owner Name	TwnRange	Section	Nearest Turbine	Distance (miles)	Distance (feet)
0	Residence	Not Signed	Occupied	T129N R96W	1	32	5.40	8686.89
1	Residence	Not Signed	Occupied	T129N R95W	2	38	11.59	18652.08
2	Residence	Not Signed	Occupied	T129N R95W	6	32	4.65	7485.91
3	Residence	Not Signed	Occupied	T129N R95W	3	38	8.45	13596.58
4	Residence	Not Signed	Occupied	T129N R95W	5	32	3.01	4836.22
5	Residence - Abandoned	Not Signed	Abandoned	T129N R95W	6	32	2.39	3847.03
6	Residence	Not Signed	Occupied	T130N R95W	32	32	2.41	3881.77
7	Residence	Not Signed	Occupied	T130N R96W	36	32	3.97	6384.02
8	Residence	Not Signed	Occupied	T130N R96W	35	23	7.32	11788.26
9	Residence	Not Signed	Occupied	T130N R96W	35	28	5.86	9429.18
10	Residence	Signed Easement	Occupied	T130N R95W	31	28	1.90	3056.88
11	Residence	Not Signed	Occupied	T130N R96W	25	28	1.73	2789.92
12	Residence	Signed Easement	Occupied	T130N R95W	28	38	2.30	3696.97
13	Residence - Abandoned	Not Signed	Abandoned	T130N R94W	30	41	11.33	18227.35
14	Residence - Abandoned	Not Signed	Abandoned	T130N R94W	30	41	11.24	18096.84
15	Residence	Not Signed	Occupied	T130N R94W	30	45	11.19	18004.42
16	Residence	Signed Easement	Occupied	T130N R95W	28	38	1.66	2674.25
17	Residence	Signed Easement	Occupied	T130N R95W	28	41	1.68	2709.71
18	Residence	Not Signed	Occupied	T130N R96W	22	14	4.94	7945.58
19	Residence	Not Signed	Occupied	T130N R95W	24	45	6.95	11183.60
20	Residence	Not Signed	Occupied	T130N R95W	19	19	1.68	2709.57
21	Residence	Not Signed	Occupied	T130N R95W	23	45	4.55	7314.60
22	Residence	Not Signed	Occupied	T130N R96W	15	1	6.14	9889.06
23	Residence	Signed Easement	Occupied	T130N R96W	14	1	1.67	2685.51
24	Residence	Not Signed	Occupied	T130N R96W	11	2	1.66	2665.37
25	Residence	Signed Easement	Occupied	T130N R95W	15	45	2.19	3529.89
26	Residence	Signed Easement	Occupied	T130N R95W	9	13	2.29	3681.28
27	Residence	Not Signed	Occupied	T130N R95W	11	45	4.97	7998.99
28	Residence	Not Signed	Occupied	T130N R95W	7	5	2.29	3679.60
29	Residence	Not Signed	Occupied	T130N R94W	7	45	9.80	15775.36
30	Residence	Signed Easement	Occupied	T130N R95W	12	45	7.07	11377.37
31	Residence	Not Signed	Occupied	T130N R96W	12	4	3.92	6315.63
32	Residence - Abandoned	Signed Easement	Abandoned	T130N R95W	6	9	3.29	5299.12
33	Residence	Not Signed	Occupied	T130N R95W	6	8	6.75	10863.07
34	Residence	Not Signed	Occupied	T131N R95W	28	13	10.97	17657.89