APPLICATION TO THE PUBLIC UTILITIES COMMISSION OF THE STATE OF SOUTH DAKOTA FOR A FACILITY PERMIT TO CONSTRUCT A 300 MEGAWATT WIND FACILITY

CROWNED RIDGE WIND FARM

Crowned Ridge Wind, LLC

JANUARY 30, 2019

Table of Contents

1.1 Executive Summary Introduction 1

1.2 Completeness Checklist 2

2.0 Description of the Nature and Location of the Project 10

2.1 The Project 10

3.0 Name of Owner, Manager, and Participants (ARSD 20:10:22:06; 20:10:22:07) 14

4.0 Purpose of, and Demand for, the Wind Energy Facility (ARSD 20:10:22:08, 20:10:22:10) 15

4.1 Wind Resources Areas 15

4.2 Renewable Power Demand 16

4.3 Consequences of Delay 16

5.0 Estimated Cost of the Wind Energy Facility (ARSD 20:10:22:09) 17

6.0 General Site and Project Component Description (ARSDS 20:10:22:11) 18

6.1 Turbines 19

6.2 Access Roads and Crane Paths 21

6.3 Underground Electrical Collection Lines and Junction Boxes 21

6.4 Collection Substation 22

6.5 Interconnection Facilities and Reactive Power Compensation Station 22

6.6 Meteorological Tower 22

6.7 O&M Facility 22

6.8 SCADA System 23

6.9 Concrete Batch Plant 23

6.10 Laydown Area 24

6.11 Construction 24

6.12 Operations 25

7.0 Alternative Sites and Siting Criteria (ARSD 20:10:22:12) 26

7.1 General Project Location Selection 26

7.2 Site Configuration Alternatives 27

7.3 Lack of Reliance on Eminent Domain Powers 28

8.0 Environmental Information (ARSD 20:10:22:13) 29

9.0 Effect on Physical Environment (ARSD 20:10:22:14) 32

9.1 Geological Resources 32

9.1.1 Existing Geological Resources 32
9.1.2 Geological Resources Impacts/Mitigation 34
9.2 Soil Resources 35
9.2.1 Existing Soil Resources 36
9.2.2 Soil Resources Impacts/Mitigation 37
9.2.3 Prime Farmland Impacts 38
9.2.4 Mitigation 38
10.0 Effect on Hydrology (ARSD 20:10:22:15) 40
10.1 Groundwater Resources 40
10.1.1 Existing Groundwater Resources 40
10.1.2 Groundwater Resources Impacts/Mitigation 41
10.2 Surface Water Resources 42
10.2.1 Existing Surface Water Resources 42
10.2.2 Surface Water Resources Impacts/Mitigation 44
10.3 Current and Planned Water Uses 46
10.3.1 Current and Planned Water Uses within Project Area 46
10.3.2 Effect on Current or Planned Water Use 46
11.0 Effect on Terrestrial Ecosystems (ARSD 20:10:22:16) 47
11.1 Vegetation (Flora) 47
11.1.1 Existing Vegetation 47
11.1.2 Vegetation Impacts/Mitigation 50
11.2 Wetlands and Waterbodies 51
11.2.1 Existing Wetlands and Waterbodies 51
11.2.2 Wetland and Waterbody Impacts/Mitigation 52
11.3 Wildlife (Fauna) 53
11.3.1 Existing Wildlife 53
11.3.2 Wildlife Impacts/Mitigation 66
12.0 Effect on Aquatic Ecosystems (ARSD 20:10:22:17) 70
12.1 Existing Aquatic Ecosystems 70
12.1.1 Federally Listed Aquatic Species 70
12.1.2 State-Listed Aquatic Species 70
12.2 Aquatic Ecosystems Impacts/Mitigation 72

13.0 Land Use (ARSD 20:10:22:18) 73
13.1 Land Use 73
13.1.1 Existing Land Use 73
13.1.2 Land Use Impacts/Mitigation 74
13.2 Public Lands and Conservation Easements 78
13.2.1 Existing Public Lands and Conservation Easements 78
13.2.2 Impacts/Mitigation to Public Lands and Conservation Easements 79
13.3 Sound 79
13.3.1 Existing Sound Levels and Regulatory Framework 80
13.3.2 Sound Level Impacts/Mitigation 82
13.4 Shadow Flicker 84
13.5 Electromagnetic Interference 86
13.6 Visual Resources 86
13.6.1 Existing Visual Resources 86
13.6.2 Visual Impacts 86
14.0 Local Land Use Controls (ARSD 20:10:22:19) 88
15.0 Water Quality (ARSD 20:10:22:20) 89
15.1 Existing Water Quality 89
15.2 Water Quality Potential Impacts/Mitigation 89
16.0 Air Quality (ARSD 20:10:22:21) 92
16.1 Existing Air 92
16.2 Air Quality Impacts/Mitigation 92
17.0 Time Schedule (ARSD 20:10:22:22) 94
18.0 Community Impact (ARSD 20:10:22:23) 95
18.1 Socioeconomic and Community Resources 95
18.1.1 Existing Socioeconomic and Community Resources 95
18.1.2 Socioeconomic and Community Resources Impacts/Mitigation 98
18.2 Commercial, Industrial and Agricultural Sectors 100
18.2.1 Existing Agricultural Sector 100
18.2.2 Agricultural Impacts/Mitigation 101
18.3 Community Facilities and Services 102
18.3.1 Existing Community Facilities and Services 102

18.3.2 Community Facilities and Services Impacts/Mitigation 102
18.3.3 Emergency Response 102
18.4 Transportation 103
18.4.1 Existing Environment 103
18.4.2 Transportation Impacts and Mitigation 103
18.5 Telecommunications 103
18.5.1 Existing Telecommunications 104
Telecommunications Impacts/Mitigation 104
18.6 Cultural Resources 104
18.6.1 Existing Cultural Resources 105
18.6.2 Level III Survey for Cultural Resources and Architectural History Survey 107
18.6.3 Cultural Resource Impacts/Mitigation 108
19.0 Employment Estimates (ARSD 20:10:22:24) 111
20.0 Future Additions and Modifications (ARSD 20:10:22:25) 112
21.0 Decommissioning of Wind Energy Facility (ARSD 20:10:22:33:01) 113
22.0 Reliability and Safety (ARSD 20:10:22:33.02(8)) 114
22.1 Reliability 114
22.2 Safety 114
23.0 Information Concerning Wind Energy Facilities (ARDS 20:10:22:33:02) 116
24.0 Additional Information in Application (ARSD 20:10:22:36) 117
24.1 Permits and Approvals 117
24.2 Agency Coordination 117
24.3 Applicant's Burden of Proof 117
25.0 Testimony And Exhibits (ARSD 20:10:22:39) 120
26.0 Applicant's Verification 121
27.0 References 122

List of Appendices

Appendix A Figures

Appendix B Agency Coordination

Appendix C DASK-POSK Survey Report

Appendix D 2017-2018 Raptor Nest Survey Report

Appendix E Avian Use Survey Report

Appendix F Bat Habitat Assessment Report

Appendix G Bat Acoustic Survey Report

Appendix H Sound Level Modeling Report

Appendix I Shadow Flicker Modeling Report

Appendix J County Conditional Use Permits

Appendix K Property Value Effect Studies

Appendix L Decommissioning Plan

Appendix M Telecommunication Studies

List of Figures

Figure 1 – Project Area

Figure 2 – Public Lands and Facilities

Figure 3 – Project Map

Figure 4a – Typical Wind Turbine Diagram

Figure 4b – Typical Wind Turbine Diagram

Figure 5 – Typical Turbine Construction Site Layout

Figure 6 – Environmental Constraints

Figure 7 – Constraints Map

Figure 8 – Topographic Map

Figure 9a – Surficial Geology

Figure 9b – Geology Cross Sections

Figure 10 – Bedrock Geology

Figure 11 – Soil Types

Figure 12 – Water Resources

Figure 13 – Land Use

Figure 14 – Common Sound Levels in the Environment

List of Tables

Table 1.2 Completeness Checklist

Table 6.1 Sections that intersect the Project Area

Table 6.2 Sections Containing Project Features

Table 6.3 Wind Turbine Characteristics

Table 8.1. Summary of Crowned Ridge Wind Disturbance Impacts

Table 9.2.1.3. Farmland Classification within the Project Area and Project Construction Easement

Table 9.2.3. Estimated Temporary and Permanent Impacts to Farmland

Table 10.2.1.1 USGS-Named Streams/Rivers and Floodplains within the Project Construction Easement

Table 10.2.1.2 NWI-Mapped Wetlands Identified within Project Area and Project Construction Easement

Table 11.1.1 Land Cover within the Project Area and Project Construction Easement

Table 11.1.1.2 Noxious Weeds with Potential to Occur in the Project Area

Table 11.1.2 Temporary and permanent impacts as a result of the Project

Table 11.2.1 NWI Wetlands and Waterbodies Mapped Within the Project Area

Table 11.3.1.2 Federally Listed Terrestrial Species with Potential to Occur in Codington and Grant Counties

Table 11.3.1.3 State-Listed Species with Potential to Occur in Codington and Grant Counties

Table 11.3.1.4. Wildlife Studies Completed for the Crowned Ridge Wind Energy Facility Project Area and Vicinity

Table 12.1.2. State-listed aquatic wildlife with potential to be present in the Project Area

Table 13.1.2 Minimum Turbine Setback Distances Table 13.2.1 Public Lands in the Project Area

Table 13.2.1 Conservation Easements in the Project Area

Table 13.2.2 Conservation Easements in the Project Area

Table 13.3.1.1 Typical human response to A-weighted decibel sound (dBA)

Table 13.3.1.1a Sound source examples of A-weighted decibel noise (dBA)

Table 13.3.2.2 Crowned Ridge wind turbine specifications

Table 13.3.2.2a. Summary of Sound Assessment

Table 13.4.1. Summary of Shadow Flicker Assessment

Table 24.1 Setback Distances for Wind Energy Systems1

Table 17-1. Permitting and Construction Schedule

Table 18.1.1 Socioeconomic factors in select regions

Table 18.1.1a Employment by occupation in select regions, shown as percent of employed persons

Table 18.1.1b Socioeconomic projections from 2010 to 2016

Table 34. Potential Required Permits and Approvals

1.1 Executive Summary Introduction

Crowned Ridge Wind, LLC (the Applicant or Crowned Ridge), a wholly-owned, indirect subsidiary of NextEra Energy Resources, LLC (NEER), is requesting an Energy Facility Permit from the South Dakota Public Utilities Commission (Commission or SDPUC) for an up to 300 megawatt (MW) wind energy conversion facility to be located in Codington County and Grant County, South Dakota (the Project).

The Project will be situated within an approximately 53,186-acre Project Area (Figure 1 in Appendix A), and the total installed capacity of the Project will not exceed 300 MWs. Project components will include:

- Up to 130 wind turbine generators;
- Access roads to turbines and associated facilities;
- Underground 34.5-kilovolt (kV) electrical collector lines connecting the turbines to the collection substation;
- Underground fiber-optic cable for turbine communications co-located with the collector lines;
- The low-side of a 34.5 to 345-kV collection substation;
- One permanent meteorological (met) tower;
- An operations and maintenance (O&M) facility;
- Additional temporary construction areas, including laydown and batch plant areas;

The Project will utilize the Crowned Ridge 34-mile 230 kV generation tie line[1] and a new reactive power compensation substation to transmit the generation from the Project's collector substation to the Project's point of interconnection located at the Big Stone South 230 kV Substation, which is owned by Otter Tail Power Company.

The Applicant has executed a power purchase agreement (PPA) with Northern States Power Company (NSP) to sell NSP the full output of the Project. The commercial operation date for the Project is projected to be in or before the first quarter of 2020.

On July 6, 2017, the Minnesota Public Utilities Commission approved NSP's Petition for Approval of the Acquisition of Wind Generation from the Company's 2016-2030 Integrated Resource Plan, included a PPA with Crowned Ridge and the acquisition of an additional 300 MW wind facility identified as Crowned Ridge Wind II. On December 6, 2018, North Dakota Public Service Commission issued an order granting an advance determination of prudence for the PPA between NSP and CRW.

[1] The 34-mile transmission gen-tie was approved in Docket EL17-050.

The Applicant has actively developed the Project over the past 10 years, working closely with federal and state agencies, landowners, and tribal and local governments to properly design the Project. The Applicant will continue this collaborative process throughout the development, construction and operation phases of the Project.

1.2 Completeness Checklist

Consistent with South Dakota Codified Law (SDCL) 49-1-8 and Administrative Rules of South Dakota (ARSD) 20:10:13:01(1), Table 1.2 sets forth the Commission filing requirements with an identification of where the requirement is addressed in this Application.

Table 1.2 Completeness Checklist

SDCL	ARSD	Required Information	Location in Application
49-41D-11(1) through (11) 49-41B-35(2)	20:10:22:05	**Application contents.** The application for a permit for a facility shall contain a list of each permit that is known to be required from any other governmental entity at the time of the filing. The list of permits shall be updated, if needed, to include any permit the applicant becomes aware of after filing the application. The list shall state when each permit application will be filed. The application shall also list each notification that is required to be made to any other governmental entity.	24
49-41B-11(1)	20:10:22:06	**Names of participants required.** The application shall contain the name, address, and telephone number of all persons participating in the proposed facility at the time of filing, as well as the names of any individuals authorized to receive communications relating to the application on behalf of those persons.	3.0
49-41B-11(7)	20:10:22:07	**Name of owner and manager.** The application shall contain a complete description of the current and proposed rights of ownership of the proposed facility. It shall also contain the name of the project manager of the proposed facility.	3.0
49-41B-11(8)	20:10:22:08	**Purpose of facility.** The applicant shall describe the purpose of the proposed facility.	4.0
49-41B-11(12)	20:10:22:09	**Estimated cost of facility.** The applicant shall describe the estimated construction cost of the proposed facility.	5.0
49-41B-11(9)	20:10:22:10	**Demand for facility.** The applicant shall provide a description of present and estimated consumer demand and estimated future energy needs of those customers to be directly served by the proposed facility. The applicant shall also provide data, data sources, assumptions, forecast methods or models, or other reasoning upon which the description is based. This statement shall also include information on the relative contribution to any power or energy distribution network or pool that the proposed facility is projected to supply and a statement on the consequences of delay or termination of the construction of the facility.	4.0
49-41B-11	20:10:22:11	**General site descriptions.** The application shall contain a general site description of the proposed facility including a description of the specific site and its location with respect to state, county, and	6.0

SDCL	ARSD	Required Information	Location in Application
		other political subdivisions; a map showing prominent features such as cities, lakes and rivers; and maps showing cemeteries, places of historical significance, transportation facilities, or other public facilities adjacent to or abutting the plant or transmission site.	
49-41B-11(6);34A-9-7(4)	20:10:22:12	**Alternative sites.** The applicant shall present information related to the selection of the proposed site for the facility, including the following: (1) The general criteria used to select alternative sites, how these criteria were measured and weighed, and reasons for selecting these criteria; (2) An evaluation of alternative sites considered by the applicant for the facility; (3) An evaluation of the proposed plant or transmission site and its advantages over the other alternative sites considered by the applicant, including a discussion of the extent to which reliance upon eminent domain powers could be reduced by use of an alternative site, alternative generation method, or alternative waste handling method.	7.0
49-41B-11(11); 49-41B-22(2)	20:10:22:13	**Environmental information.** The applicant shall provide a description of the existing environment at the time of the submission of the application, estimates of changes in the existing environment which are anticipated to result from construction and operation of the proposed facility, and identification of irreversible changes which are anticipated to remain beyond the operating lifetime of the facility. The environmental effects shall be calculated to reveal and assess demonstrated or suspected hazards to the health and welfare of human, plant and animal communities which may be cumulative or synergistic consequences of siting the proposed facility in combination with any operating energy conversion facilities, existing or under construction. The applicant shall provide a list of other major industrial facilities under regulation which may have an adverse effect of the environment as a result of their construction or operation in the transmission site or siting area.	9.0-18.0
49-41B-11(11); 49-41B-22(2)	20:10:22:14	**Effect on physical environment.** The applicant shall provide information describing the effect of the proposed facility on the physical environment. The information shall include: (1) A written description of the regional land forms surrounding the transmission site or through which the transmission facility will pass; (2) A topographic map of the transmission site or siting area; (3) A written summary of the geological features of the or transmission site using the topographic map as a base showing the bedrock geology and surficial geology with sufficient cross-sections to depict the major subsurface variations in the siting area; (4) A description and location of economic deposits such as lignite, sand and gravel, scoria, and industrial and ceramic quality clay existent within the transmission site; (5) A description of the soil type at the transmission site; (6) An analysis of potential erosion or sedimentation which	9.0

SDCL	ARSD	Required Information	Location in Application
		may result from site clearing, construction, or operating activities and measures which will be taken for their control; (7) Information on areas of seismic risks, subsidence potential and slope instability for the transmission site; and (8) An analysis of any constraints that may be imposed by geological characteristics on the design, construction, or operation of the proposed facility and a description of plans to offset such constraints.	
49-41B-11(11); 49-41B-22(2)	20:10:22:15	**Hydrology.** The applicant shall provide information concerning the hydrology in the area of the proposed plant or transmission site and the effect of the proposed site on surface and groundwater. The information shall include: (1) A map drawn to scale of the plant or transmission site showing surface water drainage patterns before and anticipated patterns after construction of the facility; (2) Using plans filed with any local, state, or federal agencies, indication on a map drawn to scale of the current planned water uses by communities, agriculture, recreation, fish, and wildlife which may be affected by the location of the proposed facility and a summary of those effects; (3) A map drawn to scale locating any known surface or groundwater supplies within the siting area to be used as a water source or a direct water discharge site for the proposed facility and all offsite pipelines or channels required for water transmission; (4) If aquifers are to be used as a source of potable water supply or process water, specifications of the aquifers to be used and definitions of their characteristics, including the capacity of the aquifer to yield water, the estimated recharge rate, and the quality of ground water; (5) A description of designs for storage, reprocessing, and cooling prior to discharge of heated water entering natural drainage systems; (6) If deep well injection is to be used for effluent disposal, a description of the reservoir storage capacity, rate of injection, and confinement characteristics and potential negative effects on any aquifers and groundwater users which may be affected.	10.0
49-41B-11(11);49-41B-22(2)	20:10:22:16	**Effect on terrestrial ecosystems.** The applicant shall provide information on the effect of the proposed facility on the terrestrial ecosystems, including existing information resulting from biological surveys conducted to identify and quantify the terrestrial fauna and flora potentially affected within the transmission site, or siting area; an analysis of the impact of construction and operation of the proposed facility on the terrestrial biotic environment, including breeding times and places and pathways of migration; important species; and planned measures to ameliorate negative biological impacts as a result of construction and operation of the proposed facility.	11.0
49-41B-11(11);49-41B-22(2)	20:10:22:17	**Effect on aquatic ecosystems**. The applicant shall provide information of the effect of the proposed facility on aquatic	14.0

SDCL	ARSD	Required Information	Location in Application
		ecosystems, and including existing information resulting from biological surveys conducted to identify and quantify the aquatic fauna and flora, potentially affected within the transmission site, or siting area, an analysis of the impact of the construction and operation of the proposed facility on the total aquatic biotic environment and planned measures to ameliorate negative biological impacts as a result of construction and operation of the proposed facility.	
49-41B-11(11) 49-41b-22(2)	20:10:22:18	**Land use.** The applicant shall provide the following information concerning present and anticipated use or condition of the land: (1) A map or maps drawn to scale of the transmission site identifying existing land use according to the following classification system: (a) Land used primarily for row and non row crops in rotation; (b) Irrigated lands; (c) Pasturelands and rangelands; (d) Haylands; (e) Undisturbed native grasslands; (f) Existing and potential extractive nonrenewable resources; (g) Other major industries; (h) Rural residences and farmsteads, family farms, and ranches (i) Residential; (j) Public, commercial, and institutional use; (k) Municipal water supply and water sources for organized rural water systems; and (l) Noise sensitive land uses; (2) Identification of the number of persons and homes which will be displaced by the location of the proposed facility; (3) An analysis of the compatibility of the proposed facility with present land use of the surrounding area, with special attention paid to the effects on rural life and the business of farming; and (4) A general analysis of the effects of the proposed facility and associated facilities on land uses and the planned measures to ameliorate adverse impacts.	13.0
49-41B-11; 49-41B-28	20:10:22:19	**Local land use controls**. The applicant shall provide a general description of local land use controls and the manner in which the proposed facility will comply with the local land use zoning or building rules, regulations or ordinances. If the proposed facility violates local land use controls, the applicant shall provide the commission with a detailed explanation of the reasons why the proposed facility should pre-exempt the local controls. The explanation shall include a detailed description of the restrictiveness of the local controls in view of existing technology, factors of cost, economics, needs of parties, or any additional information to aid the commission in determining whether a permit may supersede or preempt a local control pursuant to SDCL.49-41B-28.	14.0
49:41B-11	20:10:22:20	**Water quality.** The applicant shall provide evidence that the	15.0

SDCL	ARSD	Required Information	Location in Application
		proposed facility will comply with all water quality standards and regulations of any federal or state agency having jurisdiction and any variances permitted.	
49-41B-11;49-41B-22	20:10:22:21	**Air quality.** The applicant shall provide evidence that the proposed facility will comply with all air quality standards and regulations of any federal or state agency having jurisdiction and any variances permitted.	16.0
49-41B-11(3)	20:10:22:22	**Time schedule**. The applicant shall provide estimated time schedules for accomplishment of major events in the commencement and duration of construction of the proposed facility.	17.0
49-41B-11(#); 49-41B-22	20:10:22:23	**Community impact**. The applicant shall include an identification and analysis of the effects the construction, operation, and maintenance of the proposed facility will have on the anticipated affected area including the following: (1) A forecast of the impact on commercial and industrial sectors, housing, land values, labor market, health facilities, energy, sewage and water, solid waste management facilities, fire protection, law enforcement, recreational facilities, schools, transportation facilities, and other community and government facilities or services; (2) A forecast of the immediate and long-range impact of property and other taxes of the affected taxing jurisdictions; (3) A forecast of the impact on agricultural production and uses; (4) A forecast of the impact on population, income, occupational distribution, and integration and cohesion of communities; (5) A forecast of the impact on transportation facilities; (6) A forecast of the impact on landmarks and cultural resources of historic, religious, archaeological, scenic, natural, or other cultural significance. The information shall include the applicant's plans to coordinate with the local and state office of disaster services in the event of accidental release of contaminants from the proposed facility; and (7) An indication of means of ameliorating negative social impact of the facility development.	18.0
49-41B-11	20:10:22:24	**Employment estimates.** The application shall contain the estimated number of jobs and a description of job classifications, together with estimated annual employment expenditures of the applicants, the contractors, and the subcontractors during the construction phase of the proposed facility. In a separate tabulation, the application shall contain the same data with respect to the operating life of the proposed facility, to be made for the first ten years of commercial operation in one-year intervals. The application shall include plans of the applicant for utilization and training of the available labor force in South Dakota by categories of special skills required. There shall also be an assessment of the adequacy of local manpower to meet temporary and permanent labor requirements during	19.0

SDCL	ARSD	Required Information	Location in Application
		construction and operation of the proposed facility and the estimated percentage that will remain within the country and the township in which the facility is located after construction is completed.	
49-41B-11(5)	20:10:22:25	**Future additions and modifications.** The applicant shall describe any plans for future modification or expansion of the proposed facility or construction of additional facilities which the applicant may wish to be approved in the permit.	20.0
49-41B-35(3)	20:10:22:33.01	**Decommissioning of wind energy facilities.** Funding for removal of facilities. The applicant shall provide a plan regarding the action to be taken upon the decommissioning and removal of the wind energy facilities. Estimates of monetary costs and the site condition after decommissioning shall be included in the plan. The commission may require a bond, guarantee, insurance, or other requirement to provide funding for the decommissioning and removal of a wind energy facility. The commission shall consider the size of the facility, the location of the facility, and the financial condition of the applicant when determining whether to require some type of funding. The same criteria shall be used to determine the amount of any required funding.	21.0
49-41B-11(2,11)	20:10:22:33:02	**Information concerning wind energy facilities.** If a wind energy facility is proposed, the applicant shall provide the following information: (1) Configuration of the wind turbines, including the distance measured from ground level to the blade extended at its highest point, distance between the wind turbines, type of material, and color; (2) The number of wind turbines, including the number of anticipated additions of wind turbines in each of the next five years; (3) Any warning lighting requirements for the wind turbines; (4) Setback distances from off-site buildings, rights-of-way of public roads, and property lines; (5) Anticipated noise levels during construction and operation; (6) Anticipated electromagnetic interference during operation of the facilities; (7) The proposed wind energy site and major alternatives as depicted on overhead photographs and land use culture maps; (8) Reliability and safety; (9) Right-of-way or condemnation requirements; (10) Necessary clearing activities; (11) Configuration of towers and poles for any electric interconnection facilities, including material, overall height, and width; (12) Conductor configuration and size, length of span between structures, and number of circuits per pole or tower for any electric interconnection facilities; and (13) If any electric interconnection facilities are placed underground, the depth of burial, distance between access points, conductor configuration and size, and number of circuits	22.0 and 23.0

SDCL	ARSD	Required Information	Location in Application
49-41B-11	20:10:22:34	**Transmission facility layout and construction.** If a transmission facility is proposed, the applicant shall submit a policy statement concerning the route clearing, construction and landscaping operations, and a description of plans for continued right-of-way maintenance, including stabilization and weed control.	N/A
49-41B-11(2)(11)	20:10:22:35	**Information concerning transmission facilities.** If a transmission facility is proposed, the applicant shall provide the following information as it becomes available to the applicant: (1) Configuration of the towers and poles, including material, overall height and width, (2) Conductor configuration and size, length of span between structures, and number of circuits per pole or tower, (3) The proposed transmission site and major alternatives as depicted on overall photographs and land use culture maps, (4) Reliability and safety; (5) Right-of-way or condemnation requirements; (6) Necessary clearing activities; and (7) If the transmission facility is placed underground, the depth of burial, distance between access points, conductor configuration and size, and number of circuits.	N/A
49-41B-7; 49-41B-22	20:10:22:36	**Additional information in application.** The applicant shall also submit as part of the application any additional information necessary for the local review committees to assess the effects of the proposed facility pursuant to SDCL 49-41B-7. The applicant shall also submit as part of its application any additional information necessary to meet the burden of proof specified in SDCL 49-41B-22.	24.0
	20:10:22:37	**Statement required describing gas or liquid transmission line standards of construction.** The applicant shall submit a statement describing existing pipeline standards and regulations that will be followed during construction and operation of the proposed transmission facility.	Not applicable
	20:10:22:38	**Gas or liquid transmission line description.** The applicant shall provide the following information describing the proposed gas or liquid transmission line: (1) A flow diagram showing daily design capacity of the proposed transmission facility. (2) Changes in flow in the transmission facilities connected to the proposed facility; (3) Technical specifications of the pipe proposed to be installed, including the certified maximum operating pressure, expressed in terms of pounds per square inch gauge (psig); (4) A description of each new compressor station and the specific operating characteristics of each station; and (5) A description of all storage facilities associated with the proposed facility.	Not applicable
	20:10:22:05	**List of Permits.** The application for a permit for a facility shall contain a list of each permit that is known to be required from any other governmental entity at the time of the filing. The list of	24.0

SDCL	ARSD	Required Information	Location in Application
		permits shall be updated, if needed, to include any permit the applicant becomes aware of after filing the application. The list shall state when each permit application will be filed. The application shall also list each notification that is required to be made to any other governmental entity.	
49-41B-22		**Applicant's burden of proof.** The applicant has the burden of proof to establish that: (1) The proposed facility will comply with all applicable laws and rules; (2) The facility will not pose a threat of serious injury to the environment nor to the social and economic condition of inhabitants or expected inhabitants in the siting area; (3) The facility will not substantially impair the health, safety or welfare of the inhabitants; and (4) The facility will not unduly interfere with the orderly development of the region with due consideration having been given the views of governing bodies of affected local units of government	24.0
	20:10:22:39	Upon the filing of an application pursuant to SDCL 49-41B-11, an applicant shall also file all data, exhibits, and related testimony which the applicant intends to submit in support of its application. The application shall specifically show the witnesses supporting the information contained in the application	25.0

2.0 Description of the Nature and Location of the Project

The Project is situated within an approximately 53,186-acre Project Area spanning across parts of Codington County and Grant County, South Dakota. The Project will consist of up to 130 proposed turbine locations and contains a collector substation and O&M facility located approximately 14-miles north-east of Watertown, SD.

The Project Area in Codington County contains 90 proposed turbine locations and extends as far south as 166th street and as far west as the half section line between 458th Avenue and 459th Avenue. The Project Area in Grant County contains 40 proposed turbine locations and extends as far north as the half section line between 149th Street and 150th Street and as far east as 472nd Avenue in Grant County, South Dakota.

2.1 The Project

In accordance with SDCL Chapter 49-41B and ARSD Chapter 20:10:22, the Application provides information on the existing environment, potential Project impacts, and proposed avoidance, minimization, and/or mitigation measures for the following resources:

- Physical (geology, economic deposits, soils; see Section 9);
- Hydrology (surface water and groundwater; see Section 10);
- Terrestrial ecosystems (vegetation, wetlands, wildlife, threatened and endangered species; see Section 11);
- Aquatic ecosystems (see Section 12);
- Land use (agriculture, residential, displacement, sound, aesthetics, electromagnetic interference, safety and health, real estate values; see Section 13);
- Water quality (see Section 15);
- Air quality (see Section 16); and
- Communities (socioeconomics, transportation and emergency response, cultural resources; see Section 18).

The Project is not expected to have significant impacts on the environment. Approximately 86 acres of permanent disturbance is expected as a result of the Project. This represents approximately 0.16% of the total acreage within the Project Area, of which the disturbances will be dispersed throughout the Project Area.

The Applicant sited facilities to avoid direct impacts to field-verified wetlands to the extent practical. Generally, wind turbines are located in higher elevation areas and avoid low-lying areas where wetlands are present. Access roads are located to avoid and minimize potential impacts to identified natural resources to the extent practical, while also minimizing impacts to existing field operations to the extent practical. Although not anticipated at this time, if shifts to

Project infrastructure are necessary, the Applicant will ensure that such changes avoid direct impacts to field-verified wetlands.

The majority of the land that will be impacted by the Project is agricultural (Section 11.1.2). Construction of the Project is not expected to adversely affect terrestrial ecosystems. Best Management Practices (BMPs) will be utilized to avoid or minimize impacts to vegetation and water resources in the Project Area during construction. The Project avoids U.S. Fish and Wildlife Service (USFWS) grassland and USFWS grassland/wetland combination easements (Section 10.2). As such, there is no federal nexus for the Project that will require National Environmental Policy Act review.

Seven species listed as threatened or endangered under the Federal Endangered Species Act have potential to occur in the Project Area counties (Sections 11.3.1 and 12.1.1): Dakota skipper (*Hesperia dacotae*, threatened); Poweshiek skipperling (*Oarisma poweshiek*, endangered); northern long-eared bat (*Myotis septentrionalis*, threatened); piping plover (*Charadrius melodus*, threatened); red knot (*Calidris canutus rufa*, threatened); whooping crane (*Grus americana*, endangered); and Topeka shiner (*Notropis topeka*, endangered). Wildlife studies and coordination with USFWS and South Dakota Game, Fish, and Parks (SDGFP) determined the Project to have a low risk of impacts to federally listed species (see Sections 11 and 12).

Existing land uses are not anticipated to be significantly changed or impacted by the Project. Sound from the Project construction activities will be temporary. Once the Project is operational, sound from the turbines and other facilities will be limited per applicable county requirements: (1) Codington County – 50 dBA, average A-weighted sound pressure level effects at the property line of existing sound receptors (i.e., non-participating residences, businesses, and buildings owned and/or maintained by a governmental entity); or (2) Grant County – 45 dBA, average A-weighted sound pressure, including constructive interference effects, measured at 25 feet from the perimeter of existing sound receptors (i.e., non-participating residences, businesses, and buildings owned and/or maintained by a governmental entity). A sound level modeling study was completed for the Project to confirm compliance with these standards (see Section 13).

Construction activities for this Project will be short-term, with no expected adverse impacts to the socioeconomics of the area. Project construction is anticipated to provide economic benefits to businesses in the region.

Construction activities may result in increased short-term airborne dust/particulate matter from construction equipment and vehicle emissions. These activities will be addressed in a Project Storm Water Pollution Prevention Plan (SWPPP). Impacts to air quality will be temporary, and no long-term impacts are anticipated from construction activities. No air quality impacts from Project operation are anticipated nor will the Project produce air emissions that will impact the surrounding area (Section 16).

In accordance with the *Guidelines for Cultural Resource Surveys and Survey Reports in South Dakota (For Review and Compliance)* (South Dakota State Historical Society 2005), cultural resources reviews were conducted for an area that includes a 1-mile buffer of the Project Construction Easement. Additionally, from June to December 2017 and April to November 2018, a Level III Survey was conducted for archaeological, historical, and tribal resources at each proposed turbine location, access route to turbines, and collection lines from turbines. The archaeologists supervising these investigations meet the U.S. Secretary of the Interior's Professional Qualifications Standards for archaeology. Tribal members from the Sisseton Wahpeton Oyate, Yankton Sioux, and Spirit Lake Nation selected to represent those tribes in identifying significant tribal resources were an integral part of investigation team. The Project has been sited to avoid and minimize impacts to identified cultural resources to the extent practical, and the Applicant will continue to coordinate with the agencies and tribal members regarding implementation of construction BMPs (e.g., site fencing) (Section 18.6).

Additional avoidance and minimization measures proposed for the Project include:

- Wind turbines will be illuminated as required by Federal Aviation Administration (FAA) regulations and recommendations;
- Existing roads will be used for construction and maintenance where possible; access roads created for the Project will be located to limit cuts and fills;
- Temporarily disturbed uncultivated areas will be reseeded with certified weed-free seed mixes to blend in with existing vegetation;
- BMPs will be used during construction to control erosion and prevent or reduce impacts to drainage ways and streams by sediment runoff from exposed soils in accordance with the SWPPP;
- The Applicant will avoid impacts to land held for conservation purposes via USFWS Grassland and USFWS Grassland/Wetland (combination) Easements;
- Construction activities will be limited in accordance with SDGFP recommendations to minimize impacts to grouse leks;
- The Applicant will avoid impacts to native grasslands to the extent practicable;
- The Applicant will meet or exceed setbacks, conditions, and siting standards required by State and local governing bodies where the wind turbines are located; and
- The Project will meet or exceed the Codington and Grant County noise requirements set forth above;
- The Project will meet or exceed the Codington and Grant County shadow flicker requirements of limiting shadow flicker to 30 hours per year or less at all schools, churches, business and occupied dwellings.

In this Application, the Applicant has addressed each matter set forth in SDCL Chapter 49-41B and in ARSD Chapter 20:10:22 (Energy Facility Siting Rules) related to wind energy facilities. Included with this Application is a Completeness Checklist (Table 1.2) that sets forth where in the Application each rule requirement is addressed.

Pursuant to SDCL 49-41B-22, the information presented here establishes that:

- The proposed wind energy facility complies with applicable laws and rules;
- The facility will not pose a threat of serious injury to the environment or to the social and economic condition of inhabitants in, or near, the Project Area;
- The facility will not substantially impair the health, safety, or welfare of the inhabitants; and
- The facility will not unduly interfere with the orderly development of the region, having given consideration to the views of the governing bodies of the local affected units of government.

3.0 Name of Owner, Manager, and Participants (ARSD 20:10:22:06; 20:10:22:07)

ARSD 20:10:22:06. Names of participants required. *The application shall contain the name, address, and telephone number of all persons participating in the proposed facility at the time of filing, as well as the names of any individuals authorized to receive communications relating to the application on behalf of those persons.*

ARSD 20:10:22:07. Name of owner and manager. *The application shall contain a complete description of the current and proposed rights of ownership of the proposed facility. It shall also contain the name of the project manager of the proposed facility.*

The owner and manager of the proposed Project is Crowned Ridge Wind, LLC, a wholly-owned indirect subsidiary of NEER.

The contact persons for the owner and manager are:

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4.0 Purpose of, and Demand for, the Wind Energy Facility (ARSD 20:10:22:08, 20:10:22:10)

ARSD 20:10:22:08. Purpose of facility. *The applicant shall describe the purpose of the proposed facility.*

ARSD 20:10:22:10. Demand for facility. *The applicant shall provide a description of present and estimated consumer demand and estimated future energy needs of those customers to be directly served by the proposed facility. The applicant shall also provide data, data sources, assumptions, forecast methods or models, or other reasoning upon which the description is based. This statement shall also include information on the relative contribution to any power or energy distribution network or pool that the proposed facility is projected to supply and a statement on the consequences of delay or termination of the construction of the facility.*

The Project will generate electricity to be delivered to the high-voltage transmission grid at the Big Stone South Substation. NSP and CRW have entered into a PPA for the full output of the Project. Although, the generation from the Project will be sold to NSP, CRW will retain ownership of the Project and is responsible for the development, construction, and O&M of the Project.

The Project provides zero-emission cost electricity to the grid and long-term, economic energy pricing in the region. Electricity generated from the Project will be utilized within the Midcontinent Independent System Operator, Inc. (MISO) regional grid to help satisfy demand within MISO's operating territory. Demand for the power and its benefits are discussed in Section 4.2.

The Project will provide benefits not only to the State, but, also, to the local communities as well in the form of construction jobs, an increase in local economy, and investments in local businesses. The Project represents an approximate $400 million investment in Codington and Grant Counties, of which Crowned Ridge will pay taxes on the Project, increasing the tax revenues available in the local communities and State. The project will employ up to 12 personnel (see Section 19).

4.1 Wind Resources Areas

The Project location was selected due to its high wind resources and open area that could easily support a large-scale wind energy facility. Studies of the wind resource were conducted by the Applicant over a period of 10-years within the Project Area and indicated that the Project Area is one area in South Dakota with premier wind sources and suitable for wind energy development. Based on data collected, composite mean wind speeds (CMWS) are 9.01m/s and generally highest in the winter (mainly December and January) months of the year. The Project is classified as an IEC Classification Class II wind site. IEC Classifications are a set of design requirements that ensure wind turbines are engineered against damage from hazards within their

planned lifetime. An IEC Class II wind site has an annual average wind speed at the hub height greater than 8.5 m/s and less than 10 m/s.

4.2 Renewable Power Demand

Demand for renewable energy is evident in the United States, the upper Midwest region, and the State of South Dakota. The National Conference of State Legislatures specifies that 29 states, Washington, D.C., and three territories have adopted a Renewable Portfolio Standard and eight states and one territory have set renewable energy goals (National Conference of State Legislatures 2018). Additionally, Xcel's Minnesota Resource Plan shows a demand for 1,800 MW of new wind energy generation by 2026 (Xcel Energy 2015).

The Project provides a solution for the demand of clean energy within the Midwest. The market exists for independently produced electricity from wind projects and other renewables to meet the growing demand for renewable energy. The Project's location is conveniently located within South Dakota's high wind resource and with close proximity to the newly available capacity along the CapX2020 transmission project which allows for windier parts of the South Dakota to satisfy the markets growing demand for electricity in more densely populated regions further east. In fact, a recently completed 70-mile stretch of the CapX2020 project in South Dakota has resulted in proposals for over nine wind projects and one natural gas plant totaling more than 2,000 MW. One of those contributing wind projects is the Crowned Ridge Wind Project, the largest proposed wind energy investment in South Dakota's history.

According to a March 2018 Gallup poll, 73% of the public believes that alternative energy is key in solving the nation's energy problems and 70% of the public think more emphasis should be put on wind energy (Gallup 2018).

4.3 Consequences of Delay

Should the Project be delayed the Project benefits for the local communities, region, and State as listed in Section 18, will be at risk. If the Project does not achieve COD by the end of the first quarter 2020, the Project will face commercial challenges that could place it at risk of completion. Delay of Project's COD could also impact savings for regional customers as a higher cost of energy may be needed to fulfill renewable standards and requirements for the region from an alternative source of energy with potentially less, long-term economic benefits for the State and the Project's local communities. To receive the Production Tax Credit (PTC), the Project must be constructed by December 31, 2020.

5.0 Estimated Cost of the Wind Energy Facility (ARSD 20:10:22:09)

ARSD 20:10:22:09. Estimated cost of facility. *The applicant shall describe the estimated construction cost of the proposed facility.*

The Project has an estimated capital cost of approximately $400 million. Estimated costs include construction costs and wind turbine pricing estimates for the proposed 130 GE 2.3 MW turbine layout. Cost estimate also includes lease acquisition, permitting, engineering, procurement, and construction of turbines, access roads, the underground electrical collector system, the Project's collection substation, interconnection facilities, O&M facility, supervisory control and data acquisition (SCADA) system, meteorological towers, and project financing. Fluctuations in capital costs could be as much as 20% percent for the Project, dependent on final micrositing and MISO interconnection costs.

6.0 General Site and Project Component Description (ARSDS 20:10:22:11)

ARSD 20:10:22:11. General site description. *The application shall contain a general site description of the proposed facility including a description of the specific site and its location with respect to state, county, and other political subdivisions; a map showing prominent features such as cities, lakes and rivers; and maps showing cemeteries, places of historical significance, transportation facilities, or other public facilities adjacent to or abutting the plant or transmission site.*

The Project will be located on approximately 53,186 acres of land in Codington and Grant Counties, northeast of Watertown, South Dakota (Figure 1). Figures provided in Appendix A provide the Project location in relation to locations of State, county, and town boundaries; lakes and rivers; railroads; and major highways and roads. There are no active transportation facilities (e.g., airports) other than roads and railroads within or directly adjacent to the Project Area. One school is located in the Project Area (Figure 2). Table 6.1 shows the counties, townships, sections, and ranges that intersect the Project Area.

Table 6.1 Sections that intersect the Project Area

County	Township Name	Township	Range	Sections
Codington	Waverly	118	51	1-5, 7-23, 28-30, 32
Codington	Rauville	118	52	13, 24-25
Codington	Leola	119	51	4-5, 7-9, 17-19, 25-36
Codington	Germantown	119	52	23-26, 36
Grant	Troy	118	50	3-10, 17-18
Grant	Stockholm	119	50	3-11, 13-18, 20-29, 31-34
Grant	Twin Brooks	120	50	17-20, 22, 26-35
Grant	Mazeppa	120	51	12-14, 23-24, 32-33

The Project will have a nameplate capacity of approximately 300 MW and will include the following permanent features: wind turbines and associated pad-mounted transformers, access roads, underground electrical collector lines, the low-side of the collection substation, interconnection facilities and switching stations, a meteorological tower, an O&M facility, and SCADA system. Table 6.2 lists the sections within the Project Area which contain features of the proposed wind energy conversion facility.

Table 6.2 Sections Containing Project Features

County	Township Name	Township	Range	Sections
Codington	Waverly	118	51	1-3, 5, 8-12, 14-23
Codington	Rauville	118	52	13, 24-25
Codington	Leola	119	51	4-5, 7-9, 17-19, 25-26, 28-32, 35-36
Codington	Germantown	119	52	23, 25-26, 36
Grant	Troy	118	50	3-6, 8, 10,
Grant	Stockholm	119	50	3-6,9-10,13-16,23-29,32-34
Grant	Twin Brooks	120	50	17, 19-20, 28-30, 32-34
Grant	Mazeppa	120	51	24, 32-33

In addition, the following temporary features will be associated with the project: crane paths, one concrete batch plant, and one laydown area. These features are described below in more detail. The dimensions and estimated temporary and permanent impacts of these features can be found in Table 8.1.

6.1 Turbines

The Crowned Ridge Wind Farm turbine layout will consist of 130 three bladed, upwind, horizontal-axis wind turbines (Figure 3) which originate from the GE 2 MW-116 model series. The proposed Project will utilize 117 GE 2.3 MW turbines with 116-meter (381-feet) rotor diameter and 90-meter (295-feet) hub height (Figure 4a) as the Project's primary turbine technology, and 13 GE 2.3 MW turbines with 116-meter (381-feet) rotor diameter and an 80-meter (262-feet) hub height (Figure 4b) as the Project's secondary technology which will be utilized in select locations. The 20 alternate turbines have the same specifications as the primary turbine technology (GE 2.3MW with 116-meter (381-feet) rotor diameter and 90-meter (295-feet) hub height). However, only a maximum of 130 turbines in total will be constructed. Alternate turbines are included to provide flexibility through the permitting and construction process in the event an unforeseen condition arises during construction that indicates a primary turbine should be dropped and an alternate turbine activated. Table 6.3 identifies the wind turbine characteristics for the Project's selected turbine models.

Table 6.3 Wind Turbine Characteristics

Manufacturer	Model	Rotor Diameter	Hub Height	Generator Nameplate Capacity
GE	GE 2MW-116	116 meters	90 meters	2.3 MW
GE	GE 2MW-116	116 meters	80 meters	2.3 MW

The turbines are comprised of three major features being the tower, the nacelle, and the rotor:

Tower: The wind turbine is mounted on top of a tubular tower. The tubular towers proposed for the Project will be conical steel structures. The tubular tower is manufactured in sections from steel plate and the 3 tubular steel sections utilize bolted connections. A lockable steel door at the base of the tower provides secure access. An internal ladder with fall protection, connected to the steel wall of the tower, provides access to the top of the tower. There are service platforms within the tower. The turbines will be grounded in accordance with National Electrical Safety Code standards and comply with all FAA requirement in accordance with FAA regulations, the towers will be painted off-white to minimize visual impact.

Nacelle: The nacelle houses the main components of the wind turbine generator. Access from the tower into the nacelle is through the bottom of the nacelle. The nacelle is ventilated. It is illuminated with electric light. A hatch at the front end of the nacelle provides access to the blades and hub. The rotor can be secured in place with a rotor lock. The nacelle components include the drive train, gearbox, generator. The nacelle is housed in a steel-reinforced fiberglass shell that protects internal machinery from the environment. The housing is designed to allow for adequate ventilation to cool internal machinery. It is also contains an anemometer and a wind vane to measure wind speed and direction. The generated electricity is conducted through cables within the tower to the Down Tower Assembly mounted at the base of the turbine tower. Attached to the top of select nacelles, per FAA specifications, will be a single, medium-intensity aviation warning light. The preferred manner of lighting is by means of an Aircraft Detection Lighting System ("ADLS"). Subject to FAA approval, applicants will install an ADLS within one (1) year of approval by FAA for the specified project. In the event FAA does not approve the use of an ADLS system, CRW will comply with all lighting and markings otherwise required by FAA.

Rotor: A rotor assembly is mounted on the drive shaft and operates upwind of the tower. Rotor speed is regulated by a combination of blade pitch angle adjustment and generator/converter torque control. The rotor spins in a clock-wise direction under normal operating conditions when viewed from an upwind location.

6.2 Access Roads and Crane Paths

Existing county roads within the Project Area will be utilized during the construction and operation of the project. Most of the county roads within the Project Area have a gravel surface, some of which may need to be improved to accommodate equipment deliveries and construction traffic. For the same reasons, some culverts also may need to be upgraded. The Applicant will obtain permits and authorizations from the appropriate agencies to comply with county, state, and federal rules for oversized loads. Additionally, the Applicant will identify routes and complete any improvements necessary in accordance with the Road Use Agreements to be developed in coordination with Grant County and Codington County. To date, a Road Use Agreement has been executed with Codington County, while a Road Use Agreement is currently under the review of Grant County.

The Applicant will construct low-profile, private, gravel roads for construction and maintenance access to each turbine, the O&M facility, and the collector substation. During the construction phase access roads to Project infrastructure will utilize a temporary width of approximately 32 feet to accommodate larger equipment. After construction, the access roads to turbines will be reduced to a permanent width of approximately 16 feet. It is anticipated that the access road network for the Project will include approximately 41.6 miles of new permanent access roads. Subject to final turbine placement, the Applicant has conservatively calculated approximately 744.9 acres of temporary disturbance and 80.7 acres of disturbance during the life of the Project for access roads.

Separate access (i.e., crane paths) is required in some cases for the cranes used to erect wind turbines. Temporary crane paths will be constructed between turbine locations and situated to minimize total ground impacts to the extent practical. Following completion of construction, the Applicant will remove temporary crane paths and restore these areas to the extent practicable. Table 8.1 summarizes the estimated ground disturbance impacts (both temporary impacts during construction and operational impacts during the life of the Project) calculated for the Project's access roads, crane paths, and other notable Project features.

6.3 Underground Electrical Collection Lines and Junction Boxes

Each wind turbine will be connected to the collector substation by underground power cables, called collection lines, and fiber optic communication lines. A pad-mounted transformer at each turbine location provides the power at 34.5 kV. The collection lines are buried at least 36 inches below ground surface to allow for existing land uses and safe operation of the Project. Fiber optic lines are collocated with collection lines and are used for communication and for operating wind turbines. Junction boxes are above-ground locations where collections lines are spliced and connected. Typical installation methods include trenching, boring, and horizontal/directional drilling. It is anticipated that 520.9 acres of temporary disturbance will result from the

construction of the underground collection lines and junction boxes, and a total of 0.7-acre of permanent disturbance will be associated with the junction boxes.

6.4 Collection Substation

All underground electrical collection cables and communication lines will terminate at the collection substation. The purpose of the Project's collection substation will be to step up the electricity generated by the project at 34.5kV to 230kV so that it may be transmitted along the transmission system. The collector substation will include two power transformers, transmission breakers, feeder breakers, disconnect switches, a control house, metering unit, and a substation pull-off superstructure. The collector substation will be monitored at a remote operations center, to ensure it is operating safely. The general location of the collector substation is planned to be constructed southeast of 161st Street and 464th Avenue, approximately 4 miles south of South Shore, South Dakota. Up to 10 acres of land will be purchased to facilitate the construction and operation of the collection substation and the collocated O&M facility (see Section 6.7 and Table 8.1). The collector substation will be located within a fenced area, designed in accordance to industry standards. It is anticipated that 1.3 acres of permanent disturbance will result from the construction of the collection substation.

6.5 Interconnection Facilities and Reactive Power Compensation Station

The single circuit, 34-mile long 230kV transmission line will use tubular steel structures. The transmission line will transmit the power from the collection substation to the reactive power compensation station. The reactive power compensation substation will contain breakers, switches, a series capacitor bank, and a shunt capacitor bank. The generated power will be transferred from the reactive power substation to the adjacent Big Stone South Substation via an approximately 100-ft overhead string bus.

6.6 Meteorological Tower

There will be one permanent meteorological tower installed with anemometers (for wind speed measurement) installed in the Project Area. The tower will be approximately 275 feet (83 meters) in height. The anemometers will be mounted at varying heights above the ground. The permanent meteorological tower will be marked and lighted as specified by the FAA. The meteorological tower will result in 1.25 acres of temporary impacts, and in only 0.001 acre of permanent impact.

6.7 O&M Facility

The O&M facility will include a main building with offices, spare parts storage, restrooms, a septic system, a shop area, outdoor parking facilities, a turn-around area for larger vehicles, outdoor lighting, and gated access with partial- or full-perimeter fencing. Located directly adjacent to the Project's collector substation, the O&M facility will comprise of a single–story

building of approximately 5,000 square-foot building, which will house operating personnel, offices, operations and communication equipment, parts storage and maintenance. The facility will be planned, maintained, and operated in compliance with applicable North American Electric Reliability Corporation Reliability Standards. The O&M organization has a program of maintenance standards providing the capability to manage compliance to transmission maintenance standards. The Applicant will use these O&M subject matter experts to develop and implement procedures for the maintenance of the transmission line and substation. Up to 10 acres of land will be purchased to facilitate the construction and operations of the O&M facility and collection substation (see Section 6.4). It is anticipated that 0.7 acres of permanent disturbance will result from the O&M facility.

6.8 SCADA System

The Project's SCADA enables the monitoring and controlling of the entire Project, inclusive of the Project's wind turbines. A fiber-optic cable system will be connected to each individual turbine within the Project Area. Two separate teams will provide real time oversite of the project: the O&M team located on site within the O&M facility and a team working remotely from the Renewable Operations Control Center (ROCC) located in Juno Beach, Florida. The SCADA system, which is monitored twenty-four hours a day, seven days a week by both the O&M team and ROCC, further ensures safety, reliability, and optimal performance of the Project. Data collected by the SCADA system allows for real time adjustments to be made to the turbines for instances such as higher wind speeds or ice build-up on the turbine blades. Additionally, the full-time observation of the SCADA system allows for the O&M team to take necessary steps on site before larger issues could occur which prevents remobilization of larger equipment to the Project Area and unnecessary disturbances to existing land uses.

6.9 Concrete Batch Plant

A large amount of concrete is needed for turbine foundations. As such, it is most efficient to mix concrete on-site. One batch plant will serve as a staging area for dry constituents (sand, aggregate cement, etc.) hauled to the Project Area from off-site sources, and water supplied from municipal or other off-site sources and trucked to the Project Area, and mixing. The appropriate water appropriation permits will be obtained for the source water, as necessary. Electrical power for the batch plants will be supplied by portable generators or the local electrical distribution system. If the location of the batch plant should change, the Applicant will site the necessary batch plant on leased land and will avoid sensitive cultural and natural resources. It is anticipated that 9.2 acres of temporary disturbance and 0 acres of permanent disturbance will result from the proposed batch plant.

6.10 Laydown Area

The laydown area will be used to conduct maintenance on construction equipment and vehicles and to store fuel. On-site fuel storage will have secondary containment and will be inspected regularly, with containment being remediated promptly in accordance with the Project's Spill Prevention, Control, and Countermeasures Plan (SPCC). Fuel handling activities and spill remediation will also adhere to the procedures outlined in the Project's SPCC. It is anticipated that 50 acres of temporary disturbance and 0 acres of permanent disturbance will result from the proposed laydown area.

6.11 Construction

Construction of the Project is expected to last between 5 to 9 months and commence in late summer 2019. Once the Applicant obtains the Facility Permit and other county, State, and federal approvals, the Applicant will complete engineering-scale design of the access roads, construction areas, turbine foundations, and electrical components. Construction of the onsite roads, tower foundations, collection lines, and substation will take approximately 3 to 6 months. Turbine installation will take approximately 2 to 3 months. Figure 5 in Appendix A shows a typical site layout during construction. Collection lines will be installed using trenching methods or, if necessary due to site conditions or the presence of sensitive resources, by other methods such as horizontal directional drilling. The Applicant will remove topsoil prior to trenching and restore topsoil after trenching is complete. The construction contractor typically will decompact up to 10 inches below grade for crane paths post construction. For road construction, topsoil will be removed and stockpiled in the temporary construction area. If necessary for access roads, culverts will be installed or improved. For turbine foundation installation, topsoil and subsoil will be removed, separated, and stockpiled at each site. Following construction, subsoil and topsoil will be restored over the area surrounding the foundation. Temporary construction areas will be restored after construction, including removing gravel, decompacting subsoil, and replacing topsoil. Temporary and permanent stabilization measures such as mulching, seeding with appropriate seed mix, and installing slope breakers, will be implemented as detailed in the Project's SWPPP.

The Applicant will coordinate with the South Dakota Department of Transportation (SDDOT), Codington County and Grant County, and Project Area townships to manage construction traffic, and to ensure that equipment and components are delivered safely to the Project. The Applicant will obtain SDDOT Highway Access and Utility Permits prior to construction, and contractors will be required to obtain applicable over height or overweight haul permits. County road permits required for right-of-way (ROW) occupancy, utility crossings, road approaches, and overweight loads will be obtained from Codington County and Grant County prior to beginning construction activities for which the permit is required. The Project is expected to employ approximately 250 people at the height of construction.

Additionally, the Applicant will work closely with affected landowners to ensure fences are maintained and livestock protected during the construction phase and throughout Project operation.

6.12 Operations

Approximately 7-12 permanent employees, consisting of an operations manager and wind technicians, will operate the windfarm and substation after construction is completed. The operations team will be at the Project Area or O&M facility during normal business hours. This team will conduct routine inspections and maintenance will occur during the life of the Project. The operations team will also address any issues and optimize the performance of the plant. The team will have personnel on-call 24 hours per day, 7 days per week to address issues arising outside of normal business hours. The onsite operations team will work in conjunction with the ROCC located in Juno Beach, Florida. The ROCC will assist in determining any turbines not operating efficiently, determine operating issues, and recommend responsive action to optimize performance of the Project. The ROCC is constantly monitoring all issues such as overheating, turbulence, and vibrations. The onsite operations team will also perform visual assessments of wind turbines and associated components for long-term viability. The Applicant's plan for addressing emergency incidents will be in place as discussed in Section 18.3.3 and Section 22.2.

During operations, the site team will perform scheduled, preventive maintenance on wind turbines. Typically, this is done with representatives of the turbine manufacturer for the first 1 – 3 years. Two separate routine maintenance checks are completed each year: one is semi-annual, and one is annual. The semi-annual turbine maintenance is performed twice a year and consists of lubrication, fluid checks, minor electrical inspections, and turbine functionality checks. The annual maintenance, completed once per year, is a 36-hour inspection with a 3-technician crew.

7.0 Alternative Sites and Siting Criteria (ARSD 20:10:22:12)

ARSD 20:10:22:12. Alternative sites. *The applicant shall present information related to its selection of the proposed site for the facility, including the following:*

(1) The general criteria used to select alternative sites, how these criteria were measured and weighed, and reasons for selecting these criteria;

(2) An evaluation of alternative sites considered by the applicant for the facility;

(3) An evaluation of the proposed plant, wind energy, or transmission site and its advantages over the other alternative sites considered by the applicant, including a discussion of the extent to which reliance upon eminent domain powers could be reduced by use of an alternative site, alternative generation method, or alternative waste handling method.

The following is a description of the general Project Area selection process, a discussion of the site configuration alternatives considered for the Project, and a summary of the Project's siting criteria applied through the development process.

7.1 General Project Location Selection

Development of the Project was an iterative process involving general Project Area identification, Project Area (i.e., boundary) refinement; and micro-siting of proposed project infrastructure within the Project Area. Each of these steps is described in more detail below.

Eliminate of alternatives, and the identification of the Project Area was primarily driven by:

- Available wind energy resource;
- Access to viable transmission interconnection;
- Landowner support for wind energy development; and
- Land use and environmental resource compatibility with wind development.

In 2006, Crowned Ridge began evaluating the available wind resource in the Project Area. Over 10-years of wind resource data was collected by the Applicant which showed that a significant wind resource was present and suitable for the development of a competitive, large scale wind energy facility. The Project Area's wind resource aided the Applicant's efforts in identifying the overall size of the Project, the Project's turbine type and technology, and the most efficient areas for the placement of turbines.

The Project is located within adequate proximity to the Big Stone South Substation where access to sufficient transmission infrastructure and interconnection capacity is available. Newly proposed transmission improvement projects, some of which are now completed in eastern South Dakota, further assured available capacity in the region and solidified the viability of the Project. With such proximity to the Big Stone South Substation, the Applicant was able to design the Project's 34-mile generation tie line to effectively and efficiently deliver power to the MISO

transmission grid while utilizing rural, agricultural lands, minimizing impacts to human settlements and providing benefits to the local economy in the form of easement payments.

Landowner support of the project has been present for over 10 years and is showcased by the Applicant's ability to obtain the necessary wind leases to adequately host the Project. Many of the Project's landowners have been wind lease holders since development commenced in 2006 and elected to renew their leases multiple times over the course of development. Within the approximately 53,186-acre Project Area leases have been obtained for 374 parcels totaling approximately 45,935 acres of land or approximately 99% of the total Project Area.

A discussion of land use and environmental resource compatibility is included in Section 7.2 below.

7.2 Site Configuration Alternatives

Previous, earlier alternative Project configurations were based on considerations such as participating landowners, available desktop wetland and floodplain data, applicable roads, and former iterations of the Codington County Wind Energy System and Grant County Wind Energy System Requirements. The purpose of previous layouts was to establish a general site configuration that will allow the Applicant's engineering and environmental teams to complete due diligence through detailed desktop analyses, field surveys, manual walkdowns, and micrositing.

The Applicant completed desktop analyses and site-specific field studies of various site configurations in accordance with the USFWS Land-based Wind Energy Guidelines (WEG) to determine the potential for presence of sensitive natural resources. Data collected during these analyses and surveys informed an iterative process of refined infrastructure micro-siting, whereby the Applicant refined the Project configuration over a period of several months.

Multiple project configurations were also considered as a result of adopted changes to the local wind energy siting requirements in both Codington County and Grant County. This process occurred during the later stages of development while the Applicant was finalizing the Project's turbine locations. New siting requirements such as 1-mile setbacks from municipal boundaries (i.e., Waverly and Stockholm) and increased setbacks from participating residences removed large quantities of leased acreage from consideration. Numerous Project configurations were evaluated but the Applicant could not successfully reach compliance with the new siting requirements without expanding the Project Area. Approximately 15,500 acres of the current Project Area was acquired from Geronimo Energy, LLC as a means for the Applicant to find suitable locations for the turbines that had to be relocated.

The current Project site layout (Figure 3) is compatible with existing land use (Section 13), utilizes the wind resource in an efficient manner, and avoids or minimizes impacts to natural (e.g., wetlands, streams) and cultural (e.g., cairns, stone circles) resources. As described in

Section 18.6, impacts to cultural resources will be avoided or mitigated in consultation with the State Historic Preservation Office (SHPO). The Applicant also will avoid or minimize impacts to terrestrial and aquatic and ecosystems, including wildlife, as described in Sections 11 and 12, respectively.

Additionally, the layout is compliant with state and county setback requirements and ordnances. Setback requirements are laid out in Section 13, Table 13.1.2.

The buildable area for turbines, after considering the setbacks shown in Table 13.1.2, and other environmental factors (Figure 6), is depicted on Figure 7.

7.3 Lack of Reliance on Eminent Domain Powers

The Applicant will not exercise eminent domain powers; rather, all easements will be voluntarily acquired.

8.0 Environmental Information (ARSD 20:10:22:13)

ARSD 20:10:22:13. Environmental information. *The applicant shall provide a description of the existing environment at the time of the submission of the application, estimates of changes in the existing environment which are anticipated to result from construction and operation of the proposed facility, and identification of irreversible changes which are anticipated to remain beyond the operating lifetime of the facility. The environmental effects shall be calculated to reveal and assess demonstrated or suspected hazards to the health and welfare of human, plant and animal communities which may be cumulative or synergistic consequences of siting the proposed facility in combination with any operating energy conversion facilities, existing or under construction. The applicant shall provide a list of other major industrial facilities under regulation which may have an adverse effect on the environment as a result of their construction or operation in the transmission site, wind energy site, or siting area.*

Sections 9 through 18 describe the existing environment at the time of the submission of the application, anticipated impacts to the existing environment from construction and operation of the proposed Project, identification of irreversible changes that are anticipated to remain beyond the operating lifetime of the proposed facility, and mitigation measures the Applicant will undertake. These chapters also identify avoidance, minimization, and mitigation measures that will be implemented for the Project.

ARSD 20:10:22:13 states, "The environmental effects shall be calculated to reveal and assess demonstrated or suspected hazards to the health and welfare of human, plant and animal communities which may be cumulative or synergistic consequences of siting the proposed facility in combination with any operating energy conversion facilities, existing or under construction." The Applicant is unaware of any other operating energy conversion facilities, existing or under construction, or other major industrial facilities under regulation within or adjacent to the Project Area. As such, no cumulative or synergistic consequences related to environmental effects contemplated by the regulation are known to exist for the proposed Project. The Applicant is aware that the Dakota Range Wind 1 area located to the northwest of the Project has been permitted through the PUC, but not yet constructed. In addition, the Cattle Ridge Project also was permitted locally through Grant County and was subsequently acquired by the Applicant and is now included as part of the Project.

Table 8.1 summarizes the ground disturbance impacts (both temporary impacts during construction and permanent impacts during the life of the Project) calculated for the Project.

Table 8.1. Summary of Crowned Ridge Wind Disturbance Impacts

Project Component	Temporary Construction Disturbance	Construction Disturbance to be Reclaimed	Permanent Disturbance during Operations
Wind Turbines[1]	4.50 acres per turbine (this area includes one temporary crane pad per turbine)	4.48 acres per turbine	0.02 acres per turbine (this area includes one permanent transformer mount per turbine)
Access Roads[2]	200 feet wide per linear foot of road	184 feet wide per linear foot of road	16 feet wide per linear foot of road
Collection Lines[3]	approximately 50 feet wide per linear foot	approximately 50 feet wide per linear foot minus 12 feet by 8 feet per junction box	0 feet wide per linear foot (0.0 acre) for collection lines 12 feet by 8 feet (0.02 acre) for each junction box (35 junction boxes anticipated)
Crane Path[4]	approximately 50 feet wide per linear foot, with possibility of some locations up to 80 feet wide per linear foot	approximately 50 feet wide per linear foot	0 feet wide per linear foot
Supervisory Control and Data Acquisitions (SCADA) Meteorological (MET) Tower[5]	1.25 acres	1.25 acres minus 5 square feet (0.001-acre)	0.001 acre
O&M Facility	10.0 acres	9.3 acres, minus the collection substation	0.7 acre
Collection Substation (located on same 10-acre parcel as O&M facility)	10.0 acres	8.7 acres, minus the O&M facility	1.3 acres
Laydown Area	50.0 acres	50.0 acres	0 acre
Concrete Batch Plant	Approximately 9.2 acres	9.2 acres	0 acre

[1] *Construction impacts assumed a 250-foot construction radius around each turbine (approximately 4.50 acres per turbine). Impacts during operation account for a 30-foot diameter gravel pad, containing the turbine base, or 0.02 acres per turbine.*

[2] *Access road construction easement width is 200 feet wide to account for potential maximum impact and is a conservative estimate of disturbance. Access roads are anticipated to temporarily be 32 feet or less in width during construction and later will be reduced to a permanent 16-foot width for operation. Access road impacts also assume all proposed roads are new access roads and do not consider improvements to existing roads separately.*

[3] *Collection line impacts are based on proposed collection corridors that vary in width from 50-90 feet. Where collection line corridors overlap access road construction easements, the respective impact buffers generally overlap. Once collection lines are further defined, final impacts will be less than those currently calculated.*

[4] *Crane path width is based on turbine types. Crane paths required to support crane access to turbines typically are up to 50 feet wide. In select and highly constrained portions of the Project, up to 80 feet in width may be needed for crane paths. Overall, temporary impacts are a conservative estimate of disturbance. Where crane paths overlap access road construction easements, the respective impact buffers generally overlap.*

[5] *Area of impact is 1.25 acres for one guyed tower during installation. Once installed, the tower has a one square-foot base plate and four one square-foot anchor points, for a total of five square feet.*

9.0 Effect on Physical Environment (ARSD 20:10:22:14)

ARSD 20:10:22:14. Effect on physical environment. *The applicant shall provide information describing the effect of the proposed facility on the physical environment. The information shall include:*

(1) A written description of the regional land forms surrounding the proposed plant or wind energy site or through which the transmission facility will pass;

(2) A topographic map of the plant, wind energy, or transmission site;

(3) A written summary of the geological features of the plant, wind energy, or transmission site using the topographic map as a base showing the bedrock geology and surficial geology with sufficient cross sections to depict the major subsurface variations in the siting area;

(4) A description and location of economic deposits such as lignite, sand and gravel, scoria, and industrial and ceramic quality clay existent within the plant, wind energy, or transmission site;

(5) A description of the soil type at the plant, wind energy, or transmission site;

(6) An analysis of potential erosion or sedimentation which may result from site clearing, construction, or operating activities and measures which will be taken for their control;

(7) Information on areas of seismic risks, subsidence potential and slope instability for the plant, wind energy, or transmission site; and

(8) An analysis of any constraints that may be imposed by geological characteristics on the design, construction, or operation of the proposed facility and a description of plans to offset such constraints.

9.1 Geological Resources

The following sections describe the existing physical environment within the Project Area and the potential effects of the proposed Project on the physical environment.

9.1.1 Existing Geological Resources

The following sections describe the existing geological resources, landforms, surficial geology, bedrock geology, economic deposits, seismic risks, and subsidence potential within the Project Area.

9.1.1.1 Regional Landforms and Surficial Geology

The Project lies within three ecoregions, namely the Prairie Coteau Escarpment to the northeast, the central Prairie Coteau, and the Big Sioux Basin to the southwest. As described by Bryce et al. (1996), the Prairie Coteau Escarpment is a distinctive landform rising 300 to 600 feet above the Minnesota River valley that is incised by steep perennial streams that flow off it to the Minnesota River valley to the east. The Prairie Coteau formed from stagnant glacial ice melting beneath sediment layers, which resulted in tightly undulating, hummocky topography with no discernable drainage pattern. The region contains closely spaced semi-permanent and seasonal wetlands, with a chain of large lakes that formed where there was little ice shear and higher precipitation amounts, which support widespread burr oak woodlands near wetland margins. The Big Sioux Basin ecoregion is a trough that penetrates the core of the Prairie Coteau and is characterized by a well-developed drainage network with more tilled agriculture due to a general lack of wetlands and gentler topography than the Prairie Coteau.

Project elevations range from approximately 1,040 to 1,400 feet above mean sea level (fmsl) in the Prairie Coteau Escarpment region, to 1,947 fmsl to 2,032 fmsl in the Prairie Coteau region, and from approximately 1,912 fmsl to 2,050 fmsl in the Big Sioux Basin. Project topography is shown in Figure 8.

As illustrated in Figure 9a, the Project is underlain from northeast to southwest by till consisting of heterogeneous, clay with silt to boulder-size clasts, that is characterized by elevated linear ridges with hummocky terrain in the Prairie Coteau Escarpment. The Prairie Coteau portion consist of stagnation moraine, end moraine, collapsed outwash, and ground moraine deposits, while till consisting of end moraine and undifferentiated moraine deposits underlies the western portion of the project in the Big Sioux Basin. The till deposits generally consist of a compact, silty, clay-rich matrix with sand- to boulder-sized clasts of glacial origin, with an estimated composite thickness of up to 300 feet (Martin et al 2004); however, pre-Late Wisconsin drift deposits underlie the Late Wisconsin drift deposits, which results in a total thickness for all these glacial deposits of 400 to 700 feet (Gilbertson 1989). Within the till are shallow glacial outwash deposits of sand and gravel that occur at the land surface to depths of generally 50 feet or less, and deeper water-bearing sand and gravel units at depths generally greater than 100 feet below ground surface (Jensen 2003; see Section 10). Figure 9b shows the geological cross-section of the Project Area.

As described by Martin *et al* (2004), the geomorphic character of the till deposits ranges from smooth rolling terrain (ground moraine) to elevated linear ridges with hummocky terrain locally at former ice sheet margins (end moraine), while the undifferentiated till exhibits a distinctive weathered, dissected surface that is typically overlain by up to 10 feet of loess. In addition to the glacial deposits, Quaternary alluvium is present along the streams within the Project Area.

9.1.1.2 Bedrock Geology

As shown in Figure 10, upper Cretaceous bedrock, consisting of the Pierre Shale, the Niobrara Formation, and the Carlile Shale underlie the Project Area. The Pierre Shale underlies the majority of the western portion of the Project and is described as blue-gray to dark-gray, fissile to blocky shale with persistent beds of bentonite, black organic shale, and light-brown chalky shale, with minor sandstone, conglomerate, and abundant carbonate and ferruginous concretions. The Niobrara Formation occupies a narrow band in the center of Project Area and is described as white to dark-gray argillaceous chalk, marl, and shale that weathers yellow to orange and contains thin, laterally continuous bentonite beds, chalky carbonaceous shale, minor sand, and small concretions. The Carlile Shale underlies the eastern portion of the Project Area and is described as dark-gray to black, silty to sandy shale with several zones of septarian, fossiliferous, carbonate concretions, and contains up to three sandstone units in the upper portion of the formation and a sandy calcareous marl at the base. These bedrock formations (see Figure 10) are overlain by up to 700 feet of glacial deposits and are not exposed at the surface (Gilbertson 1989).

9.1.1.3 Economic Deposits

Based on data provided by the SDDENR, review of aerial photographs, and field observations, economic deposits are present in two locales in the Project Area in Codington County and in two locales in adjoining Grant County. One locale that is continuous in both counties consists of a northwest to southeast trending belt that is an outwash plain situated in the Antelope Valley and parallels a ridge known as the Altamont moraine (Schulz 1991; Jarrett 1986). This outwash deposit has an average overburden thickness of 2 to 3 feet and an average thickness of 25 to 30 feet, with aggregate thicknesses up to 60 feet. Overburden refers to soil and other geologic materials lying between the surface and the top of the economic deposit. Here, the soil and clay layers overlying the sand and gravel deposit constitute the overburden. The second locale consists of valley train outwash deposits that are found in the valleys of creeks draining into the Big Sioux River from the east (Figure 9a). Associated with these valley-train deposits are high- and low-level terraces. As described by Schulz (1991) and Jarrett (1986), multiple test borings have been conducted historically in these deposits to assess their economic potential. Sand and gravel deposits were encountered within 25 feet of the land surface with less than 5 feet of overburden. The sizes of these deposits, in conjunction with the relatively thin overburden, makes them well-suited for development as construction aggregate sources. Several areas in both counties have been tested or bonded for development of sand and gravel deposits and several gravel pits are present along the sides of Antelope Valley (Schulz 1991; Jarrett 1986). Two active sand and gravel pits are located in T118N R51W Section 15 and 16. The Applicant is not aware of any plans to develop other extractive mineral resources in the Project Area, but the potential to develop those resources does exist.

9.1.1.4 Seismic Risks

Risk of seismic activity in the Project Area is considered low. Between 1872 and 2013, 87 earthquakes were recorded in South Dakota (SDDENR 2013). None of these earthquakes occurred in Codington or Grant Counties and the closest recorded earthquake, with a Modified Mercalli Intensity of 3.7, occurred in northeastern Roberts County on October 20, 1995.

9.1.1.5 Subsidence Potential

The majority of the Project Area is underlain by the Pierre Shale, with the Niobrara Formation and the Carlisle Shale underlying the eastern portion of the Project Area. These formations are overlain by 400 to 700 feet of glacial till deposits. Limestone units and karst terrain are not present in the Project Area and thus, the potential for subsidence is negligible. The Applicant is not aware of any subsidence potential or slope instability problems within the Project Area.

9.1.2 Geological Resources Impacts/Mitigation

The risks posed by the Project are generally limited by the characteristics of the geologic materials in the area. The unconsolidated geologic materials within the Project Area are

composed of glacial till consisting of ground moraine, end moraine, stagnation moraine, and undifferentiated moraine that are generally of low permeability, although sand and gravel glacial outwash deposits and aeolian dusts and sands are present in these materials. The first occurrence of water-bearing sand and gravel deposits in the glacial till is generally greater than 100 feet, while the first occurrence of water-bearing units in the sand and gravel outwash deposits and alluvium is generally less than 50 feet (Jensen 2003). Some of the sand and gravel outwash deposits are tilted and are overlain by relatively impermeable clays that act as confining layers. Thus, at locations where the elevation is lower than the source or recharge area for these deposits, wells developed in these deposits will be artesian and, if the elevation difference is great enough, the well may be a flowing artesian well. The sand and gravel outwash and alluvial deposits have high permeability but can be limited in size and aerial extent. Turbine foundations, connecting lines, and access roads may encounter these alluvial and glacial outwash deposits at various locations within the Project Area, but the use of concrete turbine tower foundation materials and foundation depths, and connector line and access road excavation depths are not deep enough to significantly impact these resources.

Information compiled by Schulz (1991) and Jarrett (1986) indicates that economically valuable mineral deposits, such as sand and gravel, occur in two locales in the Project Area. These locales are comprised of undifferentiated and collapsed glacial outwash deposits that generally occur in a northwest to southeast trending belt in northeastern Codington County and southwestern Grant County and valley train outwash deposits along Mud Creek (Schulz 1991; Jarrett 1986). Numerous test borings within the Project Area encountered average sand and gravel deposit thicknesses of 25 to 30 feet with generally less than 3 feet of overburden and indicated a "good" economic potential to develop these outwash deposits as construction aggregate sources (Schulz 1991; Jarrett 1986). These deposits correspond to the location of the undifferentiated and collapsed outwash deposits shown on Figure 9a (Flint 1955). These deposits generally are described as tan to brown, fine- to medium- sand and clayey and silty, oxidized, fine- to medium- gravel. Permanent impacts to economic deposits may occur due to turbine towers, interconnection circuits, and access roads being located on top of these deposits that could potentially be mined at some future date, but the Applicants are not aware of any plans to develop these resources within the construction area. Even with economic mineral development at some future date, the Applicants anticipate that any permanent impacts to these deposits will be minimal.

9.2 Soil Resources

The following sections describe the existing soil resources within the Project Area and the potential effects of the proposed Project on the soil resources. Figure 11 shows the Project Area soil resources.

9.2.1 Existing Soil Resources

The following sections describe the existing soil types, erosion potential and slopes, and prime farmland soils within the Project Area.

9.2.1.1 Soil Types

The US Department of Agriculture Natural Resources Conservation Service (NRCS) office for each county defines the soil associations found within their respective county. Soil associations are defined as a group of individual soil series that occur in a repeatable pattern across the landscape and share a distinctive pattern of soils, relief, and drainage. A soil association generally includes two or three major soil series and a few minor soil series.

Soil Survey Geographic (SSURGO) Geographic Information System (GIS) data are available from the NRCS and were analyzed using ESRI's ArcMap 10.5 software to determine the soil associations located within the Project Area and construction easement. One-hundred-two (102) soil associations were identified in the Project Area, while 69 soil associations were identified in the Project Construction Easement.

9.2.1.2 Erosion Potential and Slopes

Attributes to identify erodible or highly erodible soils are not provided in the SSURGO data. However, if disturbed, the increased potential for erosion associated with surface runoff for soils increases as slope gradient rises over 2 percent (Soil Science Division Staff 2017). Thirty-three soil associations (area totaling approximately 564.0 acres) within the Project Construction Easement have a slope of 0 to 2 percent, while the remaining 36 soil associations (area totaling approximately 1,570.4 acres) have a slope that ranges from 2 to 60 percent.

9.2.1.3 Prime Farmland Soils

The NRCS defines prime farmland as areas that have acceptable acidity or alkalinity, a dependable supply of moisture from irrigation or precipitation, favorable temperature, and an adequate growing season. Typically, soils in prime farmland are sufficiently well-drained and not excessively erodible during the growing season. Table 9.2.1.3 presents the percent of area by farmland classifications for the Project Area and Project Construction Easement. Table 9.2.1.3 Farmland Classification within the Project Area and Project Construction Easement

Farmland	Project Area		Project Construction Easement	
	Total Acreage	Percent	Total Acreage	Percent
All areas are prime farmland	22,952.0	43.2%	1,183.7	55.5%
Farmland of statewide importance	9,522.2	17.9%	381.0	17.8%
Prime farmland if drained	1,277.4	2.4%	40.2	1.9%
Prime farmland if irrigated	2,523.4	4.7%	137.3	6.4%
Not prime farmland	16,911.1	31.8%	392.2	18.4%
Total	**53,186.2**	**100.0**	**2,134.4**	**100.0**

9.2.2 Soil Resources Impacts/Mitigation

9.2.2.1 Potential for Impacts to Soil Resources

Soil erosion is the greatest risk to the geologic environment. Where the land slope is relatively flat, the soil erosion potential is low. However, where steeper slopes (i.e., greater than 6 percent) are present, the potential for soil erosion increases significantly.

Thirty-three soil associations (area totaling approximately 564.0 acres) along the construction easement have a slope of 0 to 2 percent, while the remaining 36 soil associations (area totaling approximately 1,570.4 acres) have a slope that ranges from 2 to 60%. In addition to slope, soil properties that also influence erosion from water runoff include soil texture, percent organic matter, structure infiltration capacity, and soil permeability. Soils containing high proportions of silt and fine sand are most erodible, while well-drained and well-graded gravels and gravel sand mixtures with little or no silt are the least erodible materials. Slope length and gradient; frequency, intensity, and duration of rainfall; and the amount of time bare soils are exposed all influence erosion caused by storm water runoff. In addition to natural processes, erosion could be caused by site clearing and earthmoving activities.

9.2.2.2 Erosion, Slope Stability, and Sedimentation

Project construction activities described in Section 6 and Table 8.1 will result in an estimated 2,134.4 acres of temporary impacts to soils, and in approximately 86.0 acres of permanent

impacts to soils. Impacts to soils could include compaction, potential loss of soil due to erosion, and the potential contamination of soils from construction equipment spills.

9.2.3 Prime Farmland Impacts

Table 9.2.3 provides the estimated temporary and permanent impacts to farmland classifications associated with construction and operation of the Project.

Table 9.2.3. Estimated Temporary and Permanent Impacts to Farmland

Farmland Classification	Temporary Impacts (acres)[1]	Permanent Impacts (acres)[2]
All prime farmland	1,183.7	49.2
Farmland of statewide	381.0	15.0
Prime farmland if drained	40.2	1.4
Prime farmland if irrigated	137.3	5.4
Not prime farmland	392.2	15.0
Total	2,134.4	86.0

[1] *Temporary impacts are calculated assuming 4.50 acres of temporary impact around each wind turbine tower location, a 50-ft. wide collection line ROW, and up to a 200-ft. wide temporary construction disturbance for access roads.*

[2] *Permanent impacts are calculated as a 0.02-acre area around each wind turbine tower location, plus 16-foot wide permanent access roads. Because collection lines will be buried, there will be no permanent impacts from installation of those lines, except for approximately 35 junction boxes (12 feet by 8 feet) (total of 0.07 acre).*

9.2.4 Mitigation

The locations of turbine towers, collection lines, and access roads have been selected to minimize impacts to land forms, geology, and economic deposits. Available geologic data indicate that the Project will not significantly affect soil conditions or bedrock geology. Seismic activity is not anticipated to affect the performance of the wind turbines. The placement of tower foundations in the ground will have a minor impact to underlying geologic conditions. Except as described in this application, the Applicant is not aware of any additional constraints that may be imposed by geological characteristics on the design, construction, or operation of the facility. Additional geotechnical testing will be completed prior to construction to further evaluate site-specific geologic conditions at each tower location.

Soil erosion is possible in areas of steep slopes (i.e., greater than 3:1 [horizontal: vertical] or 33%); however, only 3.4% (53.6 acres) of the Project Construction Easement has slopes that may range above 30 percent. To reduce adverse effects to and from soils, the project will develop and implement a SWPPP and use BMPs during construction to protect topsoil and minimize soil erosion. Soil areas disturbed during construction will be decompacted and returned to pre-construction contours to the extent practicable and in accordance with landowner agreements.

The goal is to have all surfaces drain naturally, blend in with the undisturbed natural terrain, and be left in a condition to facilitate re-vegetation, provide for proper drainage, and prevent erosion. Temporary areas, such as the construction laydown and concrete batch areas, will be restored in accordance with the landowner agreements and the SWPPP.

10.0 Effect on Hydrology (ARSD 20:10:22:15)

ARSD 20:10:22:15. Hydrology. *The applicant shall provide information concerning the hydrology in the area of the proposed plant, wind energy, or transmission site and the effect of the proposed site on surface and groundwater. The information shall include:*

(1) A map drawn to scale of the plant, wind energy, or transmission site showing surface water drainage patterns before and anticipated patterns after construction of the facility;

(2) Using plans filed with any local, state, or federal agencies, indication on a map drawn to scale of the current planned water uses by communities, agriculture, recreation, fish, and wildlife which may be affected by the location of the proposed facility and a summary of those effects;

(3) A map drawn to scale locating any known surface or groundwater supplies within the siting area to be used as a water source or a direct water discharge site for the proposed facility and all offsite pipelines or channels required for water transmission;

(4) If aquifers are to be used as a source of potable water supply or process water, specifications of the aquifers to be used and definition of their characteristics, including the capacity of the aquifer to yield water, the estimated recharge rate, and the quality of groundwater;

(5) A description of designs for storage, reprocessing, and cooling prior to discharge of heated water entering natural drainage systems; and

(6) If deep well injection is to be used for effluent disposal, a description of the reservoir storage capacity, rate of injection, and confinement characteristics and potential negative effects on any aquifers and groundwater users which may be affected.

10.1 Groundwater Resources

10.1.1 Existing Groundwater Resources

The majority of groundwater resources in the Project Area in Codington and Grant Counties occur in deposits of sand and gravel or the Dakota Formation that are generally at depths greater than 100 feet below the land surface. However, the first occurrence of groundwater in alluvial, outwash, and sand and gravel deposits is generally less than 50 feet below ground surface (Jensen 2003). Notably, the Antelope Valley Aquifer, which is a glacial outwash channel deposit, is in a northwest/southeast-trending belt in northeastern Codington County and southwestern Grant County, while northeast/southwest-trending outwash deposits are present in the southwestern portion of the Project Area which are associated with the Big Sioux Aquifer (Hansen 1994). Additionally, deposits of recent alluvium are present along drainages and may overlie some of the outwash deposits. As mapped by the NRCS (2018), shallow groundwater occurs in the soils within the Project Area at depths ranging from 0 inches at the soil surface to greater than 80 inches. The approximate depth to shallow groundwater in the soils within the Project Area exhibit the following distribution: 0 to 18 inches, 7.7%; 6 – 18 inches, 9.0%; 16 – 28 inches, 2.6%; 18 – 30 inches, 14.1%; 30 – 41 inches, 5.1%; 43 – 55 inches, 3.8%; 49 – 61 inches, 15.4%; and greater than 80 inches, 42.3%. The minimum average depth of shallow groundwater is 23 inches and the maximum average depth is 41 inches (NRCS 2018). While these shallow groundwater resources may not provide adequate yields to wells for use as a

domestic or livestock water supply, they are important sources of recharge for the deeper underlying aquifers and to support agricultural plant growth.

10.1.2 Groundwater Resources Impacts/Mitigation

Permanent impacts to groundwater are not expected but temporary impacts to groundwater may occur. Depending upon the exact locations of the turbines (which are typically up to 8 feet deep for spread foot style turbine foundation and up to 32 feet deep for P&H style turbine foundation), there is potential that foundations will intersect the perched groundwater in the soil profile and shallow groundwater in the outwash deposits and alluvium but is not likely to impact the deeper groundwater resources. Review of the Project array and aquifer materials deposits reveals that one turbine is located on alluvium, one turbine is located where sand and gravel deposits are at a depth of 50 to 100 feet, 16 turbines are located on outwash deposits with first occurrence depths of 0 to 50 feet, and the remainder of the turbines are located on areas where the first occurrence of sand and gravel deposits is greater than 100 feet below ground surface. Construction and placement of collector lines and access roads typically are shallow (4 feet) and are unlikely to encounter the perched groundwater in the soil profile. To facilitate construction of this infrastructure, shallow groundwater dewatering may be required, which will represent a temporary impact to groundwater. If construction dewatering is anticipated, a Temporary Water Right will be obtained from the SDDENR and the Applicant will ensure that required discharge monitoring is conducted, appropriate BMPs are utilized, and the SWPPP will be amended accordingly. Appropriate BMPs will be implemented, as needed. The potential drawdown effects of any dewatering activity will be local and temporary. Permanent impacts to groundwater from construction dewatering activities and/or structure placement in the shallow groundwater flow regime is not expected.

Additional sources of groundwater may be used during construction for dust control if required by County Road Use Agreements. The Applicant expects to obtain the water from existing waste water treatment plants after treatment or reclamation and provide a beneficial re-use of water if available. If treated water for dust control is not available, the Applicant will evaluate other options to minimize water use including trucking in water from local municipalities and working with landowners to use existing pond water resources. The Applicant will obtain any necessary permits if any surface or groundwater supplies have the potential to be affected.

Risk for groundwater contamination caused by release of contaminants during construction is low. The overall low permeability of the unconsolidated geologic and soil materials will inhibit contaminant flow, although isolated high permeability granular lenses of limited size may be present that could result in a more rapid contaminant distribution. As part of the SWPPP, a spill prevention and response plan to address potential releases to groundwater or surface water will be developed and implemented.

Water sources during operations for the O&M building are expected to come from existing rural water sources. In the event existing rural water sources are not available or sufficient to supply the O&M building for drinking and sanitary use, the Applicant will explore drilling a well for potable water and will seek all appropriate permits if needed.

The Project will not require water storage, reprocessing, cooling, or deep well injection. Permanent effects to aquifers and potable water supplies are not expected.

10.2 Surface Water Resources

10.2.1 Existing Surface Water Resources

The Project is in one hydrologic region (the Missouri), covers five major watersheds within Hydrologic Unit Code (HUC) 10 (e.g., South Fork Whetstone River, North Fork Yellow Bank River, South Fork Yellow Bank River, Big Sioux Basin, and Willow Creek), and encompasses 12 sub-watersheds (HUC 12), as defined by the USGS (Seaber et al 1987). Figure 12 shows the hydrologic resources discussed in this section. The Project Area encompasses the three physiographic regions discussed in Section 9.1.1.1, with the northeastern approximately 28.2 square miles (mi^2) in the Prairie Coteau Escarpment, the central approximately 25.9 mi^2 in the Prairie Coteau, and the southwestern approximately 28.6 mi^2 in the Big Sioux Basin.

10.2.1.1 Hydrology

The Project lies within 12 subwatersheds of the five major watershed units listed above in Section 10.2.1. The USGS-named streams within the Project Construction Easement are listed in Table 10.2.1.1. Three named streams and multiple unnamed tributaries to these streams are located within the Project Area; however, only two named streams intersect the Project Construction Easement (Table 10.2.1.1).

Table 10.2.1.1 USGS-Named Streams/Rivers and Floodplains within the Project Construction Easement

Surface Water Name	Number of Crossings	Floodplain Present at River Crossing[1]
North Fork Yellow Bank River	1	No
Mud Creek	3	Yes
Total	4	-

[1] *Includes review of available digital floodplain data for Codington County and Grant County.*

Sources: National Hydrography Data (NHD) (USGS 2014a) and Federal Emergency Management Agency (FEMA) data (FEMA 2016).

According to National Wetland Inventory (NWI) data, most wetlands within the Project Area and Project Construction Easement are freshwater emergent, as shown below in Table 10.2.1.2 (USFWS 2017b).

Table 10.2.1.2 NWI-Mapped Wetlands Identified within Project Area and Project Construction Easement

NWI Wetland Type	Project Area		Project Construction Easement	
	NWI-mapped Wetland Area (Acres)	Percent of Area Containing Wetlands	NWI-mapped Wetland Area (Acres)	Percent of Area Containing Wetlands
Lake	0.0	0.0	0.0	0.0
Freshwater Emergent Wetland	2,291.7	4.3	14.3	0.7
Freshwater Forested/Shrub Wetland	51.8	0.1	0.003	0.0
Freshwater Pond	324.4	0.6	0.6	0.0
Riverine	170.0	0.3	2.0	0.1
Total	**2,838**	**5.3**	**16.9**	**0.8**

The USFWS manages wetland and grassland easements within the Project Area, which includes approximately 8,901.6 acres of USFWS wetland, grassland, or combined wetland/grassland easements. Only the designated protected basins within grassland/wetland easements are protected by the easement (discussed in in Section 13.2.1). Uplands surrounding protected basins within USFWS wetland easements are not protected, and commonly are in agricultural use. Seven turbines are sited on parcels containing USFWS wetland easements. No turbines or other infrastructure are sited within protected basins on USFWS wetland easements. No turbines or other infrastructure are sited on USFWS grassland or grassland/wetland combination easements. Additionally, the SDGFP Department manages approximately 1,343 acres of public and private lands within the Project Area as waterfowl production areas, game production areas, and Walk-in Areas (WIA) (Section 13.2.1). Three turbines are placed on these conservations or public-leased areas.

10.2.1.2 National Park Service Nationwide Rivers Inventory

There are no stream or river segments within the Project Area that are listed in the National Park Service Nationwide Rivers Inventory.

10.2.1.3 Impaired Waters

There are no TMDL or impaired waters that are included in the Section 303(d) list of impaired waters (SDDENR 2018).

10.2.1.4 Floodplains

Electronic FEMA floodplain data is available for Codington County and Grant County. Review of these data indicates that one water body within the Project Construction Easement contains 100-year-floodplains (shown as FEMA Flood Zone A on Figure 12). The Project construction activities have been planned to not cross mapped streams or floodplains. If design changes require placement of structures within the 100-year floodplain of any waterbody within the Project Construction Easement, the Applicant will obtain a floodplain development permit from the appropriate regulatory agency, as required by Section 3.11.04 of the Codington County Zoning Ordinance and Section 1106 of the Grant County Compiled Zoning Ordinance. As shown on Figure 12, an unnamed tributary to Mud Creek crosses the Project Area and is also FEMA Flood Zone A. The Project Construction Easement crosses nine unnamed tributaries within the same Zone A. Four small flood zones are crossed by the collector line easement. Other unnamed streams and water bodies do not have designated 100-year-floodplains within the Project Area.

10.2.2 Surface Water Resources Impacts/Mitigation

The Applicant has minimized or avoided direct permanent impacts to rivers, streams, and floodplains to the extent feasible, although temporary impacts may occur from construction activities. Potential impacts to rivers, streams, and floodplains are expected to be avoided or minimized by locating wind turbines outside of these areas and routing access roads and collector lines around these resources. To the extent practicable, impacts to water bodies, wetlands, and aquatic resources will be avoided or minimized through the siting process and through the use of stormwater BMPs during construction.

Impacts to wetlands and waterbodies that may result because of access road construction are minor and will be authorized under United States Army Corps of Engineers (USACE) Nationwide Permit (NWP) 12 for utility lines and associated facilities in waters of the U.S. (see Section 11). These authorized, permanent impacts may remain beyond the Project's operational lifetime. Disturbed surfaces will be restored as nearly as possible to their preconstruction conditions during Project decommissioning.

As described above, collector lines will be sited to avoid intersecting wetland or other waterbodies to the extent practical. Where collector lines must intersect these resources, the Applicant will bore under these features to the extent practical to minimize impacts (see Section 11).

Where activity must occur in a wetland area, the Applicant will utilize standard construction BMPs to minimize impacts and will make every effort to keep permanent impacts below USACE NWP thresholds. Standard construction BMPs include the following:

- On construction plans, clearly mark the limits of construction.

- In the field, fence-off water resources in close proximity to construction activities with high visibility fencing to prevent unintended impacts.
- Keep construction staging and stockpiling of materials out of wetlands and their buffers.
- Restrict site access of machinery to as few areas as possible to reduce soil compaction.
- Use removable crane mats to cross streams and wetlands instead of building construction pads.
- If movable equipment must be in the wetland or buffer, do not leave it there over night or on weekends.
- Do not store fuel or refuel movable equipment in a wetland or its buffer. When refueling equipment that is not readily movable (i.e., cranes), follow best management practice for temporary spill prevention, control, and containment.
- Do not mix, test, store, or dispose of concrete within a wetland or its buffer.

The Project Area contains USFWS wetland and wetland/grassland combination easements. The Project has been designed to avoid protected basins such that no surface impacts to protected basins are expected.

Locations of the larger areas of potential temporary or permanent impacts such as the laydown area, the substation, and the O&M facility have been selected to avoid and minimize impacts to wetlands. Wetland delineation surveys are ongoing, and results of these surveys will be utilized to refine and select precise locations of Project facilities. Further, the storm water BMPs that will be implemented as part of the SWPPP will provide additional protections to wetlands located in the Project Area. Based on the foregoing approaches, the Applicant anticipates that temporary and/or permanent impacts to wetlands during construction will be avoided or minimized.

To limit impacts to hydrologic resources caused by soil erosion, groundwater contamination or storm water runoff, the Applicant will obtain a South Dakota General Permit for Storm Water Discharges Associated with Construction Activity (SDR100000), develop and implement a SWPPP, and use BMPs to reduce impacts during construction. As required by SDR100000 and the SWPPP, any vehicle fueling within the Project Area will employ appropriate BMPs and will occur at an appropriate distance from waterways determined by site-specific conditions, such as ground cover, slope, and soil type.

10.2.2.1 Impacts to Impaired Waters and Mitigation

Review of the 2018 Integrated Report (SDDENR 2018) indicates that there are no impaired waters within the Project Area and thus, no impacts to impaired water will occur.

10.2.2.2 Impacts to Flood Storage Areas and Mitigation

Flood storage areas are not present within the Project Area and thus, no impacts to those types of facilities are anticipated.

10.3 Current and Planned Water Uses

10.3.1 Current and Planned Water Uses within Project Area

Existing water sources for residential and agricultural uses are provided by rural water systems and wells. Three named streams and multiple unnamed tributaries provide surface water opportunities for recreational purposes in the Project Area. For groundwater resources, current and planned uses are for commercial, irrigation, and domestic water supplies.

10.3.2 Effect on Current or Planned Water Use

The Applicant expects to re-use treated water from waste water treatment plants for dust control during construction. Re-use of previously treated water will minimize the use of new potable surface or groundwater supplies being utilized. If water re-use is not available, the Applicant will pursue locally available sources of pond water with participating landowners and will pursue any permits necessary to do so. Water use during operations is expected to come from existing rural water supplies for the O&M building. In the event rural water supplies are not available, the Applicant will install a groundwater well. Impacts to current or planned water uses are expected to be minimal given the avoidance and minimization measures described above.

11.0 Effect on Terrestrial Ecosystems (ARSD 20:10:22:16)

ARSD 20:10:22:16. Effect on terrestrial ecosystems. *The applicant shall provide information on the effect of the proposed facility on the terrestrial ecosystems, including existing information resulting from biological surveys conducted to identify and quantify the terrestrial fauna and flora potentially affected within the transmission site, wind energy site, or siting area; an analysis of the impact of construction and operation of the proposed facility on the terrestrial biotic environment, including breeding times and places and pathways of migration; important species; and planned measures to ameliorate negative biological impacts as a result of construction and operation of the proposed facility.*

The following sections describe the existing terrestrial ecosystems in the Project Area, potential effects to these resources from the Project, and mitigation measures intended to offset potential effects. Terrestrial ecosystem data were collected from available data sources, state and federal agency coordination, and field surveys.

11.1 Vegetation (Flora)

The following sections describe the vegetation within the Project Area and the potential effects of the proposed Project on this resource. Planned avoidance, minimization, and mitigation measures for those effects are also described.

11.1.1 Existing Vegetation

To develop a characterization of the existing environment, a desktop analysis was performed for the Project Area. The desktop analysis consisted of a review of publicly available resources with pertinent environmental data, including the USGS National Land Cover Database (NLCD), US Department of Agriculture (USDA) National Agriculture Statistics Service data, high resolution aerial imagery, and data available from South Dakota State University's Public Research Access Institutional Repository and Information Exchange. These data were combined in GIS and manually reviewed by biologists experienced with aerial photography interpretation and the ecological communities of eastern South Dakota.

The Project lies within three ecoregions, namely the Prairie Coteau Escarpment, the central Prairie Coteau, and the Big Sioux Basin (Bryce et al 1996) (Section 9). The predominant cover type within the Project Area is grass/pasture (46.66 percent) followed by agricultural (35.82 percent; Table 11.1.1; Figure 13). The predominant land cover type in the Project Construction Easement is agricultural (70.46 percent) followed by grass/pasture (26.13 percent; Table 11.1.1; Figure 13). Cropland provides minimal habitat for most terrestrial species, though it may provide a food source and cover for some.

Table 11.1.1 Land Cover within the Project Area and Project Construction Easement

	Project Area		Project Construction Easement	
Land Cover Type[1]	**Area (acres)**	**% Total**	**Area (acres)**	**% Total**
Grass/Pasture	24,816.30	46.66	579.93	26.13
Agricultural	19,049.25	35.82	1,564.41	70.46
Other Hay/Non-alfalfa	5,885.28	11.07	23.22	1.05
Developed	1,893.40	3.56	42.44	1.91
Herbaceous Wetlands	853.40	1.60	1.94	0.09
Deciduous Forest	397.15	0.75	6.92	0.31
Open Water	273.95	0.52	0.41	0.02
Fallow/Idle Cropland	1.91	0.00	1.11	0.05
Woody Wetlands	15.53	0.03	0.00	0.00
Barren			0.02	0.00
Total	**53,186.20**	**100.00**	**2,220.4**	**100.00**

[1] *Source: USDA, National Agriculture Statistics Service 2017*

The USFWS South Dakota Ecological Services Field Office publishes a list of threatened and endangered species with potential to occur within counties in South Dakota (USFWS 2017a). The SDGFP also maintains a list of threatened, endangered, and candidate species (SDCL Chapter 34A-8 and 34A-8A) and provides information on recorded observations within a given county (SDGPF 2016). Previous coordination with the USFWS and SDGPF also was reviewed for information on federally or state-listed species (Appendix C). According to these sources, there are no records of federally or state-listed plant species in Codington or Grant Counties.

11.1.1.1 Native Grassland

The National Land Cover Dataset class "herbaceous" includes land currently not used for hay/pasture or cropland, but that may or may not have been disturbed in the past. These areas likely provide suitable habitat for grassland and some prairie species. However, Bauman et al (2016) conducted a GIS exercise to quantify undisturbed lands in eastern South Dakota that are most likely to support native, undisturbed prairie that, in turn, are more likely to support prairie obligate and sensitive species. This exercise is described below.

Bauman et al (2016) utilized South Dakota Farm Service Agency's 2013 Common Land Unit data layers, and the 2012 USDA National Agriculture Imagery Program county mosaic aerial imagery, to evaluate approximately 22.6 million acres of land in the 44 counties that comprise eastern South Dakota. Land currently under crop production, or that has in the past been used for crop production, was removed from consideration for the exercise. This was followed by manual removal of other disturbed areas. The remaining land tracts were then categorized as potentially "undisturbed grassland" or "undisturbed woodland." Water bodies larger than 40 acres as

defined by the SDGFP's Statewide Water Bodies layer were then removed to allow a more accurate interpretation of the remaining undisturbed grassland/wetland complex. The resulting dataset provides an indication of the location of likely undisturbed grasslands that may support native prairies and provide habitat for prairie species (Bauman et al 2016). These areas may overlap with the cover types "herbaceous" and/or "hay/pasture" in Table 11.1.1.

According to Bauman et al (2016), there are 505 discrete tracts of land that may support native prairie within the Project Area. These tracts range in size from less than 0.1 to 631.0 acres, with an average size of 35.4 acres. The total acreage of land that may contain native prairie habitat within the Project Area according to Bauman et al is approximately 17,889.4 acres.

11.1.1.2 Noxious Weeds

Noxious weeds are regulated by State and Federal rules and regulations (SDCL 38-22 and U.S. CFR 2006) that are designed to stop the spread of plants which may be detrimental to the environment, agricultural practices, and/or the public. The South Dakota Department of Agriculture (SDDOA) lists 15 species of noxious weed that have potential to occur in Codington and/or Grant Counties (SDDOA 2016a and 2016b) (Table 11.1.1.2). Noxious weed surveys have not been completed for the Project Area. However, some species (e.g., bull thistle, Canada thistle) have been observed in the Project Area during other surveys.

Table 11.1.1.2 Noxious Weeds with Potential to Occur in the Project Area

Common Name	Scientific Name	Status
Absinth wormwood	*Artemisia absinthium*	Local noxious weed – Codington and Grant Counties
Bull thistle	*Cirsium vulgare*	Local noxious weed – Codington County
Canada thistle	*Cirsium arvense*	State noxious weed
Field bindweed	*Convulvulus arvensis*	Local noxious weed – Grant County
Hoary cress	*Cardaria draba*	State noxious weed
Leafy spurge	*Euphorbia esula*	State noxious weed
Musk thistle	*Carduus nutans*	Local noxious weed – Codington and Grant Counties
Perennial sow thistle	*Sonchus arvensis*	State noxious weed
Plumeless thistle	*Carduus acanthoides*	Local noxious weed – Codington and Grant Counties
Poison hemlock	*Conium maculatum*	Local noxious weed – Codington County
Purple loosetrife	*Lythrum salicaria*	State noxious weed
Russian knapweed	*Centaurea repens*	State noxious weed

Salt cedar	*Tamarix aphylla, T. chinensis, T. gallica, T. parviflora, and T. ramosissima*	State noxious weed
Spotted knapweed	*Centaurea maculosa*	Local noxious weed – Grant County
Yellow toadflax	*Linaria vulgaris*	Local noxious weed – Codington County

11.1.2 Vegetation Impacts/Mitigation

No impacts to federally or state-listed plants are expected to occur. No federally or state-listed plant species are known to occur in the Project Area.

The Applicant will compensate landowners for crop damage that occurs on cultivated lands. Impacts to agricultural land are discussed in detail in Section 13. Impacts to cultivated lands are not considered biologically significant, as these lands currently are frequently disturbed by tilling, planting, and harvesting activities.

Unmitigated loss of vegetation, or introduction of noxious weeds could result in an impact to vegetation resources. Construction of the Project will result in permanent impacts to approximately 86.0 acres and in temporary impacts to approximately 2,134.4 acres (Table 11.1.2.).

Table 11.1.2 Temporary and permanent impacts as a result of the Project

Land Cover Type[1]	Temporary Impacts (acres)	Permanent Impacts (acres)
Agricultural	1,504.01	60.40
Grass/Pasture	558.45	21.48
Developed	40.07	2.37
Other Hay/Non Alfalfa	21.86	1.36
Deciduous Forest	6.53	0.39
Herbaceous Wetlands	1.90	0.04
Fallow/Idle Cropland	1.11	0
Open Water	0.41	0
Barren	0.02	0
Total	2,134.4	86.0

Permanent impacts will occur from construction of specific Project features including the wind turbine foundations and access roads (see Section 6 and Table 8.1). These impacts will result in a loss of production of crops and pasture grasses. Other indirect impacts could include the spread of noxious weed species resulting from construction equipment introducing seeds into new areas, or erosion or sedimentation due to ground-clearing in construction areas.

Temporary impacts will be mitigated through use of BMPs as described in the Project SWPPP. Such BMPs include re-vegetation practices and installation of erosion control devices. For example, in temporarily impacted areas that were previously natural (i.e., non-cropland), the Applicant will use native vegetation (weed-free) seed mixes to revegetate disturbed areas to pre-construction conditions where feasible and pending landowner preferences. Where temporary impacts occur, the land will be returned to pre-construction conditions.

The Project will not involve any major tree-clearing. Where feasible, access roads have been sited to avoid crossing tree rows. The collector substation also was sited to avoid impacts to tree rows. Some minor clearing of brush or trees may be required during construction. In discrete and limited areas where minor tree-clearing will occur, the Applicant will first conduct nest clearance surveys and will implement seasonal clearing restrictions as described in Section 11.3.2.5.

11.2 Wetlands and Waterbodies

The following sections describe the wetlands and waterbodies within the Project Area and the potential effects of the proposed Project on them. Planned avoidance, minimization, and mitigation measures for those effects are also described.

11.2.1 Existing Wetlands and Waterbodies

The USACE 1987 defines wetlands as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." The manual further stipulates three criteria that a feature will exhibit if it qualifies as a wetland: dominance of hydrophytic vegetation, hydric soil, and wetland hydrology. Waterbodies are defined as those features that hold or convey water, but do not qualify as wetlands.

Publicly available data sources were used to complete a desktop analysis to assess the likelihood of wetlands and other waters of the U.S. occurring within the Project Area:

- Aerial imagery (various years, including publicly available colored-infrared imagery)
- USFWS NWI (USFWS 2017b) mapping
- USGS (USGS) National Hydrography Dataset (NHD) (USGS 2014a)
- NLCD (USGS 2014b)

The NWI indicates that there are 2,871 potential features within the Project Area. The NHD indicates that there are 425 line segments representing potential reaches of waterbodies within

the Project Area. Finally, the USFWS indicates 308 protected basins are present within the Project Area (Figure 12).

Table 11.2.1 NWI Wetlands and Waterbodies Mapped Within the Project Area

Wetland Type	Number of Features within Project Area	Acres in Project Area
Freshwater Emergent Wetland	2,220	2,291.73
Freshwater Pond	294	324.42
Riverine	302	170.01
Freshwater Forested/Shrub Wetland	55	51.84
Total	**2,871**	**2,838.00**

Wetland surveys and determinations were completed during 2017 and 2018 to more accurately characterize wetlands and waters of the U.S. within the footprint comprising project facilities (turbines, access roads, collector lines, potential substation locations, etc.). To-date, wetland determinations to ground-truth the desktop data have been conducted within more than 463 acres of the Project Area. These surveys are ongoing. During these surveys, other waterbodies (e.g., streams) also are recorded. Results of these surveys have informed, and will continue to inform, project siting. Wetland delineations were completed in select areas in fall 2018. Results of these surveys are described in detail in the Project Aquatic Resources Summary Report that will be submitted to the Commission once complete.

11.2.2 Wetland and Waterbody Impacts/Mitigation

Project facilities have been sited to avoid both temporary and permanent impacts to wetlands and waterbodies to the extent practical. Through avoidance measures, the Applicant has limited impacts to wetlands and waterbodies to minimal areas associated with access roads. Impacts to wetlands and waterbodies that may result because of access road construction are minor and will be authorized under USACE Nationwide Permit (NWP) 12 for utility lines and associated facilities in waters of the U.S. These authorized, permanent impacts to wetland areas may remain beyond the Project's operational lifetime. Disturbed surfaces will be restored as nearly as possible to their preconstruction conditions during Project decommissioning.

Collector lines will be sited to avoid intersecting wetland or other waterbodies to the extent practical. Where collector lines must intersect wetlands or other waterbodies, the Applicant will bore under these features to the extent practical to minimize impacts to these resources.

11.3 Wildlife (Fauna)

The following sections describe potentially present and/or observed wildlife species within the Project Area and the potential effects of the proposed Project on these species. Planned avoidance, minimization, and mitigation measures for those effects are also described.

11.3.1 Existing Wildlife

Several wildlife surveys have been completed in the Project Area. Those surveys, and their results, are summarized in Section 11.3.1.4. Most of the observed wildlife species occurring in the Project Area are considered common and widespread species in the region, and many are adapted to developed areas and human disturbance.

Mammal inventories have not been completed for the project. Species observed in the Project Area include Richardson's ground squirrel (*Urocitellus richardsonii*), mink (*Mustela vison*), common raccoon (*Procyon lotor*), white-tailed deer (*Odocoileus virginianus*), least weasel (*M. nivalis*), and coyote (*Canis latrans*). These species are common in suitable habitats throughout the region. Six bat species have potential to occur in the Project Area: eastern red bats (*Lasiurus borealis*), silver-haired bats (*Lasionycteris noctivagans*), hoary bats (*Lasiurus cinereus*), northern long-eared bats (*Myotis septentrionalis*), little brown bats (*Myotis lucifugus*), and big-brown bats (*Eptesicus fuscus*). These bat species, and their potential to occur in the Project Area, are discussed in detail in Appendices G and F. No federally or state-listed mammal species have been observed during biological surveys in the Project Area.

The Project Area is located in the Central Flyway migration corridor. Section 11.3.1.4 provides a more detailed summary of birds, including waterfowl and raptors, observed in the Project Area.

Reptile and amphibian inventories have not been completed for the Project. Common species occurring in Grant and Codington Counties will be expected to inhabit suitable habitats in the Project Area.

11.3.1.1 Initial Site Assessment

The USFWS developed the Land-Based WEG (USFWS 2012) and the Eagle Conservation Plan Guidance (ECPG; USFWS 2013) to provide wind developers with voluntary guidelines intended to reduce potential impacts of wind energy projects on wildlife. The WEG and ECPG provide a structured approach for assessing potential risk to wildlife and promote coordination between project proponents and federal and state wildlife and natural resources agencies. The SDGFP and South Dakota Bat Working Group also have developed siting guidelines for wind energy projects (SD Siting Guidelines; SDGFP and South Dakota Bat Working Group, Undated). These guidelines generally are consistent with the WEG and provide guidance for non-wildlife resources (e.g., land use and noise).

In accordance with Tiers 1 and 2 of the WEG, and Stage 1 of the ECPG a desktop review of readily available information was conducted to determine the Project's potential to effect species of concern and/or their habitats. Data sources included and was not limited to the USFWS's Information for Planning and Conservation tool, the South Dakota Natural Heritage Database, USGS's Breeding Bird Survey, and aerial imagery. The Applicant also queried the USFWS and SDGFP for information on sensitive resources within the Project vicinity. Results of this initial site assessment informed Tier 3 studies, discussed below in Section 11.3.1.4.

Coordination with the USFWS and SDGFP regarding earlier configurations of the Project Area began in 2005 (Appendix B). The Applicant has been coordinating with the USFWS and SDGFP since 2017 on the specific Project Area described herein and continues to coordinate with these agencies to-date (Appendix B).

11.3.1.2 Federally Listed Terrestrial Species

The sources described above were reviewed for records pertaining to federally listed wildlife species known or expected to occur in Codington and/or Grant County. The results of this review for terrestrial species are provided in Table 11.3.1.2.

Table 11.3.1.2 Federally Listed Terrestrial Species with Potential to Occur in Codington and Grant Counties

Common Name	Scientific Name	County Occurrence	Status[1]	Global Rank[2]	State Rank[2]
Insects					
Dakota skipper	*Hesperia dacotae*	Codington, Grant	FT	G2G3	S2
Poweshiek skipperling	*Oarisma poweshiek*	Codington, Grant	FE	G2	S2
Mammals					
northern long-eared bat	*Myotis septentrionalis*	Codington, Grant	FT	G4	S3
Birds					
bald eagle	*Haliaeetus leucocephalus*	Codington, Grant	BGEPA	G4	S1B, S2N
golden eagle	*Aquila chrysaetos*	Codington, Grant	BGEPA	G5	S3S4B, S3N
piping plover	*Charadrius melodus*	Codington, Grant	FT	G3	S2B, SZN
red knot	*Calidris canutus rufa*	Codington, Grant	FT	G4T2	SNRN
whooping crane	*Gus americana*	Codington, Grant	FE	G1	SZN

[1]FT – federally threatened; FE – federally endangered; BGEPA – protected by Bald and Golden Eagle Protection Act.
[2] Global/State Rank Definition (applied range wide for global rank and statewide for state rank)
G1 S1 – Critically imperiled because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.
G2 S2 – Imperiled because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.
G3 S3 – Either very rare and local throughout its range, or found locally (even abundantly at some of its locations) in a restricted range, or vulnerable to extinction throughout its range because of other factors; in the range of 21 of 100 occurrences.
G4 S4 – Apparently secure, though it may be quite rare in parts of its range, especially at the periphery. Cause for long term concern.
G5 S5 – Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery.
SZ – No definable occurrences for conservation purposes, usually assigned to migrants.
SR – Element reported for the state but no persuasive documentation.
Bird species may have two state ranks, one for breeding (S#B) and one for nonbreeding seasons (S#N). Example: bald eagle (S1B, S2N) indicates an S1 rank in breeding season and S2 in nonbreeding season.

11.3.1.2.1 Prairie Butterflies – Dakota Skipper (Federally Threatened) and Poweshiek Skipperling (Federally Endangered)

The Dakota skipper (*Hesperia dacotae*) is an obligate of undisturbed, native prairies, and generally inhabits wet lowlands dominated by bluestem grasses, or dry uplands that are a mix of bluestem and needle stem grasses (Vaughn 2005). Larvae have been observed feeding on several grasses, although little bluestem (*Schizachyrium scoparium*) is the preferred food source; the preferred nectar source for adults is purple coneflower (*Echinacea angustifolia*; Vaughn 2005), in addition to other prairie flowering species. As of 2002, Dakota skippers had been recorded at 53 sites in 10 counties in South Dakota, including two sites in Codington County (USFWS 2002). Of the Dakota Skipper sites recorded in Codington County, none are within the Project Area. The closest occurrence is approximately 15 miles west of the Project Area. There is no designated critical habitat for the Dakota skipper within the Project Area. The nearest critical habitat is in Grant County, adjacent to the western boundary of the northeastern portion of the Project Area. Dakota skippers have not been recorded in the Project Area (USFWS 2017a).

The Poweshiek skipperling (*Oarisma poweshiek*) lives in high quality tallgrass prairie in both upland, dry areas and low moist areas (USFWS 2014). Nectar species for the Powesheik skipperling include purple coneflower, black-eyed Susan (*Rudbeckia hirta*), palespike lobelia (*Lobelia spicata*), and other flowering prairie species. There is no definitive research available regarding which plant species are necessary for larvae to develop, but they appear to select fine-stemmed grasses and sedges, such as slender spike rush (*Eleocharis elliptica*), prairie dropseed (*Sporobolis heterlepis*), and little bluestem (USFWS 2014; Shepherd 2005). Skadsen (2015) suggests the Poweshiek skipperling may be extirpated from South Dakota.

Dakota skipper habitat assessments were completed for earlier iterations of the Project Area in June 2008, June and July 2009, 2015, and in 2016. Habitat assessments for the current Project Area were completed in 2017 and 2018 (Appendix C). Adult presence/absence surveys were

completed within the Project Area during the 2018 adult flight season (Section 11.3.1.4.1; Appendix C). The presence/absence surveys were completed in accordance with the 2018 Dakota Skipper Survey Protocol (USFWS 2018). No Dakota skippers or Poweshiek skipperlings were observed.

11.3.1.2.2 Northern Long-eared Bat (Federally Threatened)

Summer habitat for the northern long-eared bat (*Myotis septentrionalis*) consists of forested areas with trees greater than 3 inches in diameter at breast height (USFWS 2017c). Northern long-eared bats roost in live trees and/or snags that have exfoliating bark, cracks, crevices, and/or cavities (USFWS 2017c). The species typically forages in forest interiors. These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure (USFWS 2017c). Northern long-eared bats also may roost in human-made structures such as buildings, barns, bridges, and bat houses (USFWS 2017c). The species hibernates in caves, mines, or other cave-like structures during the winter. The USFWS lists the northern long-eared bat as possibly present in Codington and Grant Counties, indicating that the Counties are within the range of the species and may contain suitable habitat. However, there are no records of the species being present in these counties (USFWS 2017a). The nearest county records published by USFWS indicating known presence of the northern long-eared bat are in Brookings County to the south of the Project and in Roberts County to the north (USFWS 2017a).

The USFWS cites White Nose Syndrome, a fungal pathogen specific to bats, as the primary cause for the decline of the species, rather than habitat removal (USFWS 2016). The northern long-eared bat was listed as a threatened species with a final 4(d) rule on April 2, 2016 (USFWS 2016). The 4(d) rule prohibits purposeful take of the species range-wide. Within the "WNS Zone" (counties within 150 miles of known occurrences of the pathogen that causes white-nose syndrome) incidental take resulting from specified activities is prohibited during certain times of year. The Project Area is within the WNS Zone, therefore incidental take that results from operation of utility-scale wind-energy turbines currently is not prohibited. Additionally, incidental take that results from tree-clearing activities is not prohibited, unless it occurs within 0.25 mile of a known northern long-eared bat hibernacula or within 150 feet of a known maternity roost tree between June 1 and July 31.

Several passive bat acoustic surveys have been completed on previous iterations of the Project Area (Table 11.3.1.4). These surveys indicated a low likelihood of northern long-eared bat presence in the study areas. A passive bat acoustic survey was completed on the current Project Area in April – November 2017. This survey is summarized in Section 11.3.1.4.3.2 and provided in Appendix G.

A desktop bat habitat assessment was conducted with the purpose of assessing the availability and suitability of bat habitat, including that of northern long-eared bats, within an earlier iteration of the Project Area in summer 2015 (Table 11.3.1.4). This assessment identified only marginal

potential northern long-eared bat habitat. A desktop bat habitat assessment was completed for the current Project Area in September 2018 (Section 11.3.1.4.2.1) (Appendix F). The assessment concluded that there is limited suitable northern long-eared bat habitat within the Project Area and that USFWS considers the species unlikely to occur except as an occasional migrant (USFWS personal communication, 2018) (Appendix F).

11.3.1.2.3 Bald Eagle and Golden Eagle (Protected under the Bald and Golden Eagle Protection Act)

Bald eagles (*Haliaeetus leucocephalus)* typically occupy habitat near large rivers, lakes, and marshes with available food sources (USFWS 2007). They build stick nests as large as 10 ft. in diameter in trees and occasionally on human-made structures (USFWS 2007). Skadsen (2017) identifies the bald eagle as an "uncommon migrant" in northeast South Dakota. The golden eagle (*Aquila chrysaetos*) nests primarily west of the Missouri River in South Dakota, usually on cliffs, rocky outcrops, and in large trees (Kochert et al. 2002; Pulkrabek and O'Brien 1974). Skadsen (2017) lists the golden eagle as a "rare migrant" in northeast South Dakota.

Several avian use and raptor nest surveys have been completed for nearby study areas, or for earlier iterations of the Project Area (Table 11.3.1.4). Surveys indicate the presence of bald eagles near the Project; however, no golden eagles were observed during these recent surveys. In 2015, studies in a nearby study area indicated bald eagles were present; however, no golden eagles were observed (Tetra-Tech 2015). A total of 453 hours of survey were conducted over all four seasons during the 2015 survey, during which four bald eagles and zero golden eagles were observed (Tetra-Tech 2015). The timing of the sightings suggests that observed individuals likely were migrants and not resident breeding adults (Tetra-Tech 2015). In the spring and fall of 2008, avian surveys were conducted for an earlier iteration of the Project in Grant, Codington, Deuel, and Brookings Counties (Tetra-Tech 2008a and 2008b). Three golden eagles and zero bald eagles were observed (Tetra-Tech 2008a and 2008b).

Most recently, large bird use surveys were completed for the current Project Area from April through November 2017 (Section 11.3.1.4.2.3). A total of 232 surveys across 29 points were completed. No bald or golden eagles were observed within the Project Area. Raptor nest aerial surveys conducted in 2017 and 2018 identified three bald eagle nests within 10 miles of the Project Area. No nests were observed within the Project Area (Section 11.3.1.4.2.1; Appendix D). The closest occupied bald eagle nest observed was in 2017 approximately 530 ft from the Project Area boundary. In 2018, the closest occupied bald eagle nest observed was approximately 4,360 ft from the Project Area boundary. No golden eagles were observed during 2017 – 2018 Project Area surveys.

11.3.1.2.4 Piping Plover (Federally Threatened)

Within South Dakota, piping plovers (*Charadrius melodus)* breed and nest on open beaches, alkaline wetlands, and sandflats (Aron 2005). In the Northern Great Plains, the nesting season

extends from late April through August, with peak activity in May and June (Aron 2005). Nests consist of shallow scrapes in the sand lined with rocks or small shells (Aron 2005). The SDGFP (2016) lists the piping plover as known to have occurred in Codington County but not Grant County; however, the USFWS (2017a) does not list the species as a known or potential occurrence in Codington County. The Platte River Recovery Implementation Program (PRRIP; 2017) indicates that the species nests primarily on the Missouri River, downstream of the Gavins Point (approximately 150 miles south of Project Area) and Fort Randall Dams (approximately 154 miles southwest of Project Area), with some nesting on tributaries of the Missouri. The PRRIP (2017) also states that piping plovers have been observed at Horseshoe Lake in western Codington County, approximately 14 miles west of the Project Area.

Several avian use surveys have been completed for nearby study areas, or for earlier iterations of the Project Area (Table 11.3.1.4). No piping plovers were observed during these surveys. Avian use surveys were completed for the current Project Area from April through November 2017. These surveys are described below in Section 11.3.1.4.2.3. Point count surveys were conducted at 29 locations throughout the Project Area. A total of 232 surveys were completed. No piping plovers were observed.

11.3.1.2.5 Red Knot (Federally Threatened)

The red knot (*Calidris canutus rufa*) is a shoreline species that breeds in drier Arctic tundra areas that generally are sparsely vegetated. Nests are cup-shaped depressions lined with vegetation and located on the ground. Outside of the breeding season, the species primarily is found in marine habitats, especially near coastal inlets, estuaries, and bays (Harrington 2001). The species may be present in South Dakota as a migrant or accidental occurrence but breeding or wintering populations have not been observed (Harrington 2001).

Several avian use surveys have been completed for nearby study areas, or for earlier iterations of the Project Area (Table 11.3.1.4). No red knots were observed during these surveys. Avian use surveys were completed for the current Project Area from April through November 2017. These surveys are described below in Section 11.3.1.4.2.3. Point count surveys were conducted at 29 locations throughout the Project Area. A total of 232 surveys were completed. No red knots were observed.

11.3.1.2.6 Whooping Crane (Federally Endangered)

The USFWS indicates that South Dakota is within the whooping crane migration corridor and that the species may stopover in suitable habitat including cropland and pastures, wet meadows, shallow marshes, shallow portions of large water bodies, and both freshwater and alkaline basins (Appendix B). The Project Area is approximately 30 miles east of the 95% core migration corridor (as delineated by Pearse et al 2018a and 2018b) at its closest, indicating that it is relatively less likely for the species to be present within the Project Area than in areas closer to the migration corridor. According to the USFWS Whooping Crane Tracking Project Database,

the closest whooping crane observation is from spring 2015, approximately 16 miles northwest of the Project Area.

Several avian use surveys have been completed for nearby study areas, or for earlier iterations of the Project Area (Table 11.3.1.4). No whooping cranes were observed during these surveys. Avian use surveys were completed for the current Project Area from April through November 2017. These surveys are described below in Section 11.3.1.4.2.3. Point count surveys were conducted at 29 locations throughout the Project Area. A total of 232 surveys were completed. No whooping cranes were observed. Additionally, a desktop whooping crane habitat assessment was conducted to identify potentially suitable in the Project Area plus a 1-mile buffer (see Section 11.3.1.4.1.2; Appendix E). The assessment found that wetlands considered suitable comprised only 0.75% of the total Project Area (Section 11.3.1.4.2.2).

11.3.1.3 State-Listed Terrestrial Species

The sources described in Section 11.3.1.1 were reviewed for records pertaining to state-listed wildlife species known or expected to occur in Codington and/or Grant County. The results of this review are provided in Table 11.3.1.3.

Table 11.3.1.3 State-Listed Species with Potential to Occur in Codington and Grant Counties

Common Name	Scientific Name	County Occurrence	Status[1]	Global Rank[2]	State Rank[2]
Mammals					
northern river otter	*Lontra canadensis*	Codington, Grant	ST	G5	S2
Birds					
osprey	*Pandion haliaetus*	Grant	ST	G5	S1B, SZN
piping plover	*Charadrius melodus*	Codington, Grant	ST	G3	S2B, SZN
whooping crane	*Gus americana*	Codington, Grant	SE	G1	SZN

[1] ST – state threatened; SE – state endangered; BGEPA – protected by Bald and Golden Eagle Protection Act.
[2] Global/State Rank Definition (applied range wide for global rank and statewide for state rank)
G1 S1 – Critically imperiled because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.
G2 S2 – Imperiled because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.
G3 S3 – Either very rare and local throughout its range, or found locally (even abundantly at some of its locations) in a restricted range, or vulnerable to extinction throughout its range because of other factors; in the range of 21 of 100 occurrences.
G4 S4 – Apparently secure, though it may be quite rare in parts of its range, especially at the periphery. Cause for long term concern.

G5 S5 – Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery.
SZ – No definable occurrences for conservation purposes, usually assigned to migrants.
SR – Element reported for the state but no persuasive documentation.
Bird species may have two state ranks, one for breeding (S#B) and one for nonbreeding seasons (S#N). Example: osprey (S1B, SZN) indicates an S1 rank in breeding season and SZ in nonbreeding season.

The piping plover and whooping crane are discussed in detail in sections 11.3.1.2.4 and 11.3.2.1.6 above, respectively.

11.3.1.3.1 Northern River Otter (State Threatened)

Northern river otters (*Lontra canadensis*) can occupy many types of habitat; however, riparian vegetation along a wetland margin is a key habitat feature (SDGFP 2012). This species is more prevalent in areas with abundant food and limited disturbance (SDGFP 2012). Northern river otters and beavers are closely associated; the northern river otter exploits dens, downed trees, ponds, and prey that thrive in beaver ponds (SDGFP 2012). The northern river otter was reintroduced into the Minnesota River valley in 1980 and 1981 (Skadsen 2016a). Since then, Skadsen (2016a) reports that the population has expanded its range and the species now is frequently observed in Grant County along the Yellowbank River drainages, which cross through the Project Area, and along other tributaries and lakes within the Minnesota River valley, which lies approximately 16 miles northeast of the Project Area. The Project Area contains lakes and streams which have the potential to support northern river otters (Section 11.2). However, it is unknown whether northern river otters frequently utilize these tributaries in Codington County (SDGFP 2012). The closest documented observation of the northern river otter was along an unnamed tributary approximately 13.8 miles east of the Project Study Area (South Dakota Natural Heritage Database spatial data accompanying correspondence shown in Appendix B).

11.3.1.3.2 Osprey (State Threatened)

Ospreys (*Pandion haliaetus)* inhabit areas near large water bodies that support their prey, which consists almost exclusively of fish (SDGFP 2017a). Their nest sites include large trees on or near water bodies, with preference to locations that offer separation from surrounding vegetation to avoid predators (SDGFP 2017a). The Project Area contains lakes and streams which have the potential to support osprey prey resources (Section 11.2), though forested areas with available nesting sites are limited throughout the Project Area (Section 11.1).

Several avian use surveys have been completed for nearby study areas, or for earlier iterations of the Project Area (Table 11.3.1.4). No ospreys were observed during those surveys. Avian use surveys were completed in the Project Area from April through November 2017. A total of 232 surveys across 29 points were completed. No ospreys were observed within the Project Area. Raptor nest aerial surveys were conducted in 2017 and 2018; no osprey nests were identified within the Project Area or within 2 miles of the Project Area.

11.3.1.3.3 Prairie Grouse

The greater prairie-chicken (*Tympanuchus cupido*) and sharp-tailed grouse (*T. phasianellus*) may be present in the Project Area. These species are not federally or state-listed as threatened or endangered. During spring 2007-2008 avian surveys, several active greater prairie-chicken leks were observed within a nearby study area. Four active leks were recorded during spring 2016 surveys in or near an earlier iteration of the Project Area, including 2 greater prairie-chicken leks and two unknown leks. Throughout agency coordination on the current Project Area, the Applicant has requested and received lek occurrence data from the SDGFP (Appendix B). These locations have been documented spatially in the Applicant's Project planning databases to ensure consideration during Project siting. During most recent avian use studies in the Project Area (Section 11.3.1.4.3.1), 1 greater-prairie chicken and 1 sharp-tailed grouse, and no leks, were observed.

11.3.1.4 Studies Conducted to Date

The Applicant has completed numerous wildlife studies for both the Project Area, and for earlier iterations of the Project Area (Table 11.3.1.4). Most recent (2017–2018) studies, which were completed on the current Project Area iteration, are described in more detail below.

Table 11.3.1.4. Wildlife Studies Completed for the Crowned Ridge Wind Energy Facility Project Area and Vicinity

Date	Survey	Survey Area
Mar. 2007 – June 2008	avian use surveys (spring)	Earlier iteration of Project Area
June 2008	Dakota skipper habitat delineation	Earlier iteration of Project Area
Aug. – Nov. 2008	avian use survey (fall)	Earlier iteration of Project Area
June – July 2009	Dakota skipper habitat delineation	Earlier iteration of Project Area
Aug. – Nov. 2014	avian use surveys (fall)	Earlier iteration of Project Area
Mar. – Nov. 2014; Nov – Mar. 2015	eagle survey	Earlier iteration of Project Area
2015	Dakota Skipper habitat evaluation	Earlier iteration of Project Area
Summer 2015	bat habitat assessment	Nearby study area
Aug. – Oct. 2015; Apr. – Oct. 2016	bat acoustic survey	Earlier iteration of Project Area
Mar. – Apr. 2016	raptor nest survey	Earlier iteration of Project Area
Apr. – May 2016	lek surveys	Earlier iteration of Project Area

Apr. – Oct. 2016	bat acoustic survey	Earlier iteration of Project Area
July 2016	bat acoustic survey	Earlier iteration of Project Area
Sept. 2016	Dakota skipper and Poweshiek skipperling habitat assessment	Earlier iteration of Project Area
Apr. 2016 – Feb. 2017	avian use survey	Earlier iteration of Project Area
Apr. and May 2017	raptor nest aerial survey	Project Area
Apr. – Nov. 2017	avian point count surveys	Project Area
Apr. – Nov. 2017	bat acoustic monitoring	Project Area
Spring 2018	raptor nest aerial survey	Project Area
June – July 2018	Dakota skipper and Poweshiek skipperling adult survey	Project Area
Summer 2018	desktop whooping crane habitat assessment	Project Area
Sep. 2018	desktop bat habitat assessment	Project Area

11.3.1.4.1 Prairie Butterflies – Dakota Skipper and Poweshiek Skipperling

The Applicant completed a thorough desktop and field-verified habitat assessment for potentially suitable Dakota skipper and Poweshiek skipperling habitat in the Project Area (see Appendix C). Based on habitat assessment results, "adult presence/absence survey areas" were identified. In these areas, the Applicant completed three rounds of Dakota skipper and Poweshiek skipperling adult presence/absence surveys between June 28 and July 12, 2018, with 48 hours' spacing between each survey round and in accordance with the USFWS's 2018 Dakota Skipper Protocol. The surveys fell within the adult flight period of both species.

Prior to the survey, the Applicant obtained USFWS concurrence with proposed survey methods. All observed butterfly species were documented and a general count of flowering plants was conducted. No Dakota skippers or Poweshiek skipperlings were observed.

11.3.1.4.2 Birds

11.3.1.4.2.1 Raptor and Eagle Nest Surveys

Two raptor nest aerial surveys were completed in 2017 and one was completed in 2018 to identify nesting raptors and to provide spatial and species information (Appendix D). Biologists surveyed for all raptor nests within the Project Area and a 2-mile (3.2-kilometer) buffer. Biologists surveyed specifically for eagle nests with the Project Area and a 10-mile (16-kilometer) buffer.

The 2017 surveys identified 22 non-eagle raptor nest structures within the 2-mile buffer survey area. Eight of these nests were considered occupied and fourteen nests were considered unoccupied. Five occupied non-eagle raptor nests (four red-tailed hawk nests, one great-horned owl nest) were observed within the Project Area. Three occupied non-eagle raptor nests (two red-tailed hawk nests, one Swainson's hawk nest) were observed outside the Project Area within the 2-mile buffer. Two occupied bald eagle (*Haliaeetus leucocephalus*) nests were observed within the 2-mile buffer. No bald eagle nests were observed within the Project Area.

The 2018 survey identified 47 non-eagle raptor nest structures within the 2-mile buffer survey area. Sixteen nests were considered occupied and thirty-one nests were considered unoccupied. Eight occupied non-eagle raptor nests (six red-tailed hawk nests, two great-horned owl nests) were observed within the Project Area. Likewise, eight occupied non-eagle raptor nests (six red-tailed hawk nests, two great-horned owl nests) were observed outside the Project Area within the 2-mile buffer. Two occupied bald eagle nests and one (likely) unoccupied eagle nest were observed within the 2-mile buffer and outside the Project Area. Three occupied bald eagle nests were identified within the 10-mile buffer and beyond the 2-mile buffer. No bald eagle nests were observed within the Project Area (Appendix D).

11.3.1.4.2.2 Whooping Crane Habitat Assessment

A desktop assessment was conducted to identify potentially suitable whooping crane habitat in the Project Area plus a 1-mile buffer (Appendix E). The assessment followed methods outlined in The Watershed Institute's (TWI) Potentially Suitable Habitat Assessment for the Whooping Crane (TWI 2013). In total, 180 wetlands, totaling 1,696.4 acres, scored 12 or higher. TWI considers a habitat score of 12 or higher as potential suitable habitat. Seventy-four of these 180 wetlands, totaling 440.2 acres, overlapped the Project Area. These wetlands comprise only 0.75% of the total Project Area.

11.3.1.4.2.3 Avian Use Surveys

Avian use surveys for the Project Area were completed April 1, 2017 through November 30, 2017 with the objective of characterizing activity, spatial distribution, and relative abundance of avian species. Study methods included large bird use surveys and small bird use surveys in accordance with recommendations set forth in the WEGs. Point count surveys were conducted at 29 locations throughout the Project Area with 800-meter and 100-meter buffers for large and small bird surveys, respectively. A total of 232 surveys across the 29 points were completed during the survey.

SWCA recorded 356 large bird observations. Flight altitudes for 209 of the 356 observations occurred at 0–200-m above ground level; however, 172 of the 209 observations (48.3%) occurred at a height below 30 m, which is outside of the typical turbine rotor-swept area. Surveyors recorded four large bird species recognized by the USFWS as birds of conservation concern (BCC) within the Project Area: ferruginous hawk (*Buteo regalis*), peregrine falcon (*F.*

peregrinus), prairie falcon (*F. mexicanus*), and marbled godwit (USFWS 2008). Twelve raptor species were observed: American kestrel (*Falco sparverius*), Cooper's hawk (*Accipiter cooperii*), ferruginous hawk, merlin (*F. columbarius*), northern harrier (*Circus cyaneus*), peregrine falcon, prairie falcon, rough-legged hawk (*B. lagopus*), red-shouldered hawk (*B. lineatus*), red-tailed hawk (*B. jamaicensis*), sharp-shinned hawk (*A. striatus*), and Swainson's hawk (*B. swainsoni*). No bald or golden eagles were observed within the Project Area. Twenty-three non-raptor species were recorded: American crow (*Corvus brachyrhynchos*), American white pelican (*Pelecanus erythrorhynchos*), blue-winged teal (*Spatula discors*), California gull (*Larus californicus*), Canada goose (*Branta canadensis*), double-crested cormorant (*Phalacrocorax auritus*), Franklin's gull (*Leucophaeus pipixcan*), gadwall (*Mareca strepera*), great blue heron (*Ardea herodias*), great egret (*Ardea alba*), greater prairie-chicken, greater yellowlegs (*Tringa melanoleuca*), marbled godwit (*Limosa fedoa*), mallard (*Anas platyrhynchos*), northern pintail (*Anas acuta*), ring-billed gull (*Larus delawarensis*), ring-necked pheasant (*Phasianus colchicus*), snow goose (*Chen caerulescens*), sharp-tailed grouse, turkey vulture (*Cathartes aura*), Wilson's snipe (*Gallinago delicata*), wild turkey (*Meleagris gallopavo*), and wood duck (*Aix sponsa*). All species observed during the 8-month survey period are considered typical for the region and seasons of observation.

A total of 644 small bird observations of 54 species were made during surveys. Flight altitudes for 643 of the 644 observations occurred at 0–200 m above ground level; however, 625 of the 643 observations (97.2%) occurred at a height below 30 m, which is outside the turbine rotor-swept area. Biologists recorded four small bird species recognized by the USFWS as BCC within the Project Area: the chestnut-collard longspur (*Calcarius ornatus*), grasshopper sparrow (*Ammodramus savannarum*), willow flycatcher (*Empidonax traillii*), and red-headed woodpecker (*Melanerpes erythrocephalus*) (USFWS 2008). Western meadowlark (*Sturnella neglecta*), red-winged blackbird *(Agelaius phoeniceus)*, and American robin *(Turdus migratorius*) accounted for 238 (36.9%) of all observations. A complete list of observed species is provided in the Avian Use Survey Report (Appendix E). All species observed during the 8-month survey period are considered typical for the region and seasons of observation.

11.3.1.4.3 Bats

11.3.1.4.3.1 Bat Habitat Assessment

A desktop bat habitat assessment was conducted with the purpose of assessing the availability and suitability of bat habitat within the Project Area, and to determine the potential for presence of state-listed and federally listed bat species (Appendix F).

Six bat species have potential to occur within the Project Area: eastern red bats (*Lasiurus borealis*), silver-haired bats (*Lasionycteris noctivagans*), hoary bats (*Lasiurus cinereus*), northern long-eared bats, little brown bats (*Myotis lucifugus*), and big-brown bats (*Eptesicus fuscus*). SWCA cross-referenced these species' requirements with availability of suitable habitat in the

Project Area, reviewed occurrence records, and coordinated with USFWS to determine seasonal likelihood of occurrence for each species.

The only federally listed species with potential to occur within the Project Area is the northern long-eared bat. There is limited suitable habitat for the northern long-eared bat within the Project Area, typically in the form of wooded riparian corridors, small woodlots, and isolated forest patches. As a forest interior species, the northern long-eared bat requires contiguous forest blocks of 15 or greater acres and prefers forested blocks of greater than 114 acres (Appendix F). The Project Area contains 246 total acres of forested blocks that individually are between 15 and 114 acres, and 341 total acres of forested blocks that individually are 114 acres or greater (Appendix F). These acreages represent a combined 1.1 percent of the Project Area qualifying as suitable roosting and/or foraging habitat. The habitat available within the Project Area is similar in availability and density to the surrounding landscape, indicating that there is no regionally unique habitat that could serve as an attractant for northern long-eared bats to the Project Area. Furthermore, the USFWS has stated that there is low likelihood of northern long-eared bats occurring within the Project Area as a summer resident (USFWS personal communication, 2018) (Appendix F). There is potential for the northern long-eared bat to occur within the Project Area as a migrant during the spring and fall, though migration behavior of the species is poorly understood.

Based on habitat suitability and availability, the remaining species with potential to occur have varying likelihoods of occurrence throughout the year (Appendix F).

11.3.1.4.3.2 Bat Acoustic Survey

A long-term, passive, acoustic bat monitoring survey was conducted within the Project Area between April 6 and December 1, 2017 in accordance with the recommendations set forth in the WEGs (Appendix G). Two acoustic detectors were deployed on a meteorological tower within the Project Area. Data were analyzed to determine bat passes per detector night of recording, where a "detector night" is equal to one detector deployed for one calendar night.

Nearly 80% of the calls recorded occurred in the fall. Although the dynamics of bat migration are not fully understood, one factor that could contribute to this difference is recruitment of juveniles into the fall migration population. Seasonal differences in the data collected suggest that the Project Area experiences limited bat migration in spring. However, if 2017 data are indicative of an overall pattern, spring bat populations are sparse when compared with other regions of the United States. The highest levels of activity observed correlated with fall migration, though even these spikes of activity were low when compared with other fall migration events.

Overall, the level of bat activity may suggest that bat use of the Project Area is relatively low. The annual mean passes the per detector night recorded during the study at 1.6. For comparison, Jain (2005) documented a mean activity level in 2003 and 2004 of 34.9 and 36.6 passes per

detector-night, respectively, in Iowa. Because of the lack of suitable roosting and foraging habitat in the project area, the number of bats is likely much lower than what might be observed in other, more ecologically diverse, parts of the country.

11.3.2 Wildlife Impacts/Mitigation

As described above, the Project will result in temporary and permanent impacts to approximately 2,134.4 and 86.0 acres, respectively. The majority (1,564.41 acres; 70.46%) of these impacts will occur in agricultural area (Table 11.1.2). Agricultural areas may provide some, although relatively limited, foraging and cover habitat for some wildlife species. As described above, the Applicant will restore temporarily impacted acres to pre-construction conditions. In temporarily impacted areas, wildlife is expected to be displaced in the short-term, re-inhabiting these areas following disturbance.

Construction of the Project may result in the direct mortality of some individuals of some wildlife species (e.g., reptiles and amphibians). Mortality associated with construction (e.g., crushing by vehicles) is expected to be limited, and not result in population-level effects. Wildlife, when mobile (e.g., adult birds, volant bats) are capable of escaping disturbance. The Applicant will implement best management practices, including pre-construction nest clearance surveys, to limit impacts to bird eggs and nestlings. Project construction also will result in noise or disturbance with potential to temporarily displace individuals of some species. However, the displacement is expected to be short-lived. In most cases, wildlife may only be temporarily displaced from habitat and will be expected to utilize adjacent habitats elsewhere in the Project Area during disturbances.

During O&M activities, wildlife may be disturbed by activity including vehicle and foot traffic. Such disturbances will be short-term, limited to the duration of activities. Many wildlife species occurring in the Project Area are adapted to human disturbance and are expected to habituate to long-term, intermittent, routine activity (e.g., O&M activities) in the Project Area.

Construction crews will be instructed to avoid disturbing or harassing wildlife when observed. Further, crews will remove trash from the Project Area to avoid inadvertently attracting scavenger species, which could in turn increase potential impacts to prey species (e.g., nesting birds).

Potential mortality to bird and bat species during the operation phase of the Project is described below.

11.3.2.1 Federally Listed Species

The following sections describe potential effects to federally listed species, if those species were to occur in the Project Area.

Northern Long-Eared Bat

No impacts to summering or wintering northern long-eared bats are expected to result from the Project.

The USFWS has indicated that the northern long-eared bat is unlikely to occur in the Project Area except as an occasional migrant (USFWS personal communication, 2018). Results of the Applicant's studies indicate an overall lack of suitable habitat for the species. It is possible that the species could occur in the Project Area as a migrant.

Where northern long-eared bats occur as summer residents, the removal and fragmentation of forested patches 15 acres or larger could affect the species. Removing potential roost trees (trees that provide roosting opportunity but are not known to be roosts) degrades the quality of habitat, and removal of trees may eliminate potential foraging habitat. Felling occupied roost trees during the summer could affect individual northern long-eared bats, where the species is present. Because the species is unlikely to occur in the Project Area as a summer resident, these impacts will not occur because of the Project. However, the Applicant has opted to minimize tree-clearing and to observe seasonal clearing restrictions to further reduce the chances for impacts to the species. Impacts to the northern long-eared bat, if present, will be minimized to the extent practicable through project design and BMPs described here and summarized in Section 11.3.2.5.

Dakota Skipper and Poweshiek Skipperling

No Dakota skippers or Poweshiek skipperlings were observed during protocol surveys in the Project Area in 2018. If occupied in future years, the Project could impact potentially suitable habitat for Dakota skippers and Poweshiek skipperlings through habitat removal or modification. Impacts could occur through placement of structures within suitable habitat or through routing of features such as access roads. The species, where present, are vulnerable to impacts within larval habitat year-round and adult habitat during the flight season (approximately June 15 – July 20, weather dependent). Where suitable habitat cannot be avoided, the Applicant will avoid construction activities in those specific locations during the adult flight period (approximately June 15 to July 20, weather dependent) to avoid direct mortality of breeding adults. Impacts to the prairie butterflies, if present, will be minimized to the extent practicable through project design and BMPs described here and summarized in Section 11.3.2.5.

Bald Eagles

Bald eagles have been observed near the Project Area. Potential impacts to bald eagles, if present in the Project Area, include the possibility for collisions with structures. Siltation and erosion that results from the Project could lead to degradation of water quality, potentially affecting bald eagle prey sources. The Applicant has avoided siting turbines within 1.5 mi of occupied bald eagle nests. Impacts to bald eagles, if present, will be further minimized to the extent practicable through project design and BMPs described here and summarized in Section 11.3.2.5.

Whooping Cranes

There is very limited likelihood that whooping cranes occur within the Project Area. No whooping cranes have been observed in the Project Area during targeted wildlife surveys. Furthermore, habitat assessments indicate a paucity of suitable stopover habitat for the species within the Project Area. The Project is not expected to impact whooping cranes.

11.3.2.2 State-Listed Species

Habitat removal and degradation are the primary potential impacts to the northern river otter. Erosion and siltation can affect water quality, limiting prey availability for northern river otters. Impacts to streams and waterbodies will be avoided to the extent practicable through project design and BMPs described in Section 11.2 and summarized below in Section 11.3.2.5.

If present, osprey have the potential to collide with vertical structures. Siltation and erosion that results from the Project could lead to degradation of water quality, potentially affecting osprey prey sources. Impacts to osprey, if present, will be avoided to the extent practicable through project design and BMPs described here and summarized in Section 11.3.2.5.

11.3.2.3 Avian Species

Impacts to avian species can be direct (e.g., turbine strike mortality) or indirect (e.g., loss of degradation of habitat).

The Applicant has selected tubular turbine design, reducing perching and nesting sites thereby reducing risk of avian mortality. In addition, the Applicant will implement BMPs, including nest clearance surveys, prior to construction to limit impacts to bird eggs and nestlings (Section 11.3.2.5).

The Applicant has completed both small and large bird use surveys of the Project Area to assess baseline conditions (Section 11.3.1.4.1.3). The Applicant plans to conduct one year of systematic post-construction mortality monitoring to confirm operational trends are consistent with previously observed trends for other projects in the region.

11.3.2.4 Bats

Impacts to bat can be direct (e.g., turbine strike mortality) or indirect (e.g., loss of degradation of habitat). As described above in Section 11.1.1, the Applicant has minimized tree-clearing, which results in avoidance and minimization of impacts to potentially suitable roosting bat habitat. Likewise, aquatic resources have been avoided to the extent practical, and the Applicant will implement erosion and sediment control devices as appropriate during construction. Such measures avoid and minimize the potential for adverse effects to potential foraging bat habitat in the Project Area.

The Applicant has completed a habitat suitability assessment, and an acoustic survey, for bats in the Project Area (Sections 11.3.1.4.2.1 and 11.3.1.4.2.2). The Applicant plans to conduct one

year of systematic post-construction mortality monitoring to confirm operational trends are consistent with previously observed trends for other projects in the region.

11.3.2.5 Avoidance, Minimization and Mitigation Measures

The following avoidance, minimization, and mitigation measures summarize those described above, which have been developed by the Applicant to avoid, minimize, or offset potential adverse impacts to terrestrial ecosystems because of the Project.

- Avoid siting turbines in wetlands or other waterbodies
- Avoid placing structures, or conducting any activity, on USFWS grassland or USFWS wetland/grassland combination easements
- Site turbines more than 1.5 miles from known occupied bald eagle nests
- Site turbines with consideration of SDGFP-documented leks
- Minimize tree clearing
- Re-vegetate disturbed areas to as close to preconstruction conditions as possible in coordination with the landowner and per applicable permit conditions and requirements.
- Conduct pre-construction bird nest clearance surveys or observe seasonal clearing restrictions to minimize impacts to breeding birds, including raptors, and summering bats
- Avoid activity in potentially suitable habitat for the Dakota skipper and Poweshiek skipperling where possible
- Minimize impacts to Dakota skippers and Poweshiek skipperlings by avoiding construction during the adult flight period (approximately June 15-July 15) to avoid mortality of breeding adults
- Implement standard erosion control measures, including temporary sediment barriers, slope breakers, and mulching to avoid sedimentation and runoff to avoid impacts to wetlands and streams
- During revegetation efforts in potentially suitable Dakota skipper and Poweshiek skipperling habitat, use seed mixes that incorporate vegetation that supports these prairie butterfly species.
- Complete one year of post-construction mortality monitoring and adhere to the Wildlife Response and Reporting System (WRRS) Manual for the life of the project. The WRRS standardizes and prescribes actions taken in response to any wildlife fatalities and/or injuries found within the Project Area boundaries.

12.0 Effect on Aquatic Ecosystems (ARSD 20:10:22:17)

ARSD 20:10:22:17. Effect on aquatic ecosystems. *The applicant shall provide information of the effect of the proposed facility on aquatic ecosystems, and including existing information resulting from biological surveys conducted to identify and quantify the aquatic fauna and flora, potentially affected within the transmission site, wind energy site, or siting area, an analysis of the impact of the construction and operation of the proposed facility on the total aquatic biotic environment and planned measures to ameliorate negative biological impacts as a result of construction and operation of the proposed facility.*

12.1 Existing Aquatic Ecosystems

Aquatic resources present in the Project Area are described in detail in Section 10 and are shown in Figure 12. Aquatic resources in the Project Area have been altered to various levels, ranging from annually cultivated wetlands to channelized watercourses to naturally occurring pothole wetlands with little physical alteration.

12.1.1 Federally Listed Aquatic Species

The USFWS South Dakota Ecological Services Field Office publishes a list of threatened and endangered species known or presumed to occur within counties in South Dakota (USFWS 2017a). Coordination with the USFWS was reviewed for information on federally or state-listed species with potential to occur in the Project Area (Appendix B). The USFWS lists one federally listed aquatic species in Codington County, the Topeka shiner (*Notropis topeka*; endangered) and none in Grant County. The Topeka shiner has a G5 global rank, and an S3 state rank (see footnote to Table 12.1.2).

12.1.1.1 Topeka Shiner (Federal Endangered)

The Topeka shiner is a small minnow native to eastern South Dakota, and is found within tributaries to the James, Vermillion, and Big Sioux drainages. The species prefers a variety of habitats including runs, pools, and backwater areas in cool, perennial streams. Occupied streams typically are groundwater-fed; and have high water quality, clean gravel substrates, and vegetated banks (Shearer 2003). Shearer (2003) synthesized available occurrence data and identified 16 streams where the Topeka shiner was observed before 1997, and 38 streams where the species was observed between 1997 and 2002. None of those streams are in Grant or Codington Counties. However, additional tributaries to the Big Sioux River do occur in the Project Area, and the USFWS (2017a) lists the species as known from Codington County. There is no information available to determine whether the Topeka shiner currently inhabits streams in the actual Project Area or Project Construction Easement.

12.1.2 State-Listed Aquatic Species

The SDGFP maintains a list of threatened, endangered, and candidate species (SDCL Chapter 34A-8 and 34A-8A) and provides information on recorded observations within a given county

(SDGPF 2016). Available resources through the SDGPF were reviewed for information on federally or state listed species with potential to occur in the Project Area (Appendix C). The SDGFP lists two state-listed aquatic species with documented occurrences in Grant County: the blacknose shiner (*Notropis heterolepis*) and northern redbelly dace (*Chrosomus eos*) (SDGFP 2016). The SDGFP also lists the Topeka shiner as documented in Codington County; however, the species is not state-listed in South Dakota.

Table 12.1.2. State-listed aquatic wildlife with potential to be present in the Project Area

Common Name	Scientific Name	Status[1]	County Records	Global Rank[2]	State Rank
blacknose shiner	*Notropis heterolepis*	SE	Documented in Grant County	G5	S1
northern redbelly dace	*Chrosomus eos*	ST	Documented in Grant County	G5	S2

1 SE – state endangered; ST – state endangered

2 Global/State Rank Definition (applied rangewide for global rank and statewide for state rank; these may change with new information):

S1 = Critically imperiled because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.

S2 = Imperiled because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.

G3 S3 = Either very rare and local throughout its range, or found locally (even abundantly at some of its locations) in a restricted range, or vulnerable to extinction throughout its range because of other factors; in the range of 21 of 100 occurrences.

G5 S5 = Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery.

12.1.2.1 Northern Redbelly Dave (State Threatened)

The northern redbelly dace (*Chrosomus eos)* is a small olive to dark brown-colored fish native to eastern South Dakota that prefers quiet spring-fed areas of streams, bogs, and beaver ponds with aquatic vegetation (SDGFP 2017b). It is found within tributaries to the Missouri, Minnesota, Big Sioux, White, Niobrara, and Keya Paha River drainages. McCoy and Hales (1974) observed the northern redbelly dace in both the North and South Forks of the Yellowbank River in Grant County in 1973 (SDNHD spatial data accompanying correspondence shown in Appendix B), but the species was not observed during subsequent surveys (Dieterman and Berry 1996; Burgess and Shearer 2008). It is hypothesized that the species may be extirpated from northeast South Dakota (Skadsen 2016b). Tributaries to the North Fork of the Yellow Bank River are present

within the Project Area and are crossed by the Project Construction Easement (Section 10). However, there is no information available to determine whether the northern redbelly dace currently inhabits streams within the actual Project Area or Project Construction Easement.

12.1.2.2 Blacknose Shiner (State Endangered)

The blacknose shiner (*Notropis heterolepis*) is a small minnow native to eastern South Dakota, and is found in tributaries to the Minnesota, Big Sioux, James and Keya Paha River drainages. The species prefers cool, clear streams with deep pools, abundant vegetation and sandy to gravel substrates (SDGFP 2017c). Historical records exist for the Little Minnesota River and Lake Traverse, neither of which are in Grant County (Bailey and Allum 1962). Skadsen (2016b) lists the blacknose shiner as likely extirpated from northeast South Dakota. Additional tributaries to the Minnesota River do occur in the Project Area, and the SDGFP (2016) indicates that the species is known from Grant County. However, there is no information available to determine whether the blacknose shiner currently inhabits streams in the Project Area or Project Construction Easement.

12.2 Aquatic Ecosystems Impacts/Mitigation

As described in Section 11, the Applicant will avoid siting turbines, access roads, collector lines, and other Project facilities in wetlands to the extent practicable. Where wetlands must be intersected, the Applicant will either bore under these features, or minimize impacts to NWP thresholds to the extent practical (Section 11.2.2).

The primary potential for impact to any aquatic ecosystem will be as a result of increased sediment or total suspended solids in aquatic resources due to construction-related soil erosion. Generally speaking, surficial soils in flat areas are less prone to erosion than soils in sloped areas. Construction on or adjacent to steep slope areas can render soils unstable, accelerate natural erosion processes, and cause slope failure. Most of the soils in the Project Area are not highly susceptible to erosion; however, care will be taken to avoid or minimize excavation in steep slope areas. Excavation in such areas is expected to be limited to discrete areas, such as portions of access roads. Where possible, access roads will be sited to avoid steep slopes. There may also be limited trenching of underground cabling in steep slopes, although that will be minimized as much as possible. During construction, BMPs will be implemented to help ensure that drainage ways and streams are not impacted by sediment runoff from exposed soils during precipitation events (see Section 11).

Project construction will require coverage under the General Permit for Storm Water Discharges Associated with Construction Activities issued by the SDDENR. A condition of this permit is to develop and implement a SWPPP. The Applicant will develop the SWPPP prior to construction. The SWPPP will describe BMPs for erosion and sedimentation control. Such BMPs may include silt fences, straw wattles, water bars, vegetative buffers, and other measures to control storm water run-on and runoff to mitigate erosion and sedimentation. As a result of erosion and

sediment control BMPs, no impacts to aquatic ecosystems are anticipated. Further, because no impacts to aquatic ecosystems are anticipated, no impacts to the state- or federally listed species discussed above, if present in the Project Area, are anticipated.

13.0 Land Use (ARSD 20:10:22:18)

ARSD 20:10:22:18. Land use. *The applicant shall provide the following information concerning present and anticipated use or condition of the land:*

(1) A map or maps drawn to scale of the plant, wind energy, or transmission site identifying existing land use according to the following classification system:
(a) Land used primarily for row and nonrow crops in rotation;
(b) Irrigated lands;
(c) Pasturelands and rangelands;
(d) Haylands;
(e) Undisturbed native grasslands;
(f) Existing and potential extractive nonrenewable resources;
(g) Other major industries;
(h) Rural residences and farmsteads, family farms, and ranches;
(i) Residential;
(j) Public, commercial, and institutional use;
(k) Municipal water supply and water sources for organized rural water systems; and
(l) Noise sensitive land uses;
(2) Identification of the number of persons and homes which will be displaced by the location of the proposed facility;
(3) An analysis of the compatibility of the proposed facility with present land use of the surrounding area, with special attention paid to the effects on rural life and the business of farming; and
(4) A general analysis of the effects of the proposed facility and associated facilities on land uses and the planned measures to ameliorate adverse impacts.

13.1 Land Use

This section discusses the existing land use, displacement of residences or businesses, public lands and conservation easements, sound, shadow flicker, electromagnetic interference, and visual resources of the Project Area. Also described are the Project's potential impacts on these resources and measures to mitigate the potential impacts. Local land use controls, including zoning ordinances, are discussed in Section 14.

13.1.1 Existing Land Use

The Project is located entirely on private land, which includes undeveloped rural areas, agricultural lands, and residential farmsteads. The primary land use within the Project Area is agricultural (Section 11, Table 11.1.1 for land cover acreage and percentages). Within the Project Construction Easement, land is agricultural (1,564.4 acres or 70.5%), grass/pasture (579.9 acres or 26.1%), developed (42.4 acres or 1.9%), other hay/non-alfalfa (23.2 acres or 1.1%), deciduous forest (6.9 acres or 0.3%), herbaceous wetlands (1.9 acres or 0.1%), fallow/idle cropland (1.1

acres or 0.1%), open water (0.4 acre and 0.02%), and barren land (0.02 acre and 0.0%) (Figure 2). Land within the Project Construction Easement is characterized by tilled agriculture and a well-developed drainage network across the Big Sioux Basin, hummocky topography with no distinct drainage pattern in the Prairie Coteau, and relatively gradual slopes with eastern flowing perennial streams along the Prairie Coteau Escarpment. Vegetation is primarily cropland and grassland with small patches of planted trees in shelterbelts around farmsteads/homesteads, and near natural streams. Two active sand and gravel pits are located in T118N R51W Section 15 and 16. Potential extractive nonrenewable resources are present within the Project Construction Easement. The following land classification are not present within the Project Construction Easement: irrigated land, major industries, areas zoned as residential, commercial or institutional uses, or municipal water supply and water sources for organized water systems. Rural residence and farmsteads are located within the Project Construction Easement.

13.1.2 Land Use Impacts/Mitigation

The Project is compatible with existing land use and is not anticipated to result in sizable permanent impacts to the surrounding land, including agricultural operations. Typically, wind farm projects do not result in sizable permanent impacts due to their limited construction easement of ground-disturbing activities, and wind farm projects typically remove less than 1 acre per turbine. Land use will be permanently modified in areas where turbines, substations, collection lines, and access roads are located. Temporary impacts will occur for initial construction and installation of other ancillary features, such as collection and communication lines, or for crane walks and temporary access. Where temporary impacts occur, the land will be returned to pre-construction conditions. Most of the land within the Project Construction Easement is primarily used for agricultural production (50.6%; see Section 13.1.1 and Figure 2), which is expected to continue following construction and during operation of the Project. Construction of the Project will result in short-term disturbances to soils and vegetation and increased traffic and noise on local roads. Noise and temporary air quality impacts, in the form of diesel exhaust and dust resulting from the operation of heavy equipment, are anticipated. However, once construction is complete, traffic and noise levels will return to pre-construction levels. Long-term operation of the Project is not expected to adversely impact rural lifestyles or create hardships for rural residents. The Project will contribute to rural lifestyles by improving road conditions and access through the Project Area. Because operation of the Project is a compatible land use, the additional easement income for the agricultural landowners is expected to facilitate continued farming and ranching of the lands in agricultural production. Landowners will also be compensated for crop damage during Project construction and operations that impact agricultural lands.

Based on farmstead data collected by the Applicant, 297 structures, including residences, barns, silos, and other accessory buildings associated with farmsteads are located within the Project Area.

The Applicant will execute lease options or purchase land rights to acquire private property required by the Project, in accordance with state and federal land acquisition requirements. Land rights will be recorded as part of the public record. Land for the substation and O&M facilities will be purchased.

Approximately 133 residences (excluding accessory farmstead buildings and barns and silos), including 42 residences in the towns of Stockholm and 17 residences in the town of Waverly are located within the Project Area. According to the South Dakota GIS and farmstead data collected by the Applicant, five existing MET towers and one proposed MET tower is in the Project Area. The closest existing MET tower in proximity to a turbine is 560 feet of a proposed turbine (CRI-120). The proposed MET tower is 734 feet from the nearest proposed turbine (CRI-11). The minimum distances between an occupied residence, business, or governmental building and a proposed turbine location are summarized in Table 13.1.2. Based on the proposed layout of the turbines, access roads, and collector lines, there will be no displacement of residences or businesses due to construction of Project facilities.

Table 13.1.2 Minimum Turbine Setback Distances **Category**	**Requirements/Commitments**
	State Requirements
Setbacks	Turbines shall be set back at least 500 feet or 1.1 times the height of the tower, whichever is greater, from any surrounding property line (SDCL 43-13-24).
Codington County Requirements: Section 5.22.03 General Provisions (Vertical height of Tower 75' to 500')	
Setbacks[1]	- 550' from participating occupied residence, business, church, or school - 1,500' from non-participating occupied residence, business, church, or school (within all Districts other than Town Districts) - 5,280' from non-participating occupied residence, business, church, or school (within Town Districts) - 5,280' from Municipal Boundaries at the time of Conditional Use Application - 110% of the height of the wind turbine from Right-of-Way of public roads[2] - 110% the height of the wind turbines from any property line[3] *Exception: The Board of Adjustment may allow setback/separation distances to*

	be less than the established distances identified above if the road authority, participating or non-participating landowners, or municipality (by resolution of the governing body) agree to a lesser setback/separation distance. If approved, such agreement is to be recorded and filed with the Codington County Zoning Officer. Said agreement shall be binding upon the heirs, successors, and assigns of the title holder and shall pass with the land.
Noise	Noise level generated by wind energy system shall not exceed 50 dBA, average A-weighted Sound pressure level effects at the property line of existing non participating residences, businesses, and buildings owned and/or maintained by a governmental entity[4]
Flicker Analysis	Flicker at any receptor shall not exceed thirty (30) hours per year within the analysis area for all schools, churches, businesses and occupied dwellings within a one (1) mile radius of each turbine within a project. *Exception: The Board of Adjustment may allow for a greater amount of flicker than identified above if the participating or non-participating landowners agree to said amount of flicker. If approved, such agreement is to be recorded and filed with the Codington County Zoning Officer. Said agreement shall be binding upon the heirs, successors, and assigns of the title holder and shall pass with the land.*
Turbine Spacing	The turbines shall be spaced no closer than three (3) rotor diameters (RD) (measurement of blades tip to tip) within a straight line. If required during final micro siting of the turbines to account for topographic conditions, up to ten (10) percent of the towers may be sited closer than the above spacing but the permittees shall minimize the need to site the turbines closer.

1) Setback distance to be measured from the wall line of the neighboring principal building to the base of the WES tower. The vertical height of the wind turbine is measured from the ground surface to the tip of the blade when in a fully vertical position.
2) The horizontal setback shall be measured from the base of the tower to the public right-of-way.
3) The horizontal setback shall be measured from the base of the tower to the adjoining property line unless wind easement has been obtained from adjoining property owner.
4) Noise level measurements shall be made with a sound level meter using the A-weighting scale, in accordance with standards promulgated by the American National Standards Institute. An L90 measurement shall be used and have a measurement period no less than ten minutes unless otherwise specified by the Board of Adjustment

Grant County Requirements:
Section 1211.0 General Provisions

Setbacks[1]	- 1,500' from participating residence, business, church, or school, building owner and/or operated by a governmental entity[2] - 1,500' from non-participating residence, business, church, or school, building owned and/or operated by a governmental entity - 5,280' from Municipal Boundaries existing at the time of Conditional Use Permit Application - 500' or 110% of the vertical height of the wind turbine, whichever is greater, from Public Right-of-Way[3] - 500' or 110% of the vertical height of the wind turbine, whichever is greater, from any property line[4] *Exception: The Board of Adjustment may allow setback/separation distances to be less than the established distances identified above if the road authority, participating or non-participating landowners, or municipality (by resolution of the governing body) agree to a lesser setback/separation distance. If approved, such agreement is to be recorded and filed with the Register of Deeds. Signed agreement shall be binding upon the heirs, successors, and assigns of the title holder and shall pass with the land.*
Noise	- Noise level shall not exceed 45 dBA, average A-weighted Sound pressure including constructive interference effects measured twenty-five (25) feet from the perimeter of the existing non-participating residences, businesses, and buildings owned and/or maintained by a governmental entity.[5] - Noise level shall not exceed 50 dBA, average A-weighted Sound pressure including constructive interference effects measured twenty-five (25) feet from the perimeter of participating residences, businesses, and buildings owned and/or maintained by a governmental entity. [5]
Flicker Analysis	Flicker at any receptor shall not exceed thirty (30) hours per year within the analysis area for all schools, churches, businesses and occupied dwellings within a one (1) mile radius of each turbine within a project. *Exception: Exception: The Board of Adjustment may allow for a greater amount of flicker than identified above if the participating or non-participating landowners agree to said amount of flicker. If approved, such agreement is to be recorded and filed with the Grant County Register of Deeds. Said agreement shall be binding upon the heirs, successors, and assigns of the title holder and shall pass with the land.*
Turbine Spacing	The turbines shall be spaced no closer together than three (3) rotor diameters (RD) (measurement of blades tip to tip) within a string. If required during final micro siting of the turbines to account for topographic conditions, up to ten (10) percent of the towers may be sited closer than the above spacing but the permittees shall minimize the need to site the turbines closer.

1) Setback distance to be measured from the wall line of the neighboring principal building to the base of the WES tower. The vertical height of the wind turbine is measured from the ground surface to the tip of the blade when in a fully vertical position.
2) No less than 110% of the vertical height of the wind turbine if agreed upon by participating entity.

3) The horizontal setback shall be measured from the base of the tower to the public right-of-way. *4) The horizontal setback shall be measured from the base of the tower to the adjoining property line unless wind easement has been obtained from adjoining property owner.* *5) Noise level measurements shall be made with a sound level meter using the A-weighting scale, in accordance with standards promulgated by the American National Standards Institute. A L90 measurement shall be used and have a measurement period no less than ten (10) minutes unless otherwise specified by the Board of Adjustment*	
Voluntary	
Setbacks, Noise, Flicker Analysis	Applicant voluntarily agreed to meet the setbacks, noise and shadow flicker requirements before the new ordinances were formerly adopted
Punished Woman's Lake	The turbines will be set back at least 1-mile from the shoreline of Punished Woman's Lake.

13.2 Public Lands and Conservation Easements

13.2.1 Existing Public Lands and Conservation Easements

Public lands within the Project Area consist of privately owned lands that are leased by the SDGFP as Waterfowl Production Areas, Game Production Areas, and WIAs. Waterfowl Production Areas are managed to protect habitat for waterfowl and migratory birds. Game Production Areas are managed to provide wildlife habitat, improve production of wildlife, and provide opportunities for wildlife viewing and hunting. Walk-in Areas allow public hunting on private lands with agreements lasting one to three years. Table 13.2.1 indicates the acreage of public lands within the Project Area (Figure 2).

Table 13.2.1 Public Lands in the Project Area

Land Type	Area (acres)	Easement Parcels (number)
Waterfowl Production Areas	4.3	2
Game Production Areas	3.5	8
Walk-in areas	1,335.2	3
Total	**1,343**	**13**

Conservation easements within the Project Area include USFWS wetland easements, grassland easements, wetland/grassland combination easements, and Farmers Home Administration (FHA) easements. There are approximately 8,901.6 acres of wetland, grassland, or wetland/grassland

combination easements in the Project Area (Table 13.2.2). Within wetland easements, the USFWS and private landowners agree to avoid impacts to specific wetlands. These wetlands are referred to as protected basins.

Table 13.2.2 Conservation Easements in the Project Area

Easement Type	Area (acres)	Easement Parcels (number)
Grassland Easement	96.0	3
Wetland Easement	3,942.0	28
Wetland/Grassland Easement	4,863.6	18
TOTAL	**8,901.6**	**49**

13.2.2 Impacts/Mitigation to Public Lands and Conservation Easements

Three turbines and associated infrastructure are placed on WIAs. Walk-in Areas are privately-owned areas that are accessible to the public for hunting. Walk-In Areas may be temporarily disrupted for Project construction. The Applicant will coordinate with landowners regarding impacts and access to Walk-in areas during construction.

No turbines or other infrastructure have been sited on grassland, wetland/grassland combination easements, or on FHA easements. Seven turbines and associated infrastructure have been sited on parcels containing wetland easements. No turbines or other infrastructure have been sited in, or directly adjacent to, protected basins. Construction of any access road or turbine in proximity to a protected basin will include additional protective measures including, but not limited to, erosion control measures and SWPPP BMPs (see Section 10.2.2). No turbines or other infrastructure will be placed on grassland or wetland/grassland combination easements within the Project Construction Easement.

13.3 Sound

The primary land use surrounding the Project is agricultural and consists of farms with dispersed recreation areas, fishing areas, and lakes. Farming activities and vehicle traffic on county and local roads account for the largest amount of sound within the Project Construction Easement. The cities of South Shore, Strandburg, and Twin Brooks lie outside of the Project boundary while the communities of Waverly, Stockholm, and Troy are located within the Project Area boundary.

13.3.1 Existing Sound Levels and Regulatory Framework

13.3.1.1 Sound Terminology

Sound, also referred to as noise, is measured on a logarithmic scale in units of decibels (dB). Human hearing is not equally sensitive to all frequencies of sound, and the A-weighted decibel (dBA) scale most closely corresponds to the frequency sensitivity range for human hearing. Sound levels capable of being heard by humans are measured in dBA (Table 13.1.1.1). Cumulative sound increases along the scale of human perception in a logarithmic scale with sound levels at less than 3 dBA being barely perceptible and changes in sound levels over 20 dBA being dramatically perceived.

Table 13.3.1.1 Typical human response to A-weighted decibel sound (dBA)

Sound Pressure Level (dBA)	Human perception
Less than 3 dBA	Barely perceptible
5 dBA	Clearly noticeable
10 dBA	Doubling or halving of loudness
20 dBA	Dramatic change in loudness

Existing sound in rural areas varies between 40 and 50 dBA, with sound in suburban areas is generally between 50 and 60 dBA, and sound in urban areas ranges from 60 to 70 dBA (Smith et al. 1999). General background sounds such as a quiet rural area, a whisper, a library, and a quiet suburb are under 50 dBA. Sounds in urban areas include conversations in restaurants, offices, and running of household items, such as a dishwasher, vacuum, or radio. Everyday common sound levels are noted in Table 13.3.1.1a. Higher sound levels, generally those between 80 to 180 dBA, include jet takeoffs, motorcycles, concerts, stadium noise, shotguns, and a rocket launch (Noise Help 2017; IAC Acoustics 2017). Figure 14 shows select common sound levels in the environment.

Table 13.3.1.1a Sound source examples of A-weighted decibel noise (dBA)

Sound Pressure Level (dBA)	Noise Source Example(s)
10	A pin dropping
20	Rustling leaves
30	Whisper; quiet rural area
40	Computer; library
50	Refrigerator; quiet suburb
60	Air conditioner at 100 ft.; conversation in restaurant, office, background music
70	Dishwasher; vacuum cleaner; radio; passenger car at 65mph; Excavation

	equipment (loader, dump truck, concrete mixer truck, air compressor)
80	Garbage Disposal, car wash, propeller plane flyover at 1,000 ft.; diesel truck at 40 mph, Excavation equipment (grader, bulldozer, excavator, concrete truck)
90	Boeing 737 at one nautical mile; lawn mower
100	Motorcycle (riding); garbage truck; jet flyover at 1,000 ft.
110	Concert with live rock music; jackhammer; steel mill, automobile horn at 1 meter
120	Thunderclap; chainsaw; oxygen torch
130	Peak stadium crowd noise
140	Jet engine at takeoff; air craft carrier deck
150	Fighter jet launch
160	Shotgun
170	Safety airbag
180	Rocket launch

Sources: Noise Help 2017; IAC Acoustics 2017.

13.3.1.2 Sound Regulations

The state of South Dakota does not have regulatory sound limits for wind turbines. Codington County and Grant County ordinances do have regulatory sound limits for wind turbines.

The Codington County Zoning Ordinance #68, Section 5.22.03.12 prescribes sound limits for wind turbine projects:

> "12. Noise
>
> a) Noise level generated by wind energy system shall not exceed 50 dBA, average A weighted sound pressure including constructive interference level effects at the property line of existing off site non participating residences, businesses, and buildings owned and/or maintained by a governmental entity.
>
> b) Noise level measurements shall be made with a sound level meter using the A-weighting scale, in accordance with standards promulgated by the American National Standards Institute. An L90 measurement shall be used and have a measurement period no less than ten minutes unless otherwise specified by the Board of Adjustment."

Grant County's current Ordinance, 2016-01C, Section 1211.04, paragraph 14 prescribes sound limits for wind turbine projects as follows:

> "14Noise. Noise level shall not exceed 45 dBA, average A-weighted Sound pressure including constructive interference effects measured twenty-five (25) feet from the perimeter of existing off-site non-participating residences, businesses, and buildings owned and/or maintained by a governmental entity.

Noise level shall not exceed 50 dBA, average A-weighted Sound pressure including constructive interference effects measured twenty-five (25) feet from the perimeter of participating residences, businesses, and buildings owned and/or maintained by a governmental entity.

Noise level measurements shall be made with a sound level meter using the A-weighting scale, in accordance with standards promulgated by the American National Standards Institute. A L90 measurement shall be used and have a measurement period no less than ten (10) minutes unless otherwise specified by the Board of Adjustment."

Codington County's sound limit is 50 dBA and is only applicable at the property line of existing non-participating residences, businesses and government buildings. Although not required by the county, the sound pressure levels at participating property boundaries and participating and non□participating occupied structures (i.e., residences, business, and buildings) within 2 kilometers of a wind turbine also were evaluated. Grant County's current applicable sound limit is 45 dBA for all nonparticipating, and 50 dBA for all participating, existing off site residences, businesses, and buildings owned and/or maintained by a governmental entity.

13.3.2 Sound Level Impacts/Mitigation

13.3.2.1 Construction Sound Levels

Construction activities will generate short-term and intermittent noise that may affect nearby residences on a short-term basis. Short duration construction noises may range depending on equipment used and the operation being performed but may typically range from 70 to 100 dBA for construction equipment such as air compressors, backhoes, concrete mixers, cranes, dozers, generators, jackhammers, scrapers, shovels, and trucks (Table 13.3.1.1a; Federal Transit Administration 2006). Sounds levels are expected to be quieter for areas farther away from facilities.

During construction, noise levels will be minimized by ensuring that construction equipment is equipped with working mufflers to minimize noise levels. Construction activities generally will be limited to the hours of 7 a.m. to 9 p.m. Major construction activities for the windfarm ideally will begin in August 2019 and complete December 2019. No additional mitigation measures are necessary as there will be minimal noise impacts from Project.

13.3.2.2 Operational Sound Levels

Sound from operational activities includes the sound of the wind turbine rotor blades interacting with air flow as they turn. The level of sound is based on the speed of the turbine and the distance of the listener to the turbine. The wind turbine nacelle, where the mechanical and electrical equipment is housed, will also create sound, but is designed to reduce noise from the turbine through vibration of the mounts, gears, and acoustic insulation.

The Applicant conducted a preliminary sound assessment of the wind turbine specifications to be used on the project (EAPC 2019; Appendix H). According to the GE sound documentation, the loudest normal operating sound pressure level emitted from the 2.3 116 is 107.5 at 10 m/s and higher at 90 m AGL. Since the value is reported at hub height, it is the same value for both 80-meter and 90-meter hub height turbines.

Table 13.3.2.2 Crowned Ridge wind turbine specifications

Manufacturer	Model	Hub Height (m)	Rotor Diameter (m)	Cut-In Wind Speed (m/s)	Cut-Out Wind Speed (m/s)	Max. Sound Press. Level (dBA)	Max. Sound Press. Level LNTE (dBA)
General Electric	GE 2.3	80	116	3	22	107.5	106
General Electric	GE 2.3	90	116	3	22	107.5	106

Source: EAPC 2019

A sound analysis was conducted for the Project Area by EAPC utilizing wind PRO and the ISO 9613-2 "Attenuation of sound during propagation outdoors, Part 2" sound calculation model with "General" ground attenuation and an attenuation factor of 0.5, which represents a typical mixed vegetation (i.e., prairie grass, weeds, brush) and crop cover (EAPC 2019). Realistic sound pressure levels were calculated at 1.5 m AGL at the participating and non□participating existing occupied structures and occupied parcel boundaries (Codington County only). The term "realistic" in this case, means that some amount of ground attenuation is accounted for (EAPC 2019).

The inputs for the windPRO sound calculation include the following:

- Turbine Coordinates
- Turbine Specifications
- Turbine Sound Emission Data
- Sound Receptor Coordinates
- Participation Status
- USGS Digital Elevation Model (DEM) (height contour data)
- Uncertainty Factor
- Meteorological Conditions
- Ground Attenuation

The sound analysis indicates that no non□participating existing residences will be above 45.0 dBA. Therefore, the project will be compliant with Codington and Grant County's allowable sound pressure levels as described in their respective ordinances (EAPC 2019).

Table 13.3.2.2a. Summary of Sound Assessment

County	Feature	Noise Limit (dBA)	Maximum Predicted (dBA)
Codington	Participating Occupied Structures	N/A	47.9
	Non-Participating Occupied Structures	N/A	45
	Participating Occupied Parcel Boundary Lines	N/A	53.6
	Non-participating Occupied Parcel Boundary Lines	50	48.8
Grant	Participating Occupied Structures	50	45.3
	Non-Participating Occupied Structures	45	43

Impacts to nearby residents and other potentially affected parties in terms of sound have been taken into consideration as part of the turbine siting. The Applicant proposes siting turbines no closer than 1,500 feet from non-participating residences in both Codington and Grant County and 550 feet from participating residences in Codington County or 1,500 feet in Grant County to meet or exceed the siting requirements with the County Ordinances of 50 dBA to the property line of non-participating residences in Codington and 45 dBA measured 25 feet from the perimeter of existing non-participating residences in Grant County. To the extent that the sound characteristics of the selected turbine vary, the Applicant will ensure compliance with County noise standards. The array layout has been modeled to help ensure cumulative impacts from all wind turbines, and maximum calculated noise levels for all turbine models, are below the County noise limits at residential, business, and government building receptors.

13.4 Shadow Flicker

Shadow flicker from wind turbines occurs when rotating wind turbine blades move between the sun and the observer. Shadow flicker is generally experienced in areas near wind turbines where the distance between the observer and wind turbine blade is short enough that sunlight has not been significantly diffused by the atmosphere. When the blades rotate, this shadow creates a pulsating effect, known as shadow flicker. If the blade's shadow is passing over the window of a building, it will have the effect of increasing and decreasing the light intensity in the room at a low frequency in the range of 0.4 to 0.78 Hz, hence the term "flicker." In this case, with a

maximum rotational speed of 15.6 rpm for the GE 2.3 116, the frequency will be 0.78 Hz. This flickering effect can also be experienced outdoors, but the effect is typically less noticeable, and becomes less noticeable when farther from the wind turbine causing the flicker. (EAPC 2019).

Shadow flicker can be influenced by various factors such as distance to turbine, angle of sun, time of year, time of day, environment around the turbine, and climate, and is more noticeable the closer the turbine is to the object, house, or person. This flickering effect is most noticeable within approximately 1,000 meters of the turbine and becomes more and more diffused as the distance increases. Beyond 1,700 meters, the shadow flicker effects are indistinguishable (EAPC 2019). The farther away from the turbine, the less effect of shadow flicker. The time of year also influences shadow flicker, which is greatest in the winter months when the angle of sun is lower and casts longer shadows. It is also more pronounced around sunrise and sunset when the sun is near the horizon. Trees and buildings and other obstacles can reduce shadow flicker effects and they provide their own shadows. Climate and weather can increase or decrease the amount of shadow flicker depending on when the sun is present or blocked by clouds, or if bad weather or lack of wind means that the turbines are not in operation.

While there are no explicit state regulations on the limit the number of shadow flicker hours allowed, the shadow flicker ordinances of both Codington and Grant Counties limit the maximum number of shadow flicker to 30 hours per year at occupied structures. Both Grant and Codington County allow shadow flicker to exceed 30 hours per year either at either a participating or non-participating landowner if waived in writing with an agreement that is recorded and filed with the County Register of Deeds.

For the turbine array provided, no occupied structure experienced more than 29 hours and 50 minutes of shadow flicker per year based on realistic assumptions regarding operational time and sunshine probability (Table 13.4.1; Appendix I).

Table 13.4.1. Summary of Shadow Flicker Assessment

County	Feature	Shadow Limit (hr/yr)	Maximum Predicted (hr/yr)
Codington	Participating Occupied Structures	30	28:42
	Non-Participating Occupied Structures	30	28:20
Grant	Participating Occupied Structures	30	29:50
	Non-Participating Occupied Structures	30	25:18

13.5 Electromagnetic Interference

Power frequency electric and magnetic fields (EMF) are created wherever electricity flows, which includes the wiring in homes and schools, power lines, and the electrical equipment and devices we use at work and home. Leading U.S. and international scientific organizations, such as the National Cancer Institute and the World Health Organization, have evaluated EMF research. These organizations generally conclude that overall the body of scientific research does not show that exposure to EMF causes or contributes to any type of cancer or any other disease or illness (NIEHS 1999).

13.6 Visual Resources

Landscapes that include a balance of diversity and harmony have the highest potential for scenic value and may be considered important to persons living in or traveling through a region. Viewer perception is founded on two items: the sensitivity and magnitude of the viewer's concern for the view shed, and exposure (i.e., function of the type, distance, perspective, and duration of the view). Sensitive visual and aesthetic resources within the Project Area include historical structures, open space, and water resources.

13.6.1 Existing Visual Resources

Dominant visual characteristic in the Project Area is agricultural land (both cultivated and grazed) followed by a mixture of rural residential, wetlands, and water features. Constructed infrastructure, including homes, county roads, barns, silos, and other structures exist throughout the Project Area but not within the Project Construction Easement, except for roads. Other visual characteristics common in the Project Area include communication and transmission lines, MET towers, cell towers. Wind turbines have also been constructed adjacent to the Project Area in Brookings and Deuel Counties. Area topography includes a well-developed drainage network and tilled agriculture along the Big Sioux Basin. However, along the Prairie Coteau Escarpment, steep slopes are present, and undulating topography is present within the Prairie Coteau zone. Visual topographic characteristics include seasonal and semi-permanent wetlands, hummocks, hills, perennial streams, and flat land areas. Topography and project elevation are discussed in detail in Section 9. Project topography is shown in Figure 8.

13.6.2 Visual Impacts

The degree to which the Project will be visible will vary by location. The Project will frequently be visible to landowners who live along or near the Project, or residents who travel the roads near the Project. However, constructed features (e.g., existing utility lines), topography, and natural landscape features such as tree cover, in relation to a viewer's physical location, may impede view of the Project. Generally, the Project also will be visible outside of local communities, such as Watertown and Milbank. The Project also will be visible to local and

regional travelers along State Highway 29 and County Road 123 and 212 and recreational users on WIAs and public lands.

The primary visual impact from the Project will include the introduction of additional vertical and horizontal lines on the horizon from wind turbines and transmission lines. Structures will be visible during the day due to visual contrast and potential surface glare, and at night with potential lighting.

The Applicant utilizes measures to minimize the impact the Project will have upon existing scenic integrity including incorporating County setback requirements and commitments in the Project design (see Table 13.1.2). Many areas near the Project Area currently are visually impacted by existing roadways and local transmission lines. Placement of infrastructure will be designed to minimize visual impacts to scenic locations and maximize the feasible distance from road and trail crossings. The Applicant will use care to preserve the natural landscape and prevent impacts to the natural surroundings where feasible.

The Project's wind towers will be marked as required by the FAA. In an attempt to further reduce visual impacts, CRW voluntarily agreed to apply for the use of an Aircraft Detection Lighting System (ADLS). The use of an ADLS is subject to FAA approval and CRW will install an ADLS within 1-year of approval by FAA for the Project. The ADLS turns on its lights when it detects an aircraft within a designated range and minimizes negative view shed impacts for residents. In the event FAA does not approve the use of an ADLS system, CRW will comply with all lighting and markings otherwise required by FAA. CRW intends to apply for the use of an ADLS upon receiving the necessary DNHs from the FAA which is expected in the second quarter of 2019.

14.0 Local Land Use Controls (ARSD 20:10:22:19)

ARSD 20:10:22:19. Local land use controls. *The applicant shall provide a general description of local land use controls and the manner in which the proposed facility will comply with the local land use zoning or building rules, regulations or ordinances. If the proposed facility violates local land use controls, the applicant shall provide the commission with a detailed explanation of the reasons why the proposed facility should preempt the local controls. The explanation shall include a detailed description of the restrictiveness of the local controls in view of existing technology, factors of cost, economics, needs of parties, or any additional information to aid the commission in determining whether a permit may supersede or preempt a local control pursuant to SDCL 49-41B-28.*

The Project will be constructed in accordance with Section 5.22 of the Codington County Comprehensive Zoning Regulations and Section 12.11.1.0 of the Grant County Compiled Zoning Ordinances and land use control policies. Comprehensive land use plans are available for Codington and Grant Counties. Construction of the Project will comply with applicable local ordinances as discussed in Section 24.0 and are consistent with the Codington County Comprehensive Land Use Plan and the Grant County Comprehensive Land Use Plan.

The setback distances adopted by Codington and Grant Counties are summarized in Table 13.1.2 and compliance with these requirements will minimize land use impacts from the Project.

In preparing this Application, the Applicant submitted the following local land use permit applications:

- A combined application for a Conditional Use Permit (CUP) to Codington County dated June 8, 2018, for the Crowned Ridge Wind and Crowned Ridge Wind II wind energy systems. The Applicant obtained the CUP from Codington County on July 16, 2018 containing conditions as displayed in Appendix J.

- A combined application for a CUP to Grant County dated September 17, 2018, for the Crowned Ridge Wind and Crowned Ridge Wind II wind energy systems. The Applicant obtained the CUP from Grant County on December 17, 2018 containing conditions as displayed in Appendix J.

- An application for a CUP to Grant County dated February 8, 2017 was submitted by Cattle Ridge Wind Farm, LLC, a subsidiary of Geronimo Energy, LLC. Cattle Ridge Wind Farm, LLC obtained the CUP from Grant County on March 13, 2017. Cattle Ridge Wind Farm, LLC was acquired by the CRW on November 22, 2017 for inclusion with the Project.

15.0 Water Quality (ARSD 20:10:22:20)

ARSD 20:10:22:20. Water quality. *The applicant shall provide evidence that the proposed facility will comply with all water quality standards and regulations of any federal or state agency having jurisdiction and any variances permitted.*

15.1 Existing Water Quality

Section 303(d) of the federal Clean Water Act requires that the states develop a list of waterbodies that do not meet their designated uses due to excess pollutants (impaired waters) and to determine total maximum daily loads of all pollutants from all sources that a waterbody can receive and still meet applicable water quality standards. The 303(d) list of impaired waters is issued every 2 years and is based on violations of water quality standards. Review of the 2018 list (SDDENR 2018) indicates that Project Construction Easements do not cross any waterbodies that are listed as impaired by the U.S. Environmental Protection Agency (USEPA).

15.2 Water Quality Potential Impacts/Mitigation

During the construction of the Project there is a potential for sediment from disturbed lands or other contaminants to reach surface waterbodies because of excavation, grading, equipment operation, construction traffic, or other unforeseen circumstances If land surface erosion or other potential contaminant sources are not controlled during construction, the quality of any receiving surface waterbodies has the potential to be affected.

Construction of the Project will avoid surface waterbodies to the extent feasible to minimize the potential for direct impacts to these resources. Because wind turbine towers are generally located at higher elevations within the Project Area to maximize wind exposure, impacts to surface waterbodies and drainageways from the turbine sites are not anticipated. Collection line routes and access road locations have been selected to avoid wetlands and other waterbodies to the extent practicable, but some infrastructure may cross streams, intermittent drainageways, and wetlands at various locations. If trenching through drainageways is needed, temporary impacts to surface drainage patterns may occur during construction. However, these impacts will be short-lived, and existing contours and drainage patterns will be restored. To avoid impacts to perennial streams, horizontal directional drilling will be used to bore underneath streams for installation of the underground collection lines. Where access road crossings of streams or drainageway cannot be avoided, appropriately designed culverts will be installed to maintain the free flow of water and therefore, the Project will not result in changes to the existing drainage patterns within the Project Area.

If direct and permanent impacts are expected as a result of infrastructure placement, the Applicant will keep all crossings of potentially jurisdictional wetlands and waters under the 0.10-acre threshold of permanent impacts to remain eligible for using NWP 12. There are approximately

16.9 acres of NWI wetlands and freshwater ponds that are crossed by the Project Construction Easement (see Table 10.2.1.2). For wetland areas, authorized construction methods (e.g., trenching, temporary filling, etc.) under NWP 12 will be utilized and appropriate storm water BMPs will be implemented to minimize surface water impacts.

Due to the nature and extent of the construction activity, the Applicant will obtain a National Pollutant Discharge Elimination System (NPDES) General Permit Authorizing Stormwater er Discharges Associated with Construction Activities (SDR100000) issued by the SDDENR. As required by that permit, the Applicant will prepare and implement a SWPPP that prescribes storm water BMPs to control erosion and subsequent sedimentation from construction activities. BMPs may include the use of silt fences, straw wattles, erosion control blankets, water bars, vegetative buffers, or other methods to control storm water runoff and mitigate erosion and sedimentation. Additionally, the SWPPP will include a Spill Prevention and Response Procedures section that will describe procedures to prevent spills of petroleum products and other hazardous materials, actions to take for an effective response to stop and control any spill, when and how to notify appropriate regulatory agencies, and how wastes generated during cleanup activities will be managed and properly disposed.

Once Project construction has been completed, no significant impact to surface water quality is expected because wetland and waterbody impacts will have been avoided or minimized, and disturbed land will be restored to as close to pre-construction conditions as possible, as required by Section 3.20 of the general permit and the SWPPP. Any spills of petroleum products or other hazardous our toxic materials will be remediated, and the land restored to pre-construction conditions as much as possible.

The Applicant will implement BMPs during construction of the Project to protect topsoil and adjacent waterbodies and minimize soil erosion. Structural and non-structural erosion and sediment control practices will be employed to minimize the potential for contaminants to be discharged to surface waterbodies. Structural BMPs include, but are not limited to:

- Place stockpiled materials away from surface waterbodies and shorelines;
- Control storm water run-on and runoff;
- Segregate and stockpile topsoil separately in areas where topsoil is removed. Topsoil will be re-spread after construction has been completed. In temporary crane paths, the laydown area, or other areas where the topsoil has become compacted, the topsoil will be decompacted prior to reseeding;
- Install temporary control measures, such as silt fences, straw wattles, erosion control blankets, check dams, surface roughening, and seeding to protect disturbed soils; and,
- Disturbed areas will be reseeded and revegetated.

Non-structural BMPs include, but are not limited to:

- Develop and implement a SWPPP;
- Schedule earth-disturbing activities to times when precipitation events are less-likely to occur;
- Regularly water disturbed areas to control dust;
- Develop and maintain inspection schedules and correct deficiencies noted during these inspections;
- Perform routine trash collection and grounds maintenance; store collected trash in containers (with lids) for disposal at a suitable offsite facility; and,
- Familiarize employees with good housekeeping procedures, tips, reminders, and pollution prevention concepts.

16.0 Air Quality (ARSD 20:10:22:21)

ARSD 20:10:22:21. Air quality. *The applicant shall provide evidence that the proposed facility will comply with all air quality standards and regulations of any federal or state agency having jurisdiction and any variances permitted.*

16.1 Existing Air

The State of South Dakota follows ambient air quality goals and standards as defined under the federal government regulations (ARSD 74:36:02). The nearest Ambient Air Quality Monitoring Site is located in Watertown in Codington County, South Dakota, southeast of the Project. The primary emission sources within the Project Area include agricultural-related equipment and vehicles traveling along state highways or county roads.

The existing air quality of the Watertown region is good, based on the air quality index established by the USEPA under federal regulations. The Project Study Area has limited air pollutant emissions. The Brookings and Watertown area has only exceeded the 24-hour particulate matter 10 microns in diameter or less (PM 10) standard three times in the 27 years the measurement system has been in operation. These exceeding events were due to high wind events casing fugitive dust levels to exceed the 24-hour standard (SDDENR 2014). Fugitive dust emissions are generated from wind erosion of disturbed areas and may affect both rural and urban environments. Air quality pollutant emissions include particulate matter such as fine dust from vehicle travel on unpaved roads; agricultural activities; other wind-blown dust and air pollutants; ozone or ground-level smog such as carbon monoxide; and sulfur dioxide and nitrogen oxides from vehicles, stationary sources burning coal and oil, electric utilities, and industrial boilers. Sulfur dioxide and nitrogen oxide are monitored in Sioux Falls, which is the closest monitoring station to the Project Study Area that monitors these elements (SDDENR 2018b).

16.2 Air Quality Impacts/Mitigation

Temporary impacts to air quality are expected as a result of Project construction. Construction activities may result in increased short-term airborne dust/particulate matter and construction equipment and vehicle emissions. Construction activities may include ROW clearing, hauling and excavation that could generate dust; airborne mobilization of dust particles constitutes wind erosion that will be addressed in the SWPPP. These impacts are temporary, and no long-term impacts are anticipated from construction activities. No impacts from Project operation are anticipated nor will the Project produce air emissions that will impact the surrounding area.

The entire state of South Dakota is in attainment for all criteria pollutants (USEPA 2018). Therefore, general conformity is not applicable. The Applicant will use standard BMPs to

minimize air quality pollution emissions. Such BMPs may include dust suppression/control, and reclamation during and after construction, as required by the SWPPP and/or Codington County and Grant County Haul Road permits that may be required.

17.0 Time Schedule (ARSD 20:10:22:22)

ARSD 20:10:22:22. Time schedule. *The applicant shall provide estimated time schedules for accomplishment of major events in the commencement and duration of construction of the proposed facility.*

Table 17-1. Permitting and Construction Schedule

Milestone	Date
Land Leasing	2006 to Spring of 2019
Environmental Studies	2008 to 2019
County Conditional Use Permits	2018
SDPUC Facility Permit	January 2019 to July 2019
Pre-construction Engineering	2017 to 2019
Finalize layout	December 2018
Construction	August 2019 to December 2019
Commercial Operations Date	No later than Q1 2020

18.0 Community Impact (ARSD 20:10:22:23)

ARSD 20:10:22:23. Community impact. *The applicant shall include an identification and analysis of the effects the construction, operation, and maintenance of the proposed facility will have on the anticipated affected area including the following:*

(1) A forecast of the impact on commercial and industrial sectors, housing, land values, labor market, health facilities, energy, sewage and water, solid waste management facilities, fire protection, law enforcement, recreational facilities, schools, transportation facilities, and other community and government facilities or services;

(2) A forecast of the immediate and long-range impact of property and other taxes of the affected taxing jurisdictions;

(3) A forecast of the impact on agricultural production and uses;

(4) A forecast of the impact on population, income, occupational distribution, and integration and cohesion of communities;

(5) A forecast of the impact on transportation facilities;

(6) A forecast of the impact on landmarks and cultural resources of historic, religious, archaeological, scenic, natural, or other cultural significance. The information shall include the applicant's plans to coordinate with the local and state office of disaster services in the event of accidental release of contaminants from the proposed facility; and

(7) An indication of means of ameliorating negative social impact of the facility development.

This section describes the main community characteristics in and around the Project Study Area, including the Project's impacts on socioeconomics, community resources, agriculture, transportation, and cultural resources. Socioeconomic variables evaluated include population, minority populations, poverty, employment and income, and housing. These variables were obtained or derived from 2010 and 2016 U.S. Census Bureau data and projections.

18.1 Socioeconomic and Community Resources

The socioeconomics analysis area is Codington and Grant Counties. Data for the City of Watertown and the State of South Dakota are used occasionally for comparison purposes.

18.1.1 Existing Socioeconomic and Community Resources

Table 18.1.1 summarizes select demographic factors for Watertown, Codington County, Grant County, and South Dakota. Watertown's percentage of minorities is lower than Codington County and the state as a whole. The percent of population living below the poverty level is highest for the state, followed by Watertown, Codington County, and Grant County.

Table 18.1.1 Socioeconomic factors in select regions

Location	Population	Minority Populations (Percent)	Population Below Poverty Level (Percent)	Per Capita Income
Watertown	21,482	5.2	11.1	$26,389
Codington Co.	27,227	5.7	10.8	$26,767
Grant Co.	7,148	2.9	9.2	$26,741
State of South Dakota	814,180	14.1	13.5	$26,747

Source: U.S. Census Bureau 2010

The median annual household income in 2010 was $46,766 in Watertown, $48,912 in Codington County, $51,272 in Grant County, and $50,957 in the state of South Dakota. The median annual household income accounts for multiple household earners, whereas the per capita income (Table 18.1.1) is the average income earned by each person in a given area so that multiple income earners in the same family or household are counted separately. Using 2015 inflation-adjusted dollars, the per capita income in Watertown was $26,389, in Codington County was $26,787, and in Grant County was $26,741, while the per capital income for the state was $26,747. The percentage of persons living below the poverty level ranked highest at the state level at 13. 7%, followed by Watertown at 11.1 %, Codington County at 10.3%, and Grant County at 9.2%.

As shown in Table 18.1.la, the largest employment and labor markets by occupation in Watertown and Codington County are similar and consist of sales and administration (27.3 % and 25.9%, respectively), production and transportation (17.9% and 17.4%, respectively), science and arts, including health facilities (9.7% and 9.9%, respectively), management (6.9% and 8.7%, respectively), and construction and extraction (5.6% for each region). The largest employment and labor markets by occupation in Grant County are sales and administration (25.4%), management (15.8%), production and transportation (8.7%), farming (8.2%), and construction and extraction (5.8%). The three largest employment industries in Watertown and Codington County are similar and include manufacturing (21.6% and 20.2%, respectively), educational and healthcare services (16.9% and 16.4%, respectively), and retail trade (13.1 % and 12.2%, respectively). The three largest employment industries in Grant County are agricultural (16.7%), educational and healthcare services (16.3%), and wholesale trade (8.7%) (U.S. Census Bureau 2010). Smaller industries and labor markets with fewer employees in

Watertown, Codington County, and Grant County include infrastructure, fire protection, law enforcement, recreational facilities, schools, and other community or government services.

Table 18.1.1a Employment by occupation in select regions, shown as percent of employed persons

Industry/Labor Market	Watertown	Codington Co.	Grant Co.
Sales and Administration	27.3	25.9	25.4
Production and Transportation	17.9	17.4	8.7
Science and Arts, including Health Facilities	9.7	9.9	5.5
Management	6.9	8.7	15.8
Farming	1.4	2.2	8.2
Construction and Extraction	5.6	5.6	5.8
Installation, Maintenance, and Repair	3.7	3.5	5.3
Business	3.1	3.0	2.6

Current housing and land values in the region are similar across all areas. In 2016, the U.S. Census Bureau reported 10,050 housing units in Watertown, 12,937 housing units in Codington County, and 3,572 housing units in Grant County. The Codington County 2016 data reflect a 4.36% increase in housing units when compared with 2010 Census data, and the Grant County 2016 data shows a 1.99% increase. Watertown shows a 4.06% increase since 2010. In 2010, the median value of owner-occupied housing units in Watertown and Codington County were similar at $144,900 and $145,500, respectively, while Grant County was lower at $107,900. The Codington County 2016 figures reflect a 4.36% increase in value since the 2010 Census, Grant County shows a 1.29% increase, and Watertown shows a 4.37% increase.

The U.S. Census Bureau provides periodic socioeconomic estimates for selected geographies to help provide information on the changing demographics of the population between decennial censuses. Through the American Community Survey, the Census provided 3-year socioeconomic estimates for Codington and Grant Counties and the State of South Dakota, as summarized in Table 18.1.lb.

Table 18.1.1b Socioeconomic projections from 2010 to 2016

Location	Population	Race Percentage (White)	Percentage of Population Below Poverty Level	Per Capita Income
Watertown	22,172	94.8	11.1	$26,389
Codington County	28,063	94.4	10.8	$26,767
Grant County	7,148	96.6	9.2	$26,741
South Dakota	865,454	85.2	13.7	$26,747

Source: U.S. Census Bureau 2010 and 2016

18.1.2 Socioeconomic and Community Resources Impacts/Mitigation

There will be short- and long-term benefits from the Project that include, but are not limited to, an increase in the counties' tax base as a result of the incremental increase in revenues from utility property taxes (based on the Project value of $400 million; Section 5). The chief economic effect of the Project will result from property taxes paid for the proposed improvements in Codington and Grant Counties infrastructure of approximately $41 million. Land lease payments to Project landowners will result in approximately $40 million over the contracted term of the Project. Additional benefits will result from the Project's capability to transmit energy generated from renewable energy resources that could spur energy development in the area, thereby generating additional economic gains. Further information on benefits of the Project is presented in Section 4.0.

Construction and operation of the Project is not expected to affect the local distribution of jobs or occupations in the community and is not anticipated to have significant short- or long-term effects on commercial and industrial sectors, housing, land values, labor markets, health facilities, sewer or water treatment facilities, solid waste management facilities, fire or police facilities, schools, recreational facilities, and other government facilities or services. The Applicant does not expect a permanent impact on the population, income, occupation distribution, or integration or cohesion of communities.

The Project will be offset from roads and section lines; the turbines and construction easement are not located within the state or county highway roadway ROWs; collector lines will bore under roads. The final engineering design will consider planned or programmed future improvements to area roadways to ensure that sufficient roadway ROWs are maintained for future roadway widening. The Applicant will develop a Road Use Agreement with each County that will govern procedures for road use, repair and restoration after construction, and any operational maintenance required.

The Project will have a positive impact on the local area as a result of lodging and food sales and other indirect economic benefits associated with transient workers. The Applicant expects the

Project will employ workers associated with the construction and support services areas. Employee estimates are described in Section 19.

A common concern of communities surrounding wind energy facilities is the potential impact on residential property values. Wind energy projects drive economic development, job growth, and tax revenue which benefits landowners and land values in areas (Appendix K; NextEra Fact Sheet). Landowners who host wind turbines on their property earn regular lease payments, which add to its value, and lease payments continue with a sale of the property. Hoen et al. (2009) collected data from "7,500 sales of single-family homes situated within 10 miles of 24 existing wind facilities in nine different U.S. States." Rural areas in Iowa, Illinois, and Wisconsin that were analyzed in the study are similar in nature to the communities in South Dakota found in the current Project Area.

Analysis of eight hedonic pricing models on repeat sales and sales volume models show no conclusive evidence of impacts of wind facilities to widespread property value in communities surrounding these facilities. Hoen et al (2009) conclude the following:

> "Neither the view of the wind facilities nor the distance of the home to those facilities is found to have any consistent, measurable, and statistically significant effect on home sales prices. Although the analysis cannot dismiss the possibility that individual homes or small numbers of homes have been or could be negatively impacted, it finds that if these impacts do exist, they are either too small and/or too infrequent to result in any widespread, statistically observable impact" (Hoen et al 2009).

The base model for the study also concluding the following: 1) there is no statistically significant difference in sales price between homes found within 1 mile and 5 miles of wind energy facilities; 2) while home buyers and sellers consider the scenic vista of a home when establishing sales prices, there is no statistically significant home sale price difference apparent in the model for homes having minor, moderate, substantial, or extreme views of wind turbines (Hoen et al. 2009).

Additionally, Hoen et al. (2013) examined data from 50,000 home sales in 27 counties in nine states analyzed, including the states of Minnesota, Iowa, and Illinois, which are similar in rural nature to South Dakota. The study found no statistically significant difference in home sales prices between 1 to 5 miles of wind turbines within a wind energy facility during the post-construction or post announcement/pre-construction periods of wind energy facilities. Research suggested that the "property-value effect of wind turbines is likely to be small, on average, if it is present at all" (Hoen et al. 2013).

RM Hoefs & Associates, Inc. completed a 2015 survey of marker reactions to wind turbines and/or wind energy facilities with the objective of studying effect of wind turbines on property values (Appendix K, RM Hoefs & Associates, Inc. 2015). The analysis was based on 12 wind farms in North Dakota, although paired sales were only found at 5 wind farms. Out of a review

of 26 participants, 25 did not consider any negative impacts or detrimental conditions on property values by adjacent wind energy facilities (Appendix K, RM Hoefs & Associates, Inc. 2015). Based on the studies outlined above, the Project is expected to have a negligible effect, if any, on the assessed values of private property and, therefore, on property taxes.

The transportation, treatment, and disposal of hazardous waste will be required in accordance with state and federal regulations. The use and storage of petroleum products will be in accordance applicable local, state, and federal regulations, the spill prevention and response procedures established in the SWPPP, and the SPCC developed for the Project. Additionally, there is the possibility that the improper use, storage, and/or disposal of hazardous materials such as fuels, oils, and maintenance fluids could result in a release that could cause contamination and exposure during construction, operation, and maintenance activities associated with the Project. Direct effects of a release will include contaminating soil and water resources; indirect effects could include exposing humans, wildlife, and vegetation to the contamination. The SPCC Plan implemented by the Applicant will minimize this risk and the contamination potential. Specifically, this plan will ensure that necessary resources are available to respond to a release and will minimize the risk of contaminating soil and water resources and the associated exposure to humans, wildlife, vegetation, and air quality. The risk of contamination and exposure will be further minimized by the Project's overall design and SPCC Plan requirements, such as adequately sized containment structures, regular facility inspections, and properly trained personnel. As required by the SPCC rule (40 CFR 112.7(j)), the Project SPCC Plan will incorporate county and state oil storage requirements as well.

Consistent with the Applicant's corporate environmental health and safety policy, the Applicant will also implement an Environmental Training and Monitoring Program that will communicate environmental concerns and appropriate work practices, including spill prevention, control, and countermeasure protocols to all field personnel.

18.2 Commercial, Industrial and Agricultural Sectors

18.2.1 Existing Agricultural Sector

The Project Area is in the agricultural sector and, except for two active sand and gravel pits located in T118N R51W Section 15 and 16, no commercial, industrial, mining, or institutional land uses are located within the Project Area.

Codington County has a total land area of 717 square miles, with approximately 577 square miles of land (80% of the county land area) being in farms (rounded to the nearest whole number) (U.S. Census Bureau 2013, Census of Agriculture 2012). In 2012, there were a total of 713 farms, and the average-sized farm was 518 acres. Crop sales were primarily grains, oil seeds, dry beans, and dry peas, while cattle, hogs, and sheep comprised the majority of livestock sales (Census of Agriculture 2012). From 2007 to 2012, the number of full-time farms increased by

7.5 percent and land acres used for farming increased by 0.94 percent, while the average farm size decreased by 0.65 percent. Sales of farm goods increased 60 percent from 2007 to 2012 and totaled $172,411,000 in 2012.

Grant County has a total land area of 688 square miles, with approximately 670 square miles of land (97% of the county land area) being in farms (rounded to the nearest whole number) (Census of Agriculture 2012). In 2012, there were a total of 618 farms, and the average-sized farm was 694 acres. Crop sales were primarily grains, oil seeds, dry beans, and dry peas, while cattle, hogs, and sheep comprised the majority of livestock sales (Census of Agriculture 2012). From 2007 to 2012, the number of full-time farms increased by 11.4 percent, land acres used for farming increased by 17.9 percent, and the average farm size increased by 0.60 percent. Sales of farm goods increased 80 percent from 2007 to 2012 and totaled $240,819,000 in 2012.

18.2.2 Agricultural Impacts/Mitigation

The Project is expected to have relatively minor impacts on agriculture in the region. Field observations and review of aerial photography indicate that most active farming operations involve non-tilled agriculture and livestock production, and non-tilled agriculture (e.g., with a minimal amount of tilled agriculture.

The Project will result in temporary and limited permanent impacts to farmland within the Project footprint. During construction, livestock operations may be temporarily affected by restricted access to active construction areas to protect the safety of livestock and construction workers. Coordination of property access with landowners with gates will occur to minimize impacts on agricultural operations and repair any gates or agricultural access routes that may be impacted during construction. After construction is completed, grazing in the Project constructions areas will be permitted. Permanent impacts to agricultural lands primarily will result from installation of access roads, substations, and wind turbines. Construction of the Project is anticipated to result in permanent loss of approximately 86.0 acres of farmland within the Project Area (see Table 9.2.3). The permanent impacts associated with each structure were calculated based on the facility footprint information provided in Table 8.1. Construction of the Project will result in an estimated 2,134.4 acres of temporary impacts to farmland due to the preparation of structures including turbine foundations and crane paths (see Table 9.2.3). This impact is estimated based on the current wind turbine array, associated collection line routes, access roads, and the Project Construction Easement.

Areas disturbed during construction will be repaired and restored to preconstruction contours to the extent practicable so that all surfaces drain naturally, blend with the natural terrain, and are left in a condition that will facilitate natural re-vegetation, provide for proper drainage, and prevent erosion. Temporary construction areas will be restored per landowner agreements and the SWPPP.

Drain tile lines may be present along the Project route. The Applicant will work with landowners to identify and mark drain tile lines to avoid damage during construction. Where locations are known, temporary travel paths will avoid drain tiles where possible. Where avoidance is not possible, matting may be used. If drain tile lines are inadvertently damaged by construction of the Project, the Applicants will repair tile lines. Landowners will be compensated for any crop damage that occurs during construction.

18.3 Community Facilities and Services

18.3.1 Existing Community Facilities and Services

The Project Area is located in, near or adjacent to the following communities: Waverly, Troy, Strandberg, Stockholm, and South Shore. Other existing communities are located outside of the Project Area including Watertown, Summit, Marvin, Twin Brooks, and Milbank. Facilities and services provided in these communities include but are not limited to the following: restaurants, grocery stores, hotels, postal services, equipment suppliers, packaging services, vehicle and equipment repair and maintenance shops, and gas stations.

18.3.2 Community Facilities and Services Impacts/Mitigation

The Project will provide short and long-term impacts on community facilities and services. During the project construction activities, local communities and businesses, such as restaurants, grocery stores, hotels, postal services, equipment suppliers, packaging services, vehicle and equipment repair and maintenance shops, and gas stations, will see an increase in business from construction workers. Other services such as equipment, fuel, operating supplies, and products may also be utilized from the county and state. Short-term construction personnel may be hired locally or from outside of the local communities for both skilled and unskilled labor positions. Additionally, housing may be needed for non-local construction laborers.

18.3.3 Emergency Response

The Applicant will coordinate with first responders, including but not limited to local police and sheriff, fire services, ambulance and EMT services. The Applicant will develop a safety plan for construction and operation personnel that will be shared with local emergency response personnel, as needed. The Applicant will complete any high angle rescues in the event needed during turbine operations and bring any injured personnel to the ground for transportation to local medical facilities by first responders. The Project will not result in an increased need for emergency services, fire protection, or public services, local utilities, or other government or community services.

18.4 Transportation

Transportation within the Project Area includes that occurring on U.S. highways (including an interstate), state highways, Codington and Grant County highways, township roads, unauthorized roads, and roads on private lands.

18.4.1 Existing Environment

Most of the Project is within 0.25 mile of existing transportation routes, including township and county roads. The network that will comprise the transportation system used during Project construction and O&M includes rural and section line roads. The One active railroad traverses the Project in three locations (T121N R47W and T119N R50W and T119N R51W). Major roads within the Project Area are depicted in Figures 1 and 2. Airports in the Project's vicinity in South Dakota include Watertown Regional Airport, west of Interstate 29 and approximately 14.4 miles west of Project Area; the Ortonville Municipal Airport, 3.9 miles northeast of the Project Area; and Milbank Municipal Airport, 1.0 mile west of the Project Study Area. No private air strips occur near the Project Area. No impacts to registered commercial facilities are anticipated.

18.4.2 Transportation Impacts and Mitigation

The Project is not anticipated to result in permanent impacts to transportation resources in the Project Area. Indirect effects may include increased traffic volume along local, state, and federal roadways. Impacts are anticipated to be minor, as a relatively low number of workers and equipment will be accessing any one location within the Project Area at any time during operations. Impacts from potential construction associated with 200 to 300 temporary workers are expected to be limited in duration and temporary. Direct effects to transportation also will be minimal during O&M activities. The Applicant will work with state and local highway departments regarding applicable permitting requirements. Collector lines will bore under active highways in four locations: T119N R51W Section 18 (SE quarter) and Section 19 (NE quarter); T119N R50W Section 13 (SW quarter) and Section 24 (NW quarter). The Applicants also will coordinate with railroads to bore active and inactive lines, and to ensure construction and operation in the Project construction easement will not affect use of the railroads. Collector lines will bore under active railroads in three locations: T119N R50W Section 23 (NW SE Quarter); and T119N R51W Sections 29 (SESW quarter) and Section 32 (WSW quarter). There will no anticipated impacts to registered commercial aviation facilities.

18.5 Telecommunications

This section describes the potential for interference of licensed communication links in close proximity to the proposed Crowned Ridge Wind Project area for the purposes of determining exclusion zones to aid the design of a proposed wind energy generation project. Wind Logics, Inc completed a report for the Project that summarizes the microwave links and towers along

with local cellular towers, media towers (AM and FM), television, and aviation towers, identified within and near the assessment area (Appendix M).

18.5.1 Existing Telecommunications

A review of the FCC national database and the Universal Licensing System was conducted to identify possible constraints. Wind turbine offset distances were taken into consideration for the design of the wind turbine array. Five microwave towers were identified within the Project area. In addition, twelve microwave links have been identified near the project area and ten have been found to intersect the Project area. The Worst Case Fresnel Zone for all of these links have been calculated, and the appropriate turbine offset has been used to minimize any harmful impact from the proposed turbine layout. One cellular tower was identified within the project boundary. Four additional cellular towers were discovered within 25 km of the project boundary. No active AM radio towers were identified within the project boundary or within 25 km of the project boundary. No digital or analog television stations were identified within the project boundary. No active Aviation towers were identified within the project boundary or within 25 km of the area of interest.

18.5.2 Telecommunications Impacts/Mitigation

Electromagnetic analysis results show that interference is not expected to impact nearby microwave, AM, FM, cellular, TV, and aviation towers based on the array design. Harmful interference associated with cellular towers is not likely as cellular transitions or packet switching occurs when a cellular link becomes unavailable. While the impact of wind turbines on digital television reception is not well known due to limited cases and testing, any interference is expected to be limited to areas near the edge of station reception, areas near a turbine that is within the line-of-sight between the transmit tower and receptor, and areas of complex topography (Appendix M). While no harmful interference is expected for the aviation towers; Crowned Ridge Wind is subject to a FAA to determine any exclusion zones. Proposed turbine locations will maintain the standard appropriate offset distances in addition to any setbacks set by the agency to minimize harmful impact.

18.6 Cultural Resources

This section presents the results of a record search, a review of previously recorded cultural resources, as well as the results of the current Level III survey conducted for the Project.

In accordance with the *Guidelines for Cultural Resource Surveys and Survey Reports in South Dakota (For Review and Compliance)* (South Dakota State Historical Society 2005), cultural resources reviews were conducted for an area that includes a 1-mile buffer of the Project Construction Easement. The cultural resources survey of the Project Construction Easement was performed for an area within at least a 300 ft. radius around each proposed turbine location

000122

center point; this area was expanded to a radius of up to 500 ft. around some turbines to allow for an expanded construction area. Access routes to turbines were encompassed in cultural resources survey for a width of 200 ft. along their full length to provide adequate flexibility for construction and establishment of the typically 16-ft.-wide right of way. Collection lines from turbines encompassed in cultural resources survey for a width of 100 ft. along their full length to provide adequate flexibility for construction, and work space for boring equipment where needed.

Historic architectural survey reviewed buildings and structures within a 1-mile radius of the turbine locations. The record search for the Project Area considered all cultural resources documented within and up to 1 mile beyond the Project boundary.

The records search was conducted on May 15, 2018 through the Archaeological Research Center at the South Dakota State Historical Society for the Project Area. Pursuant to South Dakota Codified Law 1-20-21, information contained within the records search data is considered confidential and not for public distribution. Additional background research conducted for the Project Area included review of the historical General Land Office (GLO) plat maps available online from the Bureau of Land Management. Information presented below is a summary of the data obtained from the Archaeological Research Center and from the GLO database; site specific location information is considered confidential and is not included in this review.

The results of the records search indicate that 31 previous cultural resource inventories have been conducted within one mile of the Project Area for other projects. Two of these inventories overlap the Project Construction Easement. Four of the previous inventories were completed in the past 10 years.

18.6.1 Existing Cultural Resources

The Records Search was conducted within 1-mile of the Project Area, per SD State Historic Preservation Officer guidance. This search determined that 133 previously documented archaeological sites, 6 previously documented historic bridges, 83 previously documented standing historic structures, and 5 previously documented cemeteries have been recorded inside and within 1 mile outside of the Project Area. Previously documented sites eligible for National Register of Historic Places (NRHP) and State Register of Historic Places (SRHP) intersected by the Project Construction Easement and within 1 mile of the Project Area are discussed below by resource type.

18.6.1.1 Previously Documented Archaeological Sites

The 133 previously documented archaeological sites include Native American artifact scatters, cairns, earthworks, and stone circles and alignments, and include European-American artifact scatters, cairns, dams, depressions, farmsteads, foundations, railroads, and roads. Of the 133

previously recorded sites, 21 are eligible for the NRHP and SRHP, 12 are not eligible for the NRHP or SRHP, and 100 sites have not been evaluated for the NRHP or SRHP.

The Project Construction Easement overlaps nine of the previously documented archaeological sites (Appendix E, Table 1). These nine sites include three Native American sites, four historic European-American sites, one Native American/European-American site, and one site of unknown age in antiquity. The Native American sites consist of one alignment; one artifact scatter; and one combined artifact scatter, earthwork, and mound site. The four historic European-American resources include two farmstead ruins; one debris concentration; and one combined alignment feature, earthen depression, debris concentration, and building foundation. One multicomponent Native American and European-American artifact scatter and one cairn of unknown age are also located within the Project Construction Easement. Treatment of archaeological sites within the Project Construction Easement is addressed below at Section 18.6.3 Cultural Resource Impacts/Mitigation.

18.6.1.2 Previously Documented Standing Structures

Eighty-three (83) previously documented standing structures have been identified within 1 mile of the Project Area (Appendix E, Table 2). These standing structures include residences, agricultural buildings, farmsteads, churches, schools, and commercial buildings. No previously documented standing structures are located within the Project Construction Easement.

Of the 83 previously documented standing structures within 1 mile but outside of the Project Area, two are determined eligible for the NRHP and SRHP, 80 have been determined not eligible for the NRHP and SRHP, and one has not been evaluated for the NRHP or SRHP. The structures eligible for the NRHP and SRHP are the Brown Earth Presbyterian Church and the combined Potters Stage Coach Station and U.S. Post Offices. The Brown Earth Presbyterian Church is listed on the NRHP. The buildings/structures recorded as the Potters Stage Coach Station and U.S. Post Offices are no longer extant and, on this basis, no longer retain their integrity for NRHP eligibility.

18.6.1.3 Previously Documented Historic Bridges

Six previously documented historic bridges have been identified within 1 mile of the Project Area (Appendix E, Table 3). One historic bridge is eligible for the NRHP, and five bridges have been determined not eligible for the NRHP. However, the Project Construction Easement does not intersect any of these resources and the bridges will not be altered by Project vehicle use of public roadways.

18.6.1.4 Previously Documented Cemeteries

Five previously documented cemeteries have been identified within 1 mile of the Project Area (Appendix E, Table 4). Four of the cemeteries are determined not eligible for the NRHP and one

cemetery remains unevaluated. The Project Construction Easement does not intersect any of these resources.

18.6.1.5 General Land Office Review

The GLO survey plat maps were reviewed for historic features that may be located with the Project Construction Easement. This review revealed that from 1873 and 1874 three townships: T118N, R52W; T119N, R50W; and T119N, R52W exhibited signs of European-American settlement (e.g., unnamed trails) within the Project Area. In addition to direct evidence of European-American settlement, the GLO mapping also shows a historic boundary labeled "Eastern Boundary of Sissiton & Warpeton [sic] Indian Reservation." By the 1873 survey, this boundary is no longer depicted, nor is it shown on the subsequent mapping of these townships. Codington County was established in 1877 and Grant County was formed in 1873; however, Grant County was previously part of Deuel County from 1862 until its creation (South Dakota Genealogy Trails 2006ab). Evidence of settlement on the examined maps includes trail routes identified on the 1873 GLO mapping (but are not identified on subsequent maps, in previous documented site files, or in current Level III field surveys).

18.6.2 Level III Survey for Cultural Resources and Architectural History Survey

From June to December 2017 and April to October 2018, a Level III Survey was conducted for archaeological, historical, and tribal resources at each proposed turbine location, access route to turbines and collection lines from turbines. The archaeologists supervising these investigations meet the U.S. Secretary of the Interior's Professional Qualifications Standards for archaeology. The area of Level III survey covers the Project Construction Easement.

Tribal members from the Sisseton Wahpeton Oyate, Yankton Sioux, and Spirit Lake Nation selected to represent those tribes in identifying significant tribal resources were an integral part of the survey field team. Tribal members were responsible for identifying site of religious and cultural significance to the tribes, or traditional cultural properties (TCPs). An architectural history survey was also conducted of standing buildings and structures within 1 mile of the Project Construction Easement for all proposed turbine locations. The architectural history survey was led by architectural historians meeting the U.S. Secretary of the Interior's Professional Qualification Standards in that field.

The Level III Survey identified 960 Native American sites and isolated artifacts including four previously recorded sites or site components during Project Construction Easement surveys, and identified 34 historic European-American archaeological sites or isolated artifact occurrences, including seven previously recorded historic archaeological sites or site components as discussed in Section 18.6.1.1 Previously Documented Archaeological Sites. The historic architectural survey further field-checked approximately 982 standing building and structure locations within

1 mile but outside of the Project Area (the project is set back from standing buildings and structures by design). The historic architectural survey focused on those sites where historic setting and feeling may be important and considered the potential visibility of Project turbines.

All TCP sites identified by tribal members, which are sites represented by rock cairns, alignments, and other traditionally recognized features on the landscape, are considered important to the identifying tribes and will be considered as eligible for listing on the NRHP. The newly identified historic European-American archaeological remains, primarily represented by sparse artifact debris or the occasional building foundation ruins, are proposed as not eligible for NRHP listing due to their lack of historical importance and lack of significant scientific research value. One previously recorded historic archaeological farmstead complex is recommended eligible for the NRHP as a result of Phase III survey for the Project, but is not located within the Project Construction Easement.

No NRHP- or SRHP-eligible standing buildings and structures within 1 mile of the Project Construction Easement will potentially be exposed to significant Project impacts. Although previously undocumented segments of an abandoned Chicago & North Western Railroad grade may be used or crossed by Project access, the original structure of these segments will remain in place and the Project will not significantly alter the historic qualities that make them eligible for NRHP listing. No other NRHP- or SRHP-eligible historic buildings or structures are located within 1 mile of Project turbines, including any identified during current field checks of previously undocumented historic buildings and structures within the greater Project Area. The NRHP-listed the Brown Earth Presbyterian Church is located outside (northeast) of the Project Area, approximately 2 miles from the nearest proposed turbine location, and, therefore, is outside of the considerable area of Project impact. The Potters Stage Coach Station and U.S. Post Offices no longer exist and are no longer of consideration for potential Project impacts.

18.6.3 Cultural Resource Impacts/Mitigation

Planned construction activities for the Project may occur within the vicinity of sites important to tribal cultural traditions, archaeological sites, or historic standing structures. Sites evaluated as not eligible for NRHP listing are not significant and impacts to these sites will therefore not be considered. Those sites that are evaluated as eligible for NRHP listing by the participating tribes or by SHPO, or of undetermined NRHP eligibility, will be protected by establishing avoidance measures at those portions of the resources that make them eligible for NRHP listing to exclude them from physical impacts from the Project. In addition to avoiding potential direct physical impacts to significant site areas during Project construction, indirect secondary effects from the introduction of new visual elements into the setting of NRHP-eligible tribal resources and historic buildings and structures could impact the integrity of these sites. However, regarding potentially affected historic and archaeological sites, state preservation law SDCL 1-19A-11.1 applies to those that are currently listed on the NRHP or SRHP, not simply those that are eligible

for listing. No buildings or structures listed on the NRHP or on the SRHP occur within 1 mile of proposed Project turbines.

18.6.3.1 Tribal and Archaeological Resource Impacts/Mitigation

NRHP-eligible tribal and archaeological resources are identified as TCPs by the coordinating tribes on the Project, including the Sisseton Wahpeton Oyate, Yankton Sioux, Rosebud Sioux, and Spirit Lake Tribes. Since setting and feeling are important and contributing aspects of these sites' traditional character and experience, Sisseton Wahpeton Oyate, Yankton Sioux, Rosebud Sioux, and Spirit Lake Tribal Historic Preservation Officers believe that the Project will impose setting-related impacts at sites of traditional, cultural, and religious importance to Native peoples. Archaeological consultants on the Project support this finding. Project developers worked together with the consulting tribes and archaeologists to create the avoidance, minimization, and mitigation measures identified for TCPs below:

- Standard avoidance or resource protection practices (e.g., barrier fencing, contractor training) where feasible in collaboration with the tribes listed here and the Project Developer.
- Make best effort to identify possible willing and participating landowners (the landowners) who may be willing to work with the tribes on site preservation, accessibility and protection of TCPs on their property.
- Conduct site revisits prior to construction.
- Help facilitate post-construction site revisits for tribes with the landowners.
- Education/interpretation opportunities regarding tribal resource preservation and/or Native American perspectives which may include sensitivity training when needed.

The treatments and recommendations to address the impacts to TCPs were developed by Tribal Cultural Specialists who are traditional practitioners having specific training and specialized knowledge about these features and sites.

All of the TCPs identified in this investigation are considered and recommended eligible for NRHP listing. Although this Project is private and federal permitting requirements do not apply, the criteria used for impact assessment is similar to that employed for federally-regulated projects. The Sisseton Wahpeton Oyate, Yankton Sioux, Rosebud Sioux and Spirit Lake Tribal Historic Preservation Officers and the Project developer have worked together to create a set of avoidance, minimization, and mitigation measures to address these impacts.

18.6.3.2 Historic Building and Structure Impacts/Mitigation

No construction-related activities that will permanently alter important historic aspects of historic buildings or structures will occur directly within the boundaries of NRHP-eligible historic building or structure sites. For historic railroad grades that may be crossed by project access, the railroad grade will be maintained and returned to its previous condition without

alteration to the important historic aspects of the structure that make it eligible for the NRHP. The historic railroad within the Project Construction Easement, although eligible, is not in fact listed on the NRHP or SRHP and requires no further a under state preservation law SDCL 1-19A-11.1. No other NRHP- or SRHP-eligible or listed buildings or structures were identified within 1 mile of turbines where the integral historic setting of such buildings or structures could be impacted by the introduction of new visual elements.

19.0 Employment Estimates (ARSD 20:10:22:24)

ARSD 20:10:22:24. Employment estimates. *The application shall contain the estimated number of jobs and a description of job classifications, together with the estimated annual employment expenditures of the applicants, the contractors, and the subcontractors during the construction phase of the proposed facility. In a separate tabulation, the application shall contain the same data with respect to the operating life of the proposed facility, to be made for the first ten years of commercial operation in one-year intervals. The application shall include plans of the applicant for utilization and training of the available labor force in South Dakota by categories of special skills required. There shall also be an assessment of the adequacy of local manpower to meet temporary and permanent labor requirements during construction and operation of the proposed facility and the estimated percentage that will remain within the county and the township in which the facility is located after construction is completed.*

The Project is expected to employ approximately 250 temporary workers during the 5-9-month construction period of the Project. It is likely that general skilled labor is available either in Codington and Grant Counties or the state to serve the basic infrastructure and site development needs of the Project. Specialized labor will be required for certain components of Project construction. It is likely that this labor will be imported from other areas of the state or from other states, as the relatively short duration of construction does not warrant special training of local or regional labor. Balancing the use of local contractors and imported specialized contractors will likely alleviate any labor relations issues.

After construction of the Project is completed, approximately 7-12 employees will be hired for full time positons on the Project's O&M team. Employment positions will consist of a full time Operations Manager and Wind Technicians who will operate the windfarm and substation for the life of the project. The team will have personnel on-call 24 hours per day, 7 days per week to address issues arising outside of normal business hours.

20.0 Future Additions and Modifications (ARSD 20:10:22:25)

ARSD 20:10:22:25. Future additions and modifications. *The applicant shall describe any plans for future modification or expansion of the proposed facility or construction of additional facilities which the applicant may wish to be approved in the permit.*

The Applicant does not have planned or anticipate any future modifications needed to the Project. However, in addition to the Project, a separate Facility Permit application for the construction of a 300 MW wind project will be filed by Crowned Ridge Wind II, LLC. The additional 300 MW project, Crowned Ridge Wind II, is to be located adjacent to the Project and will be owned and operated by NSP.

21.0 Decommissioning of Wind Energy Facility (ARSD 20:10:22:33:01)

ARSD 20:10:22:33.01. Decommissioning of wind energy facilities -- Funding for removal of facilities. *The applicant shall provide a plan regarding the action to be taken upon the decommissioning and removal of the wind energy facilities. Estimates of monetary costs and the site condition after decommissioning shall be included in the plan. The commission may require a bond, guarantee, insurance, or other requirement to provide funding for the decommissioning and removal of a wind energy facility. The commission shall consider the size of the facility, the location of the facility, and the financial condition of the applicant when determining whether to require some type of funding. The same criteria shall be used to determine the amount of any required funding.*

CRW has entered into lease and easement agreements with private landowners within the Project Area for the placement of Project infrastructure. The Applicant anticipates that the life of the Project will be approximately 25 years, which is consistent with the Project's contracted term. At the end of the Project's contracted life there may be opportunities to extend the life of the Project by repowering the Project by retrofitting the turbines and power system with upgrades based on new technology, which may allow the wind farm to produce efficiently and successfully for many more years.

In the event the Project's contracted life is not extended, the Project will be decommissioned in accordance with applicable state and county regulations. Current decommissioning requirements in Grant and Codington Counties require that all towers, turbine generators, transformers, overhead collector and feeder lines, foundations, buildings, and ancillary equipment be dismantled and removed to a depth of 4 feet. To the extent possible, the site shall be restored and reclaimed to its pre-project topography and topsoil quality. All access roads shall be removed, unless written approval is given by the landowner requesting roads be retained. CRW wil comply with all decommissioning and restoration requirements in both Codington and Grant County as listed within section 9 of the Codington County ordinance and section 10 of the Grant County ordinance, which also includes requirements on financial assurances that are specific to each county. The Decommissioning Plan for the Project is included in Appendix L. The estimated net decommissioning costs for the Project are summarized in the Decommissioning Plan in Appendix L.

22.0 Reliability and Safety (ARSD 20:10:22:33.02(8))

22.1 Reliability

GE, one of the world's largest wind turbine suppliers of has over 35,000 wind turbines installed globally. GE has been producing wind turbines since 2002. Preventative maintenance based on analyzing real time data will be used to help mitigate potential failures.

To improve reliability, the Project has the ability to create short-term forecasts of wind speed and energy that will be produced. Determining weather conditions with accuracy enables the project owner and operator to efficiently maximize the facility output. Transmission system operators need to know how much energy wind facilities can deliver and when to dispatch generators on the system to match load to generation. Typically, wind projects provide a daily, hourly and incremental forecast, updated every 15 minutes to the off-taker, balancing authority, and/or regional TO. Predicting energy generation through vast, location-specific weather forecasting is used to integrate wind energy into the region's power grid and to schedule turbine and transmission maintenance windows, improving overall reliability. As wind forecasting has improved, the reliability of wind energy generation forecasts provided to the transmission operators has also improved.

22.2 Safety

The Project is located in a rural setting with low population density. Construction and operation of the Project will have minimal impacts on the security and safety of the local population. The construction team will coordinate with first responders, including, but not limited, to air ambulance, local sheriff's office(s) and local fire services to develop a safety plan during the Project's 5-9-month construction period. During the operation period of the Project, the on-site operation and maintenance team members will also be in contact with local first responders to offer information about the Project and to answer any questions response teams may have regarding Project plans and details. The following security measures will be taken to reduce the chance of physical and property damage, as well as personal injury, at the site:

- The towers will be setback from occupied residences and roadways as described in this Application in Table 13.1.2 and the applicable regulations identified herein. These distances are considered to be safe based on developer experience, and are consistent with prior Facility Permits.
- Security measures will be taken during the construction and operation of the Project including temporary (safety) and permanent fencing, gates, warning signs, and locks of equipment and wind power facilities.
- Regular maintenance and inspections will address potential blade failures, minimizing the potential for blade throw.

- Turbines will sit on steel enclosed tubular towers within which all electrical equipment will be located, except for the pad-mounted transformer where applicable.
- Access to the interior of the tower is only though a solid steel door that will be locked when not in use. The exterior cannot be climbed.
- Safety training and standardized practices will be conducted for construction crews and on-site personnel.

23.0 Information Concerning Wind Energy Facilities (ARDS 20:10:22:33:02)

ARSD 20:10:22:33.02. Information concerning wind energy facilities. *If a wind energy facility is proposed, the applicant shall provide the following information:*

(1) Configuration of the wind turbines, including the distance measured from ground level to the blade extended at its highest point, distance between the wind turbines, type of material, and color;
(2) The number of wind turbines, including the number of anticipated additions of wind turbines in each of the next five years;
(3) Any warning lighting requirements for the wind turbines;
(4) Setback distances from off-site buildings, right-of-ways of public roads, and property lines;
(5) Anticipated noise levels during construction and operation;
(6) Anticipated electromagnetic interference during operation of the facilities;
(7) The proposed wind energy site and major alternatives as depicted on overhead photographs and land use culture maps;
(8) Reliability and safety;
(9) Right-of-way or condemnation requirements;
(10) Necessary clearing activities;
(11) Configuration of towers and poles for any electric interconnection facilities, including material, overall height, and width;
(12) Conductor configuration and size, length of span between structures, and number of circuits per pole or tower for any electric interconnection facilities; and
(13) If any electric interconnection facilities are placed underground, the depth of burial, distance between access points, conductor configuration and size, and number of circuits.

The following information requirements concerning wind energy facilities have been referenced in previous sections of the Application, as indicated below.

- Configuration of wind turbine – Section 6.1
- Number of wind turbines – Section 6.1
- Warning lighting requirements for wind turbines – Sections 13.0 and 18.0
- Setback distances – Section 7.2
- Sound levels during construction and operation –13.3.2
- Electromagnetic interference – Section 13.5
- Site and major alternatives – Section 7.0
- Reliability and safety – 22.0
- Right-of-way or condemnation requirements – Sections 6.0 and 7.3
- Clearing activities – Sections 6.11 and 11.1.2
- Configuration of interconnection towers and poles – Section 6.5
- Conductor and structure configurations – Section 6.5
- Underground electric interconnection facilities – Section 6.3

24.0 Additional Information in Application (ARSD 20:10:22:36)

24.1 Permits and Approvals

24.2 Agency Coordination

The Applicant conducted meetings with Grant County officials (the Grant County Commissioners, the Grant County Planning and Zoning Officer and the Grant County Auditor) on November 8, 2016 and December 20, 2016, as well as on January 17, April 4, June 6 and June 20 in 2017. As a result of these meetings, CRW was able to better understand proposed changes to the Grant County zoning ordinance and how CRW could proactively develop the Project to ensure compliance.

The Applicant met with the Codington County Planner and First District Association of Local Governments on February 9, April 5, May 23, and August 31 of 2017 to discuss the requirements of the Codington County siting ordinances and the county's expectations through the development and construction of the Project.

CRW will continue the collaborative process with agencies throughout the development, construction and operation phases of the Project.

24.3 Applicant's Burden of Proof

As described throughout the application, the Applicant has addressed the matters set forth in SDCL Chapter 49-41B and in ARSD Chapter 20:10:22 (Energy Facility Siting Rules), related to wind energy facilities.

Pursuant to SDCL 49-41B-22, the information presented in this Application establishes that:

- The proposed wind energy facilities comply with applicable laws and rules.
- The facilities will not pose a threat of serious injury to the environment or to the social and economic condition of inhabitants in or near the Project Area.
- The facilities will not substantially impair the health, safety, or welfare of the inhabitants.
- The facilities will not unduly interfere with the orderly development of the region, having given consideration to the views of the governing bodies of the local affected units of government.

Table 24. Potential Required Permits and Approvals

Agency	Type of Permit, Approval, or Coordination	Status*	Need or Description
Federal			
U.S. Fish and Wildlife Service	Section 10 (no federal nexus, private project) of the Endangered Species Act; Migratory Bird Treaty Act; Bald and Golden Eagle Protection Act	2	Coordination regarding adherence to the voluntary Land-Based Wind Energy Guidelines; coordination with Refuges Division regarding protected easements. .
U.S. Army Corps of Engineers	Section 404 of the Clean Water Act	2	Nationwide Permit 12 is required for dredging or fill in jurisdictional waters of the U.S. for utility line projects.
Federal Avian Administration	Determination of No Hazard	1	Required for any potential obstacles to navigation airspace over 200 feet in height.
State of South Dakota			
Public Utilities Commission	Facility Permit	C*	Required for wind facility over 100 MWs.
Department of Environment & Natural Resources	Section 401 Water Quality Certification	2	Required for fill in jurisdictional waters of the U.S.
	NPDES Permit: General Permit for Storm Water Discharges Associated with Construction Activities	A	Required for disturbance of over one acre of land. Must prepare a Storm Water Pollution Prevention Plan.
	Temporary water use permit for construction activities	2	Required for compliance with the Water Pollution Control Act. Temporary permits for the use of public water for construction, testing, or drilling purposes. Construction contractors will obtain as necessary.
	General Permit for Temporary Dewatering	2	Compliance with the Water Pollution Control Act. Temporary permit for the discharge of water for construction dewatering. Construction contractors will obtain as necessary.
	Air Quality Permit	2	Required for a process or fuel burning unit that emits a pollutant into the ambient air.
South Dakota Game, Fish, and Parks Commission	Environmental review for state listed species	2	Coordination regarding state listed species and species of conservation concern
South Dakota State Historical Society	SDCL 1-19A-11.1	A	Compliance required for state permits.
Department of Transportation	Highway Access Permit; Road Crossing Agreements	2	Permit required for construction of access roads from state highways.
	Utility Permit	2	Required for utility crossings on state highway ROW, as necessary.
	Oversize/overweight Permit	2	Required for heavy hauling construction equipment and materials on state highways. Construction contractor will obtain, as necessary.
South Dakota Aeronautics Commission	Aeronautical Hazard Permit	2	Turbine lighting on conjunction with Federal Aviation Administration Review

000136

Local			
Codington County	Building Permits or Conditional Use Permits; Road Crossing Agreements; Oversize/overweight Permit; Open Burning Permits.	C	Conditional Use Permits required for the Project and the 2 substations. Building Permits, Road Crossing Agreements, and Oversize/overweight Permits may be required, as determined on a case-by-case basis.
Grant County	Conditional Use Permit	C	Conditional Use Permit required for turbines.
Townships	Road Crossing Agreements; Oversize/overweight Permit	2	The Project will require crossing agreements.

*1: Applied – decision pending
2: Final design will determine whether the permit/approval is required, or final layout is needed for permit application.
C: Complete.
C*: Permit issued, in compliance period prior to authorization for construction.
A: Permit requirement will apply, but have not yet applied. Typical for construction preparation activities.

25.0 Testimony And Exhibits (ARSD 20:10:22:39)

The Applicant is submitting testimony and exhibits in support of the Application. The Exhibits are identified in the Application, and the following will provide testimony in support of the Application:

Name and Title	Entity	Subject Matter
Sam Massey, Tyler Wilhelm	NextEra Energy Resources, LLC	Project Management and Development Activities
Kimberly Wells	NextEra Energy Resources, LLC	Environmental
Mark Thompson	NextEra Energy Resources, LLC	Construction, O&M and Decommissioning
Jay Haley	EPAC Wind Energy	Sound and Shadow Flicker Modeling and Results

26.0 Applicant's Verification

VERIFIED APPLICANT'S SIGNATURE

State of Florida)
County of Palm Beach) :SS

Jason Utton, being duly sworn, deposes and says that he is the authorized agent of Crown Ridge Wind, LLC.

He states that he does not have personal knowledge of all the facts recited in the forgoing application, but the information in the application has been gathered by and from employees, contractors of the owners of Crown Ridge Wind, LLC; and that the information in the application is verified by him as true and correct on behalf of Crowned Ridge Wind, LLC.

Dated this 4th day of January, 2019.

Jason Utton
Vice President – Development
NextEra Energy Resources, LLC

Subscribed and sworn to before me this
29th day of January, 2019.

Notary Public
My Commission Expires:

NANCY E. LLAMA
MY COMMISSION # FF 900481
EXPIRES: November 14, 2019
Bonded Thru Notary Public Underwriters

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List of Figures

Figure 1 – Project Area

Figure 2 – Public Lands and Facilities

Figure 3 – Project Map

Figure 4a – Typical Wind Turbine Diagram

Figure 4b – Typical Wind Turbine Diagram

Figure 5 – Typical Turbine Construction Site Layout

Figure 6 – Environmental Constraints

Figure 7 – Constraints Map

Figure 8 – Topographic Map

Figure 9a – Surficial Geology

Figure 9b – Geology Cross Sections

Figure 10 – Bedrock Geology

Figure 11 – Soil Types

Figure 12 – Water Resources

Figure 13 – Land Use

Figure 14 – Common Sound Levels in the Environment

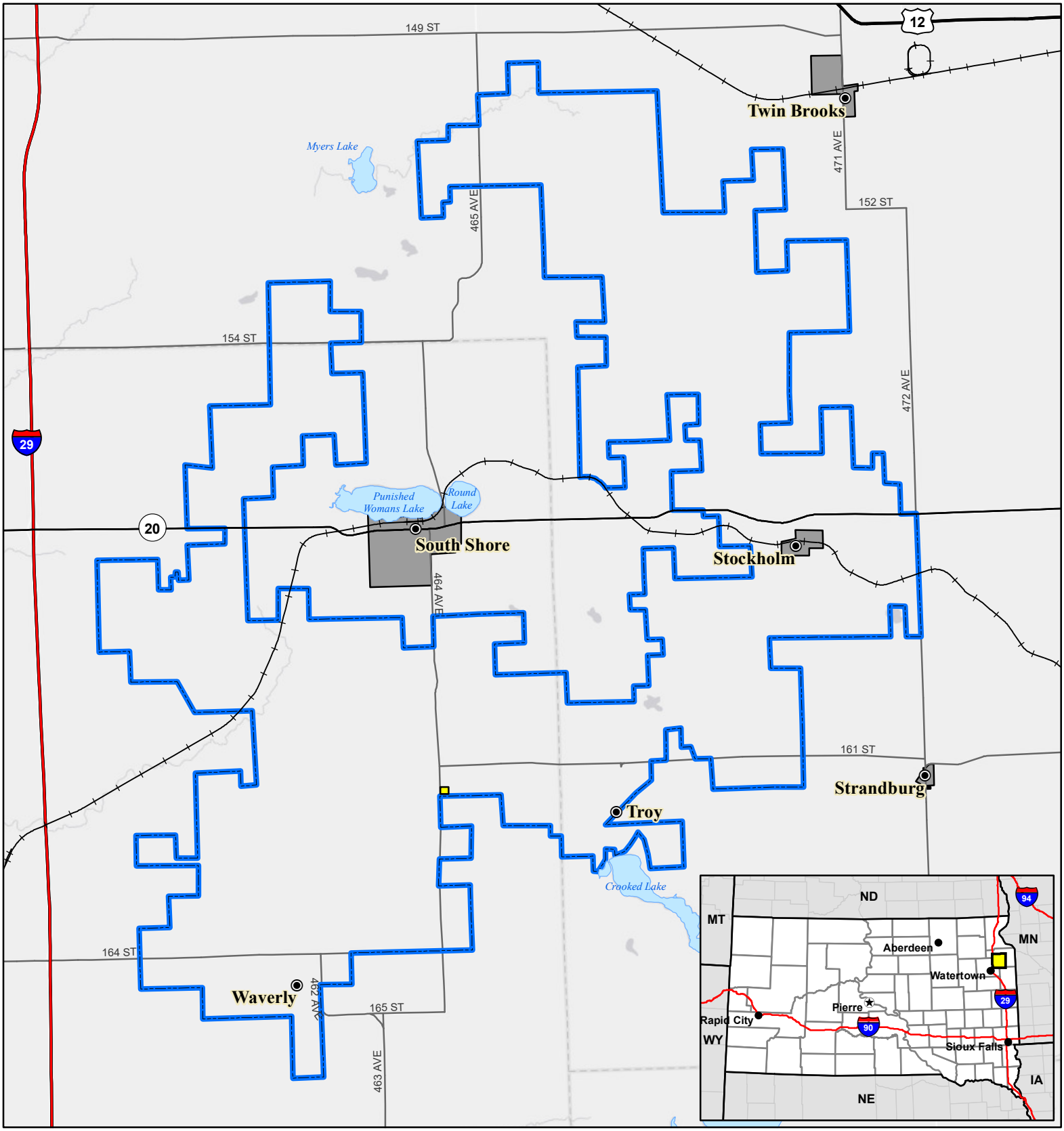


Figure 1. Project Area

Crowned Ridge Wind Farm

- City
- Railroad
- Interstate Highway
- U.S. Highway
- State Highway
- County Road
- Waterbody
- Substation
- Town Boundary
- Project Boundary

Kilometers: 0 — 5 — 10

Miles: 0 — 2.5 — 5

N W E S

Base Map: World Light Gray Canvas Base
Sources: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Codington and Grant Counties, South Dakota

Projection: NAD 1983 UTM Zone 14N

000147

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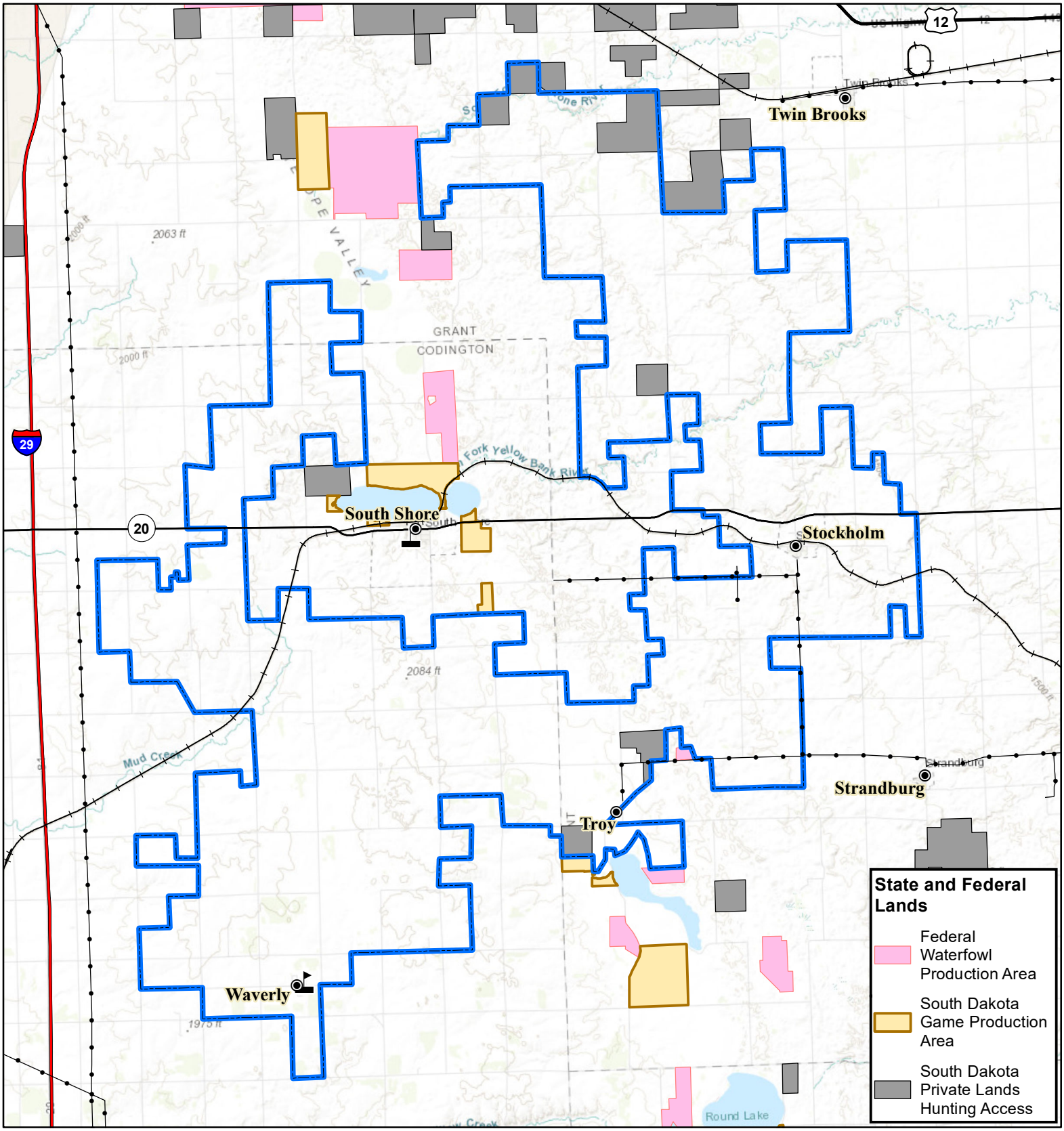


Figure 2. Public Land and Facilities

Crowned Ridge Wind Farm

- City
- School
- Electrical Line
- Railroad
- Interstate Highway
- U.S. Highway
- State Highway
- Project Boundary

Kilometers
0 5 10

Miles
0 2.5 5

Base Map: World Topographic Map
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community
Codington and Grant Counties, South Dakota

Projection: NAD 1983 UTM Zone 14N

000148

SWCA ENVIRONMENTAL CONSULTANTS

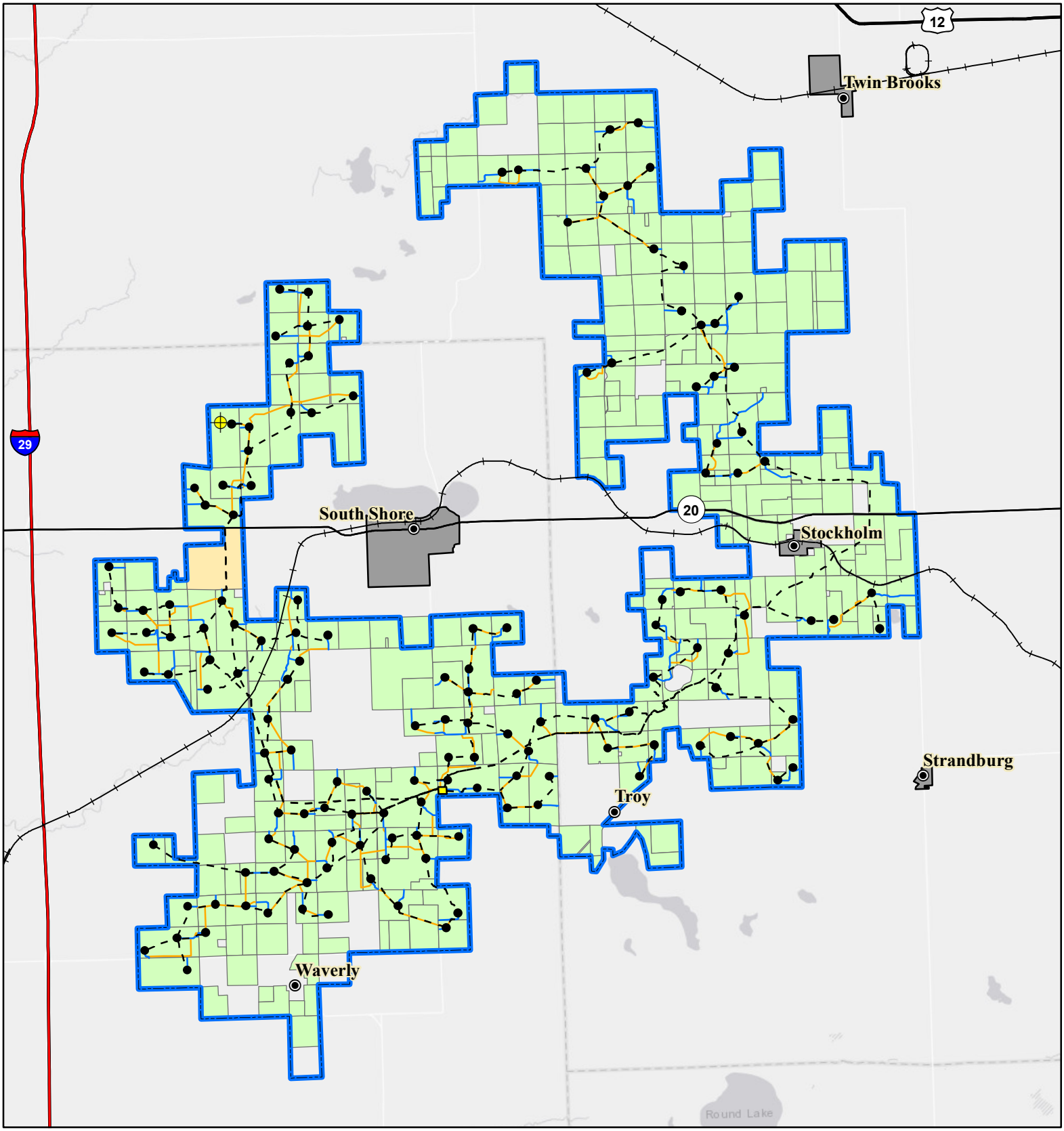


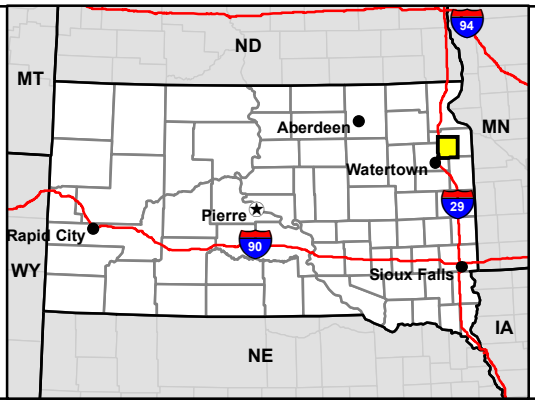
Figure 3. Project Map

Crowned Ridge Wind Farm

- MET Tower
- Turbine
- City
- Proposed Turbine Access Road
- Collector Line
- Crane Path
- Railroad
- Interstate Highway
- U.S. Highway
- State Highway
- O&M Facility/ Substation
- Town Boundary
- Project Boundary

Lease Status

- Lease, Signed
- Pending Approval



Kilometers

0 2.5 5

Miles

0 2.5 5

Base Map: World Light Gray Canvas Base
Sources: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Codington and Grant Counties, South Dakota

000149

Projection: NAD 1983 UTM Zone 14N

SWCA ENVIRONMENTAL CONSULTANTS

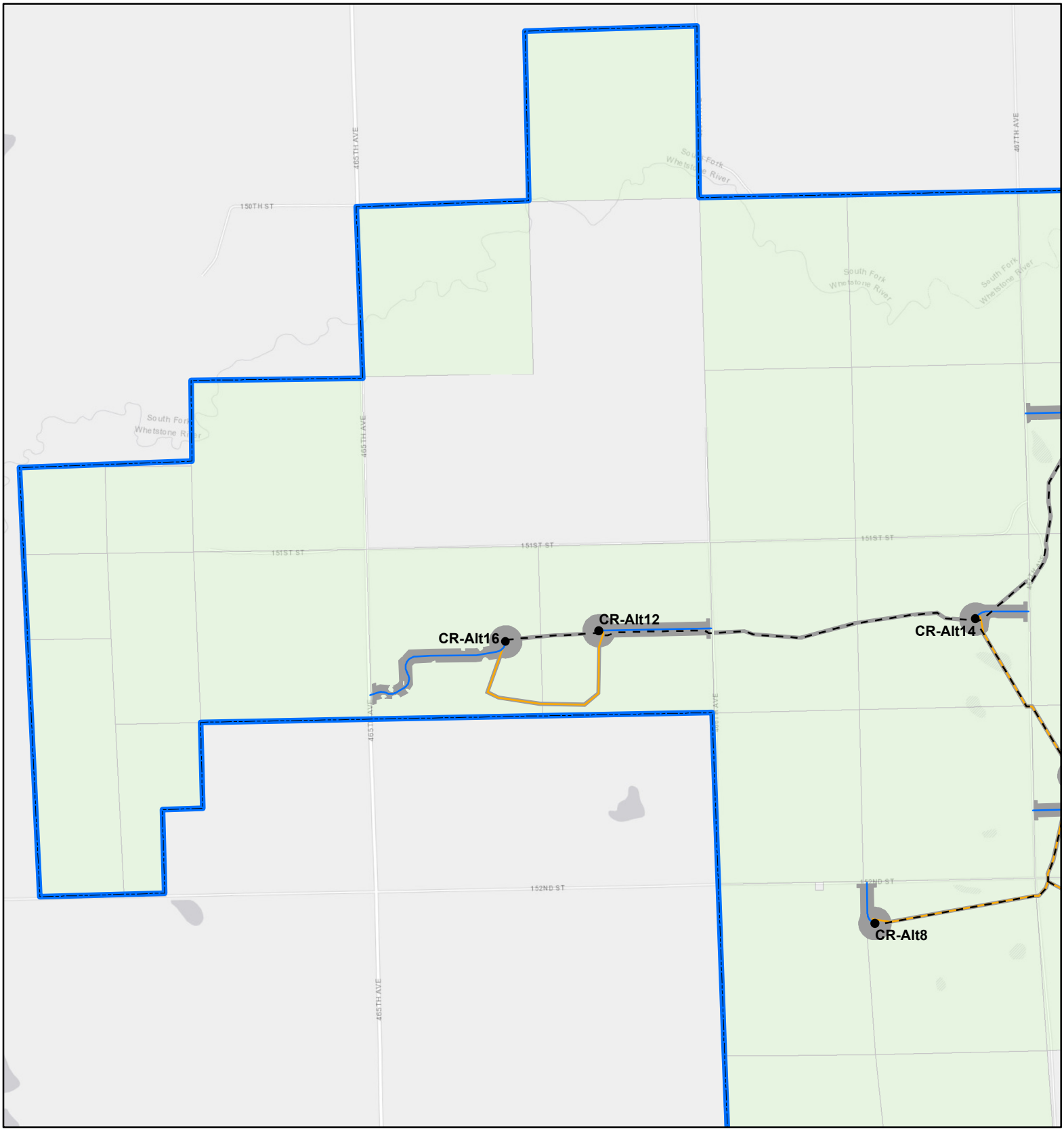
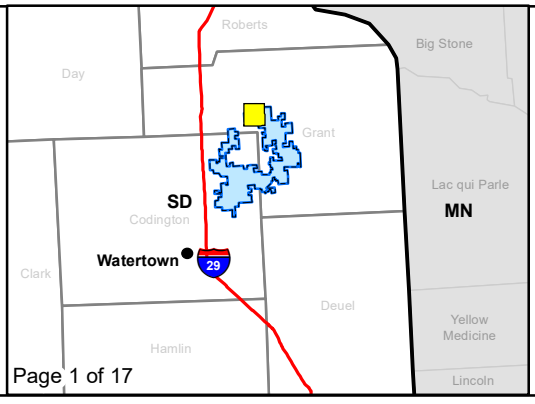


Figure 2. Project Map & Facilities

Crowned Ridge Wind Farm

- Turbine
- MET Tower
- City
- Railroad
- Collector Line
- Proposed Turbine Access Road
- Crane Path
- Interstate Highway
- U.S. Highway
- State Highway
- O&M Facility/ Substation
- Construction Easement
- Batch Plant
- Laydown Yard
- Town Boundary
- Participating Landowner
- Project Boundary



Kilometers
0 0.5 1

Miles
0 0.25 0.5

N W E S

Service Layer Credits: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Quadrangle: Antelope Valley (1973), Twin Brooks (1973)
Township/Range: T120N, R51W, T120N, R50W
Grant County, South Dakota

000150

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Projection: NAD 1983 UTM Zone 14N

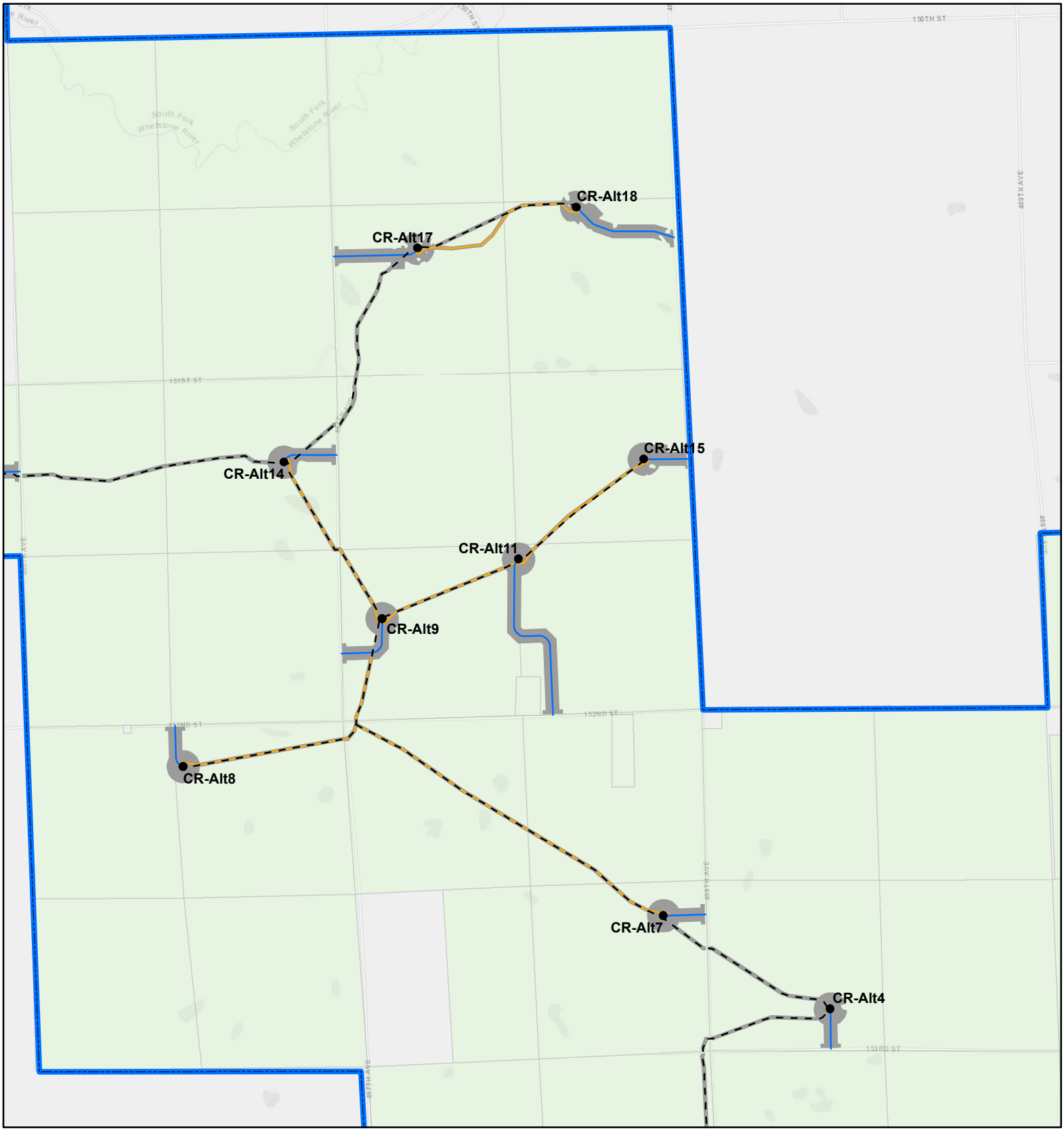
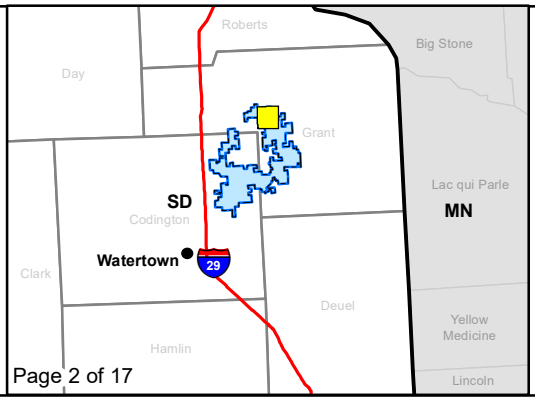


Figure 2. Project Map & Facilities

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- Project Boundary



Kilometers
0 0.5 1

Miles
0 0.25 0.5

Service Layer Credits: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Quadrangle: Antelope Valley (1973), Twin Brooks (1973)
Township/Range: T120N, R50W

Grant County, South Dakota

000151

Projection: NAD 1983 UTM Zone 14N

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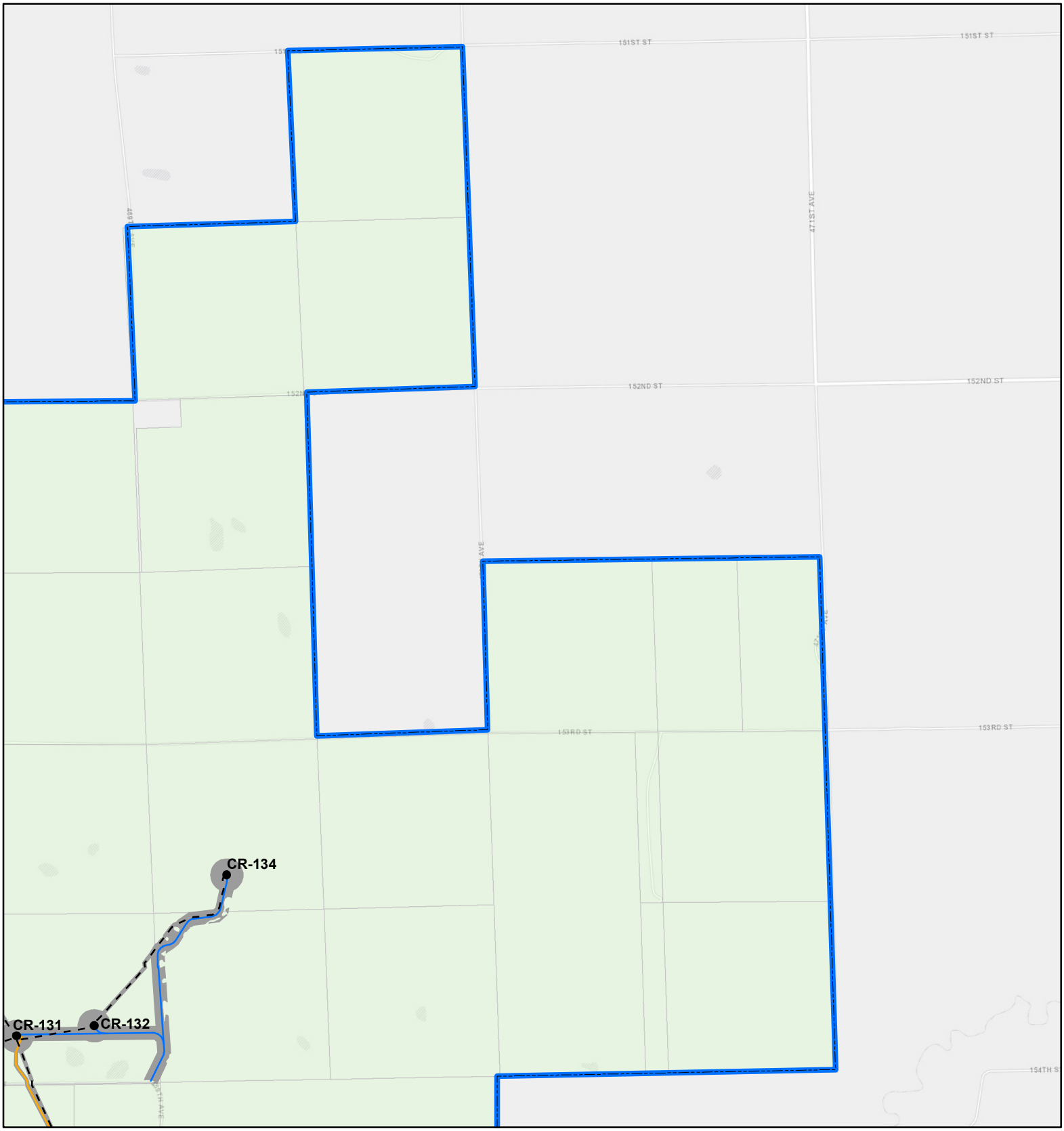
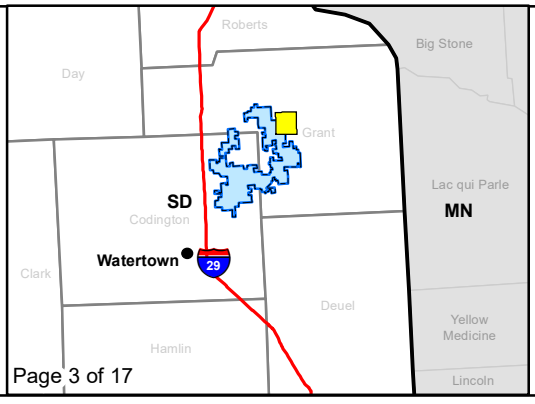


Figure 2. Project Map & Facilities

Crowned Ridge Wind Farm

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Kilometers
0 0.5 1

Miles
0 0.25 0.5

Service Layer Credits: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Quadrangle: Twin Brooks (1973)

Township/Range: T120N, R50W, T119N, R50W
Grant County, South Dakota

000152

Projection: NAD 1983 UTM Zone 14N

SWCA ENVIRONMENTAL CONSULTANTS

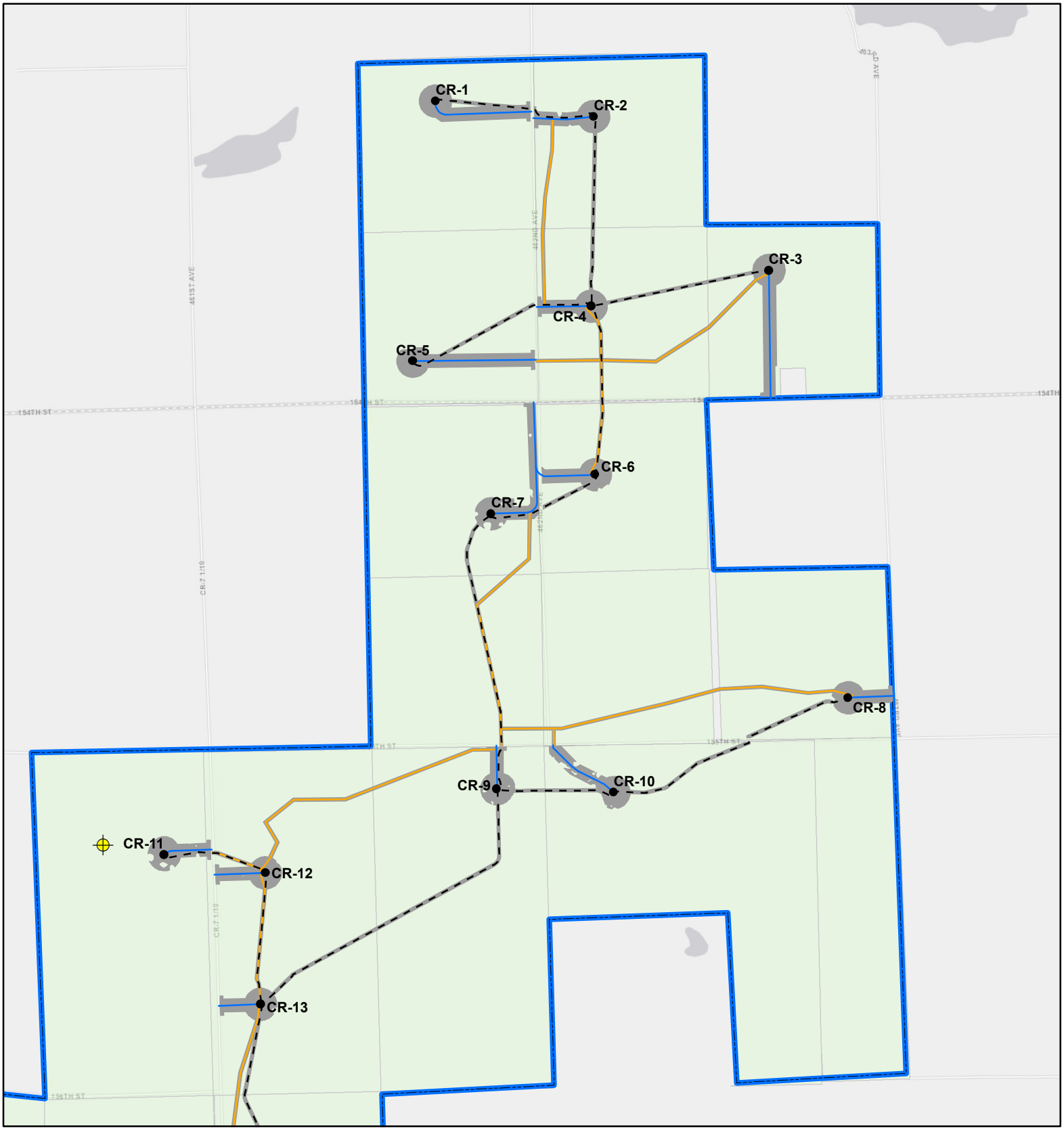
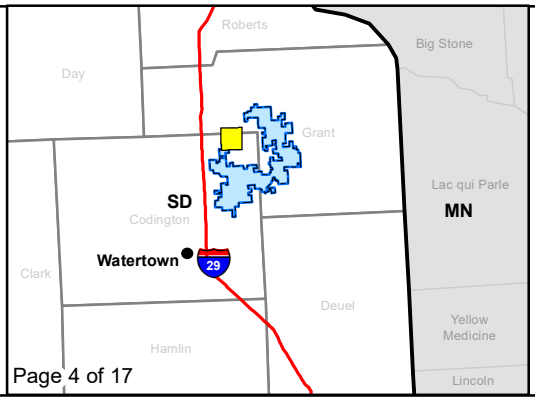


Figure 2. Project Map & Facilities

Crowned Ridge Wind Farm

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Kilometers
0 0.5 1

Miles
0 0.25 0.5

Service Layer Credits: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Quadrangle: Antelope Valley (1973), South Shore (1973)
Township/Range: T120N, R51W, T119N, R51W,
Codington and Grant Counties, South Dakota

000153

Projection: NAD 1983 UTM Zone 14N

SWCA ENVIRONMENTAL CONSULTANTS

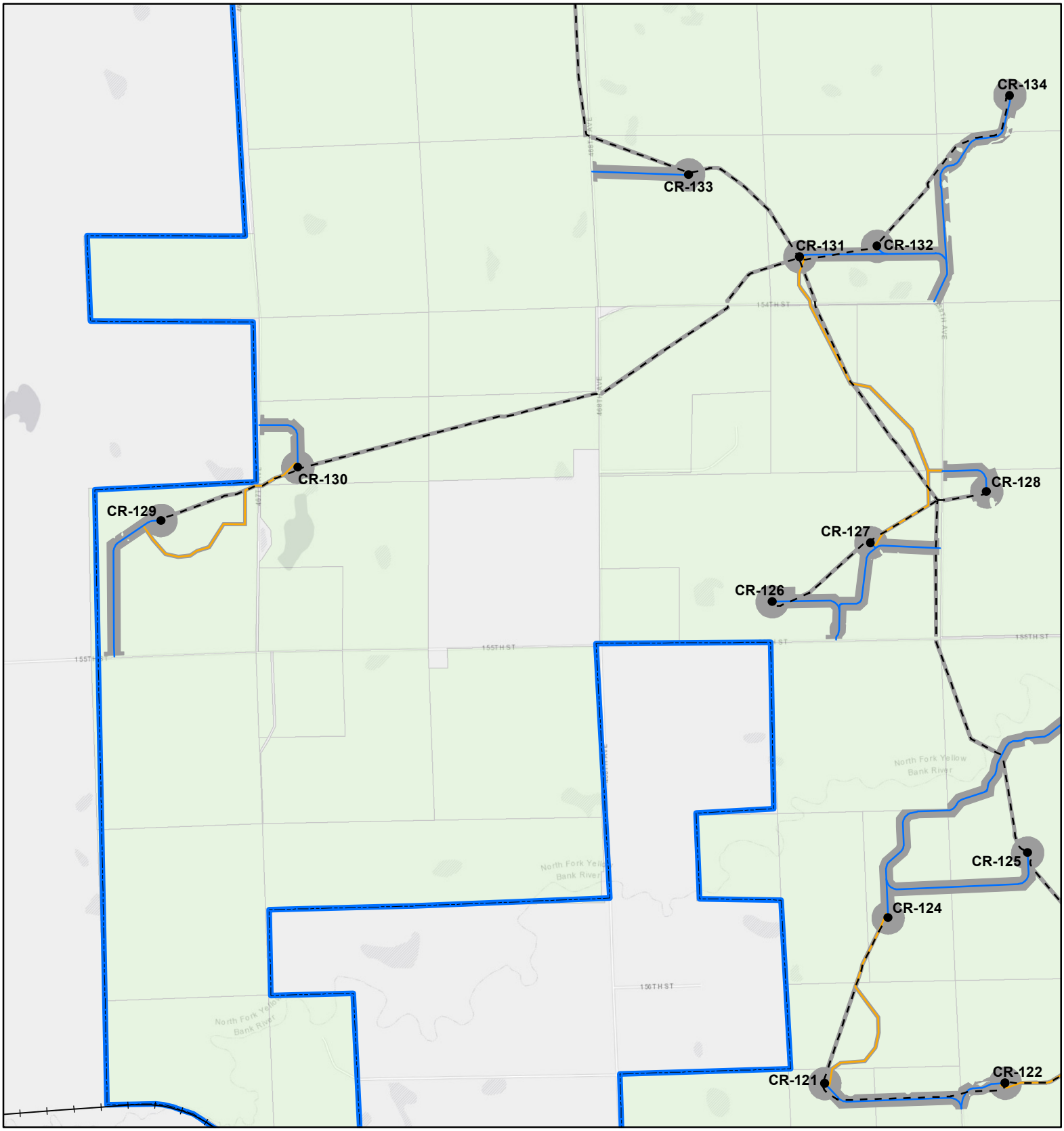
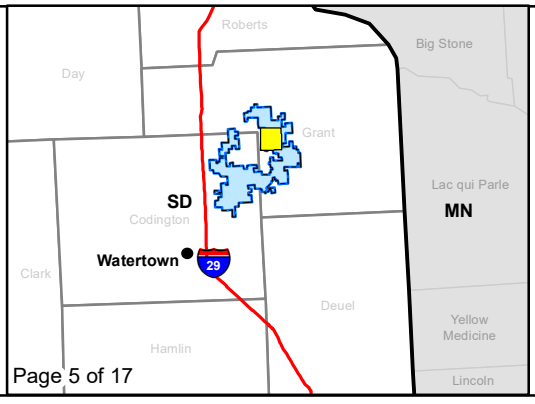


Figure 2. Project Map & Facilities

Crowned Ridge Wind Farm

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Kilometers
0 0.5 1

Miles
0 0.25 0.5

Service Layer Credits: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Quadrangle: Twin Brooks (1973), Stockholm (1973)
Township/Range: T120N, R50W
T119N, R50W
Grant County, South Dakota

000154

Projection: NAD 1983 UTM Zone 14N

SWCA ENVIRONMENTAL CONSULTANTS

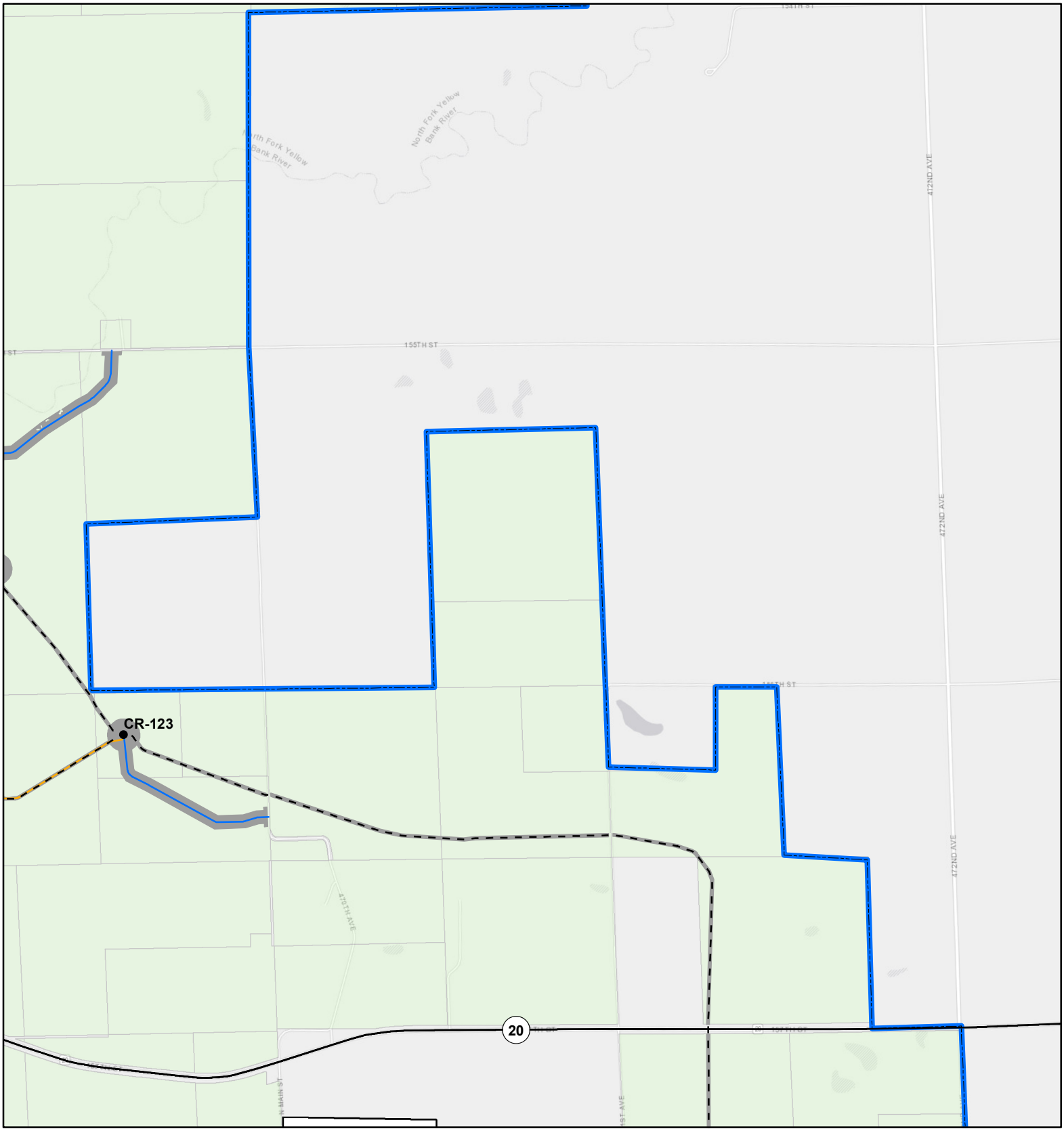
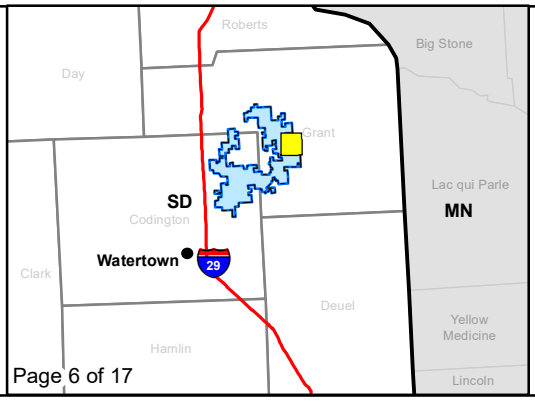


Figure 2. Project Map & Facilities

Crowned Ridge Wind Farm

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Kilometers
0 0.5 1

Miles
0 0.25 0.5

Service Layer Credits: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Quadrangle: Twin Brooks (1973), Stockholm (1973)
Township/Range: T119N, R50W

Grant County, South Dakota

Projection: NAD 1983 UTM Zone 14N

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SWCA ENVIRONMENTAL CONSULTANTS

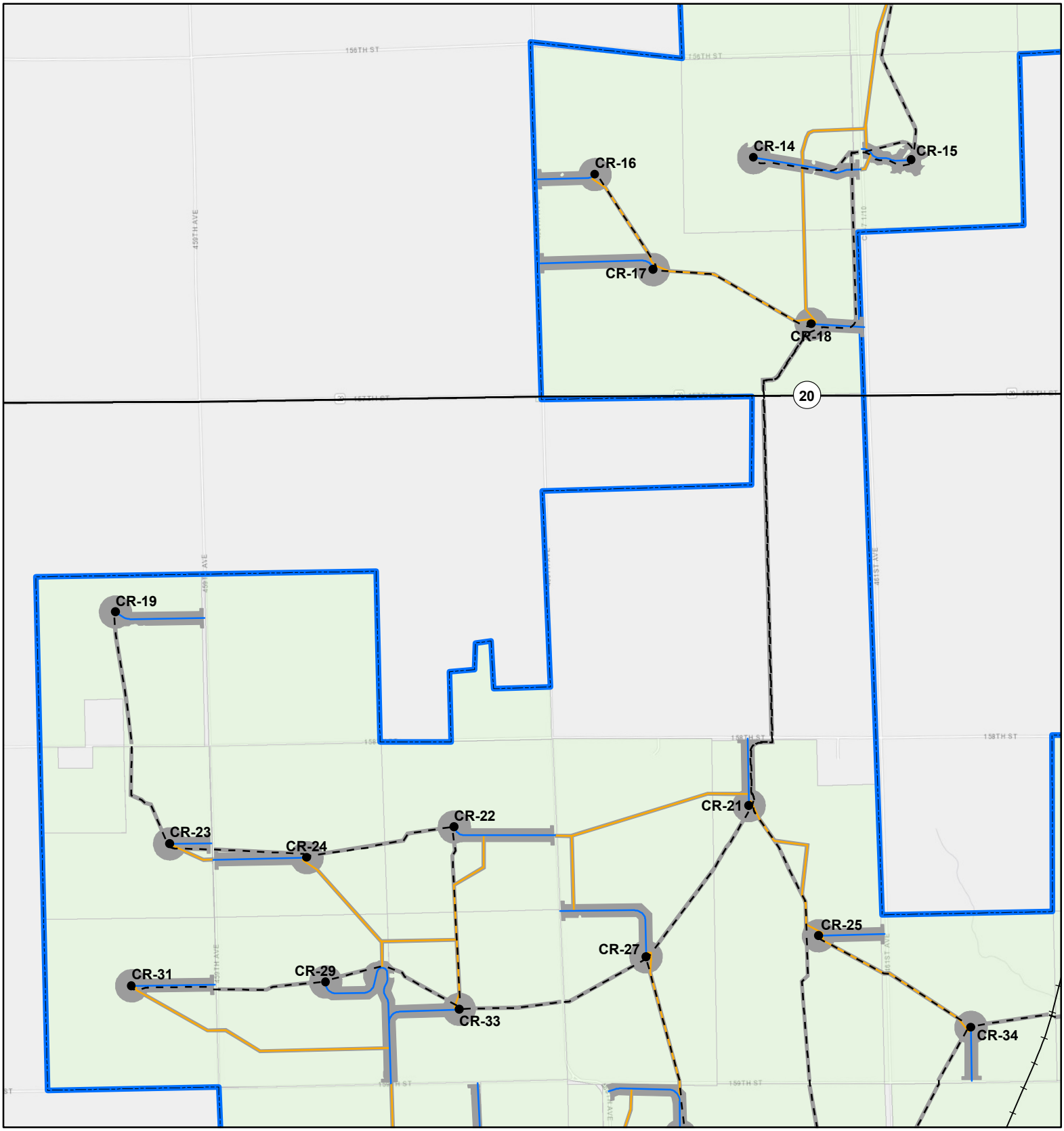
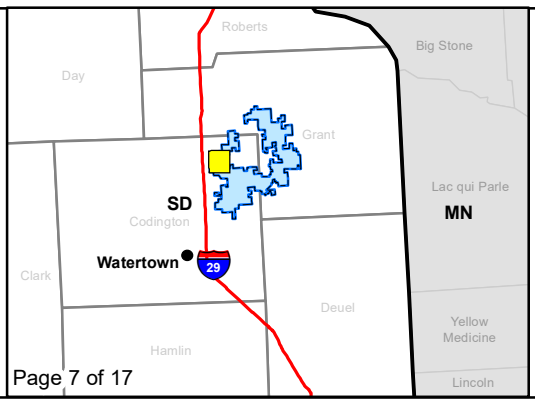


Figure 2. Project Map & Facilities

Crowned Ridge Wind Farm

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Kilometers
0 0.5 1

Miles
0 0.25 0.5

Service Layer Credits: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Quadrangle: Still Lake SE (1970), South Shore (1973)
Township/Range: T119N, R52W, T119N, R51W,
Codington County, South Dakota

Projection: NAD 1983 UTM Zone 14N

000156

SWCA ENVIRONMENTAL CONSULTANTS

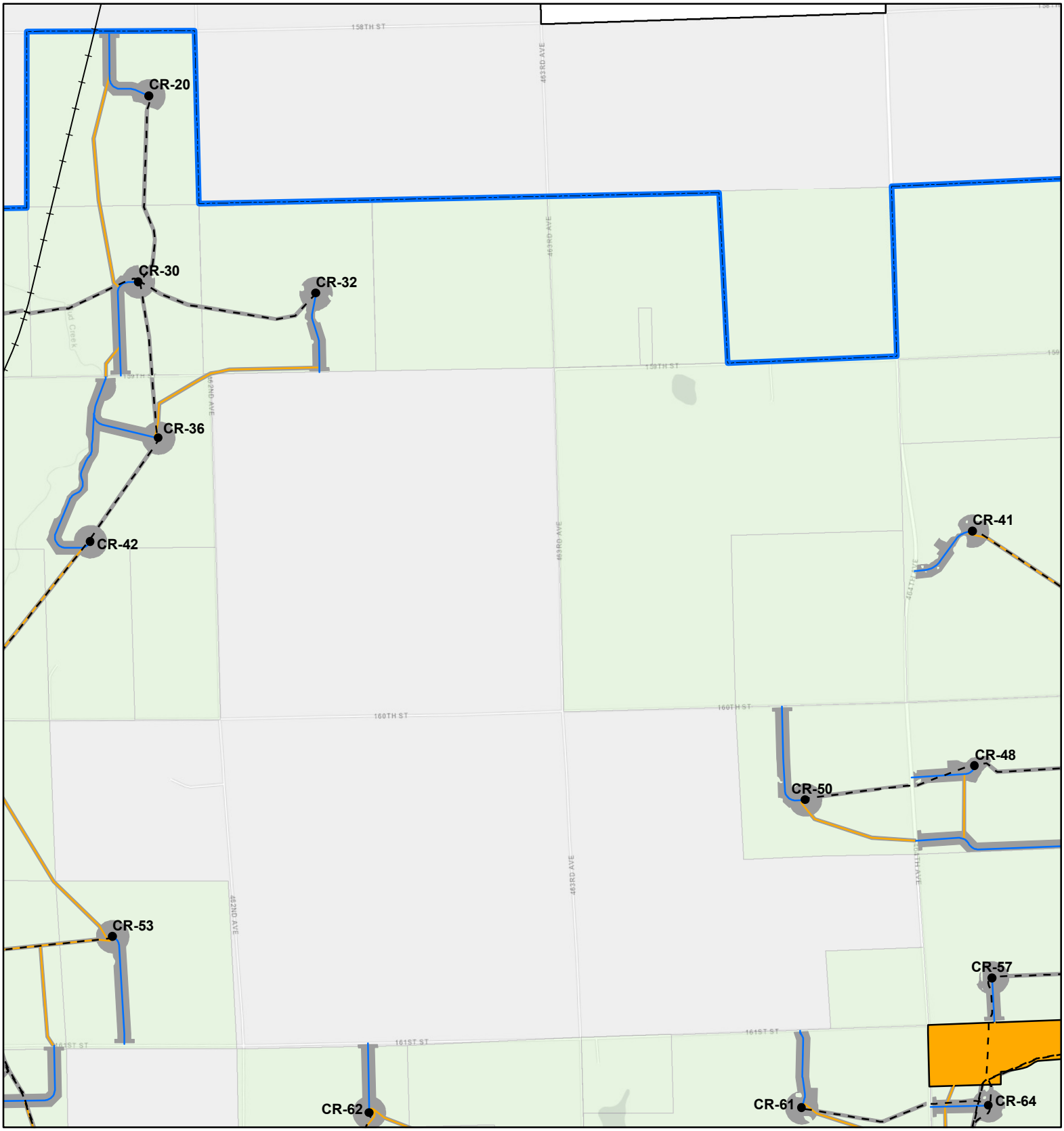
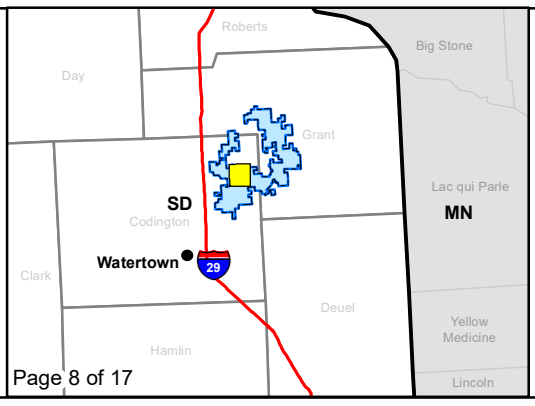


Figure 2. Project Map & Facilities

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Kilometers
0 0.5 1

Miles
0 0.25 0.5

Service Layer Credits: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Quadrangle: South Shore (1973)

Township/Range: T119N, R51W, T118N, R51W
Codington County, South Dakota

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Projection: NAD 1983 UTM Zone 14N

SWCA ENVIRONMENTAL CONSULTANTS

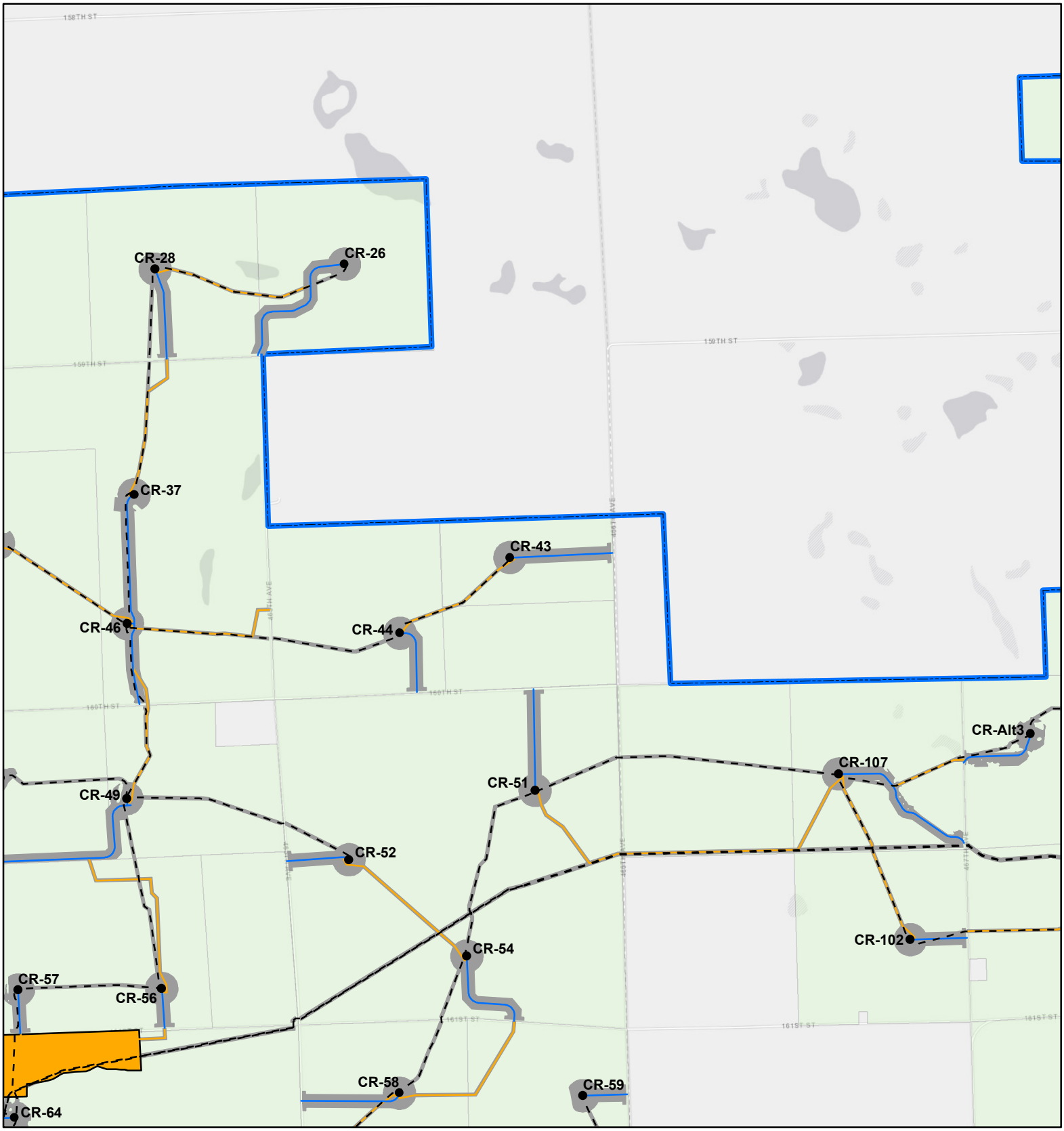
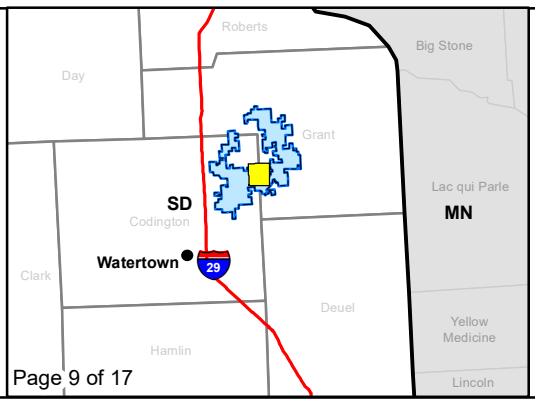


Figure 2. Project Map & Facilities

Crowned Ridge Wind Farm

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Kilometers
0 0.5 1

Miles
0 0.25 0.5

N W E S

Service Layer Credits: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Quadrangle: South Shore (1973), Stockholm (1973)
Township/Range: T119N, R51W, T119N, R50W, T118N, R51W, T118N, R50W
Codington and Grant Counties, South Dakota

000158

Projection: NAD 1983 UTM Zone 14N

SWCA ENVIRONMENTAL CONSULTANTS

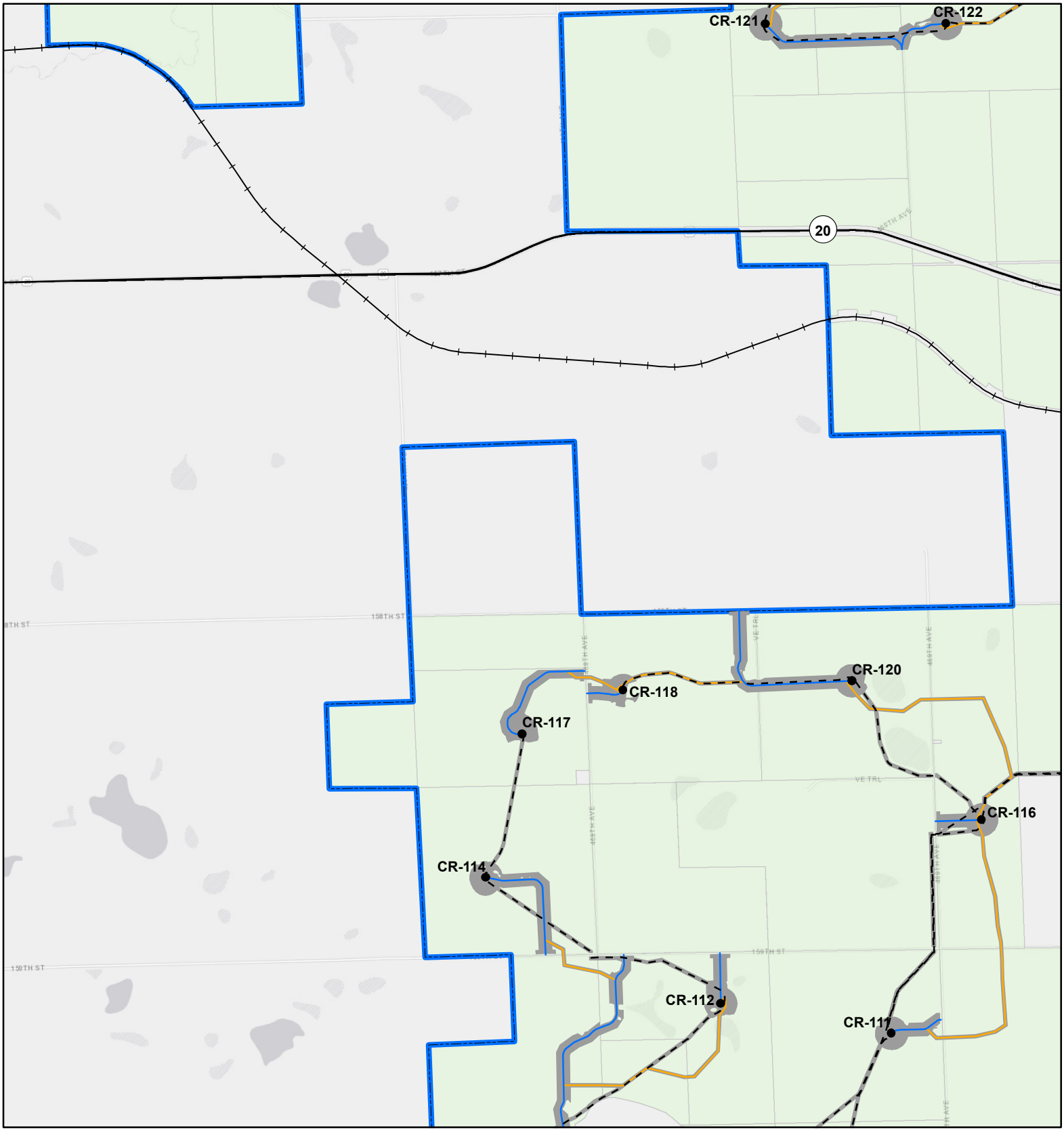
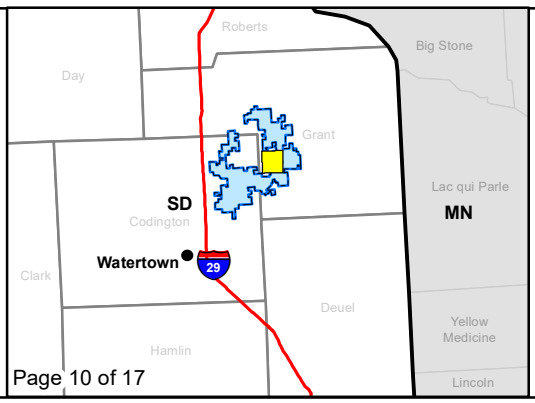


Figure 2. Project Map & Facilities

Crowned Ridge Wind Farm

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Kilometers
0 0.5 1

Miles
0 0.25 0.5

Service Layer Credits: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Quadrangle: Stockholm (1973)

Township/Range: T119N, R50W

Grant County, South Dakota

000159

Projection: NAD 1983 UTM Zone 14N

SWCA ENVIRONMENTAL CONSULTANTS

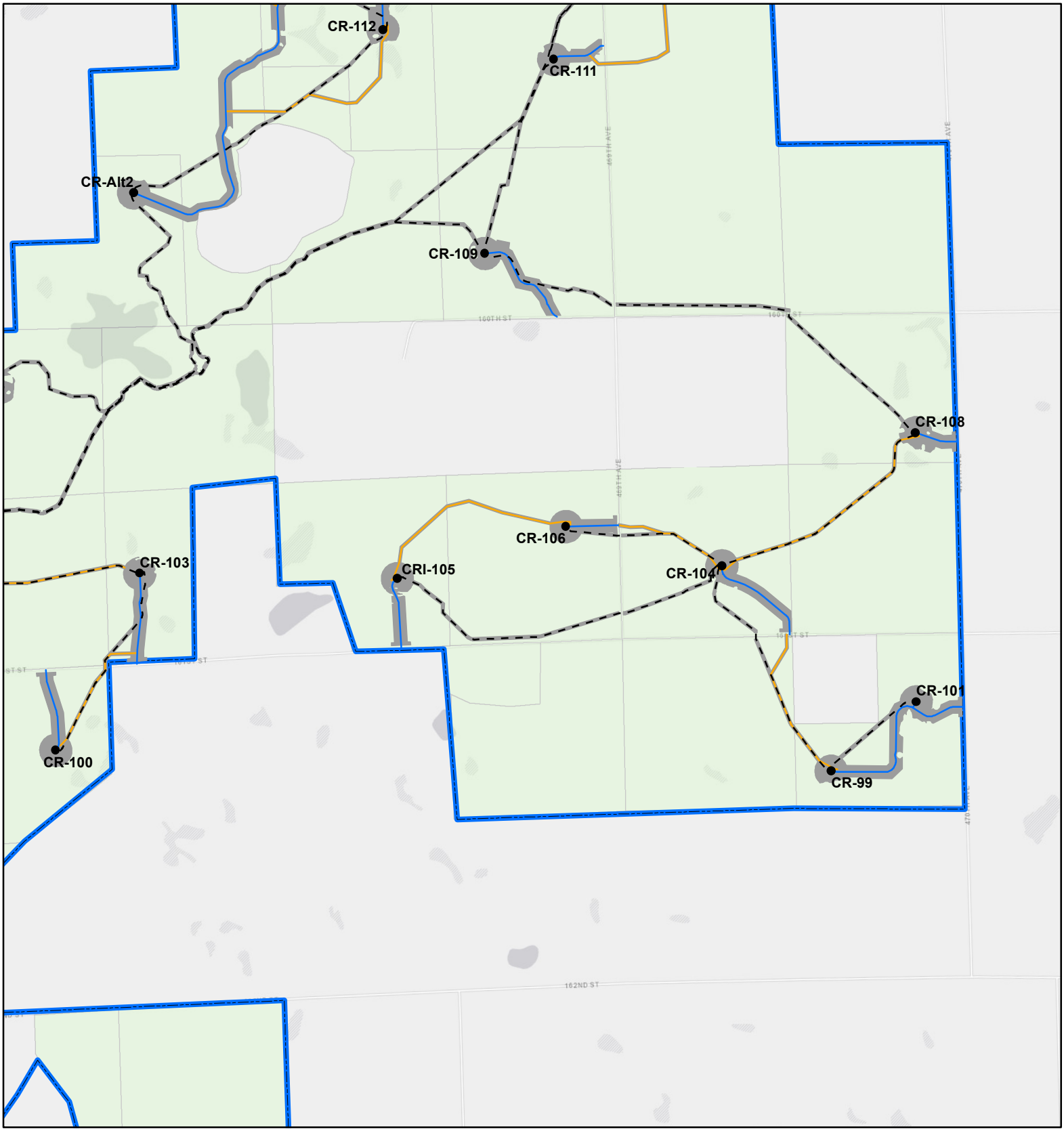
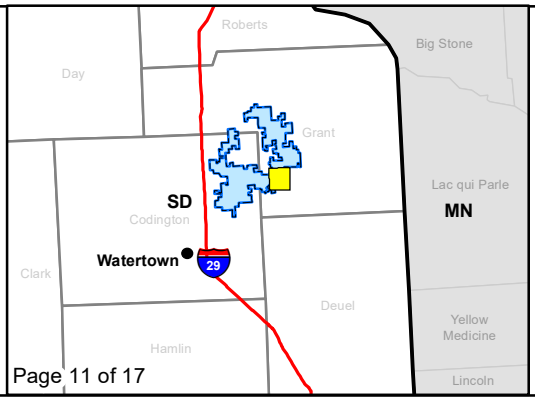


Figure 2. Project Map & Facilities

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Kilometers
0 0.5 1

Miles
0 0.25 0.5

Service Layer Credits: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Quadrangle: Stockholm (1973)

Township/Range: T119N, R50W, T118N, R50W
Grant County, South Dakota

000160

Projection: NAD 1983 UTM Zone 14N

SWCA ENVIRONMENTAL CONSULTANTS

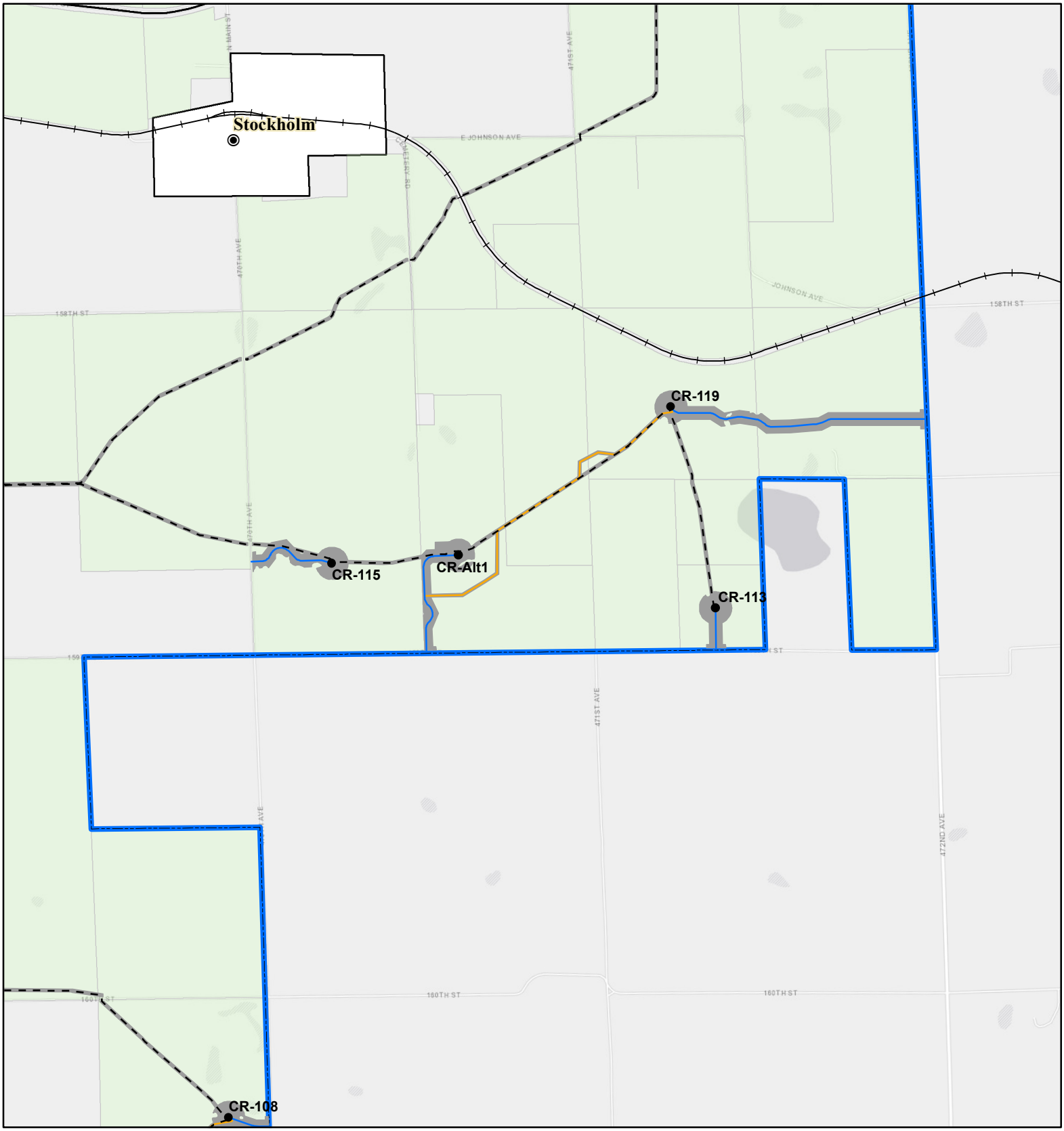
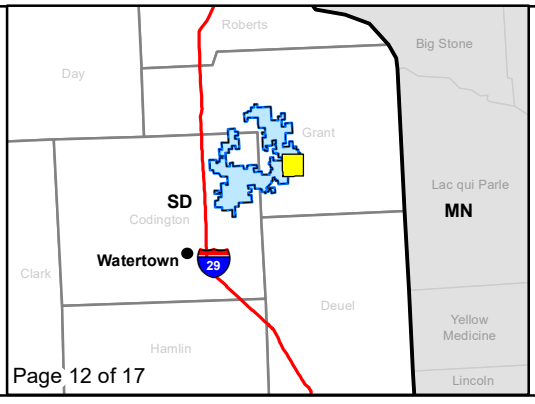


Figure 2. Project Map & Facilities

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Kilometers
0 0.5 1

Miles
0 0.25 0.5

N W E S

Service Layer Credits: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Quadrangle: Stockholm (1973)

Township/Range: T119N, R50W, T118N, R50W
Grant County, South Dakota

000161

SWCA ENVIRONMENTAL CONSULTANTS

Projection: NAD 1983 UTM Zone 14N

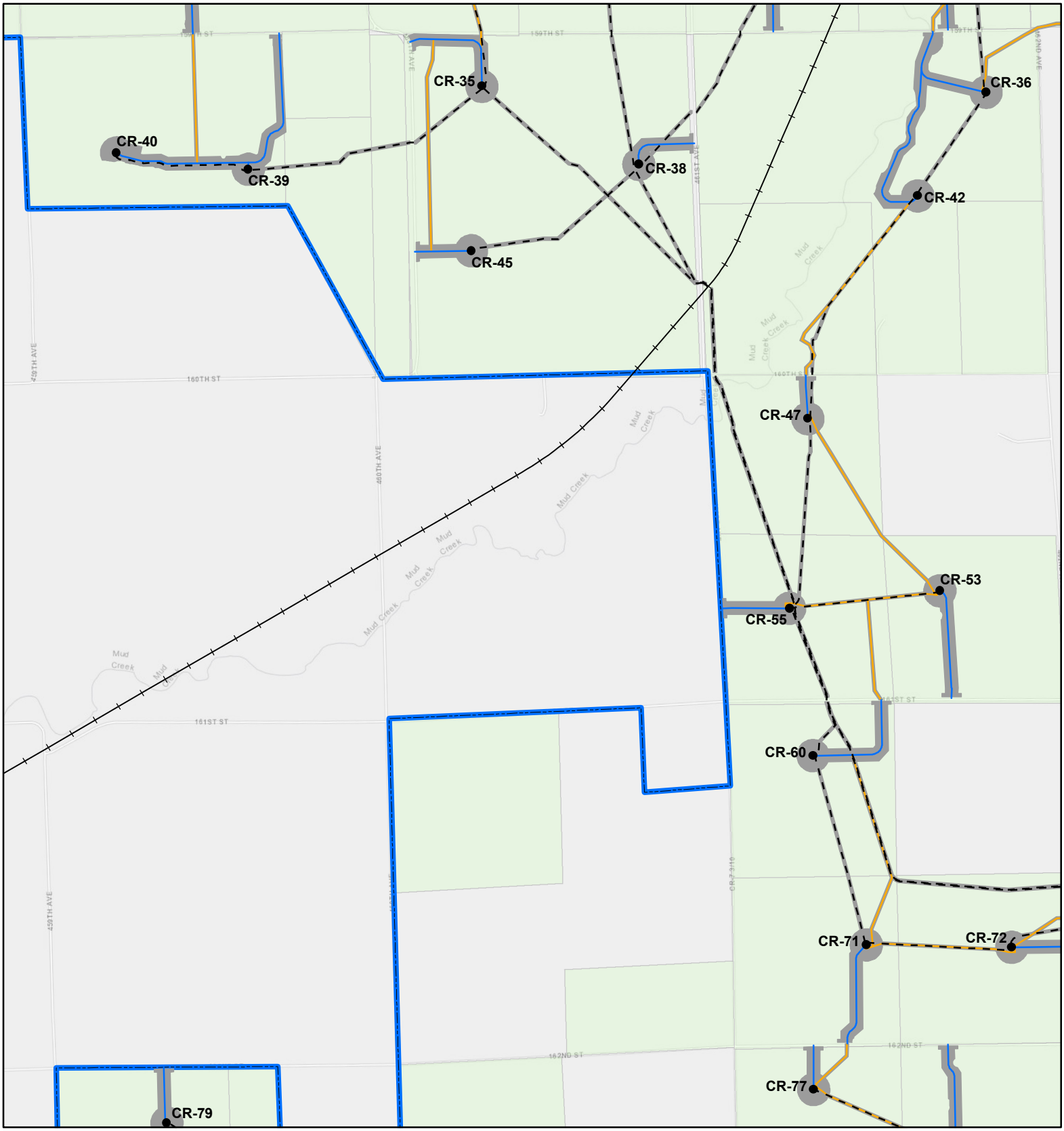
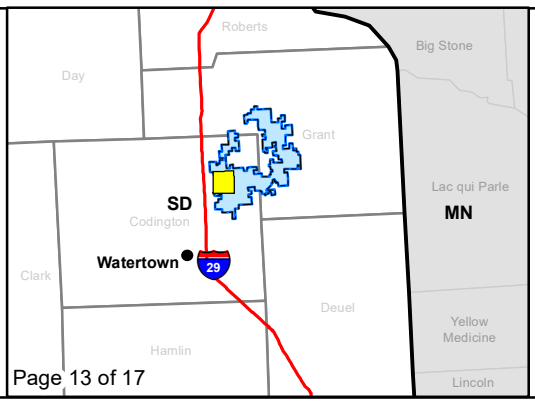


Figure 2. Project Map & Facilities

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Kilometers
0 0.5 1

Miles
0 0.25 0.5

N W E S

Service Layer Credits: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Quadrangle: Still Lake SE (1970), South Shore (1973)
Township/Range: T119N, R52W, T119N, R51W, T118N, R52W, T118N, R51W
Codington County, South Dakota

000162

Projection: NAD 1983 UTM Zone 14N

SWCA ENVIRONMENTAL CONSULTANTS

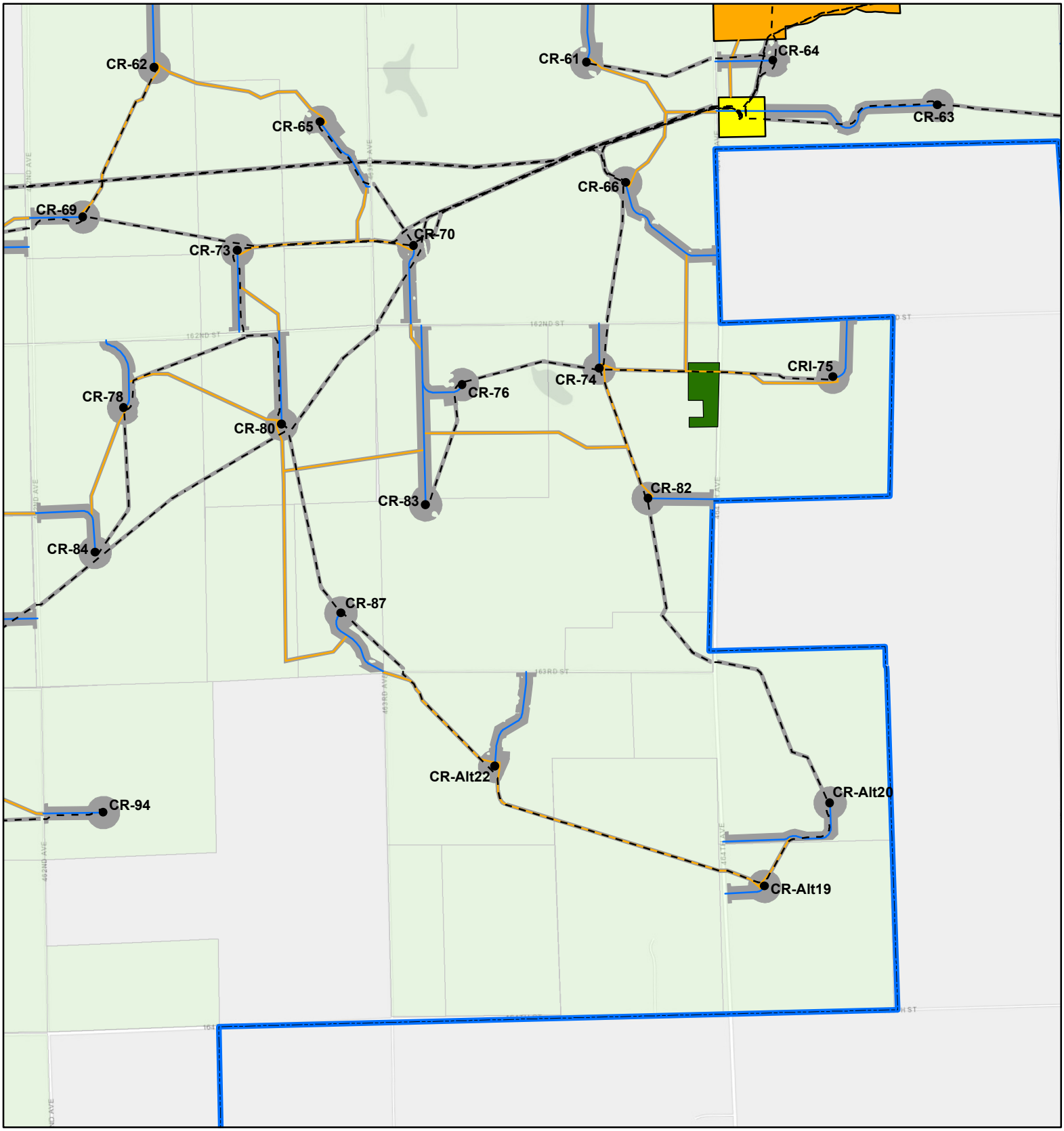
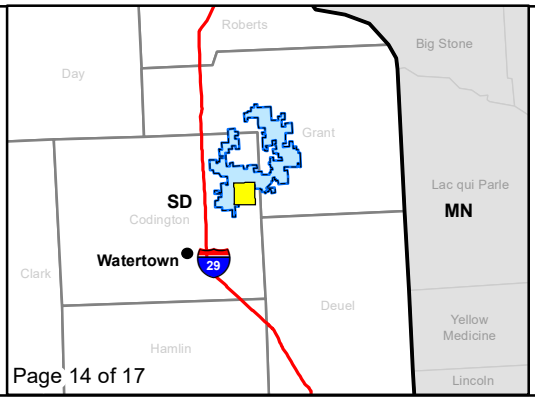


Figure 2. Project Map & Facilities

Crowned Ridge Wind Farm

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Kilometers
0 0.5 1

Miles
0 0.25 0.5

Service Layer Credits: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Quadrangle: South Shore (1973)

Township/Range: T118N, R51W

Codington County, South Dakota

Projection: NAD 1983 UTM Zone 14N

000163

SWCA ENVIRONMENTAL CONSULTANTS

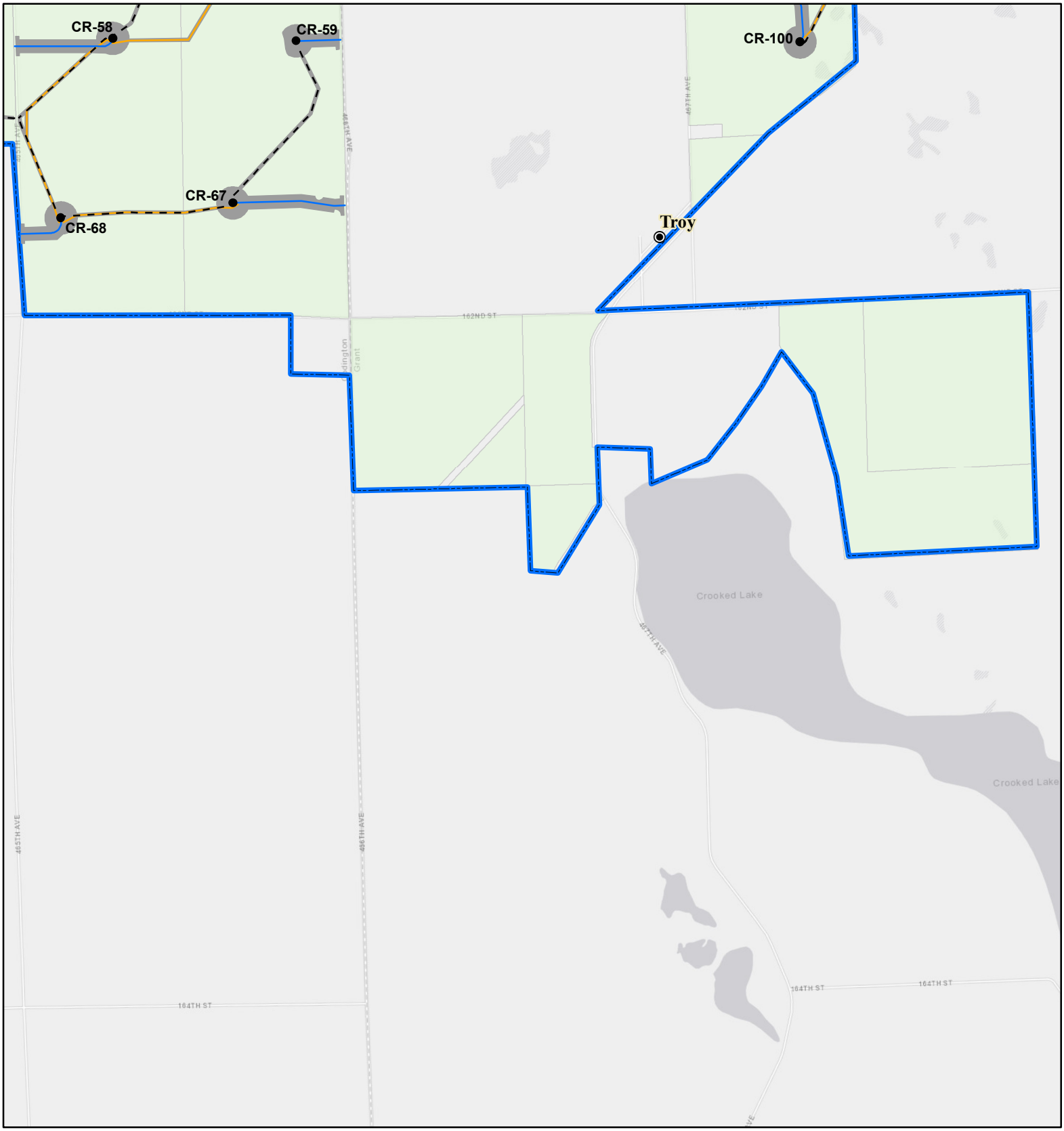
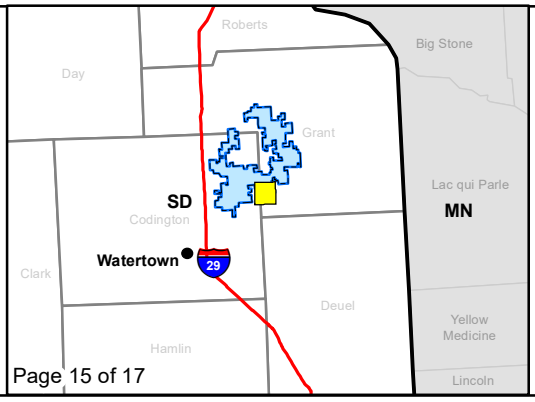


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Kilometers
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Miles
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Quadrangle: South Shore (1973), Stockholm (1973)
Township/Range: T118N, R51W, T118N, R50W
Codington and Grant Counties, South Dakota

000164

Projection: NAD 1983 UTM Zone 14N

SWCA ENVIRONMENTAL CONSULTANTS

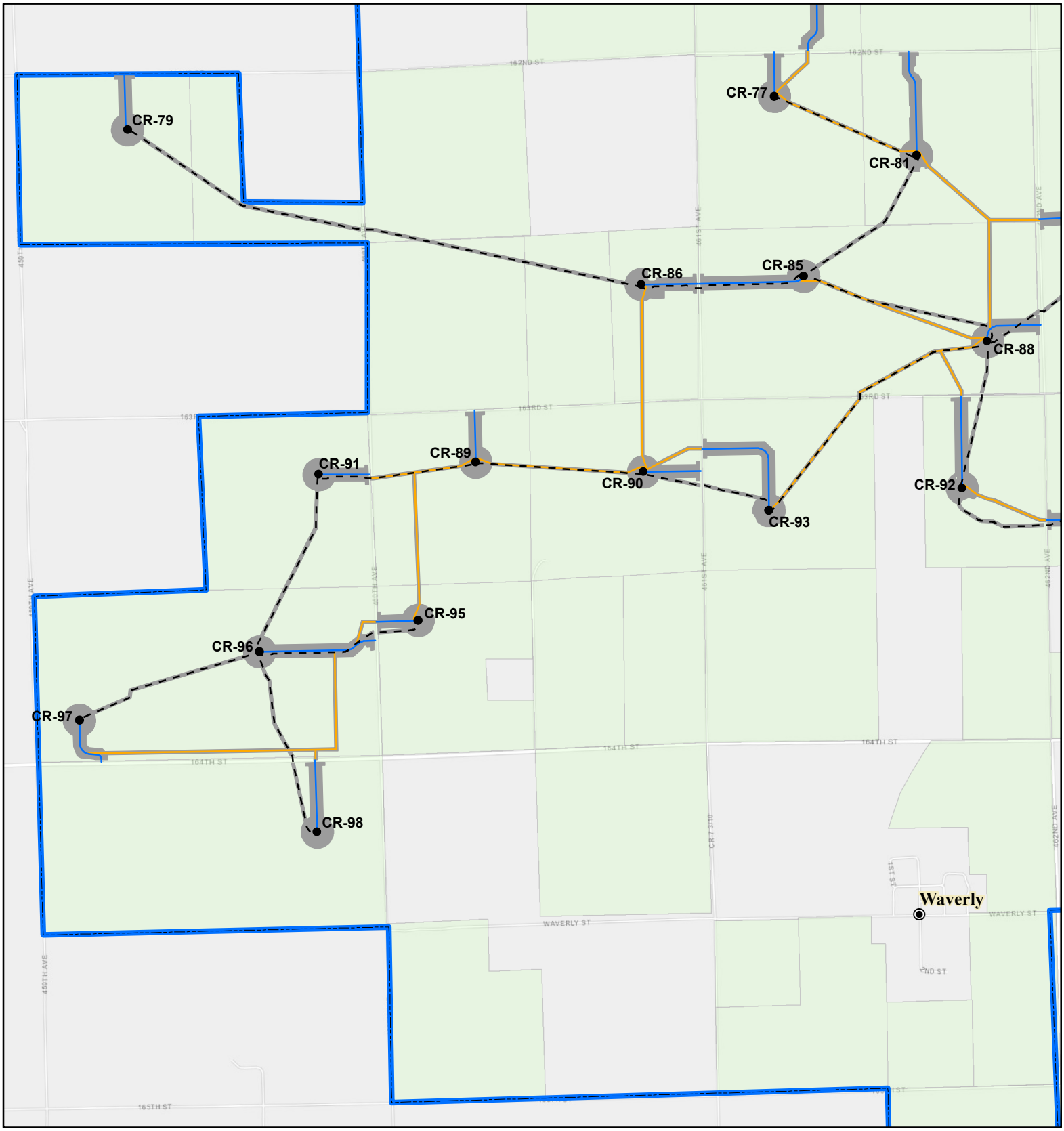
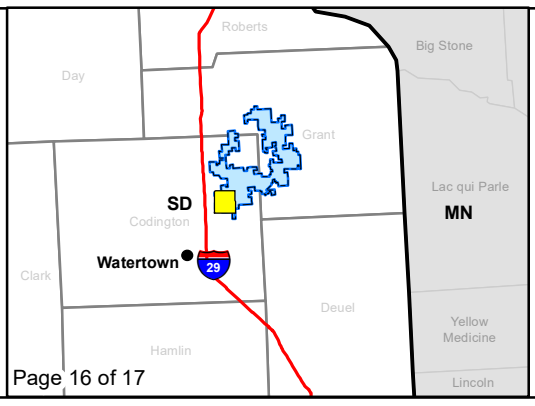


Figure 2. Project Map & Facilities

Crowned Ridge Wind Farm

- Turbine
- MET Tower
- City
- Railroad
- Collector Line
- Proposed Turbine Access Road
- Crane Path
- Interstate Highway
- U.S. Highway
- State Highway
- O&M Facility/ Substation
- Construction Easement
- Batch Plant
- Laydown Yard
- Town Boundary
- Participating Landowner
- Project Boundary



Kilometers
0 0.5 1

Miles
0 0.25 0.5

Service Layer Credits: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Quadrangle: Still Lake SE (1970), South Shore (1973) Watertown East (1969), Kranzburg (1970)
Township/Range: T118N, R52W, T118N, R51W
Codington County, South Dakota

000165

Projection: NAD 1983 UTM Zone 14N

SWCA ENVIRONMENTAL CONSULTANTS

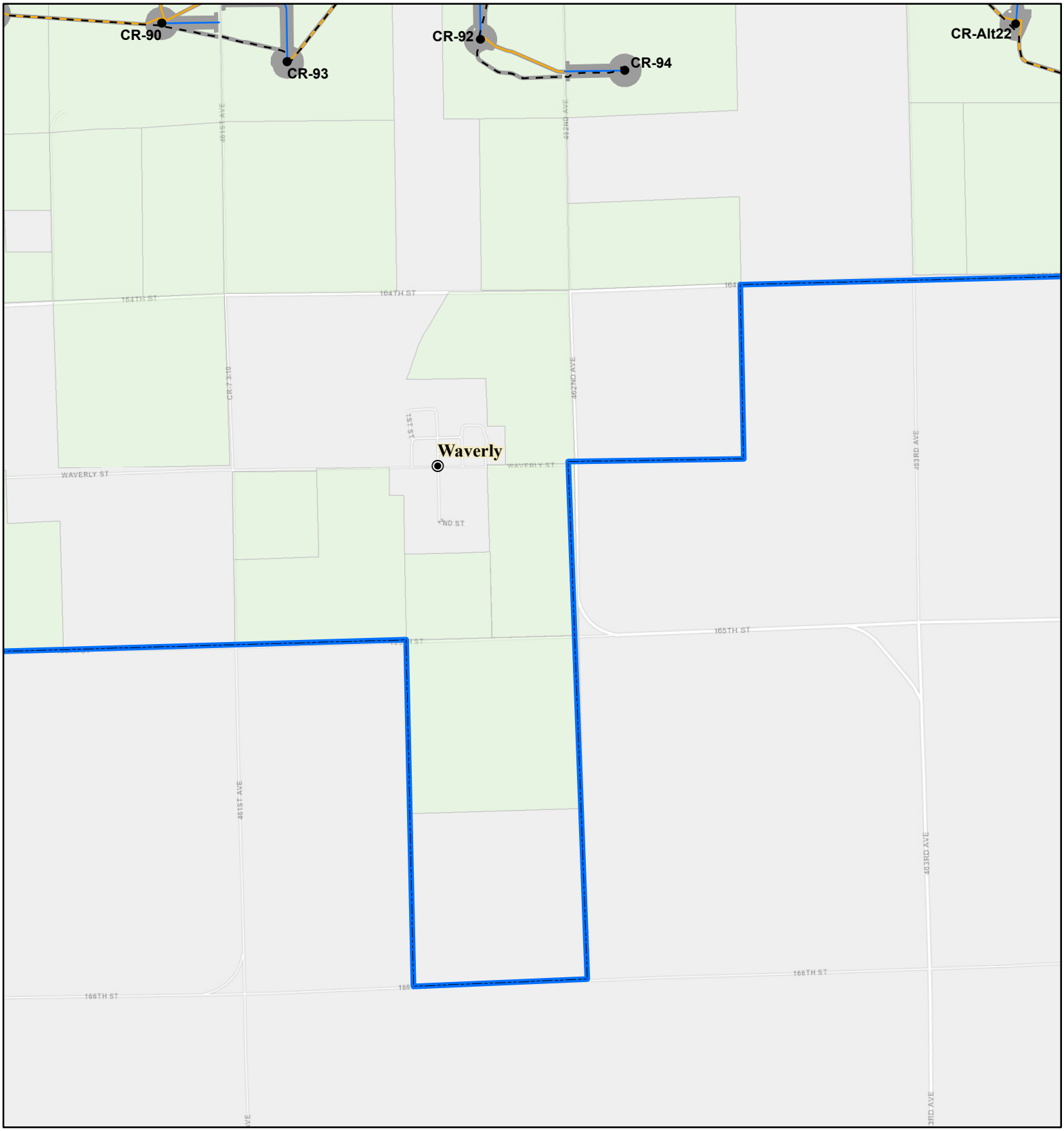
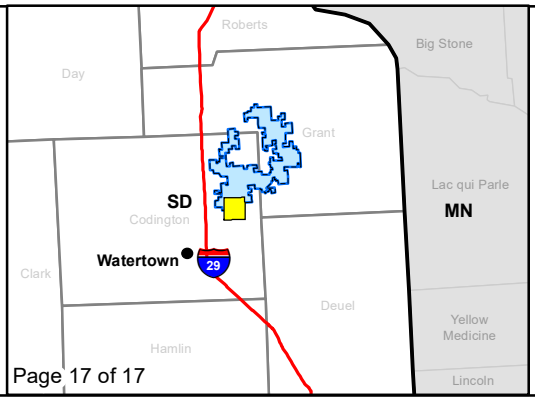


Figure 2. Project Map & Facilities

Crowned Ridge Wind Farm

- Turbine
- MET Tower
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- Construction Easement
- Batch Plant
- Laydown Yard
- Town Boundary
- Participating Landowner
- Project Boundary



Kilometers
0 0.5 1

Miles
0 0.25 0.5

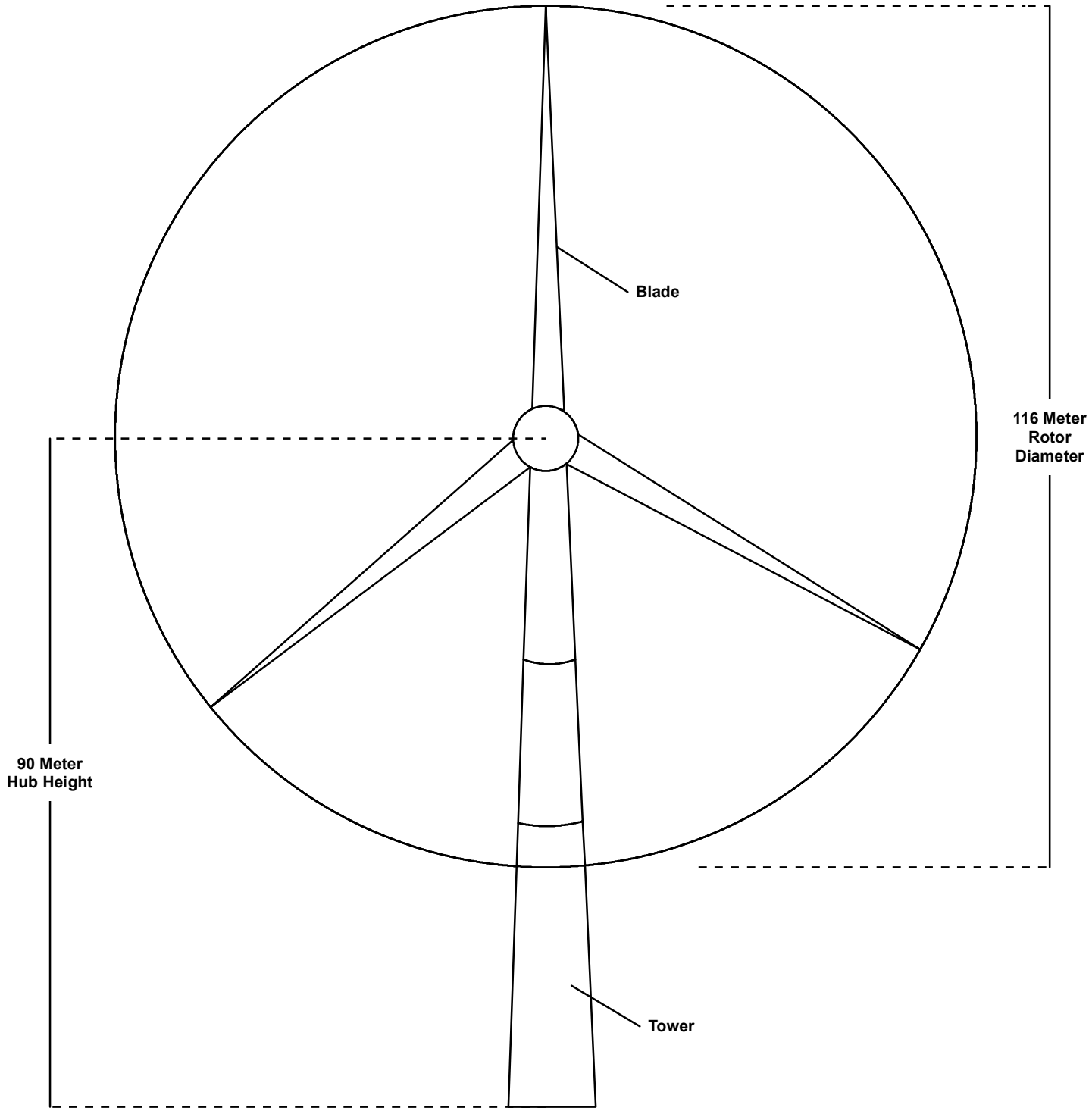
Service Layer Credits: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Quadrangle: South Shore (1973), Kranzburg (1970)
Township/Range: T118N, R51W

Codington County, South Dakota

000166

SWCA ENVIRONMENTAL CONSULTANTS

Projection: NAD 1983 UTM Zone 14N

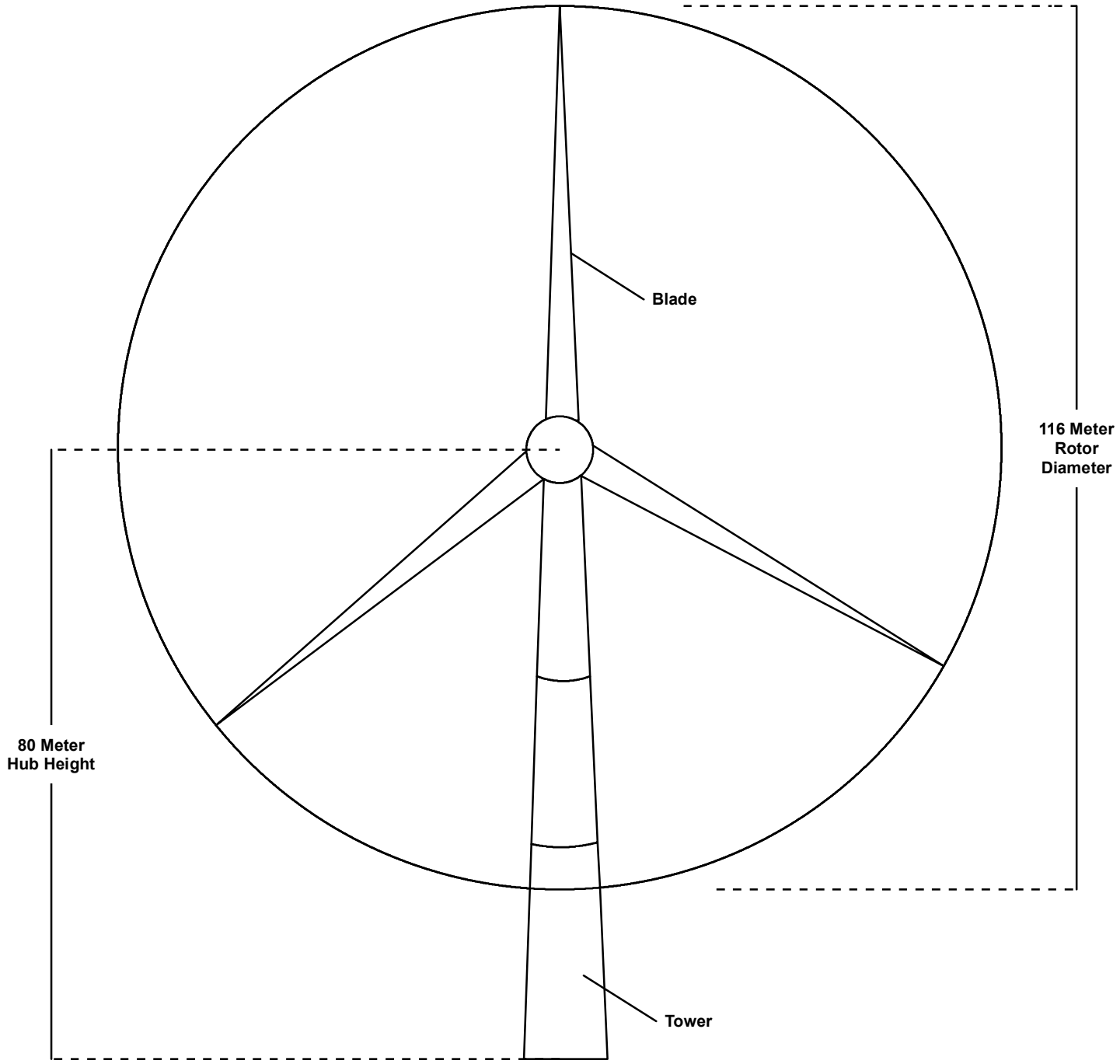


000167

Figure 4a. Typical Wind Turbine Diagram

GE 2.3 MW Turbine

SWCA ENVIRONMENTAL CONSULTANTS

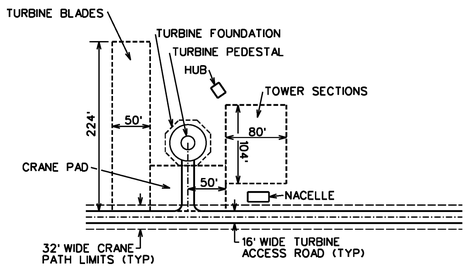


000168

Figure 4b. Typical Wind Turbine Diagram

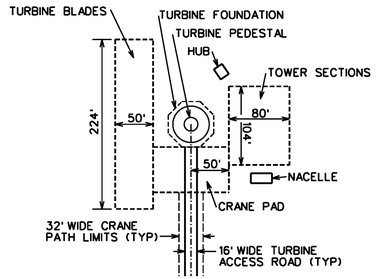
Safe Harbor
GE 2.3 MW Turbine

SWCA ENVIRONMENTAL CONSULTANTS



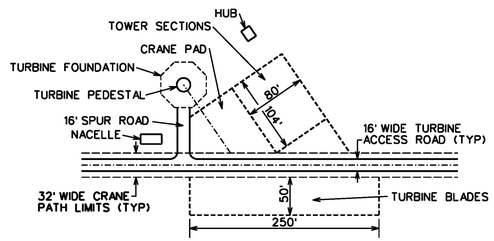
CRANE PAD LOCATIONS TO BE DETERMINED BY CONTRACTOR BASED ON FIELD CONDITIONS

TYPICAL WIND TURBINE SITE LAYOUT WITH COMPONENTS (LAYOUT 1)



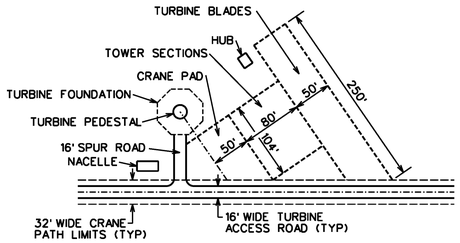
CRANE PAD LOCATIONS TO BE DETERMINED BY CONTRACTOR BASED ON FIELD CONDITIONS

TYPICAL WIND TURBINE SITE LAYOUT WITH COMPONENTS (LAYOUT 2)



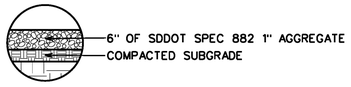
CRANE PAD LOCATIONS TO BE DETERMINED BY CONTRACTOR BASED ON FIELD CONDITIONS

TYPICAL WIND TURBINE SITE LAYOUT WITH COMPONENTS (LAYOUT 3)

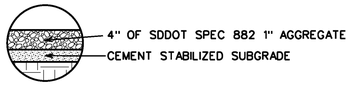


CRANE PAD LOCATIONS TO BE DETERMINED BY CONTRACTOR BASED ON FIELD CONDITIONS

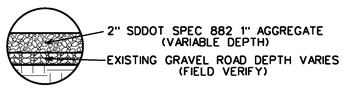
TYPICAL WIND TURBINE SITE LAYOUT WITH COMPONENTS (LAYOUT 4)



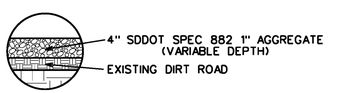
TURBINE ACCESS ROAD OPTION A



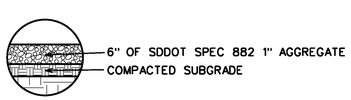
TURBINE ACCESS ROAD OPTION B



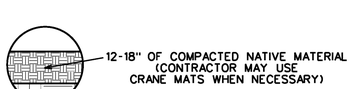
EXISTING GRAVEL ROAD UPGRADE



EXISTING DIRT ROAD UPGRADE



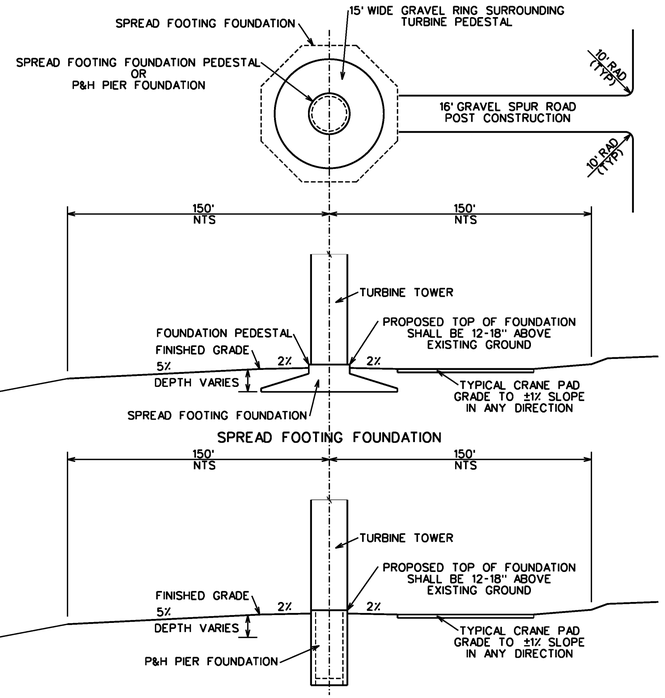
LAYDOWN YARD



CRANE PAD

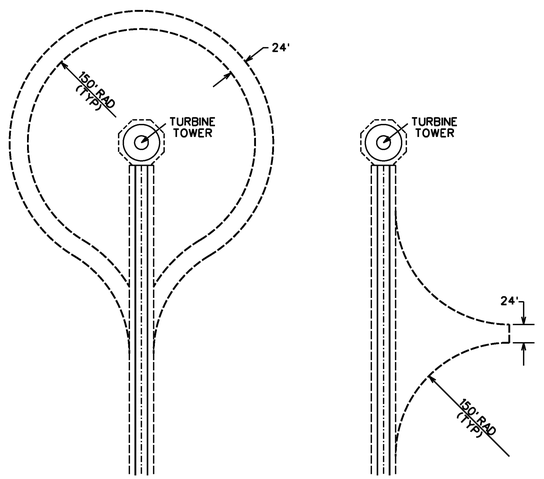
STRUCTURAL SECTIONS SHOWN ARE THE MINIMUM THICKNESS REQUIREMENTS DURING NORMAL FILED CONDITIONS. THE SECTIONS MAY NEED TO BE INCREASED BASED ON ACTUAL FIELD CONDITIONS AT THE TIME OF CONSTRUCTION. CONDITIONS INCLUDE BUT ARE NOT LIMITED TOP THE CONSTRUCTION DURING THE FREEZE/THAW CYCLE, UNUSUALLY WET PERIODS, OR IN LOW/WET AREAS.

TYPICAL CROSS SECTIONS



TYPICAL POST CONSTRUCTION DISTURBANCE AREA, FOUNDATION, SPUR ROAD FOR TURBINES AND PROFILE VIEW

FOUNDATION TYPE AND DIMENSIONS TO BE DETERMINED BY CONTRACTOR BASED ON FIELD CONDITIONS AND GEOTECH REPORT



COMPONENT DELIVERY TRUCK TURNAROUND OPTIONS

000169

ISSUE DATE: 11-19-2018

MARK	REVISION	DATE	BY
Engineer: BJF	Checked By: MCG	Scale: 1"= 100'	
Technician: DW	Date: 07-21-15	Field Bk:	Pg:

Project No: 1140140

Sheet 1 of 1

Figure 5

CROWNED RIDGE I & II, LLC

CODINGTON, DEUEL & GRANT COUNTIES, SOUTH DAKOTA

TYPICAL TURBINE CONSTRUCTION SITE LAYOUT

SNYDER & ASSOCIATES, INC.

1751 MADISON AVENUE
COUNCIL BLUFFS, IA 51503
712-322-3202 | www.snyder-associates.com

Project No: 1140140

Sheet 1 of 1

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DWEDEMEYER
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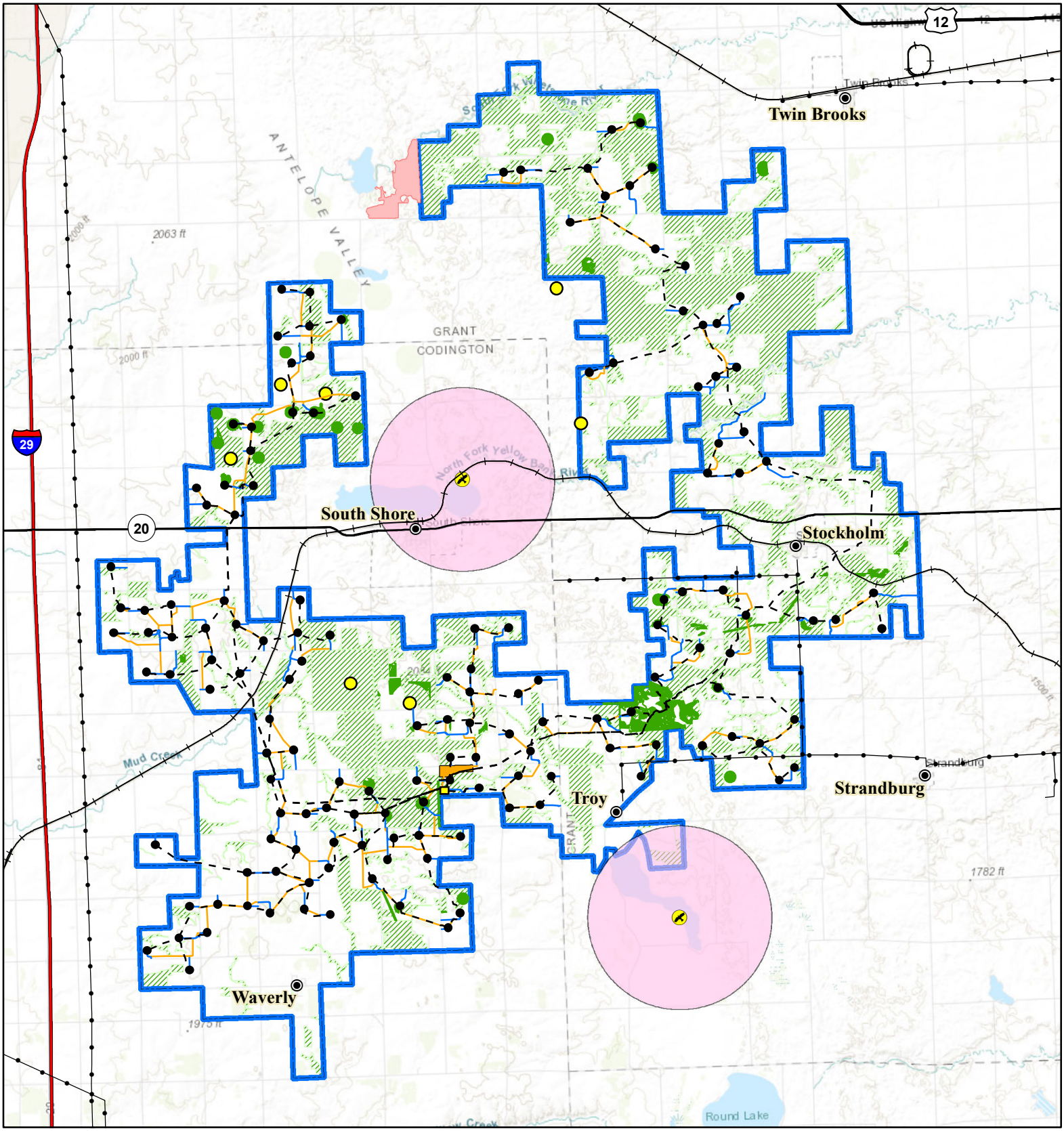


Figure 6. Environmental Constraints

Crowned Ridge Wind Farm

- Bald Eagle Nest Location
- Lek Location
- Turbine
- City
- Collector Line
- Proposed Turbine Access Road
- Crane Path
- Electrical Line
- Railroad
- Interstate Highway
- U.S. Highway
- State Highway
- O&M Facility/ Substation
- Laydown Yard
- Field Assessed Dakota Skipper Habitat
- 1.5-mile Bald Eagle Nest Buffer
- USFWS Critical Habitat
- Undisturbed Native Grasslands (Bauman 2013)
- Project Boundary

Kilometers
0 5 10

Miles
0 2.5 5

N
W E
S

Base Map: World Topographic Map
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community
Codington and Grant Counties, South Dakota

Projection: NAD 1983 UTM Zone 14N

000170

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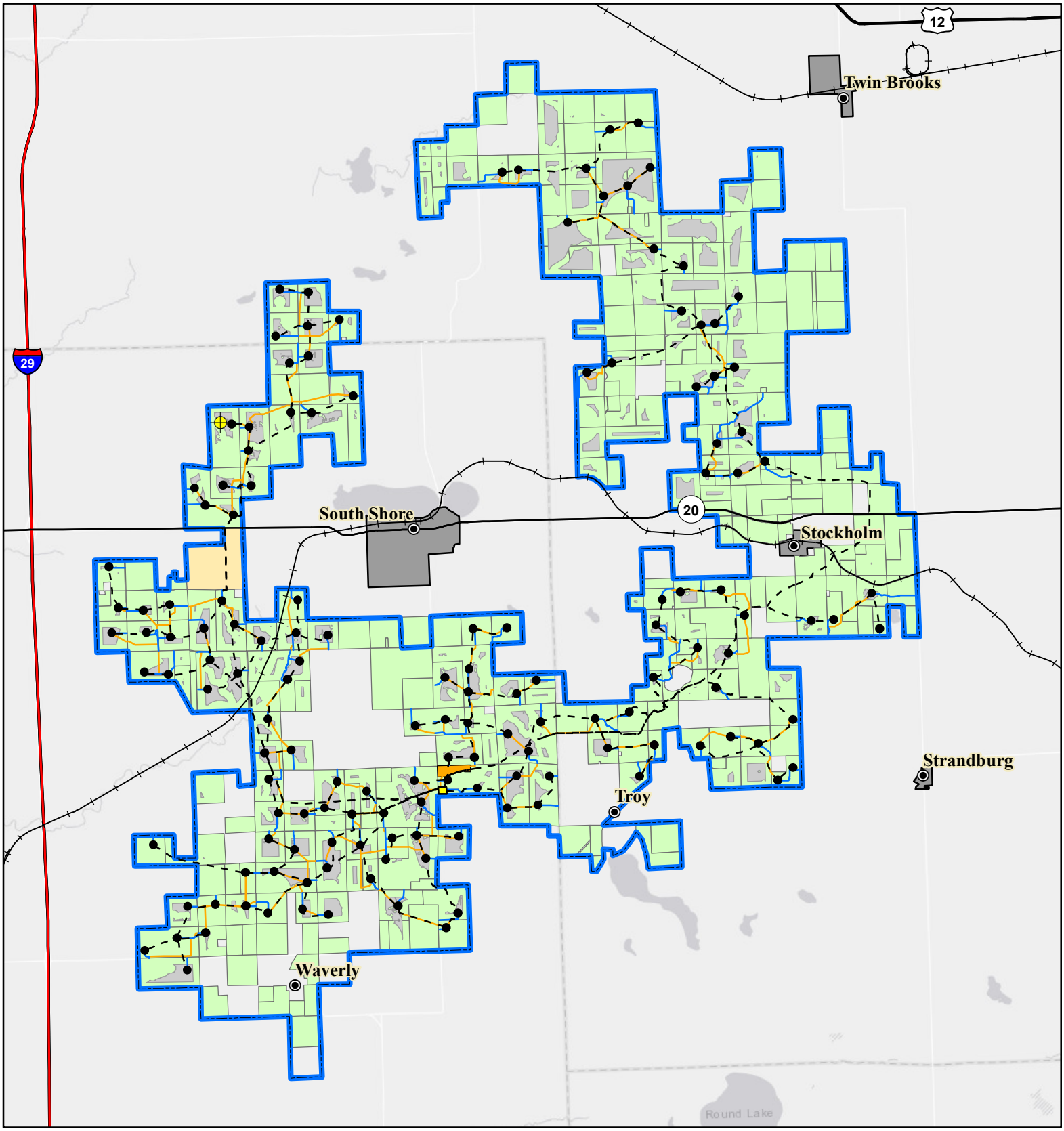


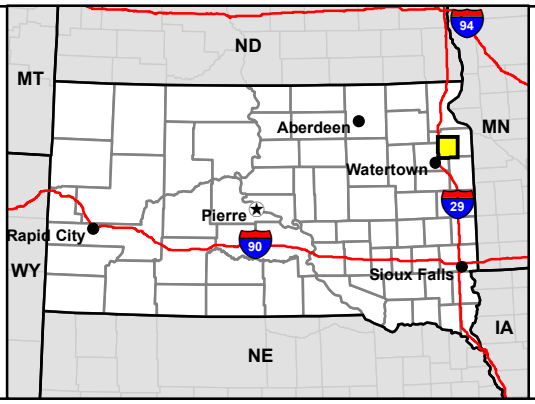
Figure 7. Constraints Map

Crowned Ridge Wind Farm

- MET Tower
- Turbine
- City
- Proposed Turbine Access Road
- Collector Line
- Crane Path
- Railroad
- Interstate Highway
- U.S. Highway
- State Highway
- O&M Facility/ Substation
- Laydown Yard
- Available Land
- Town Boundary
- Project Boundary

Lease Status

- Lease, Signed
- Pending Approval



Kilometers

0 2.5 5

Miles

0 2.5 5

Base Map: World Light Gray Canvas Base
Sources: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Codington and Grant Counties, South Dakota

000171

Projection: NAD 1983 UTM Zone 14N

SWCA ENVIRONMENTAL CONSULTANTS

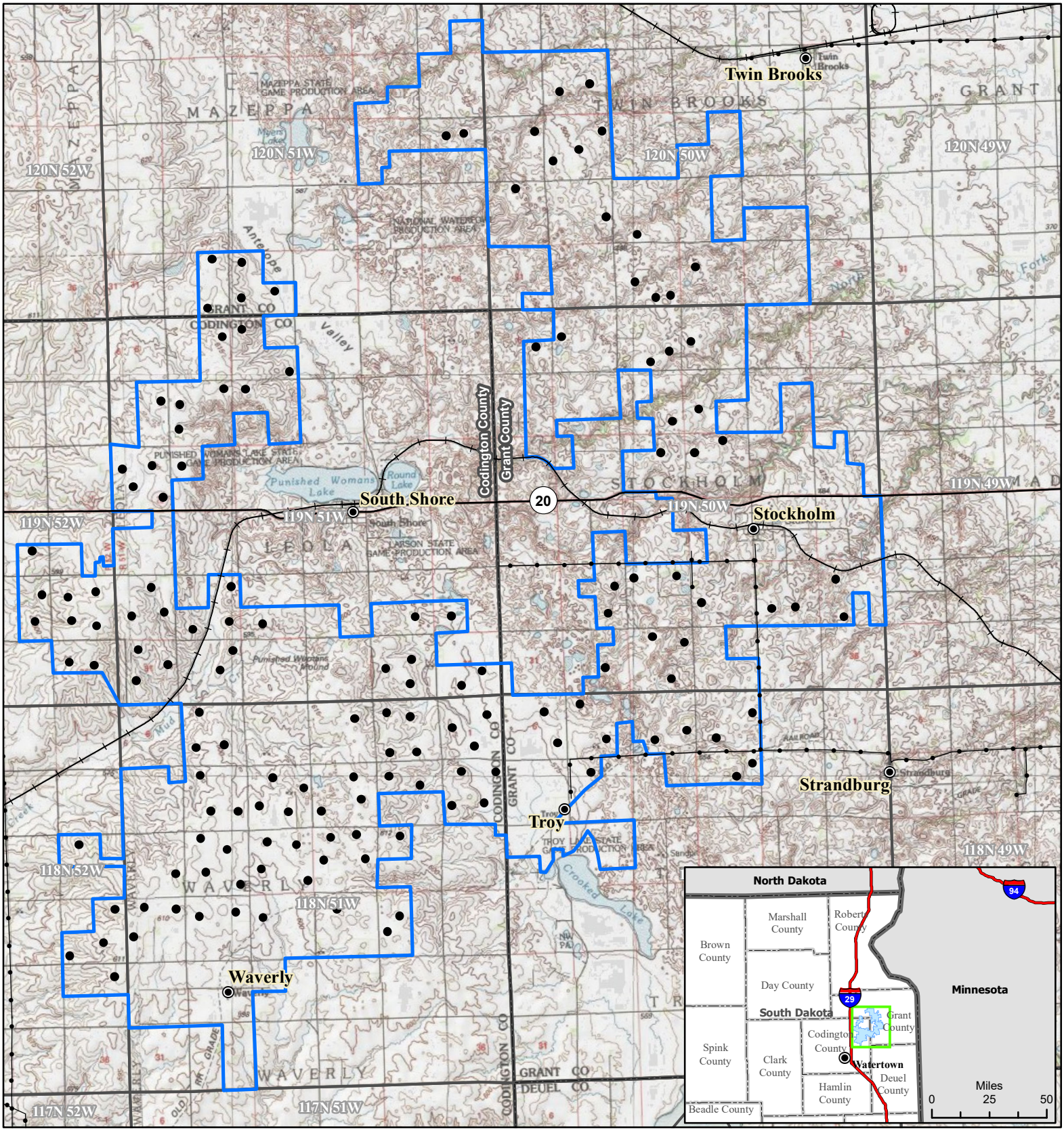


Figure 8. Topographic Map

Crowned Ridge Wind Farm

- Turbine Location
- City
- Railroad
- Electrical Line
- State Highway
- Project Boundary
- County Boundary
- Township/Range Boundary

Kilometers
0 5 10

Miles
0 2.5 5

N
W E
S

Base Map: USGS 7.5' Topographic Map
Source: Copyright: ©2014 National Geographic Society, i-cubed
Codington and Grant Counties, South Dakota

000172

Projection: NAD 1983 UTM Zone 14N

SWCA ENVIRONMENTAL CONSULTANTS

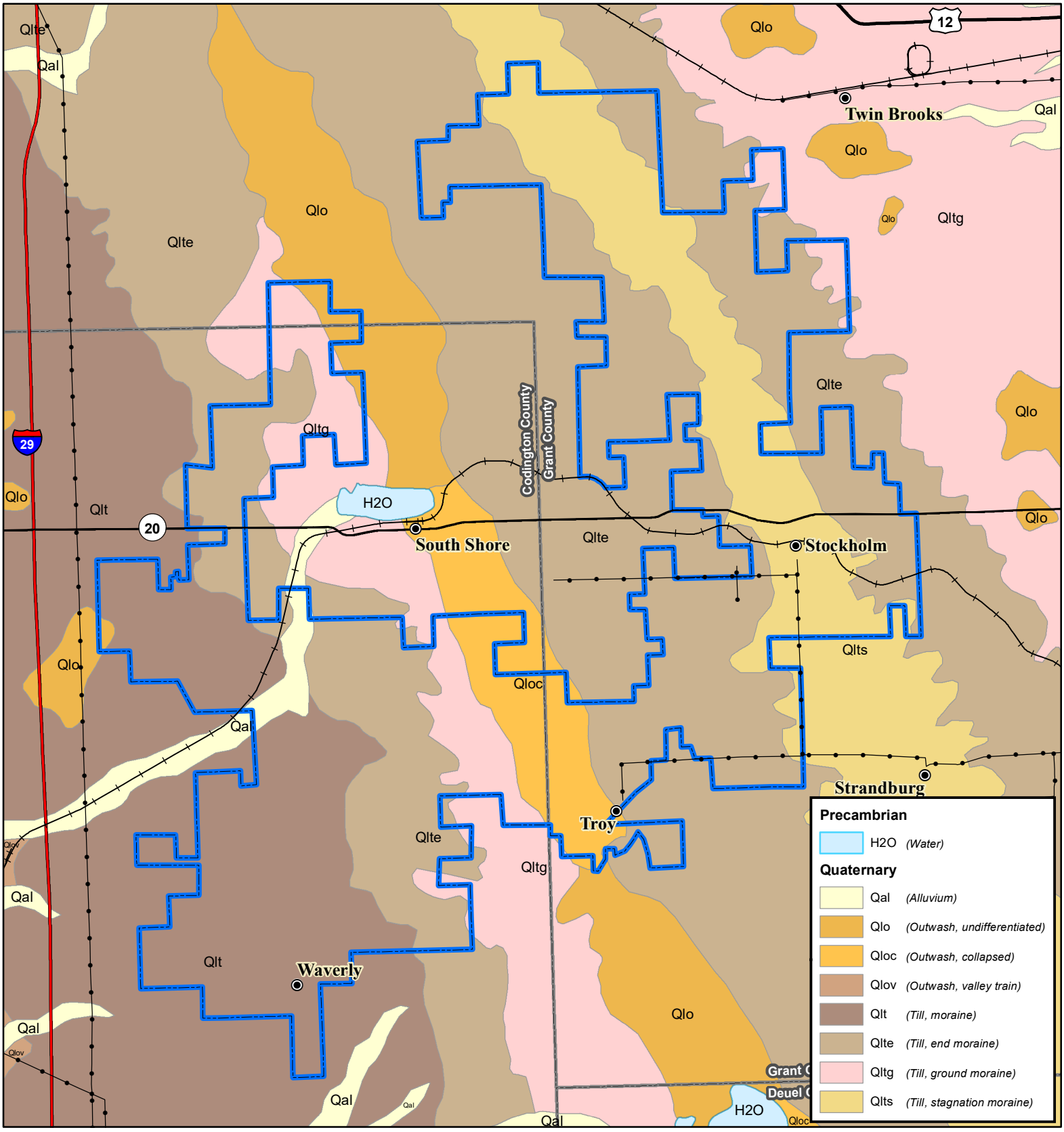


Figure 9a. Surficial Geology

Crowned Ridge Wind Farm

- City
- Electrical Line
- Railroad
- Interstate Highway
- U.S. Highway
- State Highway
- Project Boundary
- County Boundary

Kilometers
0 5 10

Miles
0 2.5 5

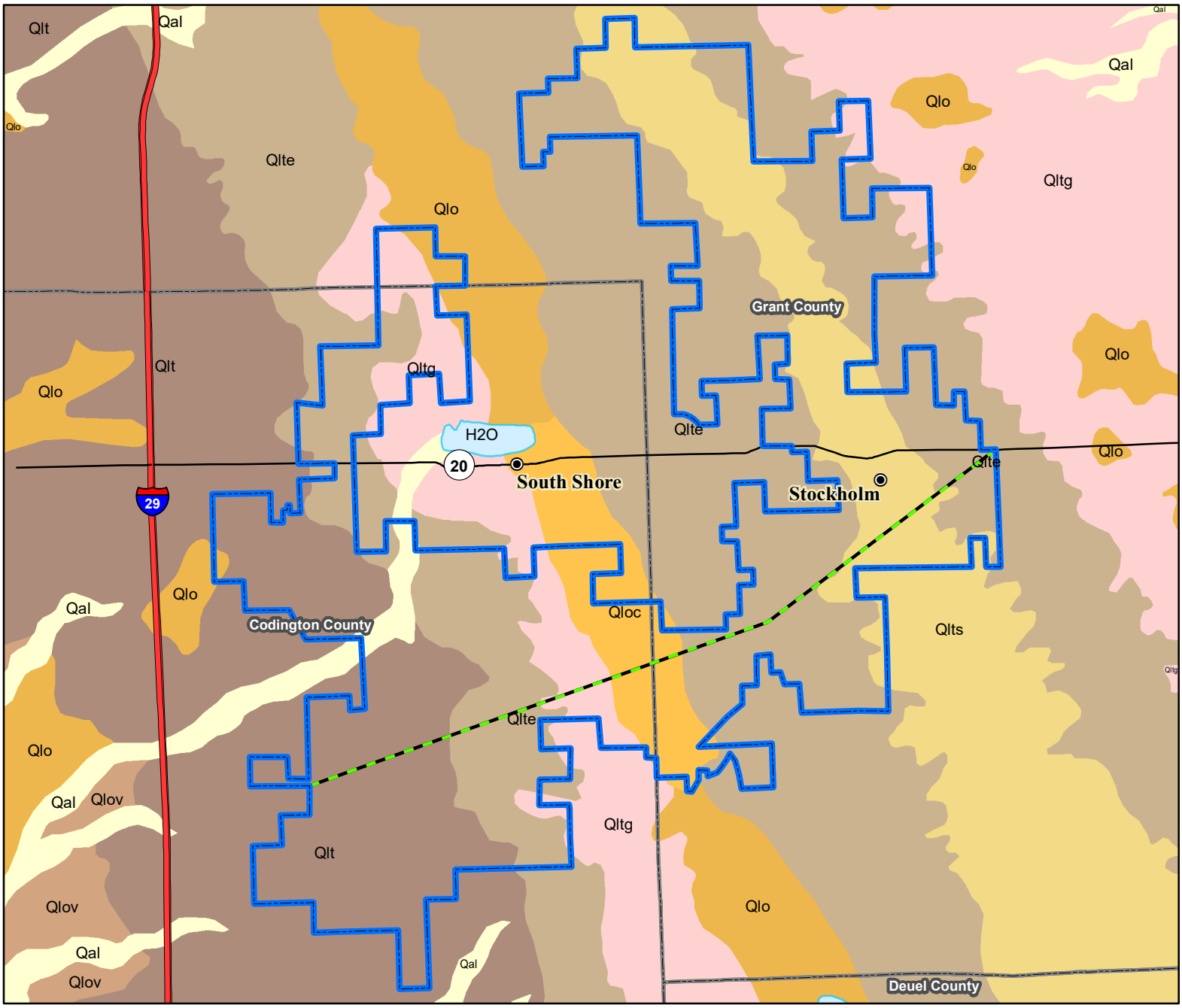
N
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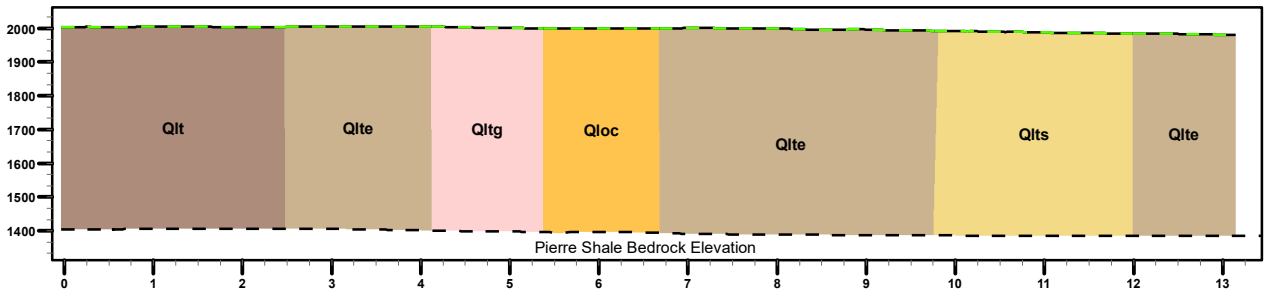
Base Map: Surficial Geology
Source: South Dakota Geological Survey via
State of South Dakota GIS
Codington and Grant Counties, South Dakota

Projection: NAD 1983 UTM Zone 14N

000173

SWCA
ENVIRONMENTAL CONSULTANTS





*Vertical axis in feet above sea level; Horizontal axis in miles

Figure 9b. Geology Cross Sections

Crowned Ridge Wind Farm

City
Cross Section
Interstate Highway
State Highway
Project Boundary
County Boundary

Surficial Geology

Precambrian

H2O *(Water)*

Quaternary

Qal *(Alluvium)*
Qlo *(Outwash, undifferentiated)*
Qloc *(Outwash, collapsed)*
Qlov *(Outwash, valley train)*
Qlt *(Till, moraine)*
Qlte *(Till, end moraine)*
Qltg *(Till, ground moraine)*
Qlts *(Till, stagnation moraine)*

Kilometers
0 5 10
Miles
0 2.5 5

N
W E
S

Base Map: Surficial Geology
Source: South Dakota Geological Survey via
State of South Dakota GIS
Codington and Grant Counties, South Dakota

Projection: NAD 1983 UTM Zone 14N

000174

SWCA
ENVIRONMENTAL CONSULTANTS

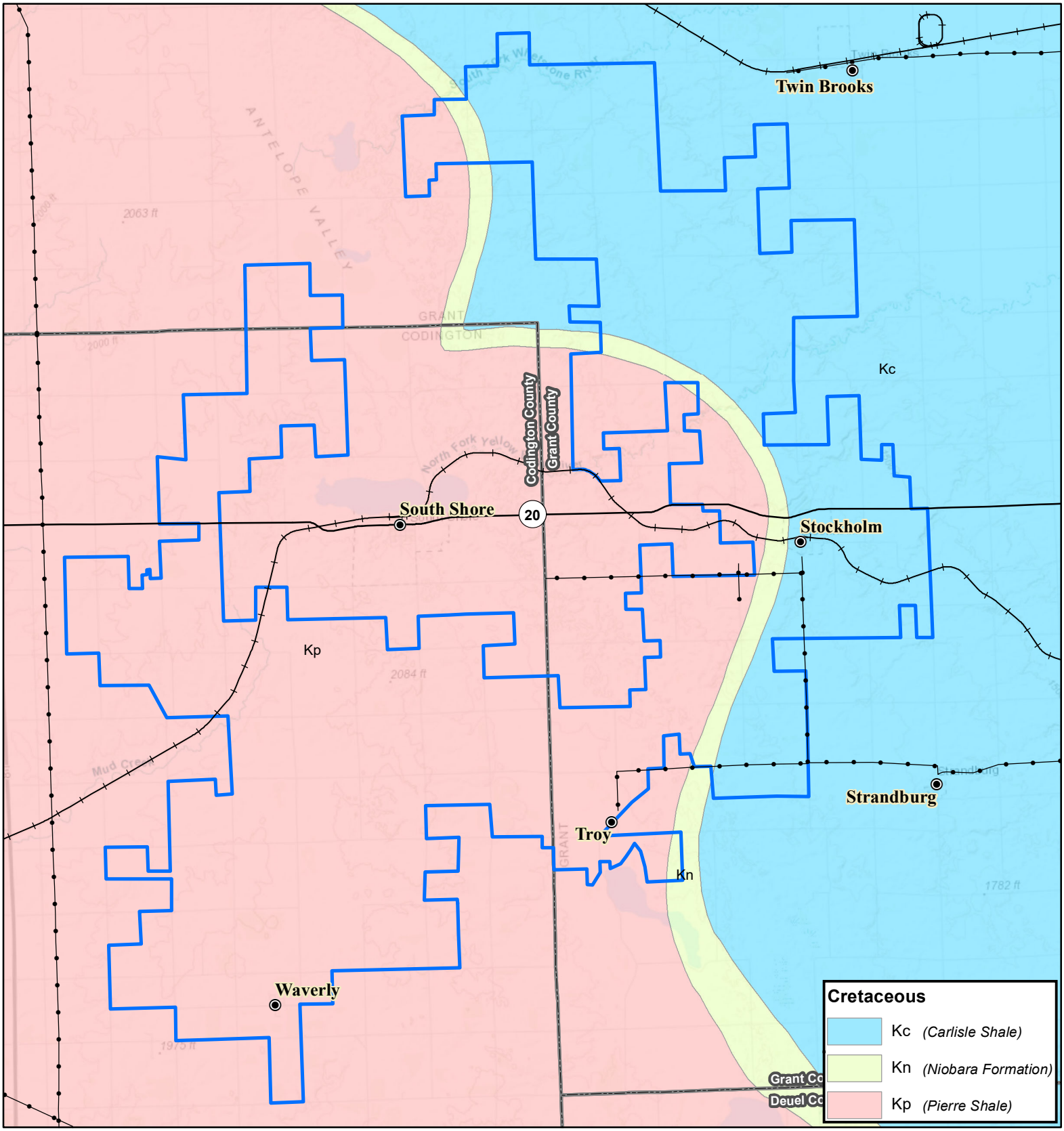


Figure 10. Bedrock Geology

Crowned Ridge Wind Farm

City

County Boundary

Railroad

Electrical Line

State Highway

Project Boundary

Kilometers

0 5 10

Miles

0 2.5 5

N

W E

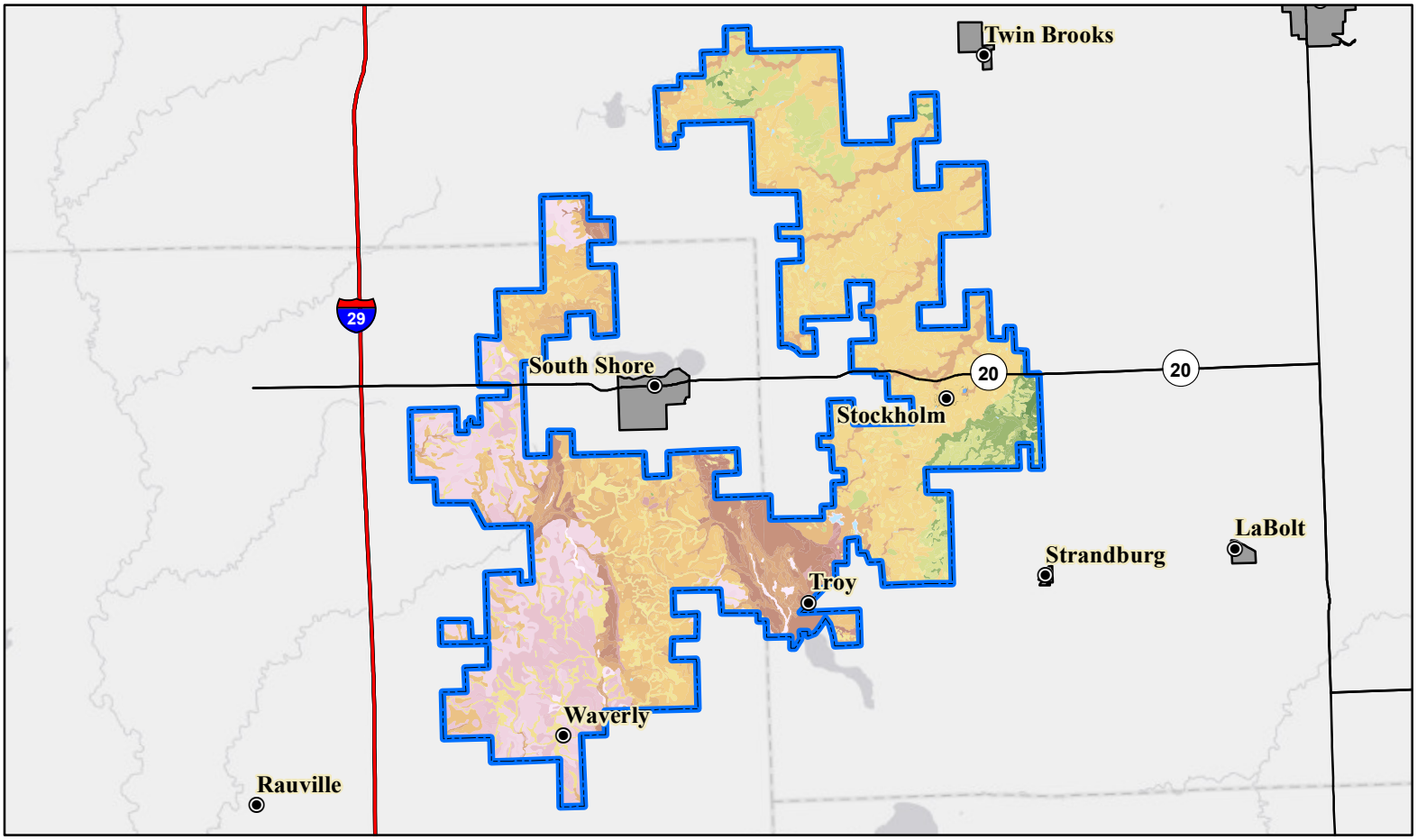
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Base Map: World Topographic Map
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community
Codington and Grant Counties, South Dakota

Projection: NAD 1983 UTM Zone 14N

000175

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MUSYM (Soil Type)

- BeF (Buse-Forman loams, 25-40% slopes)
- BfD (Buse-Forman-Aastad loams, 4-15% slopes)
- Fa (Flom Clay loam)
- FdB (Forman-Aastad loams, 1-6% slopes)
- FdC (Forman-Aastad loams, 3-9% slopes)
- FdD (Forman-Aastad loams, 4-15% slopes)
- FgC (Forman-Buse loams, 6-9% slopes)
- FgE (Forman-Buse loams, 15-25% slopes)
- FhE (Forman-Buse extremely stony loams, 9-40% slopes)
- HaD (Hattie clay loam, 9 to 15% slopes)
- HaE (Hattie clay loam, 15 to 40% slopes)
- J119E (Buse-Sioux complex, 9 to 40% slopes)
- J136A (Great Bend-Beotia silt loams, 0 to 2% slopes)
- J225B (Forman-Aastad complex)
- Lb (LaDelle silt loam, channeled)
- Lc (Ludden silty clay)
- M-W Miscellaneous Water
- Pa (Parnell silty clay loam)
- Pb (Southam silty clay loam, 0 to 1% slopes)
- PcA (Peever clay loam, coteau, 0 to 2% slopes)
- PcB (Peever clay loam, coteau, 2 to 6% slopes)
- PcC (Peever clay loam, 6 to 9% slopes)
- PeB (Peever clay loam, 2 to 6% slopes)
- Ph (Playmoor silty clay loam)
- Ta (Tonka silty clay loam, 0 to 1% slopes)
- Vb (Vallers-Parnell complex)
- W (Water)
- Z101A (Tonka silty clay loam, 0 to 1% slopes)
- Z102A (Badger-Tonka silty clay loam, 0 to 1% slopes)
- Z105A (Oldham silty clay loam, coteau, 0 to 1% slopes)
- Z106A (Southam silty clay loam, 0 to 1% slopes)
- Z107A (Parnell silty clay loam, coteau, 0 to 1% slopes)
- Z110A (Vallers loam, coteau, 0 to 1% slopes)
- Z112A (Vallers-Hamerly loams, coteau, 0 to 2% slopes)
- Z113A (Vallers-Parnell complex, coteau, 0 to 2% slopes)
- Z114A (Hamerly-Tonka complex, coteau, 0 to 2% slopes)
- Z115A (Hamerly-Badger complex, coteau, 0 to 2% slopes)
- Z116A (McKranz-Hidwood, frequently flooded, silty clay loams, 0 to 2% slopes)
- Z117A (McKranz-Badger silty clay loams, 0 to 2% slopes)
- Z119A (Hamerly-Balaton loams, coteau, 0 to 3% slopes)
- Z128B (Hetland silty clay loam, 2 to 6% slopes)
- Z131A (Forman-Aastad loams, coteau, 0 to 2% slopes)
- Z131B (Forman-Aastad loams, coteau, 1 to 6% slopes)
- Z132B (Forman-Buse-Aastad loams, coteau, 1 to 6% slopes)
- Z132C (Forman-Buse-Aastad loams, coteau, 2 to 9% slopes)
- Z132D (Forman-Buse-Aastad loams, coteau, 2 to 15% slopes)
- Z135D (Forman-Buse loams, very stony, 2 to 15% slopes)
- Z136F (Buse-Langhei complex, very stony, 9 to 40% slopes)
- Z137F (Buse-Forman loams, very stony, 15 to 40% slopes)
- Z140F (Buse-Langhei complex, coteau, 15 to 40% slopes)
- Z141A (Barnes-Svea loams, coteau, 0 to 2% slopes)
- Z141B (Barnes-Svea loams, coteau, 1 to 6% slopes)
- Z142B (Barnes-Buse-Svea loams, coteau, 1 to 6% slopes)
- Z142C (Barnes-Buse-Svea loams, coteau, 2 to 9% slopes)
- Z143C (Barnes-Buse loams, coteau, 6 to 9% slopes)
- Z144E (Buse-Barnes loams, coteau, 9 to 20% slopes)
- Z145D (Buse-Barnes loams, coteau, very stony, 2 to 15% slopes)
- Z145F (Buse-Barnes loams, coteau, very stony, 9 to 40% slopes)
- Z146F (Buse-Lamoure, channeled, frequently flooded, complex, 0 to 40% slopes)
- Z148F (Buse very stony-Lamoure, channeled, frequently flooded, complex, 0 to 40% slopes)
- Z149F (Buse-Langhei, very stony-La Prairie, channeled, occasionally flooded, complex, 0 to 60% slopes)
- Z150A (Rauville silty clay loam, coteau, frequently flooded, 0 to 1% slopes)
- Z152A (Lamoure silty clay loam, coteau, occasionally flooded, 0 to 1% slopes)
- Z153A (Lamoure-Rauville silty clay loams, channeled, frequently flooded, 0 to 2% slopes)
- Z157A (Fairdale loam, channeled, frequently flooded, 0 to 2% slopes)
- Z158A (Marysland loam, occasionally flooded, 0 to 1% slopes)
- Z159A (Divide loam, occasionally flooded, 0 to 2% slopes)
- Z160A (Moritz, occasionally flooded-Lamoure, frequently flooded, complex, 0 to 2 % slopes)
- Z161A (Spottswood loam, occasionally flooded, 0 to 2% slopes)
- Z162A (La Prairie loam, coteau, occasionally flooded, 0 to 2% slopes)
- Z166A (Fordtown loam, rarely flooded, 0 to 2% slopes)
- Z167A (Renwash loam, rarely flooded, 0 to 2% slopes)
- Z171A (Renshaw-Fordville loams, coteau, 0 to 2% slopes)
- Z171B (Renshaw-Fordville loams, coteau, 2 to 6% slopes)
- Z172A (Renshaw loam, coteau, 0 to 2% slopes)
- Z172B (Renshaw loam, coteau, 2 to 6% slopes)
- Z173B (Renshaw-Sioux complex, coteau, 2 to 6% slopes)
- Z173C (Renshaw-Sioux complex, coteau, 6 to 9% slopes)
- Z174D (Sioux-Renshaw complex, coteau, 9 to 15% slopes)
- Z174F (Sioux-Renshaw complex, coteau, 15 to 40% slopes)
- Z175D (Renshaw-Sioux complex, very stony, 2 to 15% slopes)
- Z176C (Arvilla-Sandberg sandy loams, coteau, 6 to 9% slopes)
- Z177 (Udorthents, coteau (gravel pits))
- Z178A (Rentill loam, coteau, 0 to 2% slopes)
- Z179F (Sioux-Renshaw complex, very stony, 15 to 40% slopes)
- Z184E (Maddock loamy fine sand, 9 to 25% slopes)
- Z185A (Egeland-Embden complex, coteau, 0 to 2% slopes)
- Z185B (Egeland-Embden complex, coteau, 2 to 6% slopes)
- Z186B (Maddock-Egeland sandy loams, coteau, 2 to 6% slopes)
- Z186C (Maddock-Egeland sandy loams, coteau, 6 to 9% slopes)
- Z190A (Brookings silty clay loam, 0 to 2% slopes)
- Z192A (Vienna-Brookings complex, coteau, 0 to 2% slopes)
- Z192B (Vienna-Brookings complex, coteau, 1 to 6% slopes)
- Z193C (Vienna-Buse complex, coteau, 6 to 9% slopes)
- Z194A (Barnes clay loam, coteau, 0 to 2% slopes)
- Z194B (Barnes clay loam, coteau, 2 to 6% slopes)
- Z198A (Vienna-Forestville loams, coteau, 0 to 2% slopes)
- Z199B (Vienna-Barnes-Forestville loams, 1 to 6% slopes)
- Z205B (Mauvais clay loam, occasionally ponded, extremely stony, 2 to 6% slopes)
- Z217A (McKranz silty clay loam, 0 to 2% slopes)
- Z250A (Rauville mucky silty clay loam, ponded, frequently flooded, 0 to 1% slopes)
- Z252A (Hidewood silty clay loam, frequently flooded, 0 to 2% slopes)

Figure 11. Soil Types

Crowned Ridge Wind Farm

- City
- Interstate Highway
- State Highway
- Town Boundary
- Project Boundary

Kilometers
0 5 10

Miles
0 5 10

N
W E
S

Base Map: World Light Gray Canvas Base
Sources: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Codington and Grant Counties, South Dakota

Projection: NAD 1983 UTM Zone 14N

000176

SWCA ENVIRONMENTAL CONSULTANTS

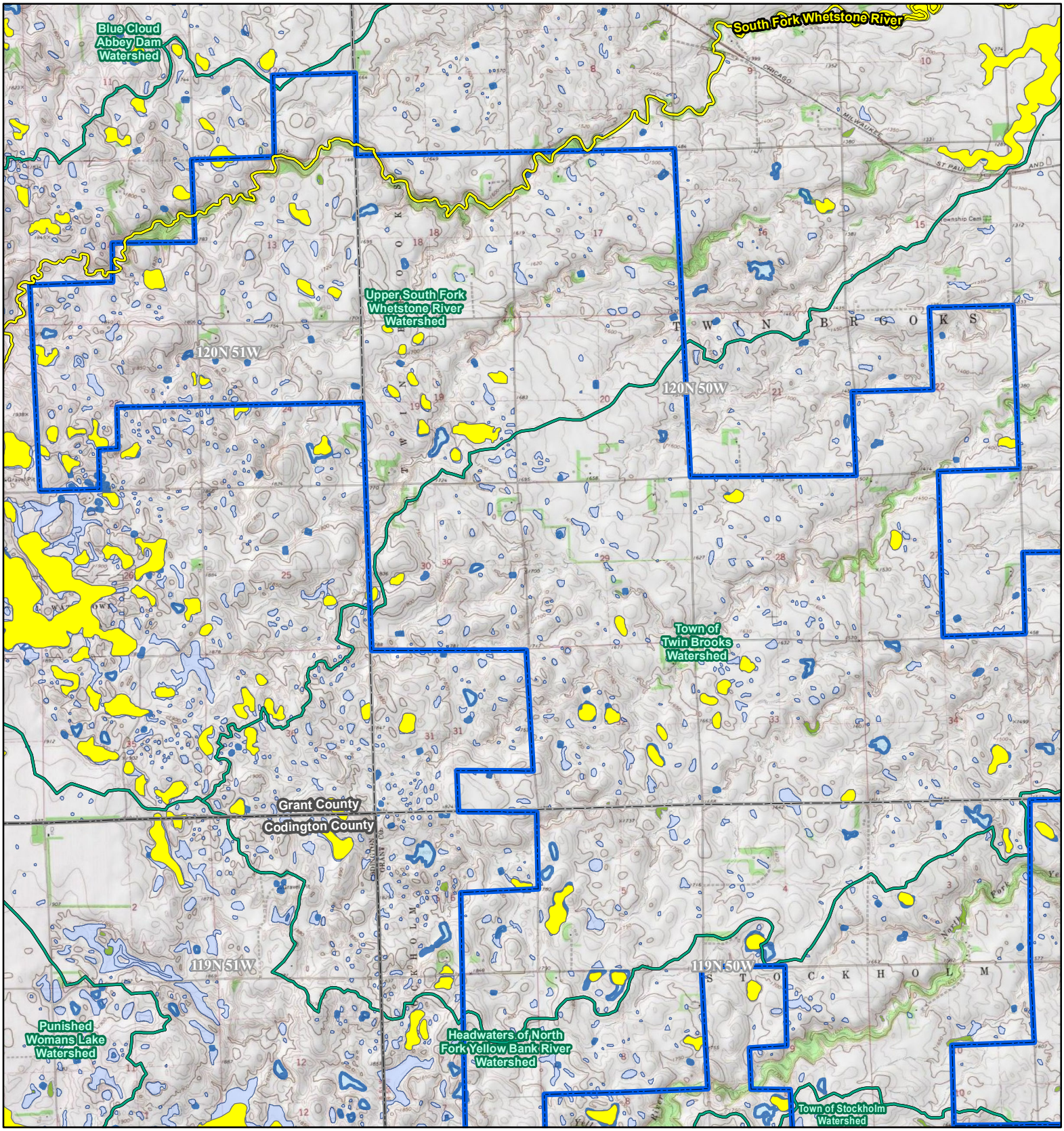


Figure 12. Water Resources

Crowned Ridge Wind Farm

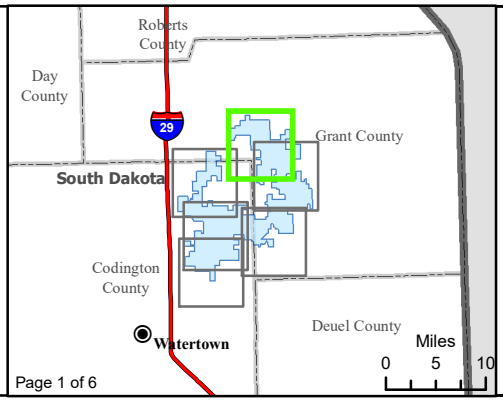
- City
- U.S. Highway
- State Highway
- South Dakota Beneficial Use Stream
- South Dakota Beneficial Use Lake
- Watershed Boundary (HUC12)
- Project Boundary
- County Boundary
- Township/Range Boundary

FEMA Flood Zone

- A

NWI Wetland

- Freshwater Emergent Wetland
- Freshwater Forested/ Shrub Wetland
- Lake, Pond, or Riverine Wetland



Kilometers
0 1 2

Miles
0 1 2

Base Map: USGS 7.5' Topographic Map
Source: Esri ArcGIS Online service
Quadrangle: Antelope Valley (1973), Twin Brooks (1973), Stockholm (1973)
Township/Range: T120N, R51W & T120N, R50W & T119N, R50W
Grant County, South Dakota

000177

Projection: NAD 1983 UTM Zone 14N

SWCA ENVIRONMENTAL CONSULTANTS

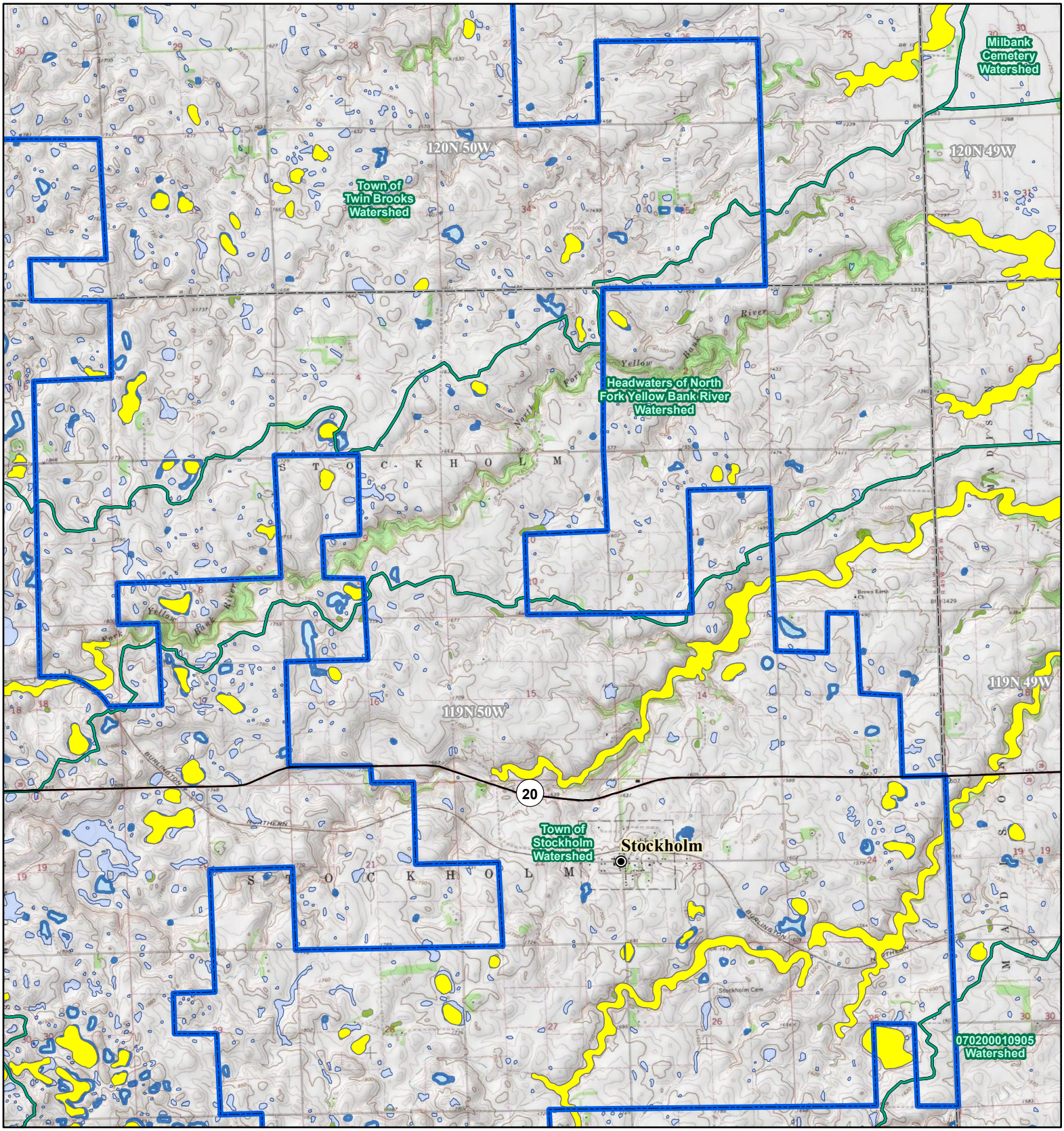


Figure 12. Water Resources

Crowned Ridge Wind Farm

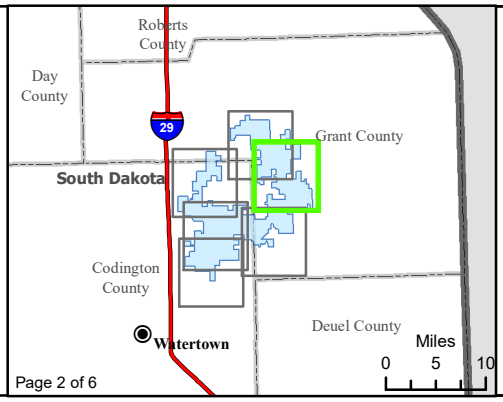
- City
- U.S. Highway
- State Highway
- South Dakota Beneficial Use Stream
- South Dakota Beneficial Use Lake
- Watershed Boundary (HUC12)
- Project Boundary
- County Boundary
- Township/Range Boundary

FEMA Flood Zone

- A

NWI Wetland

- Freshwater Emergent Wetland
- Freshwater Forested/ Shrub Wetland
- Lake, Pond, or Riverine Wetland



Kilometers
0 1 2

Miles
0 1 2

Base Map: USGS 7.5' Topographic Map
Source: Esri ArcGIS Online service
Quadrangle: Twin Brooks (1973), Stockholm (1973)
Township/Range: T120N, R50W & T119N, R50W
Grant County, South Dakota

000178

Projection: NAD 1983 UTM Zone 14N

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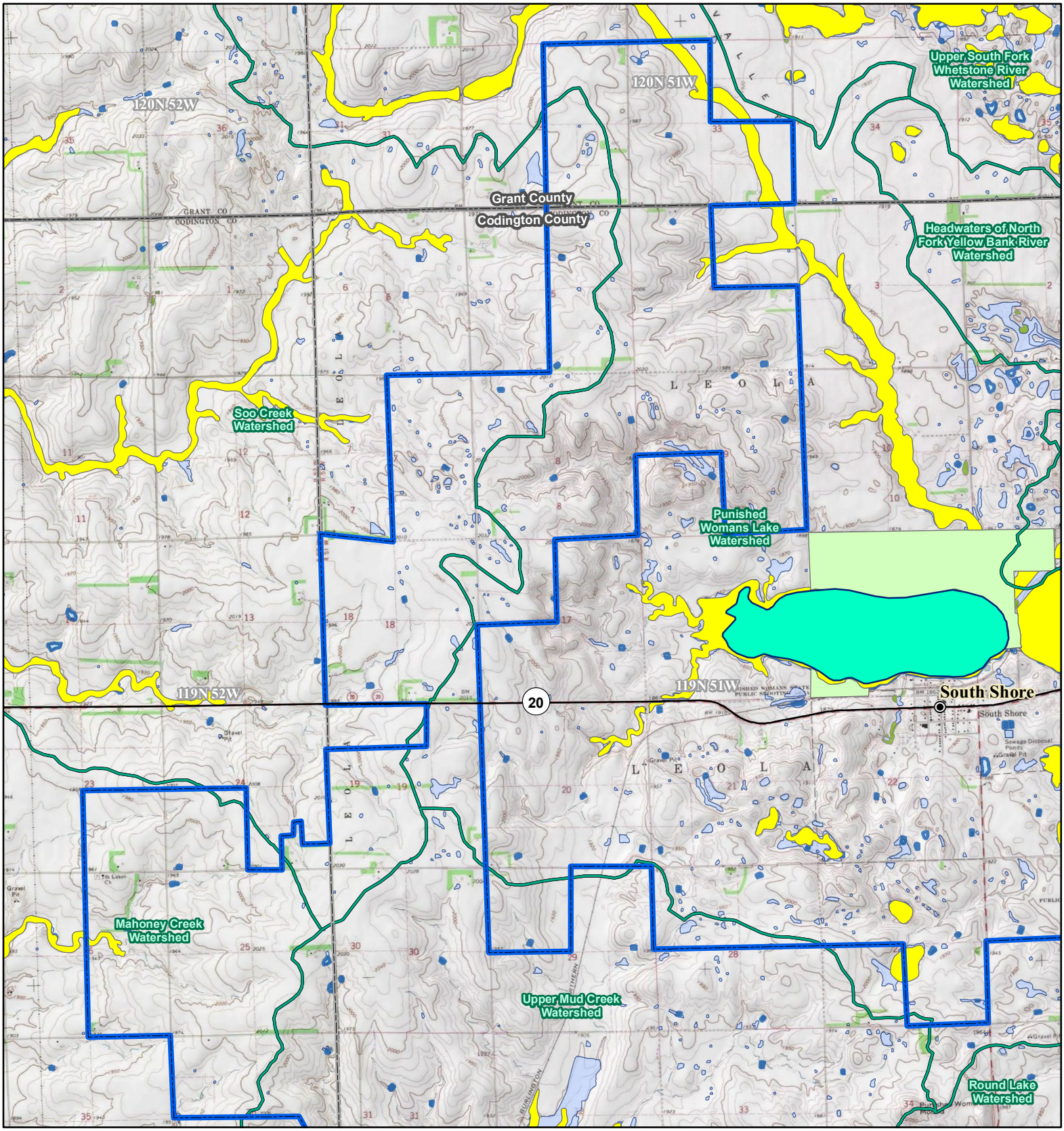


Figure 12. Water Resources

Crowned Ridge Wind Farm

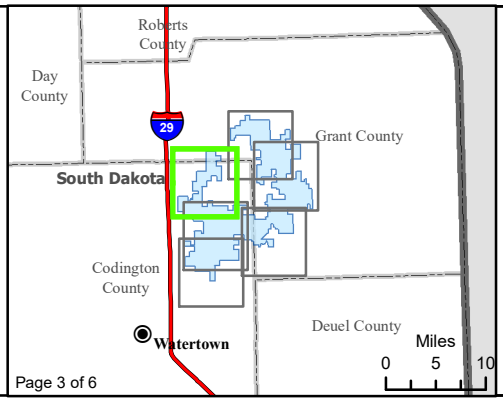
- City
- U.S. Highway
- State Highway
- South Dakota Beneficial Use Stream
- South Dakota Beneficial Use Lake
- Watershed Boundary (HUC12)
- Project Boundary
- County Boundary
- Township/Range Boundary

FEMA Flood Zone

- A
- D

NWI Wetland

- Freshwater Emergent Wetland
- Freshwater Forested/ Shrub Wetland
- Lake, Pond, or Riverine Wetland



Kilometers
0 1 2

Miles
0 1 2

Base Map: USGS 7.5' Topographic Map
Source: Esri ArcGIS Online service
Quadrangle: Antelope Valley (1973), Still Lake SE (1970), South Shore (1973)
Township/Range: T120N, R51W & T119N, R52W & T119N, R51W
Codington and Grant Counties, South Dakota

000179

Projection: NAD 1983 UTM Zone 14N

SWCA ENVIRONMENTAL CONSULTANTS

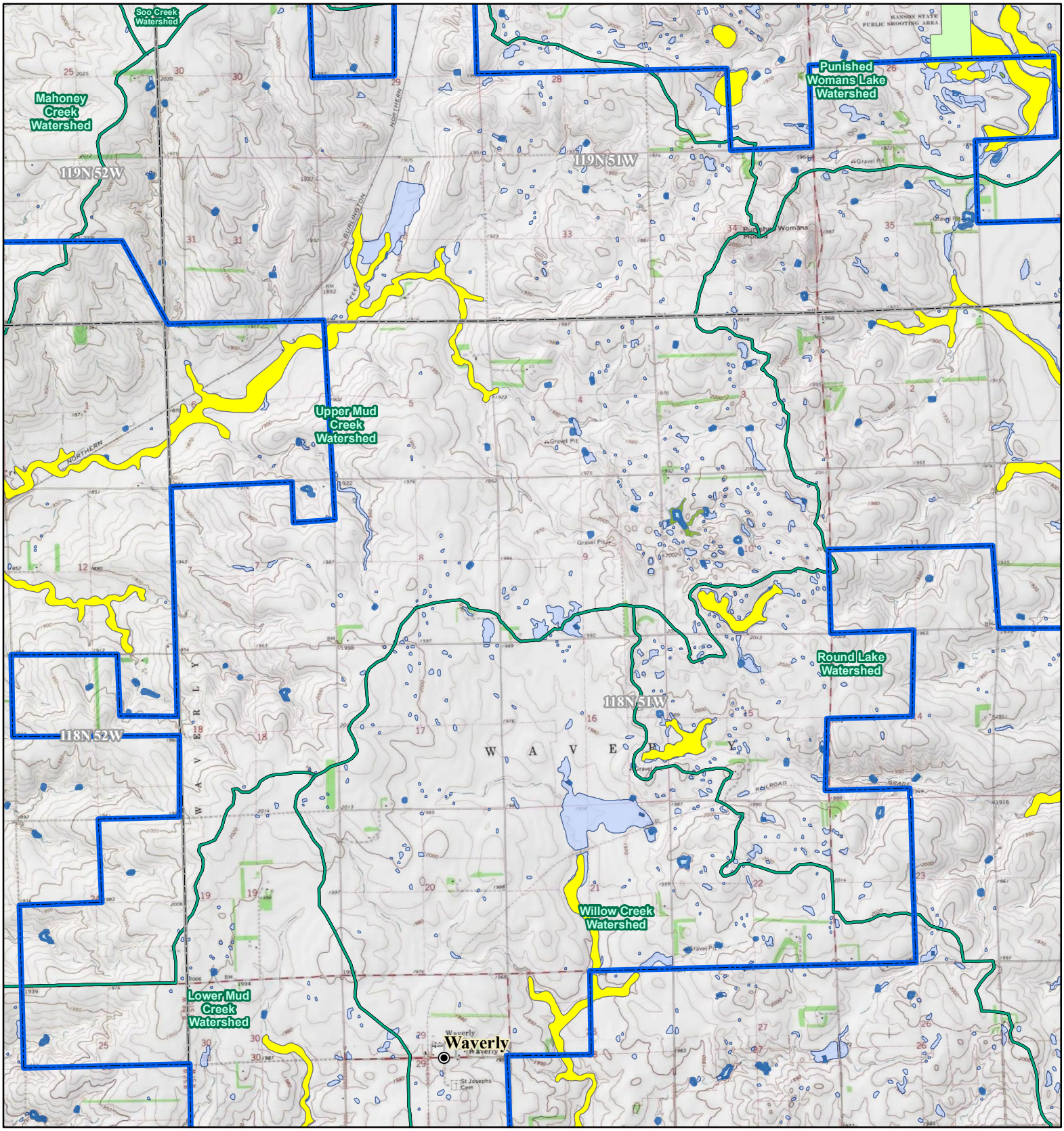


Figure 12. Water Resources

Crowned Ridge Wind Farm

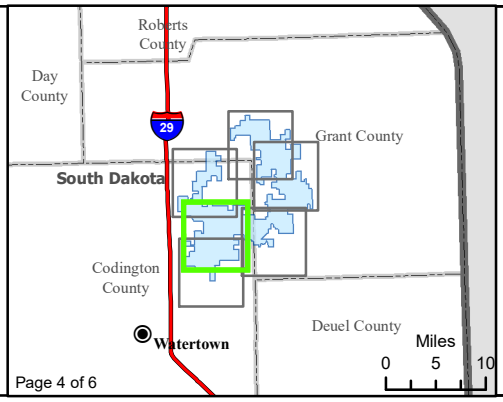
- City
- U.S. Highway
- State Highway
- South Dakota Beneficial Use Stream
- South Dakota Beneficial Use Lake
- Watershed Boundary (HUC12)
- Project Boundary
- County Boundary
- Township/Range Boundary

FEMA Flood Zone

- A
- D

NWI Wetland

- Freshwater Emergent Wetland
- Freshwater Forested/ Shrub Wetland
- Lake, Pond, or Riverine Wetland



Kilometers
0 1 2

Miles
0 1 2

Base Map: USGS 7.5' Topographic Map
Source: Esri ArcGIS Online service
Quadrangle: Still Lake SE (1970), South Shore (1973), Watertown East (1969), Kranzburg (1970)
Township/Range: T119N, R52W & T119N, R51W & T118N, R52W & T118N, R51W
Codington County, South Dakota

Projection: NAD 1983 UTM Zone 14N

000180

SWCA ENVIRONMENTAL CONSULTANTS

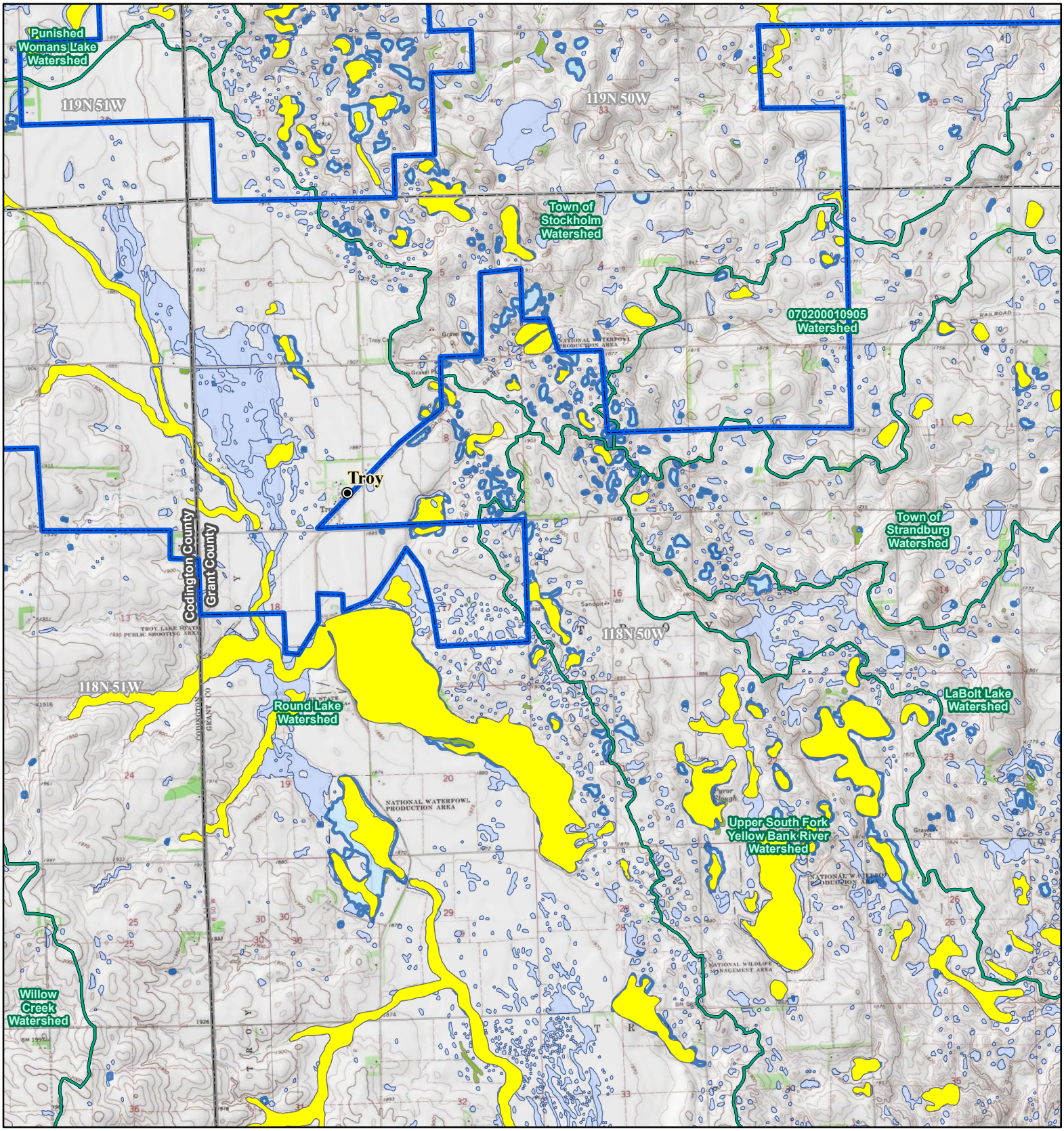


Figure 12. Water Resources

Crowned Ridge Wind Farm

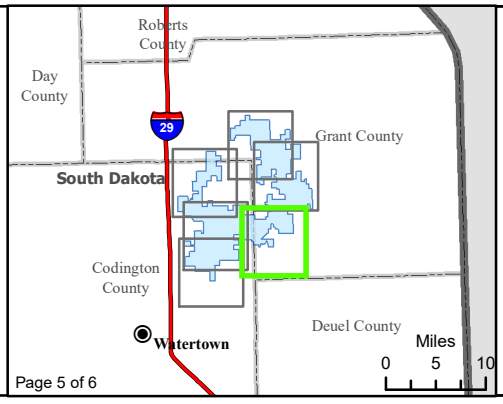
- City
- U.S. Highway
- State Highway
- South Dakota Beneficial Use Stream
- South Dakota Beneficial Use Lake
- Watershed Boundary (HUC12)
- Project Boundary
- County Boundary
- Township/Range Boundary

FEMA Flood Zone

- A

NWI Wetland

- Freshwater Emergent Wetland
- Freshwater Forested/ Shrub Wetland
- Lake, Pond, or Riverine Wetland



Page 5 of 6

Kilometers

0 1 2

Miles

0 1 2

Base Map: USGS 7.5' Topographic Map
Source: Esri ArcGIS Online service
Quadrangle: South Shore (1973), Stockholm (1973)
Township/Range: T119N, R51W & T119N, R50W & T118N, R51W & T118N, R50W
Codington and Grant Counties, South Dakota

Projection: NAD 1983 UTM Zone 14N

000181

SWCA ENVIRONMENTAL CONSULTANTS

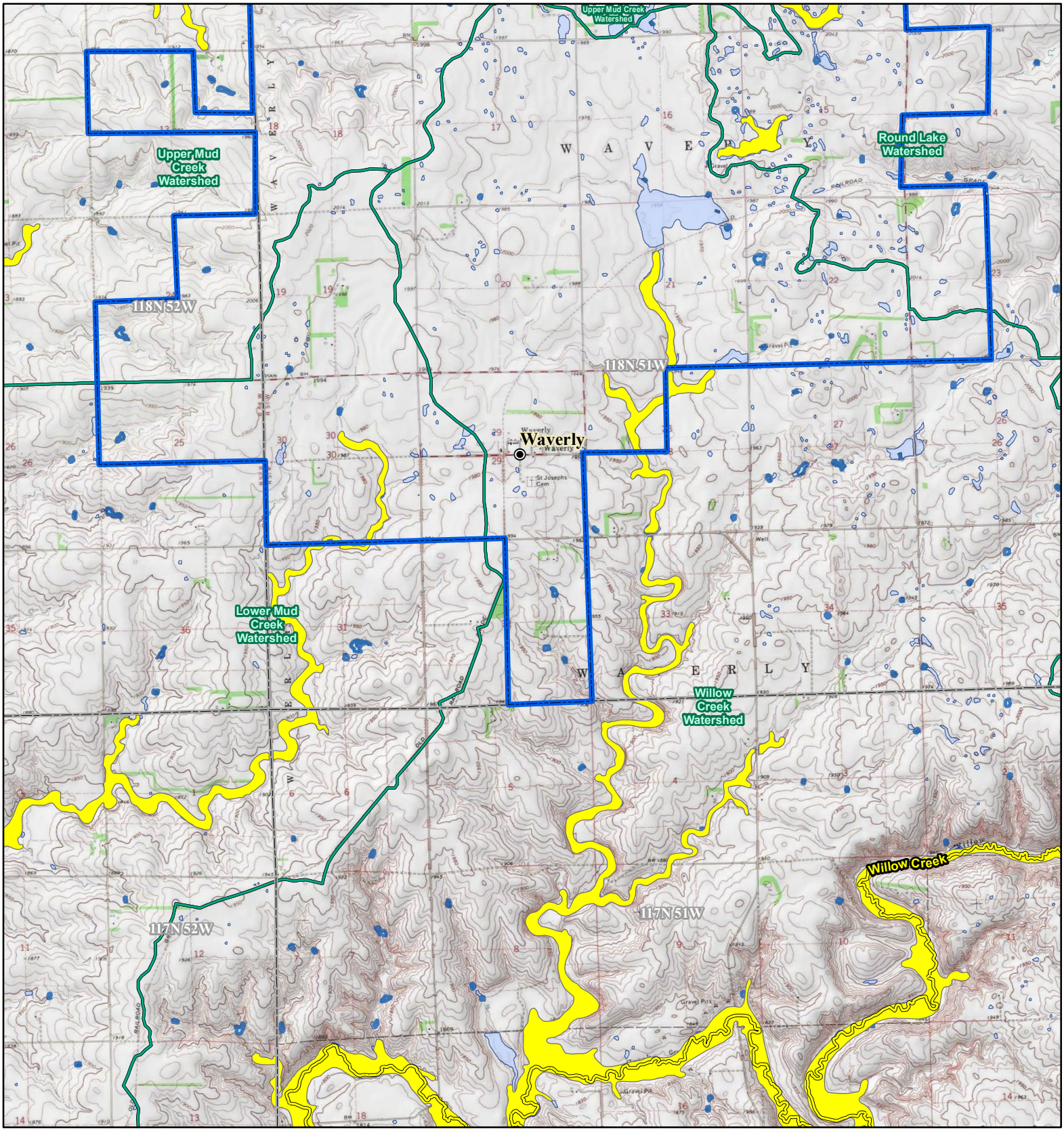


Figure 12. Water Resources

Crowned Ridge Wind Farm

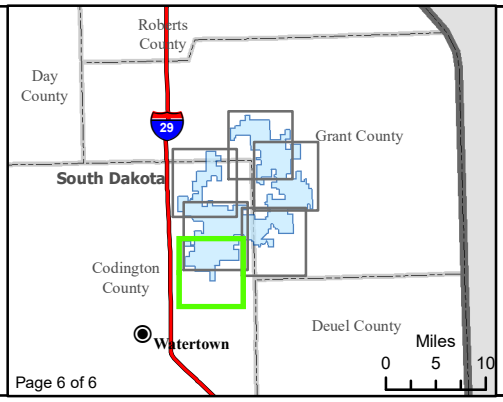
- City
- U.S. Highway
- State Highway
- South Dakota Beneficial Use Stream
- South Dakota Beneficial Use Lake
- Watershed Boundary (HUC12)
- Project Boundary
- County Boundary
- Township/Range Boundary

FEMA Flood Zone

- A

NWI Wetland

- Freshwater Emergent Wetland
- Lake, Pond, or Riverine Wetland



Kilometers
0 1 2

Miles
0 1 2

Base Map: USGS 7.5' Topographic Map
Source: Esri ArcGIS Online service
Quadrangle: Still Lake SE (1970), South Shore (1973), Watertown East (1969), Kranzburg (1970)
Township/Range: T118N, R52W & T118N, R51W
Codington County, South Dakota

000182

Projection: NAD 1983 UTM Zone 14N

SWCA ENVIRONMENTAL CONSULTANTS

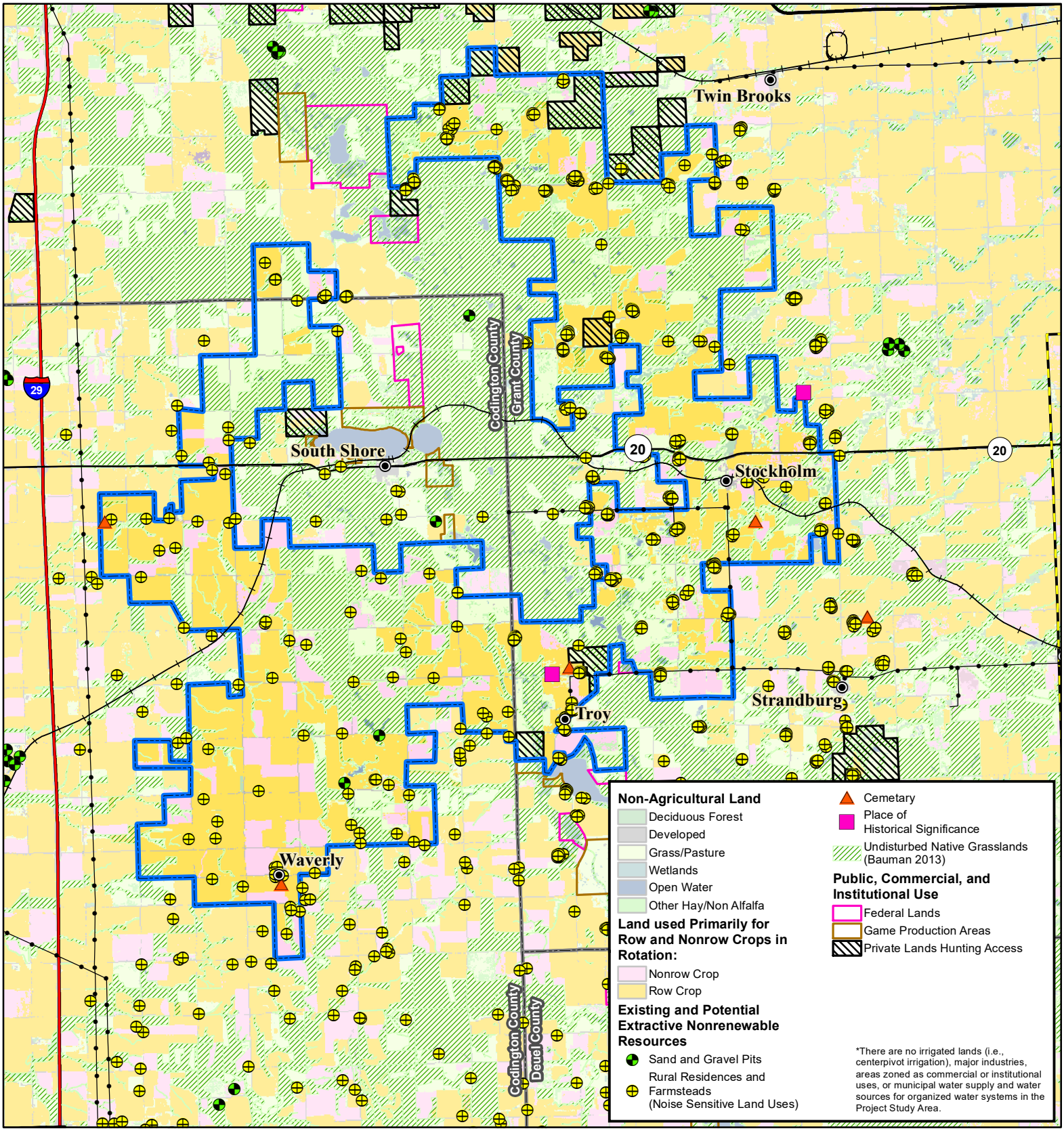


Figure 13. Land Use
Crowned Ridge Wind Farm

City
Electrical Line
Natural Gas Line
Railroad
Interstate Highway
U.S. Highway
State Highway
Project Boundary
County Boundary

Kilometers
0 5 10
Miles
0 2.5 5

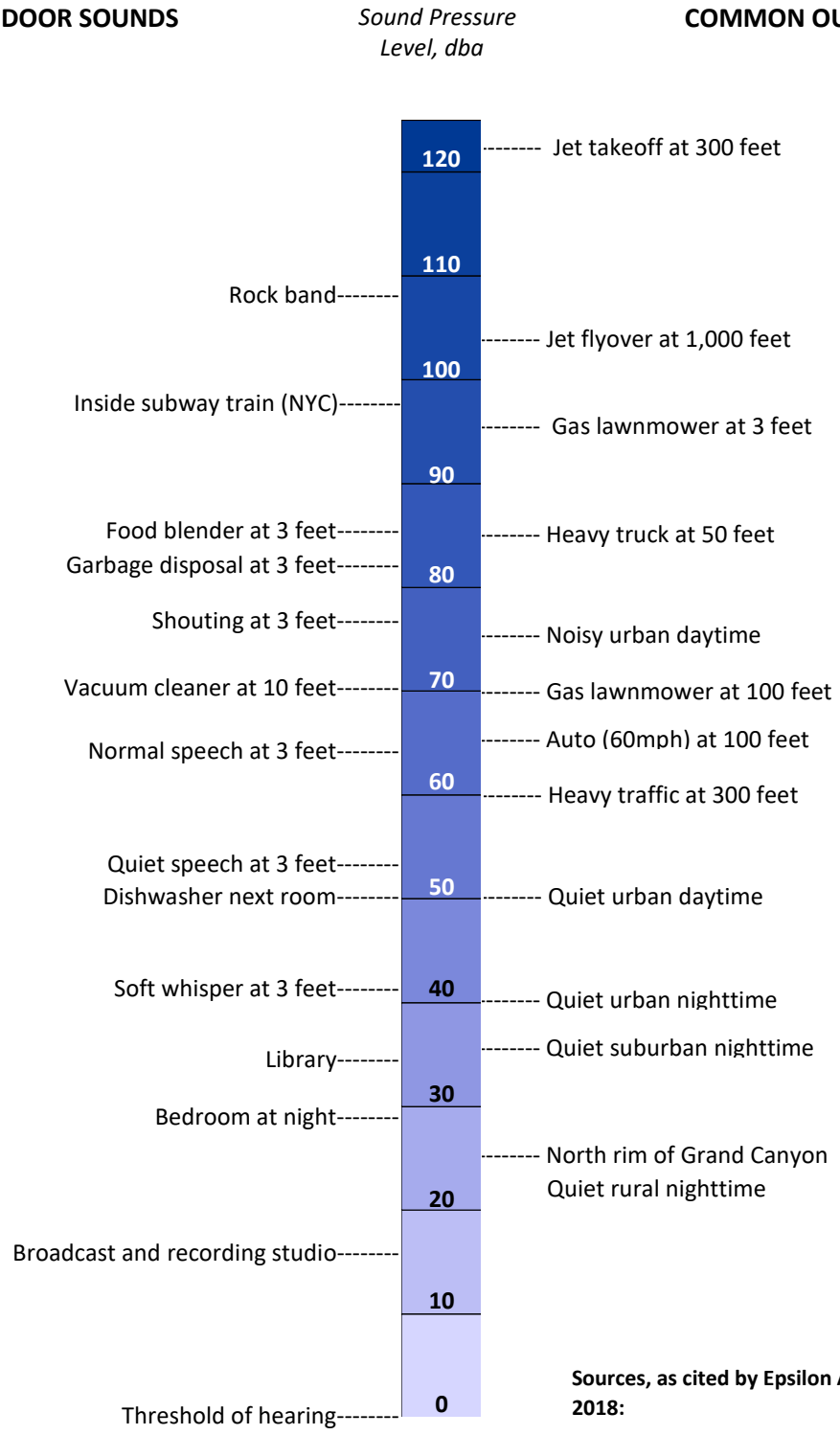
N
W E
S

Base Map: 2017 South Dakota Cropland Data Layer | NASS/USDA
Source: United States Department of Agriculture (USDA),
National Agricultural Statistics Service (NASS),
Research and Development Division (RDD),
Geospatial Information Branch (GIB),
Spatial Analysis Research Section (SARS); 2017 Edition
Codington County, South Dakota

Projection: NAD 1983 UTM Zone 14N

000183

SWCA ENVIRONMENTAL CONSULTANTS



Sources, as cited by Epsilon Associates Inc, November 19, 2018:

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

FIGURE 14
Common Sound Levels in the Environment

The following table is a summary of significant communication with federal, state, local agencies, and Tribes in chronological order.

Appendix B. Agency Coordination Dates and Correspondence

Date	Agency	Event and Participants
November 26, 2007	Department of the Interior, United States Fish and Wildlife Service (USFWS) - Ecological Services	Letter - Wind Energy Project Coordination, Eastern and North Central South Dakota; from Pete Grober, Field Supervisor, South Dakota Field Office, USFWS to Erik W. Jansen, Biologist, Tetra Tech EC, Inc.
December 3, 2007	South Dakota Game, Fish, and Parks (SDGFP)	Letter - Environmental review of Eastern and North-central Wind Resource Area as potential wind power project areas; from Silka L. F. Kempema, Wildlife Biologist, SDGFP to Erik W. Jansen, Biologist, Tetra Tech EC, Inc.
February 5, 2010	USFWS	Letter - Proposed Crowned Ridge Wind Energy Center, Codington and Grant Counties, South Dakota; from Pete Grober, Field Supervisor, South Dakota Field Office, USFWS to Anne-Marie Griger, Tetra Tech EC, Inc.
February 11, 2015	SDGFP	Letter - Crowned Ridge Wind Energy Center in Codington and Grant Counties, South Dakota; from Anne-Marie Griger, Tetra Tech, Inc., to Jeff Vonk, Secretary of SDGFP.
February 11, 2015	USFWS	Letter - Crowned Ridge Wind Energy Center in Codington and Grant Counties, South Dakota; from Anne-Marie Griger, Tetra Tech, Inc., to Scott Larson, Field Supervisor, South Dakota Field Office, USFWS.
March 23, 2014 (date is incorrect and is actually March 23, 2015)	USFWS	Letter - Crowned Ridge Wind Energy Center, Codington and Grant Counties, South Dakota; From Scott Larson, Field Supervisor, South Dakota Field Office, USFWS to Anne-Marie Griger, Tetra Tech, Inc.
April 19, 2017	USFWS and SDGFP	Technical memorandum re: Crowned Ridge II Project Background. Delivered via email.
April 20, 2017	USFWS and SDGFP	Conference call to discuss Crowned Ridge II project. Participants were Natalie Gates, USFWS Biologist, South Dakota Field Office; Natoma Hansen, USFWS Refuge Manager, Madison Wetland Management District; Connie Mueller, USFWS Project Leader, Waubay National

Date	Agency	Event and Participants
		Wildlife Refuge Complex; Silka Kempema, Wildlife Biologist, SDGFP; Kim Wells, Manager – Mid Continent Region, Environmental Services, NextEra Energy Resources (NextEra); Tyler Wilhelm, Project Manager – Wind Development NextEra; Patrick Flowers, Manager of Environmental Services, Xcel Energy; Kely Mertz, Senior Project Manager, SWCA Environmental Consultants (SWCA).
May 24, 2017	Sisseton Wahpeton Oyate of the Lake Traverse Reservation (SWO)	Cultural resource survey planning meeting. Participants were: Dianne Desrosiers, SWO Tribal Historic Preservation Officer (THPO); Rick Wadleigh, Senior Environmental Analyst, SWCA; Rich Estabrook, Archaeologist, NextEra; Carolyn Stewart, Director Tribal Relations, NextEra; Michelle Phillips, Environmental Services, NextEra; Scott Phillips, Senior Cultural Anthropologist, SWCA; Norma Crumbley, Principal, SWCA; Stephen Sabatke, Archaeologist, HDR; Jenkins Cloud, CRP Ranger, SWO THPO; Vine T. Marks, Sr., SWO Cultural Preservation Board (CPB) Chair; Wayne Cloud, 106 Coordinator Assistant, SWO THPO; Jim Whitted, 106 Coordinator, SWO THPO.
June 14, 2017	South Dakota State Historical Society (SDSHS)	Technical memo - Crowned Ridge Wind Energy Facility Overview and Cultural Resources Review.
June 15, 2017	SDGFP	Project email – data request from Kely Mertz, Senior Project Manager, SWCA to Travis Runia, SDGFP.
June 19, 2017	SDSHS	Project kickoff call to discuss June 14, 2017 memo. Participants were: Paige Olson, SDSHS; Kate Nelson, SDSHS; Jenna Dietmeir, SDSHS; Scott Phillips, Senior Cultural Anthropologist, SWCA; Norma Crumbley, Principal, SWCA; Kim Wells, Manager – Mid Continent Region, Environmental Services, NextEra; Carolyn Stewart, Director Tribal Relations, NextEra; Richard Estabrook, NextEra; Stephen Sabatke, Archaeologist, HDR.
June 19, 2017	SWO, Yankton Sioux Tribe (YST), and Spirit Lake Nation (SLN)	Cultural resource survey field work kickoff meeting. Participants were: Dianne Desrosiers, SWO THPO; Amaris

Date	Agency	Event and Participants
		Makesgood, SLN; Andrew Meng, SWO; Angelique Kitto, SWO; Carolyn Stewart, Director Tribal Relations, NextEra; Chris Shelton, SWCA; CJ Jones, YST; Dylan Eigenberger, Archaeologist, HDR; Erika Eigengerger, Archaeologist, HDR; Jason Burkard, Archaeologist, SWCA; Jenkins Cloud, SWO; Jim Whitted, 106 Coordinator, SWO THPO; Keith Winckler, YST; Londel Seaboy, SWO; Rich Estabrook, Archaeologist, NextEra; Rick Wadleigh, Senior Environmental Analyst, SWCA; Scott Phillips, Senior Cultural Anthropologist, SWCA; Stephen Sabatke, Archaeologist, HDR; Steve Cummins, Archaeologist, SWCA; Vine T. Marks, Sr., SWO CPB Chair.
July 11, 2017	SDGFP	Email data response to June 15, 2017 project email; from Travis Runia, SDGFP to Kely Mertz, Senior Project Manager, SWCA.
July 12, 2017	SDGFP	Project letter - Crowned Ridge I and II Wind Energy Projects in Codington, Deuel, and Grant Counties, South Dakota; from Kely Mertz, Senior Project Manager, SWCA to Silka Kempema, Wildlife Biologist, SDGFP.
July 12, 2017	USFWS	Project letter - Crowned Ridge I and II Wind Energy Projects in Codington, Deuel, and Grant Counties, South Dakota; from Kely Mertz, Senior Project Manager, SWCA to Natalie Gates, Biologist, USFWS.
August 1, 2017	SDGFP	Email data response to July 12, 2017 project letter; from Casey Heimerl, SDGFP to Kely Mertz, Senior Project Manager, SWCA. Spatial data were provided as an attachment to the email.
April 20, 2018	SDGFP	Project email – data request from Kely Mertz, Senior Project Manager, SWCA to Casey Heimerl, SDGFP.
April 24, 2018	SDGFP	Email data response to April 20, 2018 project email; from Casey Heimerl, SDGFP to Kely Mertz, Senior Project Manager, SWCA. Spatial data were provided as an attachment to the email.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
420 South Garfield Avenue, Suite 400
Pierre, South Dakota 57501-5408

November 26, 2007

Mr. Erik W. Jansen, Biologist
Tetra Tech EC, Inc.
1750 SW Harbor Way, Suite 400
Portland, Oregon 97201

Re: Wind Energy Project Consultation, Eastern and North Central South Dakota

Dear Mr. Jansen:

This letter is in response to your request dated October 19, 2007, for listed threatened or endangered species and environmental comments regarding the above referenced project. Your letter indicates a general interest in wind energy development in all or portions of five counties in eastern and north-central South Dakota: the West half (W ½) of Grant County, the Northeast quarter (NE 1/4) of Codington County, the West half (W ½) and South half (S ½) of Deuel County, the Northeast quarter (NE 1/4) of Brookings County, and all of McPherson County.

In accordance with section 7(c) of the Endangered Species Act, as amended, 16 U.S.C. 1531 et seq., we have determined that the following federally listed species may occur in the project area (this list is considered valid for 90 days):

Species	Status	Expected Occurrence
American burying beetle (Nicrophorus americanus)	Endangered	Historic Records, No Recent Specimens, Brookings County.
Western prairie fringed orchid (Platanthera praeclara)	Threatened	Possible Habitat, No Recent Specimens, Brookings County.
Topeka shiner (Notropis topeka)	Endangered	Known Resident in Codington, Deuel, and Brookings Counties.
Whooping crane (Grus americana)	Endangered	Migration Records in Codington and McPherson Counties.
Dakota skipper (Hesperia dacotae)	Candidate	Resident in Brookings, Codington, Deuel, Grant, and McPherson Counties.

While historic records of the American burying beetle exist for Brookings County, recent documentation of the species in South Dakota has occurred only in Todd, Gregory, and Bennett Counties. The American burying beetle was formerly known to occupy a broad geographic range, and habitat was not thought to be limiting. However, recent studies have shown some preference by this species for sandy or sandy-loam grasslands with interspersed stands of low-meadow cottonwoods. If this type of habitat exists at the proposed project areas, surveys for the American burying beetle should be considered and any results reported to this office.

The Western prairie fringed orchid has not recently been documented in South Dakota. However, the life cycle of the plant often makes it difficult to detect. Additionally, populations currently exist in the neighboring states of Nebraska, Iowa, Minnesota, and North Dakota, and potential habitat may still be found in South Dakota. Although the plant is typically associated with intact native prairie, the Western prairie fringed orchid has also been found on disturbed sites. Potential habitats generally include mesic upland prairies, wet prairies, sedge meadows, subirrigated prairies, and swales in sand dune complexes. If these habitats exist within the proposed project areas, surveys for the Western prairie fringed orchid should be considered prior to construction.

Topeka shiners are known to occupy numerous small streams within eastern South Dakota within the Big Sioux, Vermillion, and James River watersheds. Activities affecting instream habitat of waterways within any of these three watersheds (e.g., road crossings, loss of riparian buffer) have the potential to adversely impact this minnow.

The single self-sustaining migratory population of whooping cranes remaining in the wild migrates through South Dakota as it travels between northern breeding grounds and southern wintering areas. The species occupies numerous habitats such as cropland and pastures; wet meadows; shallow marshes; shallow portions of rivers, lakes, reservoirs, and stock ponds; and both freshwater and alkaline basins for feeding and loafing. Overnight roosting sites frequently require shallow water in which they stand and rest. Line strike mortality is one of the greatest threats to this species; collisions with distribution and transmission lines are the highest known source of mortality to fledged whooping cranes. Interactions of the species with wind turbines is currently not known but, as large birds with low maneuverability, they are deemed likely to be susceptible to collision mortality with turbines as well. It is also possible that these birds may avoid wind farm areas entirely, thereby suffering a loss of potential stopover habitat in South Dakota. Additionally, should construction occur during spring or fall migration, the potential for disturbances to whooping cranes exists. Any whooping crane sightings should be reported to this office. While the species has been noted further east in South Dakota, McPherson County is included as part of the species' primary migration corridor.

The Dakota skipper may also occur on some of the proposed project areas. The Dakota skipper is a candidate species and accordingly is not, at present, provided Federal protection under the Endangered Species Act. Their candidate status defines these butterflies as a species in decline that the U.S. Fish and Wildlife Service (Service) believes needs to be listed as threatened or endangered, but listing is currently precluded by other priorities. Dakota skippers are obligate residents of high quality prairie ranging from wet-mesic tallgrass prairie to dry-mesic mixed grass prairie. In northeastern South Dakota, Dakota skippers inhabit dry-mesic hill prairies with abundant purple coneflower but also use mesic to wet-mesic tallgrass prairie habitats characterized by wood lily and smooth camas. If this type of habitat exists in the proposed project areas, surveys for the species should be considered and results reported to this office.

Please note that the bald eagle (Haliaeetus leucocephalus) also occurs throughout South Dakota throughout the year, and new nests are appearing annually. While Endangered Species Act protections for the bald eagle have been removed, effective August 8, 2007, the species will continue to be protected under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA). These laws protect bald eagles from a variety of harmful actions and impacts. Our agency has developed guidance for the public regarding means to avoid take of the bald eagle under these laws. The National Bald Eagle Management Guidelines are available online at http://www.fws.gov/migratorybirds/baldeagle.htm. We recommend that you review these guidelines as they serve to advise you of circumstances where the laws may apply to your activities so that you may avoid potential violations of this law on future projects.

In addition to concerns related specifically to threatened and endangered species, primary concerns of the Service regarding wind farms are collision mortality, the loss of habitat, and habitat avoidance behaviors by wildlife. While there is still much to be learned regarding wind turbine-wildlife interactions, we do know that wind turbines can have adverse impacts on some species. Recent studies of grassland nesting birds have shown a tendency for avoidance of areas immediately surrounding turbines; thus, when considering the issues of habitat fragmentation and grassland bird avoidance, the area impacted may be larger than the final footprint of the project.

The Service has developed voluntary interim guidelines to assist energy companies in accomplishing the goal of reducing the risk posed by turbines to wildlife. You may access these guidelines on the internet at: http://www.fws.gov/habitatconservation/wind.htm. The guidelines stress the importance of proper evaluation of potential wind turbine development sites, proper location and design of turbines and related facilities, and pre- and post-construction research and monitoring.

Areas of interest identified in your letter contain grassland with relatively high density of a variety of wetland types interspersed, McPherson County in particular. Areas in northeastern South Dakota contain ridge lines and rolling topography with quality forest/shrub/grass habitats. Thus, some areas identified in your letter may exhibit relatively high value for wildlife, particularly avian species. Currently the best means of avoiding impacts to wildlife by wind farms is to avoid such high wildlife use areas. Placement of turbines within existing cropland or in/near developed areas is recommended for this reason.

If placement of wind farms and associated facilities must occur within intact native habitats, offsetting and/or mitigative measures should be considered to compensate for loss and fragmentation of wildlife habitat. Additionally, a mixture of native grasses and forbs typical of those found in this region should be planted to reclaim temporarily disturbed areas. Monitoring and contingency measures should be worked into reclamation plans to ensure that the native prairie is reestablished and that invasive weeds do not overtake disturbed sites.

Please note that the South Dakota Department of Game, Fish and Parks (SDDGFP) has coordinated with the South Dakota Public Utilities Commission (SDPUC) regarding distribution of the SDDGFP's "Siting Guidelines for Wind Power Projects in South Dakota" to wind developers intending to construct projects within the state of South Dakota. You may wish to contact the SDPUC and/or the Wildlife Diversity Division of the SDDGFP in Pierre, South Dakota, for more information. Contact information may be found on their respective web sites: http://www.state.sd.us/puc/ index.htm and http://www.sdgfp.info/Wildlife/Diversity/index.htm. The guidelines themselves may be found on the internet at: http://www.sdgfp.info/wildlife/diversity/windpower.htm.

Additionally, bats are known to suffer mortality due to collisions with wind turbines. The SDDGFP has completed a State Management Plan for bats and may be able to provide additional information and/or recommendations regarding this project. If you have not already done so, please contact Ms. Silka Kempema at the SDDGFP-Wildlife Division, Joe Foss Building, 523 East Capitol Avenue, Pierre, South Dakota 57501, Telephone No. (605) 773-2742, for more information.

The Northern Prairie Wildlife Research Center of Jamestown, North Dakota, has initiated studies of avian responses to wind turbines in both North Dakota and South Dakota. This research may be relevant to your project. We recommend that you contact Ms. Jill Shaffer of the Northern Prairie Wildlife Research Center at (701) 253-5547 for more information.

Please note that the Service owns easement rights on numerous private properties in the state in addition to fee title ownership of Waterfowl Production Areas (WPA). Concentrations of WPA's and easements are further indication of high wildlife values of certain areas in South Dakota. The Service currently has a policy regarding placement of turbines on easements. We refer you to our Wetland Management Districts for actions that may impact easements or WPA's (see table below) and anticipate being kept informed of any actions that may impact these properties.

Office	Jurisdiction	Address	Phone
Madison Wetland Management District	Deuel, Brookings	P.O. Box 48, Madison, SD 57042	(605) 256-2974
Waubay Wetland Management District	Grant, Codington	44401 134A Street Waubay, SD 57273	(605) 947-4521
Sand Lake Wetland Management District	McPherson	39650 Sand Lake Drive Columbia, SD 57433	(605) 885-6320

Although your letter did not mention meteorological towers, it is our understanding that meteorological towers are often constructed in association with wind turbines and that these structures are often similar in design to typical communications towers: tall, lighted, lattice structured, and guyed. These types of towers can be problematic for birds that may fly into the light of the towers and may become reluctant to leave the lighted area, particularly during inclement weather. Mortality results as the birds circle the structure and collide with the guy wires or the lattice of the tower itself. We presume that if meteorological tower(s) have not already been established as part of the proposed projects, they may be in the future. We recommend review of the guidance set forth in U.S. Fish and Wildlife Service Interim Guidelines for Recommendations on Communications Tower Siting, Constructions, Operation and Decommissioning available on the internet at http://migratorybirds.fws.gov/issues/towers/comtow.html, and application of any retrofit measures possible to minimize the threat of avian mortality.

As with towers, the above ground utilities proposed in association with turbine projects (overhead transmission or distribution lines and substations) pose the risk of collision mortality and/or electrocution of birds. In addition to whooping cranes (previously mentioned), thousands of other birds are killed annually as they attempt to utilize overhead power lines or areas near power lines as nesting, hunting, resting, feeding, and sunning sites. Transmission lines are typically less problematic than distribution lines in terms of electrocutions due to their relatively

larger size and spacing between conductive components but still pose a collision mortality risk. Proposed substations may also pose a risk of electrocutions.

We recommend the installation of underground, rather than overhead, power lines whenever possible and appropriate to minimize avian mortality and environmental disturbances. For all new above ground facilities, overhead lines or modernization of old overhead lines, we recommend incorporating measures to prevent avian electrocutions and collisions. The publication entitled "Suggested Practices for Avian Protection on Power Lines - The State of the Art in 2006" has many good suggestions including pole extensions, modified positioning of live phase conductors and ground wires, placement of perch guards and elevated perches, elimination of cross arms, use of wood (not metal) braces, and installation of various insulating covers. You may obtain this publication by contacting the Edison Electric Institute on the internet via their website at www.eei.org or by calling 1-800-334-5453.

Additional information regarding simple, effective ways to prevent raptor electrocutions on power lines is available in video form. "Raptors at Risk" may be obtained by contacting EDM International, Inc. at 4001 Automation Way, Fort Collins, Colorado 80525-3479, Telephone No. (970) 204-4001, or by visiting their web site at http://www.edmlink.com/raptorvideo.htm.

We also recommend marking overhead lines in order to make them more visible to birds. Orange or yellow aviation balls are frequently used for this purpose, but other types of marking devices are also available. For more information on bird strikes, please see "Mitigating Bird Collisions With Power Lines: The State of the Art in 1994" which may be obtained by contacting the Edison Electric Institute at the same web site and telephone number listed above.

The Service has coordinated with the Avian Power Line Interaction Committee (APLIC) to develop guidelines to assist utility companies in formulating Avian Protection Plans. These plans are utility-specific and designed to reduce avian and operational risks that result from avian interactions with electric utility facilities. We submit that these guidelines may also be adapted to wind farms, and we encourage wind energy facilities to investigate the formulation of Avian Protection Plans for their projects. These guidelines may be accessed at the APLIC's web site, http://www.aplic.org/.

The Service's guidance on bald eagles, communications towers, and wind turbines, as well as the APP guidelines and "Suggested Practices . . ." publications will provide some protection for migratory birds; however, implementation of these measures will not remove any liability should violations of the law occur. Please be apprised of the potential application of the Migratory Bird Treaty Act of 1918 (MBTA), as amended, 16 U.S.C. 703 et seq., and the Bald Eagle Protection Act of 1940 (BEPA), as amended, 16 U.S.C. 668 et seq., to the project(s). The MBTA does not require intent to be proven and does not allow for "take," except as permitted by regulations. Section 703 of the MBTA provides: "Unless and except as permitted by regulations . . . it shall be unlawful at any time, by any means, or in any manner, to . . . take, capture, kill, attempt to take, capture, or kill, possess . . . any migratory bird, any part, nest, or eggs of any such bird . . . ." The BEPA prohibits knowingly taking, or taking with wanton disregard for the consequences of an activity, any bald or golden eagles or their body parts, nests, or eggs, which includes collection, molestation, disturbance, or killing activities.

Our foremost recommendation to preclude impacts to migratory birds, federally listed species, and other wildlife by wind energy development is to avoid placing wind farms in high wildlife use areas.

If the a Federal agency is involved in the proposed projects, that agency or their designated representative must determine whether adverse affects may be incurred on listed species in South Dakota and, if so, should request formal consultation from this office. If a "may affect - not likely to adversely affect" determination is made for this project, it should be submitted to this office for concurrence. If a "no effect" determination is made, further consultation may not be necessary. However, a copy of the determination should be sent to this office. Private companies with no Federal nexus should be advised of the potential to impact listed species and note that avenues exist to obtain take permits for their actions via further consultation with this office.

If changes are made in the project plans or operating criteria, or if additional information becomes available, the Service should be informed so that the above determinations can be reconsidered.

The Service appreciates the opportunity to provide comments. If you have any questions regarding these comments, please contact Natalie Gates of this office at (605) 224-8693, Extension 234.

Sincerely,

Pete Gober
Field Supervisor
South Dakota Field Office

cc: USGS; Jamestown, ND
(Attention: Jill Shaffer)
Secretary, SDDGFP; Pierre, SD
(Attention: Silka Kempema)
USFWS; Madison, SD
(Attention: Tom Tornow)
USFWS; Waubay, SD
(Attention: Larry Martin)
USFWS; Columbia, SD
(Attention: Gene Williams)

NAGate

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Number Of Pages (Including Cover): 7 **Date:** 11/27/07

TO Erik Jansen

AGENCY Tetra Tech **CITY** Portland **STATE** OR

FACSIMILE NO. 503 227 1287 **COMMERCIAL NO.** _____

FROM Natalie Gates

SUBJECT Wind Proposal USFWS Response

MESSAGE

Fax As requested, Enc

Natalie

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DEPARTMENT OF GAME, FISH AND PARKS
Foss Building
523 East Capitol
Pierre, South Dakota 57501-3182

December 3, 2007

Erik W. Jansen, Biologist
Tetra Tech EC, Inc.
1750 SW Harbor Way, Suite 400
Portland, OR 97201

RE: Environmental review of Eastern and North-central Wind Resource Area as potential wind power project areas

Dear Mr. Jansen:

The following comments are in response to your letter dated 19 October 2007 requesting environmental considerations and concerns of the Eastern (W1/2 Grant Co., NE 1/4 Codington Co., W1/2, S1/2 Duel Co., and NE1/4 Brookings Co.) and North-central (McPherson County) Wind Resource Areas.

The proposed siting and operation of these wind power projects have potential to directly and indirectly impact area wildlife by killing bats and birds through wind turbine and power line strikes and altering important and declining habitats and breeding and movement behavior of wildlife. While we applaud efforts to provide alternative energy sources, we offer the following considerations for your planning efforts, encouraging responsible siting and mitigation where appropriate to avoid or lessen direct and indirect impacts. As requested, I have provided separate comments for each wind resource area in addition to final comments that apply to any other potential wind power project in South Dakota.

Eastern Wind Resource Area (EWRA)

Grasslands - The EWRA is located within the tall-grass prairie zone. Native grasslands within this zone are decreasing at an alarming rate. Less than one percent of native tall-grass prairie habitat in South Dakota remains (Samson et al. 1998). Other grassland types such as rangeland (grazed grasslands with native plant spp.), pasture (grazed grasslands with non-native plant spp.) and Conservation Reserve Program lands (tilled land planted to vegetative cover) serve as grassland wildlife habitat (Haufler 2005). Fragmentation resulting from woody encroachment, road construction, and conversion of surrounding habitat has resulted in the remaining grassland habitats existing as smaller disjunct patches. Patches often provide less suitable habitat for many native species of grassland wildlife. Some of the last remaining contiguous grasslands tracts occur along the Coteau escarpment that angles through the EWRA.

Grassland birds - Placement of turbines in this area may fragment grassland wildlife habitat reducing its suitability to serve as habitat and modify behavior of grassland bird species, a group of species which has shown the most consistent and long term declines of any other group of bird species in North America (Peterjohn and Sauer 1999). This area is known to have abundant sharp-tailed grouse populations. Greater prairie chickens also are present. The greater prairie chicken is a species known to be area-sensitive, requiring comparatively large tracts of open, contiguous grassland. The lesser prairie chicken, a similar species found more commonly in the southern Great Plains, avoids nesting within 400 m of transmission lines or improved roads (Pitman et al 2004). This highly suggests that placement of turbines and associated infrastructure (roads and transmission lines) may also negatively affect greater prairie chickens.

Birds are susceptible to direct strikes with wind turbines. Based on a study conducted in the Buffalo Ridge area of Minnesota, species with known wind turbine strike mortality and are known to occur in the EWRA include grasshopper sparrow and western meadowlark (Higgins et al 2007).

Properly timed, species-appropriate surveys for prairie grouse (greater prairie chickens and sharp-tailed grouse) and other grassland bird species should be conducted pre-construction. Prairie grouse surveys should be conducted in spring when breeding individuals are on communal display grounds (leks). Surveys for other breeding grassland birds are best conducted in June, although mid-May through early July is acceptable.

Butterflies - Four rare butterfly species are located within the EWRA. These species are classified as Species of Greatest Conservation Need, as listed in our State Wildlife Action Plan (http://www.sdgfp.info/Wildlife/Diversity/Comp_Plan.htm) and are rare species monitored by our Natural Heritage Program (NHP). They include: 1) Dakota skipper, 2) Powesheik skipperling, 3) regal fritillary, and 4) Ottoe skipper.

The range of the Dakota skipper in South Dakota is limited to eleven counties in the north eastern portion of the state. The Dakota skipper requires native mid- to tall-grass prairie and is found on rolling rangeland with abundant wetlands. Larval host plants are grasses, especially little bluestem. Flight of emerging adults occurs from June to mid-July. This species is a candidate for listing under the Federal Endangered Species Act (ESA). As such, I recommend contacting the U.S. Fish and Wildlife Ecological Services Field office in Pierre, South Dakota (605-224-8693) for further information regarding the protection of this species required under ESA. Current threats to this species include, but are not limited to, improper land management uses, agricultural cultivation, road construction, and invasive plant species. South Dakota populations are important to the existence of this species and approximately half of known populations are located on private lands.

The Powesheik skipperling distribution in South Dakota also is limited to eleven counties in the north eastern portion of the state. The Powesheik skipperling prefers native tall-grass prairie and wetlands. Larval host plants are sedges. Flight of emerging adults occurs primarily in July. Threats include excessive prescribed burning, loss of habitat due to conversion to other uses, invasive plants, population isolation, and extreme population crashes.

The regal fritillary is rapidly declining across its range in the United States. In South Dakota, its range is restricted to native prairie sites. Some of the last strongholds of this species are located in prairie states, such as South Dakota, with areas of large expanses of suitable habitat (such as the EWRA) that support larval host plants (violets). Flight periods are from June to September. Threats include loss and fragmentation of habitat to agriculture (excluding grazing or haying), conversion to cropland, woody encroachment, chemicals (e.g., pesticides and herbicides), and improper fire management.

The Ottoe skipper also requires relatively undisturbed native prairie with nectar sources (coneflowers, grayfeathers, asters, etc). It is uncommon to rare throughout the state. Peak flight for the Ottoe skipper is in mid-July. The reduction and degradation of prairie habitat is the main threat to this species.

The conservation of the four rare butterfly species documented in the EWRA requires protection of remaining undisturbed tracts of native prairie with associated nectar sources and larval host plants. There are potential disturbances to these rare butterfly species associated with the construction and maintenance of a wind power project. Road construction and turbine pad maintenance increases the chances of non-native, invasive plant species invasion. Chemical control of these species is a known threat. Pre-construction surveys for these species should be conducted during the appropriate times (flight periods). Construction in areas that are or potential butterfly habitat should be avoided.

Wetlands - The proposed project area is located within the Prairie Pothole region. This glaciated region, characterized by high densities of wetland basins of various depths and sizes, extends from Iowa into Minnesota, the Dakotas, Montana and parts of Canada. It is the major waterfowl production area in North America. Wetland losses in the Prairie Pothole Region are staggering and range from 99% in Iowa to 35% in South Dakota. Wetland basin densities (# of basins/10 mi^2) in the EWRA range from 90 to over 420 basins/10 $miles^2$. More specifically, this area is known to have some of the highest seasonal and semipermanent wetland basin densities in the state (Johnson and Higgins 1997). These remaining, high density wetlands provide critical wildlife habitat.

Wetland birds - Waterbird species such as loons, black terns, great egrets, and green backed herons are known to occur in the EWRA. Abundant waterfowl such as mallard, blue-winged teal, redhead, ruddy duck, American coot, and bufflehead also can be found in the area. Birds are susceptible to direct strikes with wind turbines. Based on a study conducted in the Buffalo Ridge area of Minnesota, species with known wind turbine strike mortality and are known to occur in the EWRA include ruddy duck, American coot, and Franklin's gull (Higgins et al 2007). Proper siting of turbines outside of daily and seasonal migration routes of waterbirds and waterfowl and the protection of remaining wetlands within the proposed project area is crucial to reduce the impact to wetland dependent species.

Bats - Bats forage and migrate along rivers, streams, and lakes. Construction of a wind power plant may affect daily and seasonal bat movements between breeding and foraging areas. Thirteen species of bats are found in South Dakota, some of which are summer residents, year-round residents, or migratory (Table 1).

Table 1. South Dakota Bats

Common Name	Scientific Name	State Residency
Big Brown Bat	*Eptesicus fuscus*	Year-round resident
Fringed Myotis	*Myotis thysanodes*	Year-round resident
Little Brown Myotis	*Myotis lucifugus*	Year-round resident
Long-eared Myotis	*Myotis evotis*	Year-round resident
Long-legged Myotis	*Myotis volans*	Year-round resident
Northern Myotis	*Myotis septentrionalis*	Year-round resident
Townsend's Big-eared Bat	*Corynorhinus townsendii*	Year-round resident
Western Small-footed Myotis	*Myotis ciliolabrum*	Year-round resident
Hoary Bat	*Lasiurus cinereus*	Summer resident
Silver-haired Bat	*Lasionycteris noctivagans*	Summer resident
Evening Bat	*Nycticeius humeralis*	Migratory
Eastern pipistrell	*Pipistrellus subflavus*	unclassified

There has been limited research conducted on bats in South Dakota. However, Swier (2006) reported four species of bats occurring near the EWRA: 1) big brown bat, 2) Eastern red bat, 3) hoary bat, and 4) little brown myotis.

Six bat species are considered rare and monitored by the NHP: 1) long-eared myotis, 2) fringed myotis, 3) Northern myotis, 4) silver-haired bat, 5) Townsend's big-eared bat, and 6) evening bat. Although the NHP data base has no records of theses species in the proposed project area, this does not preclude the presence of any of these species in the area. Because of limited, EWRA-specific data, we would suggest pre-construction surveys of the area for potential bat habitat and species. Surveys for species should be conducted for at least one full year before construction.

Recently, South Dakota Department of Game, Fish and Parks (SDGFP) in cooperation with the South Dakota Bat Working Group (SDGWG), developed a South Dakota Bat Management Plan specific to bats and their habitats in South Dakota (http://www.sdgfp.info/Wildlife/Diversity/batmanagmentplan71304.pdf). Please review this document for pertinent information. Again, because bats reside and migrate through South Dakota, it is important to evaluate the propose project area for roosting, feeding, migration and/or stopover habitat and to survey these areas for bats.

Landscape considerations - Placement of a wind power project should take into account larger landscape-level (e.g. surrounding land uses) and cumulative impacts (e.g. existing and potential wind power projects) as well as project associated infrastructure (i.e. transmission lines and roads).

Public lands - Several Game Production Areas within the EWRA are managed by SDGFP. Placement of public lands is often done so in areas with existing and potential wildlife habitat. Management of these lands, for wildlife, is conducted in the public interest. In addition, several USFWS Waterfowl Protection Areas are also located within the EWRA. Public lands managed

for wildlife may be affected by the placement of a wind power project in the vicinity.

Migrating wildlife - The resulting mosaic of grassland and wetland basins and corridors makes it an important migration route for birds (e.g., neotropical migrants, shorebirds, and waterfowl). The Central Flyway, an important pathway for migratory ducks, geese, swans, and cranes runs through the midsection of the country, including South Dakota. Species using this flyway during migration, and particularly during inclement weather when birds alter their flight altitude, may suffer increased mortality due to direct strikes with wind turbines and associated power lines. Appropriately timed, pre-construction surveys for migratory bird species should be conducted. Spring migration can begin as early as late-March, early-April, tapering off in mid-May, depending on the species. Fall migration can begin as early as mid-July and extend through October/November depending on weather conditions and species.

Powerlines - Construction of powerlines is often associated with a proposed wind power project. Power line strikes are a known cause of mortality to birds (Erickson et al. 2005). Waterfowl (ducks, geese, swans, and cranes), raptors, and passerines are species most susceptible to powerline collisions. The Avian Protection Power line Interaction Committee (APLIC) has developed two documents that may be of use to reduce powerline strikes and mortality: 1) 'Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006' and 2) 'Mitigating Bird Collisions with Power lines'. Both of these documents are available from the Edison Institute (http://www.aplic.org/, under 'products and services'). The new and existing power lines associated with the proposed project should be buried, marked, or retrofitted to reduce strikes and electrocutions of bird species.

Non-native species - During the construction and maintenance phase of a wind power project existing roads often experience increased traffic and new roads are constructed. This increases the amount of area disturbed and allows for the introduction and establishment of non-native species. Resulting control of those species through pesticides and herbicides may also impact habitats of rare wildlife species. Non-native species are one of the major threats to rare and declining wildlife species. Improved access can also increase human activity in the area.

The matrix of grassland and wetland habitats in the proposed project area plays a crucial role in the life history of several wildlife species whether migratory or resident. Because of the potential impacts placement of the proposed wind power project would have on unique and declining habitats in the region and their associated species, we recommend the placement of turbines in areas currently disturbed (e.g. cultivated areas) and the use of existing infrastructure (roads and transmission lines) as much as possible.

North-central Wind Resource Area (McPherson County)

Grassland habitat - McPherson County is located within the mixed-grass prairie zone. In the United States, native mixed-grass prairie is disappearing at an alarming rate. In South Dakota, the area of mixed-grass prairie has decreased 70% (Samson et al. 1998). The native prairie that still remains is most often grazed (i.e. rangeland). These and other grassland types such as pasture (grazed grasslands of non-native plant spp.) and Conservation Reserve Program lands (tilled land idled and planted to vegetative cover) also serve as grassland wildlife habitat (Haufler 2005). Fragmentation resulting from woody encroachment, road construction, and conversion of surrounding habitat has resulted in the remaining grassland habitats existing as smaller disjunct patches. Patches often provide less suitable habitat for many native species of grassland wildlife. McPherson County has large tracts of contiguous grassland habitat (including rangeland) located along the ridge extending through Wacker, Weber, Hoffman, and Central McPherson townships.

Grassland birds - Placement of turbines in this area may fragment grassland wildlife habitat reducing its suitability to serve as habitat and modify behavior of grassland bird species, a group of species which has shown the most consistent and long term declines of any other group of species in North America (Peterjohn and Sauer 1999). Two grassland bird species, Baird's sparrow and Sprague's pipit, are known to occur in McPherson County. Range-wide, both of these species have exhibited significant long term negative population trends. In South Dakota, these species hold special conservation status and are classified as Species of Greatest Conservation Need, as listed in our State Wildlife Action Plan (http://www.sdgfp.info/Wildlife/Diversity/Comp_Plan.htm) and are rare species monitored by our NHP. In addition, these species are considered Grassland Species of Concern in South Dakota (Bakker 2005). Regionally they are Species of Special Concern as defined by Partner's in Flight and are considered a Species of Conservation Concern by the USFWS. The amount of emphasis placed on the conservation of these species indicates populations are declining.

Baird's sparrows breed in the north-western and north-central part of the state. Throughout most of its breeding range, it is known to prefer native mixed grass prairie interspersed with forbs (broad-leaved, herbaceous plant), moderate amounts of litter (dead layers of vegetation), and little to no shrub cover. Although the Baird's Sparrow has a strong tendency to prefer native prairie, it can be observed in non-native grasslands (e.g. crested wheatgrass) that provide appropriate habitat structure. Baird's sparrows are known to prefer large patches of grassland habitat and show avoidance of areas with extensive woody vegetation and areas near roads.

Sprague's pipits are found in the northwestern portion of the state, preferring plains and short-grass prairie with intermediate vegetation height. This species prefers native prairie, although they are known to occupy habitat consisting of non-native plant species. Sprague's pipits are most common in large contiguous grassland areas and are known to be area sensitive.

Properly timed, species-appropriate pre-construction surveys should be conducted for grassland bird species. Surveys for most breeding grassland birds are best conducted in June, although mid-May through early July is suitable. Prairie grouse surveys should be conducted in spring when breeding individuals are on communal display grounds (leks).

Wetland habitats - McPherson County is located within the Prairie Pothole Region. This glaciated region, characterized by a diversity and quantity of basin wetlands, extends from Iowa into Minnesota, the Dakotas, Montana and parts of Canada. It is the major waterfowl production area in North America. Wetland losses in the Prairie Pothole Region are staggering and ranging from 99% in Iowa to 35% in South Dakota. Throughout McPherson County, wetland basin density is high (270 - over 420 basins/10 mi^2). More specifically, the eastern quarter of the County has some of the highest concentrations of temporary and seasonal wetlands (Johnson and Higgins 1997) in the state. Remaining wetlands provide important wildlife habitat.

Wetland birds - In terms of waterfowl breeding activity, the western two-thirds of McPherson County has over 100 breeding duck pairs/mi^2. This is some of the highest breeding waterfowl densities in the Prairie Pothole region. Conservation of this habitat also is critical to waterbirds and shorebirds for breeding, feeding, and migration habitat.

Bird diversity - Reflective of the diversity and quality of native wetland and grassland habitats in the region, the northeastern portion of McPherson County has some of the highest bird species richness in the state (Peterson 1995). This is based upon data gathered from a five-year, state-wide breeding bird survey efforts.

Bats - Bats forage and migrate along rivers, streams and lakes. Construction of a wind power project may affect daily and seasonal bat movements between breeding and foraging areas. Thirteen species of bats are found in South Dakota, some of which are summer residents, year-round residents, or migratory (Table 1). There has been limited research conducted on bats in South Dakota, especially in McPherson County. The NHP database has no records of bat species considered rare in the proposed project. However, this does not preclude the presence of any of these or other bat species in the area. Because of limited information on bats in McPherson County, we would suggest pre-construction surveys of the area for potential bat habitat and species. Surveys for species should be conducted for at least one full year before construction.

Recently, SDGFP in cooperation with the SDBWG, developed a South Dakota Bat Management Plan specific to bats and their habitats in South Dakota (http://www.sdgfp.info/Wildlife/Diversity/batmanagmentplan71304.pdf). Please review this document for pertinent information. Again, because bats reside and migrate through South Dakota, it is important to evaluate the propose project area for roosting, feeding, migration and/or stopover habitat and to survey these areas for bats.

Landscape considerations - Placement of a wind power project should take into account larger landscape-level (e.g. surrounding land uses) and cumulative impacts (e.g. existing and potential wind power projects) as well as project associated infrastructure (i.e. transmission lines, roads).

Public lands - Several Game Production Areas within McPherson County are managed by SDGFP. Placement of public lands is often done so in areas with existing and potential wildlife habitat. Management of these lands, for wildlife, is conducted in the public interest. In addition, several U. S. Fish and Wildlife Service Waterfowl Protection Areas are also located within McPherson County. Public lands managed for wildlife may be affected by the placement of a

wind power project in the vicinity.

Migrating wildlife - The resulting mosaic of grassland and wetland basins and corridors in the County make it an important migration route for birds (e.g., neotropical migrants, shorebirds, waterfowl). The Central Flyway, an important pathway for migratory ducks, geese, swans, and cranes runs through the midsection of the country, including South Dakota. Species using this flyway during migration, and particularly during inclement weather when birds alter their flight altitude, may suffer increased mortality due to direct strikes with wind turbines and associated power lines. Appropriately timed, pre-construction surveys for migratory bird species should be conducted. Spring migration can begin as early as late-March, early-April, tapering off in mid-May, depending on the species. Fall migration can begin as early as mid-July and extend through October/November depending on weather conditions and species.

Powerlines - Construction of powerlines is often associated with a proposed wind power project. Power line strikes are a known cause of mortality to birds (Erickson et al. 2005). Waterfowl (ducks, geese, swans, and cranes), raptors, and passerines are species most susceptible to powerline collisions. The Avian Protection Power line Interaction Committee (APLIC) has developed two documents that may be of use to reduce powerline strikes and mortality: 1) 'Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006' and 2) 'Mitigating Bird Collisions with Power lines'. Both of these documents are available from the Edison Institute (http://www.aplic.org/, under 'products and services'). The new and existing power lines associated with the proposed project should be buried, marked, or retrofitted to reduce strikes and electrocutions of bird species.

Non-native species - During the construction and maintenance phase of a wind power projects existing roads often experience increased traffic and new roads are constructed. This increases the amount of area disturbed and allows for the introduction and establishment of non-native species. Resulting control of those species through pesticides and herbicides may also impact habitats of rare wildlife species. Non-native species are one of the major threats to rare and declining wildlife species. Improved access can also increase human activity in the area.

The matrix of grassland and wetland habitats in the proposed project area plays a crucial role in the life history of several wildlife species whether migratory or resident. Because of the potential impacts placement of the proposed wind power project would have on unique and declining habitats in the region and their associated species, we recommend the placement of turbines in areas currently disturbed (e.g. cultivated areas) and the use of existing infrastructure (roads and transmission lines) as much as possible.

Research and Monitoring

As outlined above, our agency has concerns regarding direct and indirect impacts to wildlife and habitats in association with the siting of the proposed project. Before project construction, appropriate monitoring should be conducted to determine bird and bat use of the project areas. Based upon results of these studies, project construction should be modified, continued, or cancelled. If the project is continued, monitoring should be conducted for a minimum of two years post-construction to determine if and how many bird and bat strikes are caused by this project, if habitats have been significantly altered, and if the surrounding public lands and their uses have been impacted. Any mitigation should be carefully planned, funded, and followed.

If monitoring involves live trapping or collection of wildlife species, you must first obtain a collection permit from our agency. Also, we kindly request that if you or your associates observe any of the animal (http://www.sdgfp.info/Wildlife/Diversity/RareAnimal.htm) or plant species (http://www.sdgfp.info/Wildlife/Diversity/rareplant2002.htm) monitored by the NHP, please contact myself or any of our NHP staff (http://www.sdgfp.info/Wildlife/Diversity/staff_contact.htm).

In coordination with the SDBWG, the SDGFP has developed 'Siting Guidelines for Wind Power Projects in South Dakota' This document addresses many of the concerns involved with siting wind power projects in South Dakota and may be found at on the world wide web (http://www.sdgfp.info/Wildlife/Diversity/windpower.htm). I have enclosed a copy for your convenience.

The SDGFP appreciates the opportunity to provide comments on the proposed project wind resource areas. As plans are further refined, I would be willing to conduct a site visit with you or your associates to continue to provide siting recommendations to reduce conflicts with wildlife. If you have any questions on the above comments, please feel free to contact me at 605-773-2742 or Silka.Kempema@state.sd.us.

Regards,

Silka Kempema

Silka L. F. Kempema
Terrestrial Wildlife Biologist

CC: Natalie Gates, US Fish and Wildlife Service, Pierre, SD
Will Morlock, SD Game, Fish and Parks, Watertown, SD
Mary Clawson, SD Game, Fish and Parks, Aberdeen, SD

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CR-0113

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
420 South Garfield Avenue, Suite 400
Pierre, South Dakota 57501-5408

February 5, 2010

Ms. Anne-Marie Griger
Tetra Tech, EC Inc.
7800 Shoal Creek Boulevard, Suite 253 East
Austin, Texas 78757

Re: Proposed Crowned Ridge Wind Energy Center, Codington and Grant Counties, South Dakota

Dear Ms. Griger:

This letter is in response to your request dated December 7, 2009, for environmental comments regarding the above referenced project involving construction of a wind farm up to 150 megawatts in size and an associated 34-mile transmission line. The proposed location of the project is north and east of the city of Watertown and includes various sections within Townships 118- 121 North, Ranges 48-52 West, Codington and Grant Counties, South Dakota. Herein we provide information regarding U.S. Fish and Wildlife Service (Service) trust resources, including easement properties, federally endangered species, eagles, birds of conservation concern, and other migratory birds that may occur in the project area. We have included recommended measures to be applied to various components of a wind farm, including meteorological towers, power lines, and the turbines themselves in order to minimize impacts to Service trust resources and to assist the development company in achieving compliance with Federal laws.

Threatened/Endangered Species

In accordance with section 7(c) of the Endangered Species Act (ESA), as amended, 16 U.S.C. 1531 et seq., we have determined that the following federally listed species may occur in the project area (this list is considered valid for 90 days):

Species	Status	Expected Occurrence
Topeka shiner (Notropis topeka)	Endangered	Known Resident.

Topeka shiners are known to occupy numerous small streams within eastern South Dakota and are concentrated within the Big Sioux, Vermillion, and James River watersheds. Willow Creek in the Big Sioux watershed of Codington County is a known occupied stream with a tributary that appears to fall within the project area. Project activities that may impact this waterway directly or indirectly have the potential to negatively affect the Topeka shiner. The Service recommends avoidance of these impacts, particularly related to instream work. Further consultation may be required to determine the possibility of adverse affects to this species.

As indicated by Appendix 1 included with your letter (Summary of Surveys Conducted to Date), you are aware that the Dakota skipper (Hesperia dacotae) is known to occur in northeastern South Dakota. The Dakota skipper is a candidate species and accordingly is not, at present, provided Federal protection under the ESA. Their candidate status defines these butterflies as a species in decline that the Service believes needs to be listed as threatened or endangered, but listing is currently precluded by other priorities. Dakota skippers are obligate residents of high quality prairie ranging from wet-mesic tallgrass prairie to dry-mesic mixed grass prairie. In northeastern South Dakota, Dakota skippers inhabit dry-mesic hill prairies with abundant purple coneflower but also use mesic to wet-mesic tallgrass prairie habitats characterized by wood lily and smooth camas. Per your surveys, it appears that significant percentages of good to excellent Dakota skipper grasslands exist in the project area. Surveys for this species by a qualified biologist may be useful to confirm the ranking of habitat (excellent, good, poor) described in the summary of surveys. The Service requests the results of any such surveys and recommends avoidance and minimization of impacts to Dakota skipper habitats.

If a Federal nexus exists for this project and the Federal action agency or their designated representative determines that the project "may adversely affect" listed species in South Dakota, it should request formal consultation from this office. If a "may affect - not likely to adversely affect" determination is made for this project, it should be submitted to this office for concurrence. If a "no effect" determination is made, further consultation may not be necessary; however, a copy of the determination should be forwarded to our office.

Please note that, if impacts to federally listed species may occur as a result of projects with no Federal nexus, avenues to avoid violations of section 9 of the ESA should be investigated via contact with this office.

Bald and Golden Eagles

A golden eagle was reported in Appendix 1 included with your letter (Summary of Surveys Conducted to Date). Please note also that the bald eagle (Haliaeetus leucocephalus) occurs throughout South Dakota in all seasons, and new nests are appearing each year. While ESA protections for the bald eagle have been removed, effective August 8, 2007, both bald and golden eagles will continue to be protected under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) (more on these laws below). These laws protect eagles from a variety of harmful actions and impacts. The Service has developed guidance for the public regarding means to avoid take of the bald eagle under these laws. The *"National Bald Eagle Management Guidelines"* are available online at: http://www.fws.gov/migratorybirds/baldeagle.htm. We recommend reviewing these guidelines as they serve to advise of circumstances where these laws may apply and to assist in avoiding potential violations on this and future projects. Additionally, permit regulations have been published for bald eagles and golden eagles. These regulations may be found in the Federal Register (Volume 74, No. 175, Friday, September 11, 2009) online at: http://www.gpoaccess.gov/fr/index.html.

Birds of Conservation Concern

Your survey efforts revealed South Dakota state-sensitive species in the project area. Please note that the Migratory Birds Division of the Service has identified bird species of conservation concern: *"Birds of Conservation Concern 2008"* may be found online at: http://www.fws.gov/migratorybirds/NewReportsPublications/SpecialTopics/BCC2008/BCC2008.pdf. This document is intended to identify species in need of coordinated and proactive

conservation efforts among State, Federal, and private entities, with the goals of precluding future evaluation of these species for ESA protections and promoting/conserving long-term avian diversity. A primary threat to many of these species is habitat loss and fragmentation.

In accordance with Executive Order 13186 regarding migratory bird protection, we recommend avoidance, minimization, and finally compensation to reduce the impacts to species protected by the MBTA. Compliance with this law may be partially addressed in an Avian and Bat Protection Plan (see below); however, a separate mitigation plan that specifically addresses direct and indirect take of birds during and after construction is also recommended. Particularly if placement must occur within intact native habitats, we strongly recommend development of mitigative/offsetting measures for this habitat and its associated wildlife.

U.S. Geological Survey (USGS) Research

The USGS's Northern Prairie Wildlife Research Center in Jamestown, North Dakota, has initiated studies of avian responses to wind turbines in both North Dakota and South Dakota. Their research may be relevant to your project, depending on habitat within the project area. We recommend that you contact Ms. Jill Shaffer of the Northern Prairie Wildlife Research Center at Telephone No. (701) 253-5547 for more information and for the possibility of participation in that research.

Service Wetland Management District

Our records indicate that the Service holds easements on some of the properties proposed for construction, and your letter indicates that you have been in contact with the Habitat and Population Evaluation Team's office to obtain the locations of these easements. If you have not already done so, please also contact Mr. Larry Martin of the Service's Waubay Wetland Management District at 44401 134A Street, Waubay, South Dakota 57273, Telephone No. (605) 947-4521, for additional information.

Bats

Bats are known to suffer mortality due to direct collisions with wind turbines, and it has been recently determined that many also die as a result of air pressure changes at the turbine blades that cause internal injuries. The South Dakota Department of Game, Fish and Parks (SDDGFP) has completed a State management plan for bats and may be able to provide additional information and/or recommendations on bats relative to this project. Your letter states that you have contacted the SDDGFP; thus, you may have already received a response from Silka Kempema of that agency. Nonetheless, her contact information is SDDGFP-Wildlife Division, Joe Foss Building, 523 East Capitol Avenue, Pierre, South Dakota 57501, Telephone No. (605) 773-2742.

Fisheries

As per the map sent with your letter, the project area contains the Whetstone River and the North Fork Yellow Bank River which have been classified by the Service as Type II, High Priority Fishery Resources. Riverine and riparian areas are among the highest resource priorities in this region of the Service. We recommend minimization of impacts to these resources and mitigation of all unavoidable habitat losses. The following methods should be implemented to minimize environmental impacts:

1. Instream work should not be undertaken during fish spawning periods. Most spawning occurs in April, May, and June.

2. Stream bottoms and wetlands impacted by construction activities should be restored to pre-project elevations.

3. Removal of vegetation and soil should be accomplished in a manner to reduce soil erosion and to disturb as little vegetation as possible.

4. Grading operations and reseeding of native species should begin immediately following construction.

5. If trees or brush will be impacted by the project, a ratio of at least 2:1 acres planted versus acres impacted should be incorporated into mitigation plans for the project.

Wetlands

According to National Wetlands Inventory maps (available online at http://wetlands.fws.gov/), numerous wetlands exist within the proposed project area. If a project may impact wetlands or other important fish and wildlife habitats, the Service, in accordance with the National Environmental Policy Act of 1969 (42 U.S.C. 4321-4347) and other environmental laws and rules, recommends complete avoidance of these areas, if possible; then minimization of any adverse impacts; and finally, replacement of any lost acres; in that order. Alternatives should be examined and the least damaging practical alternative selected. If wetland impacts are unavoidable, a mitigation plan addressing the number and types of wetland acres to be impacted and the methods of replacement should be prepared and submitted to the resource agencies for review.

Wind Turbine Guidelines

Among the Service's primary concerns regarding wind turbines are avian collision mortality and the loss of habitat/habitat avoidance behaviors by wildlife, including federally listed species as indicated above. While there is still much to be learned regarding wind turbine-wildlife interactions, we do know that wind turbines can have adverse impacts on some species. Turbine location, spacing, aspect, lighting, size, and design are all potential factors related to the risk posed to resident and migratory wildlife as are the types of surrounding habitats, their use by various species of wildlife, landscape features, prey base, migration corridors, and behavioral patterns. Direct collision mortality is a concern as is loss of habitat caused by the footprint of the turbines and associated roads and structures, along with impacts that can occur with encroachment of invasive weeds as a result of these disturbances. Recent studies of grassland nesting birds have shown a tendency for avoidance of areas immediately surrounding turbines, causing indirect habitat loss as well. Currently, perhaps the best means of avoiding impacts to wildlife is to avoid placing wind farms within high wildlife use areas. Placement of turbines within existing cropland or other disturbed areas is recommended for this reason.

The Service has developed voluntary *"Interim Guidelines to Avoid and Minimize Wildlife Impacts from Wind Turbines"* to assist energy companies in accomplishing the goal of reducing the risk posed by turbines to wildlife. These guidelines may be accessed on the internet at: http://www.fws.gov/habitatconservation/Service%20Interim%20Guidelines.pdf. The guidelines stress the importance of proper evaluation of potential wind turbine development sites (via development of a Potential Impact Index score for the proposed site and a reference area), appropriate location and design of turbines and related facilities, and pre- and post-construction

research and monitoring. If the proposed project is to be constructed, we request the results of any pre-/post-construction wildlife monitoring, including any incidental mortality detected.

Please note that the SDDGFP has coordinated with the South Dakota Public Utilities Commission (SDPUC) regarding distribution of SDDGFP's *"Siting Guidelines for Wind Power Projects in South Dakota"* to wind developers intending to construct projects within the state of South Dakota. You may wish to contact the SDPUC and/or the Wildlife Diversity Division of the SDDGFP in Pierre for more information. Contact information may be found on their respective websites: http://puc.sd.gov/ and http://www.sdgfp.info/Wildlife/Diversity/index.htm. The guidelines themselves may be found online at: http://www.sdgfp.info/wildlife/diversity/windpower.htm.

Meteorological Towers

Meteorological towers constructed in association with wind turbines are often similar in design to typical communication towers: tall, lighted, lattice structured, and guyed. These types of towers can be problematic for birds, particularly during inclement weather, as they enter the lighted area, become reluctant to leave it, and suffer mortality as they circle the structure and collide with the guy wires or the lattice tower itself. We recommend following the guidance set forth in *"U.S. Fish and Wildlife Service Interim Guidelines for Recommendations on Communications Tower Siting, Constructions, Operation and Decommissioning,"* found online at: http://www.fws.gov/habitatconservation/communicationtowers.html, to minimize the threat of avian mortality at these towers. Monitoring at these towers would provide insight to the effectiveness of the minimization measures. We request the results of any wildlife monitoring and any data obtained regarding wildlife mortality at towers associated with this project.

In order to obtain information on the usefulness of the communications tower guidelines in preventing birds strikes and to identify any recurring problems with their implementation which may necessitate modifications, please advise us of the final location and specifications of any towers associated with the wind turbine project and which of the measures recommended for the protection of migratory birds were implemented. If any of the recommended measures cannot be implemented, please explain why they were not feasible. A Tower Site Evaluation Form is also available via the above communication tower website (http://www.fws.gov/habitatconservation/communicationtowers.html). If meteorological towers are to be constructed, please complete this form and forward it to our office.

Power Lines

The construction of additional overhead power lines associated with wind farms creates the threat of avian electrocution, particularly for raptors, and collisions. Thousands of these birds, including endangered species, are killed annually as they attempt to utilize overhead power lines as nesting, hunting, resting, feeding, and sunning sites. The Service recommends the installation of underground, rather than overhead, power lines whenever possible/appropriate to minimize environmental disturbances. For all new overhead lines or modernization of old overhead lines, we recommend incorporating measures to prevent avian electrocutions. The publication entitled *"Suggested Practices for Avian Protection on Power Lines - The State of the Art in 2006"* has many good suggestions, including pole extensions, modified positioning of live phase conductors and ground wires, placement of perch guards and elevated perches, elimination of cross arms, use of wood (not metal) braces, and installation of various insulating covers. You may obtain this publication by contacting the Edison Electric Institute via their website at www.eei.org or by calling 1-800-334-5453.

Please note that utilizing just one of the *"Suggested Practices . . ."* methods may not entirely remove the threat of electrocution to raptors. In fact, improper use of some methods may increase electrocution mortality. Perch guards, for example, may be only partially effective as some birds may still attempt to perch on structures with misplaced or small-sized guards and suffer electrocution as they approach too close to conducting materials. Among the most dangerous structures to raptors are poles that are located at a crossing of two or more lines, exposed above-ground transformers, or dead end poles. Numerous hot and neutral lines at these sites, combined with inadequate spacing between conductors, increases the threat of raptor electrocutions. Perch guards placed on other poles has in some cases served to actually shift birds to these more dangerous sites, increasing the number of mortalities. Thus, it may be necessary to utilize other methods or combine methods to achieve the best results. The same principles may be applied to substation structures.

Please also note that the spacing recommendation within the *"Suggested Practices . . ."* publication of at least 60 inches between conductors or features that cause grounding may not be protective of larger raptors such as eagles. This measure was based on the fact that the skin-to-skin contact distance on these birds (i.e., talon to beak, wrist to wrist, etc.) is less than 60 inches. However, an adult eagle's wingspan (distance between feathertips) may vary from 66 to 96 inches depending on the species (golden or bald) and gender of the bird. Unfortunately, wet feathers in contact with conductors and/or grounding connections can result in a lethal electrical surge. Thus, the focus of the above precautionary measures should be to a) provide more than 96 inches of spacing between conductors or grounding features, b) insulate exposed conducting features so that contact will not cause raptor electrocution, and/or c) prevent raptors from perching on the poles in the first place.

Additional information regarding simple, effective ways to prevent raptor electrocutions on power lines is available in video form. *"Raptors at Risk"* may be obtained by contacting EDM International, Inc. at 4001 Automation Way, Fort Collins, Colorado 80525-3479, Telephone No. (970) 204-4001, or by visiting their website at: http://www.edmlink.com/raptorvideo.htm.

In addition to electrocution, overhead power lines also present the threat of avian line strike mortality. Particularly in situations where these lines are adjacent to wetlands or where waters exist on opposite sides of the lines, we recommend marking them in order to make them more visible to birds. For more information on bird strikes, please see *"Mitigating Bird Collisions With Power Lines: The State of the Art in 1994"* which may be obtained by contacting the Edison Electric Institute at the same website and telephone number listed above. Please note that, while marking of power lines reduces line strike mortality, it does not preclude it entirely. Thus, marking of additional, existing, overhead lines is recommended to further offset the potential for avian line strike mortality.

Avian Protection Plans

As a means to address some of the above issues, the Service has coordinated with the Avian Power Line Interaction Committee (APLIC) to develop guidelines to assist companies in formulating Avian (and Bat) Protection Plans (APP). APPs are utility-specific and designed to reduce avian and operational risks that result from avian interactions with electric utility facilities, but they may be adapted to wind energy facilities as well and include consideration of bat species which are known to suffer mortality at wind farms. We encourage project developers to investigate the formulation of an Avian (and Bat) Protection Plan for specific projects and perhaps generate APPs at the company level. The APP guidelines may be accessed at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/BirdHazards.html.

The Service has developed an online reporting system for mortalities. Instructions for our "Bird Fatality/Injury Reporting Program" may be found online at: http://www.aplic.org/USFWS_BirdFatality_FilerInstructions.pdf, and the reporting site itself is located online at: https://birdreport.fws.gov/. Migratory bird mortalities or injuries located by your company, contractors, or other individuals should be recorded to this online site within 30 days of discovery. Use of this reporting program will benefit migratory birds by increasing our tracking capability of activities impacting migratory birds. This program may be used to compliment an Avian (and Bat) Protection Plan.

MBTA and BGEPA

Although adherence to the Service's recommendations will provide some protection for migratory birds, implementation of these measures alone will not remove any liability should violations of the law occur. The MBTA prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Department of the Interior. The BGEPA prohibits knowingly taking, or taking with wanton disregard for the consequences of an activity, any bald or golden eagles or their body parts, nests, or eggs, which includes collection, molestation, disturbance, or killing activities (again, refer to the new regulations regarding take of eagles in the September 11, 2009, publication of the Federal Register for additional information).

While the MBTA has no provision for allowing unauthorized take, the Service realizes that some birds may be killed as a result of this project even if all reasonable measures to protect them are used. The Service's Office of Law Enforcement carries out its mission to protect migratory birds through investigations and enforcement as well as by fostering relationships with individuals, companies, and industries that have taken effective steps to minimize their impacts on migratory birds and by encouraging others to enact such programs. It is not possible to absolve individuals, companies, or agencies from liability even if they implement avian mortality avoidance or similar conservation measures. However, the Office of Law Enforcement focuses its resources on investigating and prosecuting individuals and companies that take migratory birds without regard for their actions or without following specific agreements to avoid take.

In summary, the following items are pertinent to the proposed project, and we recommend addressing these issues if/when the project progresses:

- ✓ ESA listed species impacts: Topeka shiner
- ✓ Bald and golden eagle impacts (BGEPA and MBTA)
- ✓ Migratory bird impacts (MBTA), including Birds of Conservation Concern, with application of pre-/post-construction monitoring and mortality data and mitigative/offsetting measures to be coordinated with and reported to the Service
- ✓ USGS avian/wind studies and potential participation in their ongoing research
- ✓ Service easement impacts
- ✓ Fisheries and wetlands impacts
- ✓ SDDGFP wind siting guidelines and bat issues

✓ Existing guidelines for various project components:

a) Wind farm siting: Service's *"Interim Guidelines to Avoid and Minimize Wildlife Impacts from Wind Turbines"*

b) Meteorological Towers: Service's *"Interim Guidelines for Recommendations on Communications Tower Siting, Constructions, Operation and Decommissioning"* and the associated Tower Site Evaluation Form

c) Overhead power lines: APLIC's *"Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006"* and *"Mitigating Bird Collisions With Power Lines: The State of the Art in 1994"*

d) Overall project construction/operation: Service's *"National Bald Eagle Management Guidelines,"* APLIC's *"Avian Protection Plan Guidelines,"* and the Service's "Bird Fatality/Injury Reporting Program"

If changes are made in the project plans or operating criteria, or if additional information becomes available, the Service should be informed so that the above determinations can be reconsidered.

The Service appreciates the opportunity to provide comments. If you have any questions on these comments, please contact Natalie Gates of this office at (605) 224-8693, Extension 234.

Sincerely,

P Gober

Pete Gober
Field Supervisor
South Dakota Field Office

cc: Service/Waubay WMD; Waubay, SD
(Attention: Larry Martin)
Secretary, SDDGFP; Pierre, SD
(Attention: Silka Kempema)
USGS/NPWRC; Jamestown, ND
(Attention: Jill Shaffer)
SDPUC; Pierre, SD
(Attention: Brian Rounds)

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TETRA TECH

February 11, 2015

Mr. Jeff Vonk
Secretary
South Dakota Game Fish and Parks
523 East Capitol Avenue
Pierre, SD 57501

RE: Crowned Ridge Wind Energy Center in Codington and Grant Counties, South Dakota

Dear Mr. Vonk:

As part of our Tier 1 preliminary site evaluation and Tier 2 site characterization under the U.S. Fish and Wildlife Service (USFWS) voluntary Land-Based Wind Energy Guidelines, Tetra Tech, Inc. (Tetra Tech) is writing on behalf of NextEra Energy Resources, LLC (NextEra), to request information regarding ecologically significant areas and listed endangered, threatened or special concern species including eagles at a potential wind energy development site in Codington and Grant counties, South Dakota. We contacted your agency in 2007 regarding a much larger area for wind energy development that NextEra may develop in a later phase (see attached response letter dated December 3, 2007); however, the current project area in in Codington and Grant counties is the subject of this inquiry.

The proposed Crowned Ridge Wind Energy Center (Project) is anticipated to have a nameplate capacity of 200 megawatts and to begin commercial operation in 2016. A 40-mile, 230-kV transmission line is also proposed. We will submit an application to the South Dakota Public Utilities Commission (PUC) for a Facility Permit, as required under South Dakota Codified Law (SDCL) Chapter 49-41B and South Dakota Administrative Rules, Section 20:10:22.

The 26,038-acre Project Area is depicted on the enclosed United States Geological Survey (USGS) topographic map; a corridor for the proposed 40-mile transmission line is also shown on the map. The land sections within the Project Area and transmission line corridor are listed in the tables below. We have provided the map to facilitate your review and greatly appreciate your efforts to treat the Project and its location as confidential at this time.

Project Area:

County	Township Name	Township	Range	Sections
Grant	Mazeppa	120N	51W	7-8, 17-20, 29, 32
Codington	Germantown	119N	52W	24-26, 36
	Leola	119N	51W	4-5, 7-9, 17-19, 26-35
	Germantown	118N	52W	24
	Waverly	118N	51W	2-5, 8-11, 14-19, 22-23, 26-27

.

Transmission Line Corridor:

County	Township Name	Township	Range	Sections
Codington	Leola	119N	51W	13-17, 20-30, 36
Grant	Vernon	119N	48W	6,7,19
Grant	Madison	119N	49W	1-2, 10-24, 30, 31
Grant	Stockholm	119N	50W	13-36
Grant	Alban	120N	48W	1-2, 11-14, 20-33
Grant	Grant Center	120N	49W	25, 36
Grant	Big Stone	121N	46W	18
Grant	Big Stone	121N	47W	13, 24-26, 34-36

In addition to federally protected wildlife and plant species, Tetra Tech is interested in sensitive habitats and wildlife management areas that may be located in or proximate to the proposed Project Area. In particular, we would like information on documented eagle nests within 10 miles of the Project Area and 2 miles of the transmission line corridor. Tetra Tech has also contacted the USFWS South Dakota Field Office, the USFWS Habitat and Population Evaluation Team, and the Waubay Wetland Management District.

Additionally, we have initiated Tier 3 field studies at the Project Area. We have previously conducted fall and spring avian use surveys and native prairie surveys and performed wetland delineations. In March 2014, we initiated a year of eagle use surveys. Our survey protocol for the eagle use surveys are attached as Appendix 1 for your review and comment. We also conducted fall avian point-count surveys in 2014 and will conduct spring avian point-count surveys in 2015. It is our goal to perform a thorough analysis of environmental concerns within the potential Project Area. We will use the information provided by the USFWS and South Dakota Game Fish and Parks to help guide Project development in a manner that avoids impacts to sensitive resources to the extent possible. If possible, we would appreciate a response by March 10, 2015.

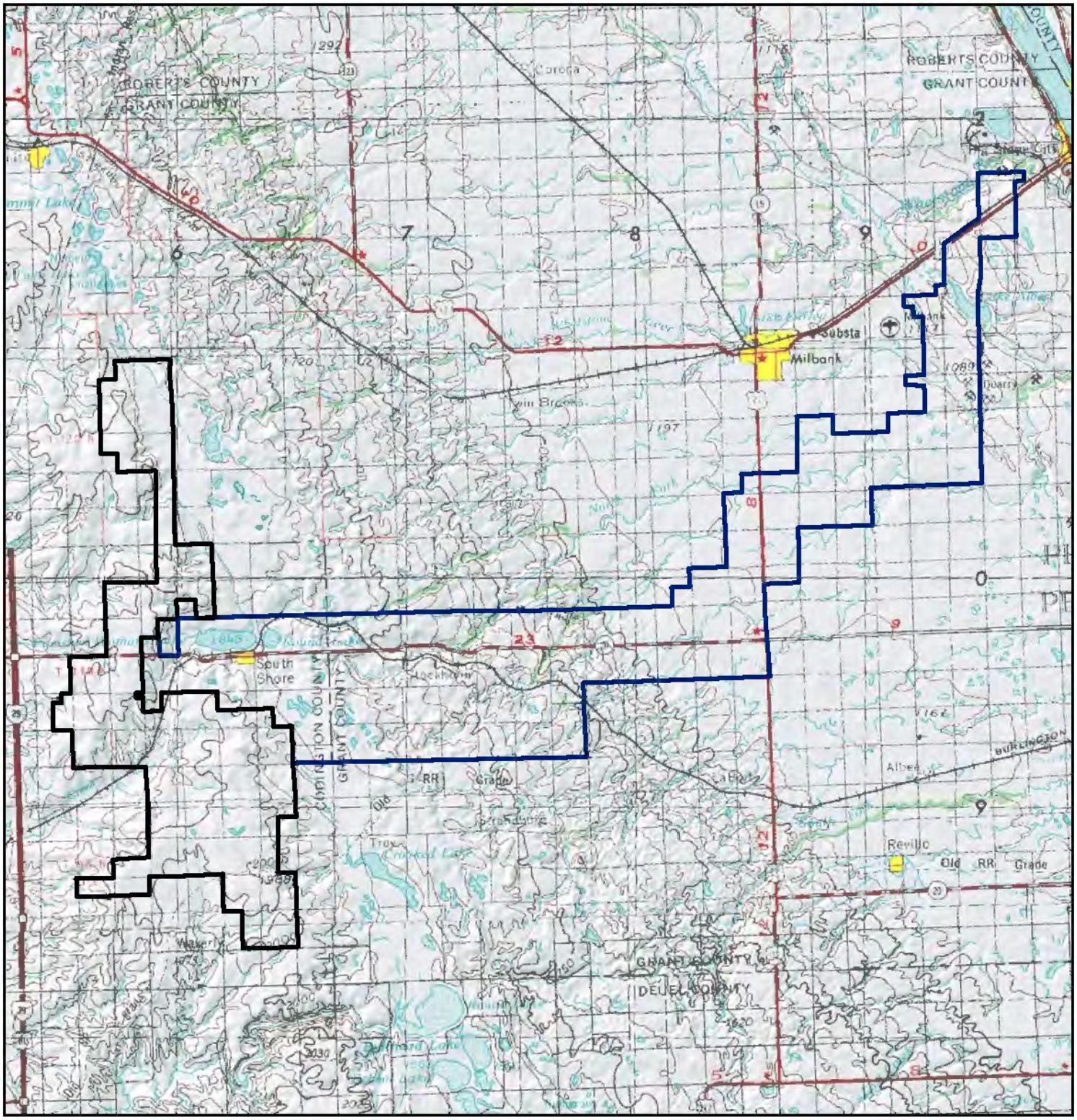
Should you have any questions or require additional information, please do not hesitate to contact me directly by phone at 512-213-8501 or email at anne-marie.griger@tetratech.com. Thank you for your assistance.

Respectfully submitted,

Anne-Marie Griger, AICP
Tetra Tech, Inc
8911 N. Capital of Texas Hwy, Bldg 2 Suite # 2310
Austin, TX 78759

Attachments: SDGFP letter dated December 3, 2007
Map
Appendix 1

TETRA TECH


ROBERTS COUNTY
GRANT COUNTY
Milbank
Substa
South Shore
CODINGTON COUNTY
GRANT COUNTY
Revillo
Old RR Grade
GRANT COUNTY
DEUEL COUNTY
Project Boundary (11-24-2014)
Transmission Line Boundary (2015-02-04)
1:238,000 WGS84 UTM Zone 14N
0 0.5 1 2 3 4
Miles
ND
MN
SD
NE
Project Location
Crowned Ridge
Codington and Grant Counties, SD
February 2015

TETRA TECH

APPENDIX 1

1) Eagle Use Surveys

The objective of eagle use surveys is to document eagle movements and behavior within and adjacent to the Project Area in all four seasons in order to assess risk to eagle species. Tetra Tech will conduct eagle use surveys following the general methods outlined in the Eagle Conservation Plan Guidance. Eagle use surveys will focus exclusively on eagles, and will occur at up to 18 survey plots. This number of point-count locations is sufficient to provide spatial coverage of approximately 26 percent of a 1-km buffer around turbine locations.

Eagle use surveys will be conducted by a qualified avian biologist beginning in spring 2014 and continue for one calendar year to capture temporal variation in eagle use of the Project Area. Surveys will be conducted twice per month during the spring (March 16 – June 15), summer (June 16 – August 15), fall (August 16 – November 15), and winter (November 16 – March 15). Each survey visit will occur over 2.5 days. There will be 26 survey weeks in total. Individual surveys will consist of a 1-hour observation period at each of the 18 point-count locations during each week of surveys, for a total of 468 hours of observations.

Eagle use data will be collected in 1-minute intervals so that the data can be translated into eagle exposure minutes, as recommended in the ECP Guidance. The data recorded for each survey will include the count start and stop times, eagle species observed, numbers and age classes of eagles seen, minutes of eagle flight in two height categories based on the ECP Guidance (≤ 200 and >200 meters {m} above ground), notes on flight and other behaviors, and an individual identifier for each flight observation allowing it to be linked to a flight map. Each eagle flight observed will be drawn on a topographic map or aerial image of the Project Area and digitized using a GIS so that eagle locations and behaviors can be overlaid with Project features. Numerical data will be collected within 800-m-radius plots, but flight lines will be documented across line-of-sight and will not be limited to the 800-m-radius survey plot.

DEPARTMENT OF GAME, FISH AND PARKS
Foss Building
523 East Capitol
Pierre, South Dakota 57501-3182

December 3, 2007

Erik W. Jansen, Biologist
Tetra Tech EC, Inc.
1750 SW Harbor Way, Suite 400
Portland, OR 97201

RE: Environmental review of Eastern and North-central Wind Resource Area as potential wind power project areas

Dear Mr. Jansen:

The following comments are in response to your letter dated 19 October 2007 requesting environmental considerations and concerns of the Eastern (W1/2 Grant Co., NE 1/4 Codington Co., W1/2, S1/2 Duel Co., and NE1/4 Brookings Co.) and North-central (McPherson County) Wind Resource Areas.

The proposed siting and operation of these wind power projects have potential to directly and indirectly impact area wildlife by killing bats and birds through wind turbine and power line strikes and altering important and declining habitats and breeding and movement behavior of wildlife. While we applaud efforts to provide alternative energy sources, we offer the following considerations for your planning efforts, encouraging responsible siting and mitigation where appropriate to avoid or lessen direct and indirect impacts. As requested, I have provided separate comments for each wind resource area in addition to final comments that apply to any other potential wind power project in South Dakota.

Eastern Wind Resource Area (EWRA)

Grasslands - The EWRA is located within the tall-grass prairie zone. Native grasslands within this zone are decreasing at an alarming rate. Less than one percent of native tall-grass prairie habitat in South Dakota remains (Samson et al. 1998). Other grassland types such as rangeland (grazed grasslands with native plant spp.), pasture (grazed grasslands with non-native plant spp.) and Conservation Reserve Program lands (tilled land planted to vegetative cover) serve as grassland wildlife habitat (Haufler 2005). Fragmentation resulting from woody encroachment, road construction, and conversion of surrounding habitat has resulted in the remaining grassland habitats existing as smaller disjunct patches. Patches often provide less suitable habitat for many native species of grassland wildlife. Some of the last remaining contiguous grasslands tracts occur along the Coteau escarpment that angles through the EWRA.

Grassland birds - Placement of turbines in this area may fragment grassland wildlife habitat reducing its suitability to serve as habitat and modify behavior of grassland bird species, a group of species which has shown the most consistent and long term declines of any other group of bird species in North America (Peterjohn and Sauer 1999). This area is known to have abundant sharp-tailed grouse populations. Greater prairie chickens also are present. The greater prairie chicken is a species known to be area-sensitive, requiring comparatively large tracts of open, contiguous grassland. The lesser prairie chicken, a similar species found more commonly in the southern Great Plains, avoids nesting within 400 m of transmission lines or improved roads (Pitman et al 2004). This highly suggests that placement of turbines and associated infrastructure (roads and transmission lines) may also negatively affect greater prairie chickens.

Birds are susceptible to direct strikes with wind turbines. Based on a study conducted in the Buffalo Ridge area of Minnesota, species with known wind turbine strike mortality and are known to occur in the EWRA include grasshopper sparrow and western meadowlark (Higgins et al 2007).

Properly timed, species-appropriate surveys for prairie grouse (greater prairie chickens and sharp-tailed grouse) and other grassland bird species should be conducted pre-construction. Prairie grouse surveys should be conducted in spring when breeding individuals are on communal display grounds (leks). Surveys for other breeding grassland birds are best conducted in June, although mid-May through early July is acceptable.

Butterflies - Four rare butterfly species are located within the EWRA. These species are classified as Species of Greatest Conservation Need, as listed in our State Wildlife Action Plan (http://www.sdgfp.info/Wildlife/Diversity/Comp_Plan.htm) and are rare species monitored by our Natural Heritage Program (NHP). They include: 1) Dakota skipper, 2) Powesheik skipperling, 3) regal fritillary, and 4) Ottoe skipper.

The range of the Dakota skipper in South Dakota is limited to eleven counties in the north eastern portion of the state. The Dakota skipper requires native mid- to tall-grass prairie and is found on rolling rangeland with abundant wetlands. Larval host plants are grasses, especially little bluestem. Flight of emerging adults occurs from June to mid-July. This species is a candidate for listing under the Federal Endangered Species Act (ESA). As such, I recommend contacting the U.S. Fish and Wildlife Ecological Services Field office in Pierre, South Dakota (605-224-8693) for further information regarding the protection of this species required under ESA. Current threats to this species include, but are not limited to, improper land management uses, agricultural cultivation, road construction, and invasive plant species. South Dakota populations are important to the existence of this species and approximately half of known populations are located on private lands.

The Powesheik skipperling distribution in South Dakota also is limited to eleven counties in the north eastern portion of the state. The Powesheik skipperling prefers native tall-grass prairie and wetlands. Larval host plants are sedges. Flight of emerging adults occurs primarily in July. Threats include excessive prescribed burning, loss of habitat due to conversion to other uses, invasive plants, population isolation, and extreme population crashes.

The regal fritillary is rapidly declining across its range in the United States. In South Dakota, its range is restricted to native prairie sites. Some of the last strongholds of this species are located in prairie states, such as South Dakota, with areas of large expanses of suitable habitat (such as the EWRA) that support larval host plants (violets). Flight periods are from June to September. Threats include loss and fragmentation of habitat to agriculture (excluding grazing or haying), conversion to cropland, woody encroachment, chemicals (e.g., pesticides and herbicides), and improper fire management.

The Ottoe skipper also requires relatively undisturbed native prairie with nectar sources (coneflowers, grayfeathers, asters, etc). It is uncommon to rare throughout the state. Peak flight for the Ottoe skipper is in mid-July. The reduction and degradation of prairie habitat is the main threat to this species.

The conservation of the four rare butterfly species documented in the EWRA requires protection of remaining undisturbed tracts of native prairie with associated nectar sources and larval host plants. There are potential disturbances to these rare butterfly species associated with the construction and maintenance of a wind power project. Road construction and turbine pad maintenance increases the chances of non-native, invasive plant species invasion. Chemical control of these species is a known threat. Pre-construction surveys for these species should be conducted during the appropriate times (flight periods). Construction in areas that are or potential butterfly habitat should be avoided.

Wetlands - The proposed project area is located within the Prairie Pothole region. This glaciated region, characterized by high densities of wetland basins of various depths and sizes, extends from Iowa into Minnesota, the Dakotas, Montana and parts of Canada. It is the major waterfowl production area in North America. Wetland losses in the Prairie Pothole Region are staggering and range from 99% in Iowa to 35% in South Dakota. Wetland basin densities (# of basins/10 mi^2) in the EWRA range from 90 to over 420 basins/10 $miles^2$. More specifically, this area is known to have some of the highest seasonal and semipermanent wetland basin densities in the state (Johnson and Higgins 1997). These remaining, high density wetlands provide critical wildlife habitat.

Wetland birds - Waterbird species such as loons, black terns, great egrets, and green backed herons are known to occur in the EWRA. Abundant waterfowl such as mallard, blue-winged teal, redhead, ruddy duck, American coot, and bufflehead also can be found in the area. Birds are susceptible to direct strikes with wind turbines. Based on a study conducted in the Buffalo Ridge area of Minnesota, species with known wind turbine strike mortality and are known to occur in the EWRA include ruddy duck, American coot, and Franklin's gull (Higgins et al 2007). Proper siting of turbines outside of daily and seasonal migration routes of waterbirds and waterfowl and the protection of remaining wetlands within the proposed project area is crucial to reduce the impact to wetland dependent species.

Bats - Bats forage and migrate along rivers, streams, and lakes. Construction of a wind power plant may affect daily and seasonal bat movements between breeding and foraging areas. Thirteen species of bats are found in South Dakota, some of which are summer residents, year-round residents, or migratory (Table 1).

Table 1. South Dakota Bats

Common Name	Scientific Name	State Residency
Big Brown Bat	*Eptesicus fuscus*	Year-round resident
Fringed Myotis	*Myotis thysanodes*	Year-round resident
Little Brown Myotis	*Myotis lucifugus*	Year-round resident
Long-eared Myotis	*Myotis evotis*	Year-round resident
Long-legged Myotis	*Myotis volans*	Year-round resident
Northern Myotis	*Myotis septentrionalis*	Year-round resident
Townsend's Big-eared Bat	*Corynorhinus townsendii*	Year-round resident
Western Small-footed Myotis	*Myotis ciliolabrum*	Year-round resident
Hoary Bat	*Lasiurus cinereus*	Summer resident
Silver-haired Bat	*Lasionycteris noctivagans*	Summer resident
Evening Bat	*Nycticeius humeralis*	Migratory
Eastern pipistrell	*Pipistrellus subflavus*	unclassified

There has been limited research conducted on bats in South Dakota. However, Swier (2006) reported four species of bats occurring near the EWRA: 1) big brown bat, 2) Eastern red bat, 3) hoary bat, and 4) little brown myotis.

Six bat species are considered rare and monitored by the NHP: 1) long-eared myotis, 2) fringed myotis, 3) Northern myotis, 4) silver-haired bat, 5) Townsend's big-eared bat, and 6) evening bat. Although the NHP data base has no records of theses species in the proposed project area, this does not preclude the presence of any of these species in the area. Because of limited, EWRA-specific data, we would suggest pre-construction surveys of the area for potential bat habitat and species. Surveys for species should be conducted for at least one full year before construction.

Recently, South Dakota Department of Game, Fish and Parks (SDGFP) in cooperation with the South Dakota Bat Working Group (SDGWG), developed a South Dakota Bat Management Plan specific to bats and their habitats in South Dakota (http://www.sdgfp.info/Wildlife/Diversity/batmanagmentplan71304.pdf). Please review this document for pertinent information. Again, because bats reside and migrate through South Dakota, it is important to evaluate the propose project area for roosting, feeding, migration and/or stopover habitat and to survey these areas for bats.

Landscape considerations - Placement of a wind power project should take into account larger landscape-level (e.g. surrounding land uses) and cumulative impacts (e.g. existing and potential wind power projects) as well as project associated infrastructure (i.e. transmission lines and roads).

Public lands - Several Game Production Areas within the EWRA are managed by SDGFP. Placement of public lands is often done so in areas with existing and potential wildlife habitat. Management of these lands, for wildlife, is conducted in the public interest. In addition, several USFWS Waterfowl Protection Areas are also located within the EWRA. Public lands managed

for wildlife may be affected by the placement of a wind power project in the vicinity.

Migrating wildlife - The resulting mosaic of grassland and wetland basins and corridors makes it an important migration route for birds (e.g., neotropical migrants, shorebirds, and waterfowl). The Central Flyway, an important pathway for migratory ducks, geese, swans, and cranes runs through the midsection of the country, including South Dakota. Species using this flyway during migration, and particularly during inclement weather when birds alter their flight altitude, may suffer increased mortality due to direct strikes with wind turbines and associated power lines. Appropriately timed, pre-construction surveys for migratory bird species should be conducted. Spring migration can begin as early as late-March, early-April, tapering off in mid-May, depending on the species. Fall migration can begin as early as mid-July and extend through October/November depending on weather conditions and species.

Powerlines - Construction of powerlines is often associated with a proposed wind power project. Power line strikes are a known cause of mortality to birds (Erickson et al. 2005). Waterfowl (ducks, geese, swans, and cranes), raptors, and passerines are species most susceptible to powerline collisions. The Avian Protection Power line Interaction Committee (APLIC) has developed two documents that may be of use to reduce powerline strikes and mortality: 1) 'Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006' and 2) 'Mitigating Bird Collisions with Power lines'. Both of these documents are available from the Edison Institute (http://www.aplic.org/, under 'products and services'). The new and existing power lines associated with the proposed project should be buried, marked, or retrofitted to reduce strikes and electrocutions of bird species.

Non-native species - During the construction and maintenance phase of a wind power project existing roads often experience increased traffic and new roads are constructed. This increases the amount of area disturbed and allows for the introduction and establishment of non-native species. Resulting control of those species through pesticides and herbicides may also impact habitats of rare wildlife species. Non-native species are one of the major threats to rare and declining wildlife species. Improved access can also increase human activity in the area.

The matrix of grassland and wetland habitats in the proposed project area plays a crucial role in the life history of several wildlife species whether migratory or resident. Because of the potential impacts placement of the proposed wind power project would have on unique and declining habitats in the region and their associated species, we recommend the placement of turbines in areas currently disturbed (e.g. cultivated areas) and the use of existing infrastructure (roads and transmission lines) as much as possible.

North-central Wind Resource Area (McPherson County)

Grassland habitat - McPherson County is located within the mixed-grass prairie zone. In the United States, native mixed-grass prairie is disappearing at an alarming rate. In South Dakota, the area of mixed-grass prairie has decreased 70% (Samson et al. 1998). The native prairie that still remains is most often grazed (i.e. rangeland). These and other grassland types such as pasture (grazed grasslands of non-native plant spp.) and Conservation Reserve Program lands (tilled land idled and planted to vegetative cover) also serve as grassland wildlife habitat (Haufler 2005). Fragmentation resulting from woody encroachment, road construction, and conversion of surrounding habitat has resulted in the remaining grassland habitats existing as smaller disjunct patches. Patches often provide less suitable habitat for many native species of grassland wildlife. McPherson County has large tracts of contiguous grassland habitat (including rangeland) located along the ridge extending through Wacker, Weber, Hoffman, and Central McPherson townships.

Grassland birds - Placement of turbines in this area may fragment grassland wildlife habitat reducing its suitability to serve as habitat and modify behavior of grassland bird species, a group of species which has shown the most consistent and long term declines of any other group of species in North America (Peterjohn and Sauer 1999). Two grassland bird species, Baird's sparrow and Sprague's pipit, are known to occur in McPherson County. Range-wide, both of these species have exhibited significant long term negative population trends. In South Dakota, these species hold special conservation status and are classified as Species of Greatest Conservation Need, as listed in our State Wildlife Action Plan (http://www.sdgfp.info/Wildlife/Diversity/Comp_Plan.htm) and are rare species monitored by our NHP. In addition, these species are considered Grassland Species of Concern in South Dakota (Bakker 2005). Regionally they are Species of Special Concern as defined by Partner's in Flight and are considered a Species of Conservation Concern by the USFWS. The amount of emphasis placed on the conservation of these species indicates populations are declining.

Baird's sparrows breed in the north-western and north-central part of the state. Throughout most of its breeding range, it is known to prefer native mixed grass prairie interspersed with forbs (broad-leaved, herbaceous plant), moderate amounts of litter (dead layers of vegetation), and little to no shrub cover. Although the Baird's Sparrow has a strong tendency to prefer native prairie, it can be observed in non-native grasslands (e.g. crested wheatgrass) that provide appropriate habitat structure. Baird's sparrows are known to prefer large patches of grassland habitat and show avoidance of areas with extensive woody vegetation and areas near roads.

Sprague's pipits are found in the northwestern portion of the state, preferring plains and short-grass prairie with intermediate vegetation height. This species prefers native prairie, although they are known to occupy habitat consisting of non-native plant species. Sprague's pipits are most common in large contiguous grassland areas and are known to be area sensitive.

Properly timed, species-appropriate pre-construction surveys should be conducted for grassland bird species. Surveys for most breeding grassland birds are best conducted in June, although mid-May through early July is suitable. Prairie grouse surveys should be conducted in spring when breeding individuals are on communal display grounds (leks).

Wetland habitats - McPherson County is located within the Prairie Pothole Region. This glaciated region, characterized by a diversity and quantity of basin wetlands, extends from Iowa into Minnesota, the Dakotas, Montana and parts of Canada. It is the major waterfowl production area in North America. Wetland losses in the Prairie Pothole Region are staggering and ranging from 99% in Iowa to 35% in South Dakota. Throughout McPherson County, wetland basin density is high (270 - over 420 basins/10 mi^2). More specifically, the eastern quarter of the County has some of the highest concentrations of temporary and seasonal wetlands (Johnson and Higgins 1997) in the state. Remaining wetlands provide important wildlife habitat.

Wetland birds - In terms of waterfowl breeding activity, the western two-thirds of McPherson County has over 100 breeding duck pairs/mi^2. This is some of the highest breeding waterfowl densities in the Prairie Pothole region. Conservation of this habitat also is critical to waterbirds and shorebirds for breeding, feeding, and migration habitat.

Bird diversity - Reflective of the diversity and quality of native wetland and grassland habitats in the region, the northeastern portion of McPherson County has some of the highest bird species richness in the state (Peterson 1995). This is based upon data gathered from a five-year, state-wide breeding bird survey efforts.

Bats - Bats forage and migrate along rivers, streams and lakes. Construction of a wind power project may affect daily and seasonal bat movements between breeding and foraging areas. Thirteen species of bats are found in South Dakota, some of which are summer residents, year-round residents, or migratory (Table 1). There has been limited research conducted on bats in South Dakota, especially in McPherson County. The NHP database has no records of bat species considered rare in the proposed project. However, this does not preclude the presence of any of these or other bat species in the area. Because of limited information on bats in McPherson County, we would suggest pre-construction surveys of the area for potential bat habitat and species. Surveys for species should be conducted for at least one full year before construction.

Recently, SDGFP in cooperation with the SDBWG, developed a South Dakota Bat Management Plan specific to bats and their habitats in South Dakota (http://www.sdgfp.info/Wildlife/Diversity/batmanagmentplan71304.pdf). Please review this document for pertinent information. Again, because bats reside and migrate through South Dakota, it is important to evaluate the propose project area for roosting, feeding, migration and/or stopover habitat and to survey these areas for bats.

Landscape considerations - Placement of a wind power project should take into account larger landscape-level (e.g. surrounding land uses) and cumulative impacts (e.g. existing and potential wind power projects) as well as project associated infrastructure (i.e. transmission lines, roads).

Public lands - Several Game Production Areas within McPherson County are managed by SDGFP. Placement of public lands is often done so in areas with existing and potential wildlife habitat. Management of these lands, for wildlife, is conducted in the public interest. In addition, several U. S. Fish and Wildlife Service Waterfowl Protection Areas are also located within McPherson County. Public lands managed for wildlife may be affected by the placement of a

wind power project in the vicinity.

Migrating wildlife - The resulting mosaic of grassland and wetland basins and corridors in the County make it an important migration route for birds (e.g., neotropical migrants, shorebirds, waterfowl). The Central Flyway, an important pathway for migratory ducks, geese, swans, and cranes runs through the midsection of the country, including South Dakota. Species using this flyway during migration, and particularly during inclement weather when birds alter their flight altitude, may suffer increased mortality due to direct strikes with wind turbines and associated power lines. Appropriately timed, pre-construction surveys for migratory bird species should be conducted. Spring migration can begin as early as late-March, early-April, tapering off in mid-May, depending on the species. Fall migration can begin as early as mid-July and extend through October/November depending on weather conditions and species.

Powerlines - Construction of powerlines is often associated with a proposed wind power project. Power line strikes are a known cause of mortality to birds (Erickson et al. 2005). Waterfowl (ducks, geese, swans, and cranes), raptors, and passerines are species most susceptible to powerline collisions. The Avian Protection Power line Interaction Committee (APLIC) has developed two documents that may be of use to reduce powerline strikes and mortality: 1) 'Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006' and 2) 'Mitigating Bird Collisions with Power lines'. Both of these documents are available from the Edison Institute (http://www.aplic.org/, under 'products and services'). The new and existing power lines associated with the proposed project should be buried, marked, or retrofitted to reduce strikes and electrocutions of bird species.

Non-native species - During the construction and maintenance phase of a wind power projects existing roads often experience increased traffic and new roads are constructed. This increases the amount of area disturbed and allows for the introduction and establishment of non-native species. Resulting control of those species through pesticides and herbicides may also impact habitats of rare wildlife species. Non-native species are one of the major threats to rare and declining wildlife species. Improved access can also increase human activity in the area.

The matrix of grassland and wetland habitats in the proposed project area plays a crucial role in the life history of several wildlife species whether migratory or resident. Because of the potential impacts placement of the proposed wind power project would have on unique and declining habitats in the region and their associated species, we recommend the placement of turbines in areas currently disturbed (e.g. cultivated areas) and the use of existing infrastructure (roads and transmission lines) as much as possible.

Research and Monitoring

As outlined above, our agency has concerns regarding direct and indirect impacts to wildlife and habitats in association with the siting of the proposed project. Before project construction, appropriate monitoring should be conducted to determine bird and bat use of the project areas. Based upon results of these studies, project construction should be modified, continued, or cancelled. If the project is continued, monitoring should be conducted for a minimum of two years post-construction to determine if and how many bird and bat strikes are caused by this project, if habitats have been significantly altered, and if the surrounding public lands and their uses have been impacted. Any mitigation should be carefully planned, funded, and followed.

If monitoring involves live trapping or collection of wildlife species, you must first obtain a collection permit from our agency. Also, we kindly request that if you or your associates observe any of the animal (http://www.sdgfp.info/Wildlife/Diversity/RareAnimal.htm) or plant species (http://www.sdgfp.info/Wildlife/Diversity/rareplant2002.htm) monitored by the NHP, please contact myself or any of our NHP staff (http://www.sdgfp.info/Wildlife/Diversity/staff_contact.htm).

In coordination with the SDBWG, the SDGFP has developed 'Siting Guidelines for Wind Power Projects in South Dakota' This document addresses many of the concerns involved with siting wind power projects in South Dakota and may be found at on the world wide web (http://www.sdgfp.info/Wildlife/Diversity/windpower.htm). I have enclosed a copy for your convenience.

The SDGFP appreciates the opportunity to provide comments on the proposed project wind resource areas. As plans are further refined, I would be willing to conduct a site visit with you or your associates to continue to provide siting recommendations to reduce conflicts with wildlife. If you have any questions on the above comments, please feel free to contact me at 605-773-2742 or Silka.Kempema@state.sd.us.

Regards,

Silka Kempema

Silka L. F. Kempema
Terrestrial Wildlife Biologist

CC: Natalie Gates, US Fish and Wildlife Service, Pierre, SD
Will Morlock, SD Game, Fish and Parks, Watertown, SD
Mary Clawson, SD Game, Fish and Parks, Aberdeen, SD

References

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TETRA TECH

February 11, 2015

Mr. Scott Larson
Field Supervisor
USFWS – South Dakota Field Office
420 S. Garfield Avenue, Suite 400
Pierre, SD 57501-5408

RE: Crowned Ridge Wind Energy Center in Codington and Grant Counties, South Dakota

Dear Mr. Larson:

As part of our Tier 1 preliminary site evaluation and Tier 2 site characterization under the U.S. Fish and Wildlife Service (USFWS) Land-Based Wind Energy Guidelines, Tetra Tech, Inc. (Tetra Tech) is writing on behalf of NextEra Energy Resources, LLC (NextEra), to request information regarding ecologically significant areas and listed endangered, threatened or special concern species including eagles at a potential wind energy development site in Codington and Grant counties, South Dakota. We contacted your agency in 2007 regarding a much larger area for wind energy development that NextEra may develop in a later phase (see attached response letter dated November 26, 2007); however, the current the project area in Codington and Grant counties is the subject of this inquiry.

The proposed Crowned Ridge Wind Energy Center (Project) is anticipated to have a nameplate capacity of 200 megawatts and to begin commercial operation in 2016. A 40-mile, 230-kV transmission line is also proposed. We will submit an application to the South Dakota Public Utilities Commission (PUC) for a Facility Permit, as required under South Dakota Codified Law (SDCL) Chapter 49-41B and South Dakota Administrative Rules, Section 20:10:22.

The 26,038-acre Project Area is depicted on the enclosed United States Geological Survey (USGS) topographic map; a corridor for the proposed 40-mile transmission line is also shown on the map. The land sections within the Project Area and transmission line corridor are listed in the tables below. We have provided the map to facilitate your review and greatly appreciate your efforts to treat the Project and its location as confidential at this time.

Project Area:

County	Township Name	Township	Range	Sections
Grant	Mazeppa	120N	51W	7-8, 17-20, 29, 32
Codington	Germantown	119N	52W	24-26, 36
	Leola	119N	51W	4-5, 7-9, 17-19, 26-35
	Germantown	118N	52W	24
	Waverly	118N	51W	2-5, 8-11, 14-19, 22-23, 26-27

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Transmission Line Corridor:

County	Township Name	Township	Range	Sections
Codington	Leola	119N	51W	13-17, 20-30, 36
Grant	Vernon	119N	48W	6,7,19
Grant	Madison	119N	49W	1-2, 10-24, 30, 31
Grant	Stockholm	119N	50W	13-36
Grant	Alban	120N	48W	1-2, 11-14, 20-33
Grant	Grant Center	120N	49W	25, 36
Grant	Big Stone	121N	46W	18
Grant	Big Stone	121N	47W	13, 24-26, 34-36

In addition to federally protected wildlife and plant species, Tetra Tech is interested in sensitive habitats and wildlife management areas that may be located in or proximate to the proposed Project Area. In particular, we would like information on documented eagle nests within 10 miles of the Project Area and 2 miles of the transmission line corridor. Tetra Tech has also contacted the USFWS Habitat and Population Evaluation Team, the Waubay Wetland Management District, and the South Dakota Game, Fish, and Parks Department (SDGFP).

Additionally, we have initiated Tier 3 field studies at the Project Area. We have previously conducted fall and spring avian use surveys and native prairie surveys and performed wetland delineations. In March 2014, we initiated a year of eagle use surveys. Our survey protocol for the eagle use surveys are attached as Appendix 1 for your review and comment. We also conducted fall avian point-count surveys in 2014 and will conduct spring avian point-count surveys in 2015. It is our goal to perform a thorough analysis of environmental concerns within the potential Project Area. We will use the information provided by the USFWS and SDGFP to help guide Project development in a manner that avoids impacts to sensitive resources to the extent possible. If possible, we would appreciate a response by March 10, 2015.

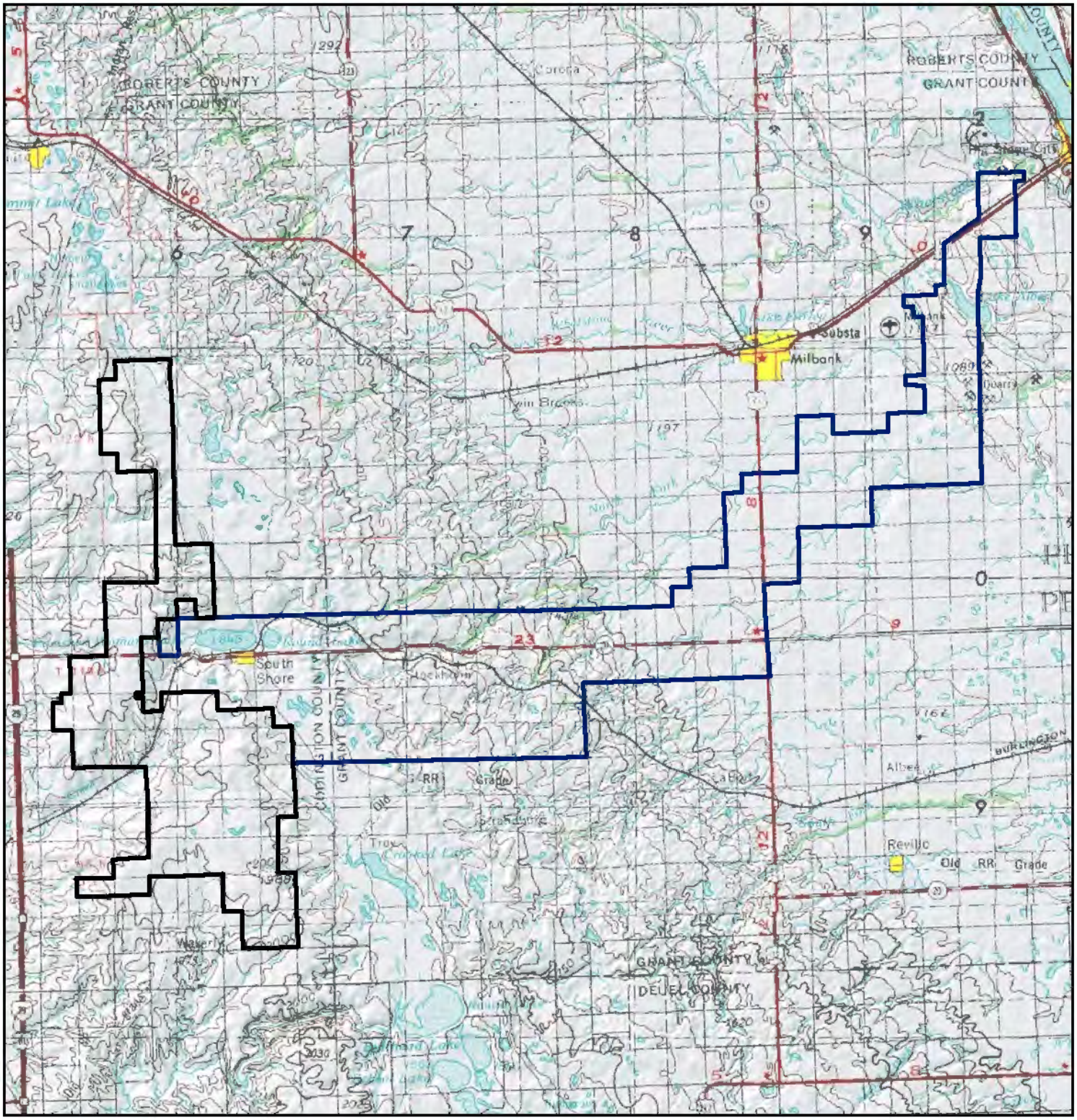
Should you have any questions or require additional information, please do not hesitate to contact me directly by phone at 512-213-8501 or email at anne-marie.griger@tetratech.com. Thank you for your assistance.

Respectfully submitted,

Anne-Marie Griger, AICP
Tetra Tech, Inc
8911 N. Capital of Texas Hwy, Bldg 2 Suite # 2310
Austin, TX 78759

Attachments: USFWS letter dated November 26, 2007
Map
Appendix 1

TETRA TECH


ROBERTS COUNTY
GRANT COUNTY
Milbank
Substa
South Shore
CODINGTON COUNTY
GRANT COUNTY
Revillo
Old RR Grade
GRANT COUNTY
DEUEL COUNTY
Project Boundary (11-24-2014)
Transmission Line Boundary (2015-02-04)
1:238,000 WGS84 UTM Zone 14N
0 0.5 1 2 3 4
Miles
ND
MN
SD
NE
Project Location
Crowned Ridge
Codington and Grant Counties, SD
February 2015

TETRA TECH

APPENDIX 1

1) Eagle Use Surveys

The objective of eagle use surveys is to document eagle movements and behavior within and adjacent to the Project Area in all four seasons in order to assess risk to eagle species. Tetra Tech will conduct eagle use surveys following the general methods outlined in the Eagle Conservation Plan Guidance. Eagle use surveys will focus exclusively on eagles, and will occur at up to 18 survey plots. This number of point-count locations is sufficient to provide spatial coverage of approximately 26 percent of a 1-km buffer around turbine locations.

Eagle use surveys will be conducted by a qualified avian biologist beginning in spring 2014 and continue for one calendar year to capture temporal variation in eagle use of the Project Area. Surveys will be conducted twice per month during the spring (March 16 – June 15), summer (June 16 – August 15), fall (August 16 – November 15), and winter (November 16 – March 15). Each survey visit will occur over 2.5 days. There will be 26 survey weeks in total. Individual surveys will consist of a 1-hour observation period at each of the 18 point-count locations during each week of surveys, for a total of 468 hours of observations.

Eagle use data will be collected in 1-minute intervals so that the data can be translated into eagle exposure minutes, as recommended in the ECP Guidance. The data recorded for each survey will include the count start and stop times, eagle species observed, numbers and age classes of eagles seen, minutes of eagle flight in two height categories based on the ECP Guidance (≤ 200 and >200 meters {m} above ground), notes on flight and other behaviors, and an individual identifier for each flight observation allowing it to be linked to a flight map. Each eagle flight observed will be drawn on a topographic map or aerial image of the Project Area and digitized using a GIS so that eagle locations and behaviors can be overlaid with Project features. Numerical data will be collected within 800-m-radius plots, but flight lines will be documented across line-of-sight and will not be limited to the 800-m-radius survey plot.

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United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
420 South Garfield Avenue, Suite 400
Pierre, South Dakota 57501-5408

March 23, 2014

Anne-Marie Griger
Tetra Tech, Inc
8911 N. Capital of Texas Hwy
Bldg 2, Suite# 2310
Austin, Texas 78759

Re: Crowned Ridge Wind Energy Center, Codington and Grant Counties, South Dakota

Dear Ms. Griger:

This letter is in response to your February 11, 2015, request for environmental comments regarding the above referenced project involving installation of the 200-MW Crowned Ridge Wind Energy Center and an associated 40- mile 230 kV transmission line. The 26,038-acre wind project area includes numerous sections in Townships 118-120 North, Ranges 51 and 52 West; the transmission line includes numerous sections in Townships 119-121 North, Ranges 46-51 West, all within Grant and Codington Counties, South Dakota.

Your current letter includes a previous (November 26, 2007) response from our office to Tetra Tech's October 19, 2007, inquiry for the Crowned Ridge facility; however, we sent an additional letter to you dated February 5, 2010 (copy enclosed) and a similar letter to Western Area Power Administration dated December 30, 2010. Herein we provide updated information.

In accordance with section 7(c) of the Endangered Species Act, as amended, 16 U.S.C. 1531 et seq., we have determined that the following federally listed/proposed species may occur in the project area (this list is considered valid for 90 days):

Species	Status	Expected Occurrence
Topeka Shiner (*Notropis topeka*)	Endangered	Known resident
Dakota Skipper (*Hesperia dacotae*)	Threatened	Resident in native prairie, northeastern SD
Poweshiek Skipperling (*Oarisma poweshiek*)	Endangered	Possible resident in native prairie, northeastern SD

Rufa Red Knot (*Calidris canutus rufa*)	Threatened	Rare seasonal migrant
Whooping Crane (*Grus americana*)	Endangered	Migration

Additionally, the following species have been proposed for listing under the Endangered Species Act and may occur in the project area:

Species	Status	Expected Occurrence
Northern Long-eared Bat (*Myotis septentrionalis)*	Proposed Endangered	Summer resident, seasonal migrant, known winter resident in Black Hills

The Topeka shiner is an endangered minnow known to occupy numerous small streams within the Big Sioux, Vermillion and James watersheds of eastern South Dakota. Willow Creek in Codington County is a known occupied stream, tributaries of which occur within the proposed project area. We recommend avoidance of impacts to this waterway and its tributaries. If instream work in the Willow Creek watershed is proposed, specific measures may be necessary to ensure that adverse impacts to the Topeka shiner are not incurred as a result of this project.

The Dakota skipper is a small prairie butterfly listed as a threatened species under the Endangered Species Act (see: http://www.gpo.gov/fdsys/pkg/FR-2014-10-24/pdf/2014-25190.pdf). Dakota skippers are obligate residents of high quality prairie ranging from wet-mesic tallgrass prairie to dry-mesic mixed grass prairie. In northeastern South Dakota, Dakota skippers inhabit dry-mesic hill prairies with abundant purple coneflower *(Echinacea angustifolia)*, but also use mesic to wet-mesic tallgrass prairie habitats characterized by wood lily (*Lilium philadelphicum*) and mountain deathacamas (smooth camas; *Zigadenus elegans*). Their dispersal ability is very limited due in part to their short adult life span and single annual flight. Extirpation from a site may be permanent unless it occurs within about 0.6 miles of an inhabited site that generates a sufficient number of emigrants. Avoidance of impacts to native prairie habitat is recommended to reduce the risk of adverse effects to this species.

The Poweshiek skipperling is a small prairie butterfly listed as endangered under the Endangered Species Act (see: http://www.gpo.gov/fdsys/pkg/FR-2014-10-24/pdf/2014-25190.pdf). The habitat of Poweshiek skipperlings includes prairie fens, grassy lake and stream margins, moist meadows, and wet-mesic to dry tallgrass prairie. Preferred nectar plants for adult Poweshieks include smooth ox-eye (*Heliopsis helianthoides*) and purple coneflower *(Echinacea angustifolia)*, but they also use stiff tickseed (*Coreopsis palmate*), black-eyed susan (*Rudbeckia hirta*), and palespike lobelia (*Lobelia spicata*). Larval food plants are assumed to include spike-rush, sedges, prairie dropseed (*Sporobolus heterolepis*) and little bluestem (*Schizachyrium scoparium*). Poweshiek skipperlings have one flight per year from about the middle of June through the end of July (depending upon weather). They have a low dispersal capability, and may not cross areas that are not structurally similar to native prairies. Extirpation from

fragmented and isolated prairie remnants may be permanent unless it occurs within about 0.6 miles of an inhabited site that generates a sufficient number of emigrants. They are vulnerable to extreme weather conditions, dormant season fire, and other disturbances (e.g., intense cattle grazing). Avoidance of impacts to native prairie habitat is recommended to reduce the risk of adverse effects to this species.

Whooping cranes migrate through South Dakota on their way to northern breeding grounds and southern wintering areas. They occupy numerous habitats such as cropland and pastures; wet meadows; shallow marshes; shallow portions of rivers, lakes, reservoirs, and stock ponds; and both freshwater and alkaline basins for feeding and loafing. Overnight roosting sites frequently require shallow water in which to stand and rest. Line strike mortality is one of the greatest threats to this species. More information on this topic is provided below. Additionally, should construction occur during spring or fall migration, the potential for disturbances to whooping cranes exists. Disturbance (flushing the birds) stresses them at critical times of the year. We recommend remaining vigilant for these birds. There is little that can be done to reduce disturbance besides ceasing construction at sites where the birds have been observed. The birds normally do not stay in any one area for long during migration. Any whooping crane sightings should be reported to this office.

The rufa red knot is a robin-sized shorebird listed as threatened under the Endangered Species Act (see: < http://www.gpo.gov/fdsys/pkg/FR-2014-12-11/pdf/2014-28338.pdf> for more information). The red knot migrates annually between its breeding grounds in the Canadian Arctic and several wintering regions, including the Southeast United States, the Northeast Gulf of Mexico, northern Brazil, and Tierra del Fuego at the southern tip of South America. Although it is primarily a coastal species, small numbers of rufa red knots are reported annually across the interior United States (i.e., greater than 25 miles from the Gulf or Atlantic Coasts) during spring and fall migration. These reported sightings are concentrated along the Great Lakes, but multiple reports have been made from nearly every interior State, including South Dakota. Any rufa red knot sightins should be reported to this office.

The northern long-eared bat is a medium-sized brown bat that has been proposed for listing as endangered under the Endangered Species Act primarily due to impacts of White Nose Syndrome (see: <http://www.fws.gov/midwest/endangered/ mammals /nlba/pdf /FRpropListNLBA2Oct2013.pdf > for more information). Their proposed status defines these bats as a species in decline that the Service believes needs to be listed. Northern long-eared bats are known to be present in South Dakota during the summer months in forested habitat, primarily roosting singly or in colonies underneath bark, in cavities or in crevices of both live and dead trees. Some hibernacula have been documented in caves/mines in the Black Hills and the species have been documented in the Missouri River corridor during migration. White nose syndrome, a fungus affecting hibernating bats, is considered a significant threat to this species, but individuals may be harmed by other activities such as modifications to hibernacula, timber harvest, human disturbance, and collisions with wind turbines. Actions that may jeopardize the continued existence of this proposed species may require formal conference procedures in coordination with the Service. A decision regarding listing of the northern long-eared bat is anticipated to be made April 2, 2015. Interim guidance has been issued for this species that may be helpful to you (see: <http://www.fws.gov/midwest/endangered/mammals/nlba/pdf/

NLEBinterimGuidance6Jan2014.pdf>. We request any northern long-eared bat survey data you may collect.

Per earlier correspondence, it is our understanding that the Western Area Power Administration (Western) is the federal action agency for this project. If Western or their designated representative determines that the project "may adversely affect" listed species in South Dakota, it should request formal consultation from this office. If a "may affect - not likely to adversely affect" determination is made for this project, it should be submitted to this office for concurrence. If a "no effect" determination is made, further consultation may not be necessary. However, a copy of the determination should be sent to this office.

Bald Eagles

Our U.S. Fish and Wildlife Service (USFWS) *Eagle Conservation Plan Guidance* (ECPG) was issued in April 2013, and per your letter you are familiar with the guidance and will be conducting eagle surveys at the project site. We have reviewed the protocol you provided. We note that the ECPG suggests at least 2 years of preconstruction surveys for eagles, as well as coverage of at least 30% of a 1-km buffer around turbine locations, while your protocol currently includes only 1 year of study, and 26% coverage. Following the ECPG more closely will strengthen the data used to estimate the risk to eagles and determine the appropriate risk category of the proposed project. Additionally, you have requested locations of documented eagle nests within 10 miles of the project area. The South Dakota Department of Game, Fish and Parks (SDDGFP) monitors known eagle nests annually, thus you may obtain this information from SDDGFP. Consider conducting surveys for eagle nests within the 10 mile radius of the project to identify any nests not currently known to SDDGFP.

Birds of Conservation Concern

In our February 5, 2010, letter we indicated the potential for occurrence of species listed in our Birds of Conservation Concern 2008 publication. That information remains relevant to this project with exception of our recommendation to develop an Avian and Bat Protection plan for the wind facility. Although that type of plan would be appropriate for the transmission portion of this project, impacts from the wind energy facility may be better addressed via development of a Bird and Bat Conservation Strategy as outlined in our *Land-Based Wind Energy Guidelines* (see page 55 of the Guidelines: <http://www.fws.gov/windenergy/docs/ WEG_final.pdf>).

Note that some species of migratory birds, particularly grassland dependent species such as the grasshopper sparrow, may tend to avoid wind turbines. This equates to habitat loss via negative behavioral response to turbines. We recommend offsetting that loss, perhaps via establishment of grassland easements, or restoration of degraded prairie/former grasslands. If the Crowned Ridge facility will impact intact grasslands, we recommend further coordination on this issue with both this office and the USFWS Waubay Wetland Management District whom you have already contacted. We request any survey data collected at the Crowned Ridge project area.

Agency Coordination

Our February 5, 2010, letter included recommended coordination with other agencies, including the U.S. Geological Survey at the Northern Prairie Wildlife Research Center, as they were conducting wind energy/wildlife interaction studies, but it is our understanding that that work has been completed. Again, continued coordination is recommended with USFWS Waubay Wetland Management District and SDDGFP regarding their areas of expertise.

Other Guidance Updates

No changes from our February 5, 2010, recommendations and advisories are provided herein regarding fisheries, wetlands, or the Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act. Your letter indicates you are familiar with our 2013 *Land-based Wind Energy Guidelines* which have been finalized since our last correspondence, and you are following the tiered steps therein, which we highly recommend. We provided information in our February 5, 2010, letter regarding meteorological towers, but note that we have updated our communication tower guidance which extends to meteorological towers; that updated guidance is enclosed. Also note that the publication *Mitigating Bird Collisions with Power Lines: The State of the Art in 1994* we had previously recommended has been updated with a 2012 version: *Reducing Avian Collisions with Power Lines: The State of the Art in 2012* which may be obtained by contacting the Edison Electric Institute at: <http://www.eei.org/resourcesandmedia/products/Pages/ProductDetails.aspx?prod=F20558BF-A097-4289-A8BA-1674B6096523&type=P>.

If changes are made in the project plans or operating criteria, or if additional information becomes available, the Service must be informed so that the above determinations can be reconsidered.

We appreciate the opportunity to provide comments on this project. If you have any questions on these comments, please contact Natalie Gates of this office at (605) 224-8693, Extension 227.

Sincerely,

Scott Larson
Field Supervisor
South Dakota Field Office

Enclosures

Cc: USFWS Waubay NWR; Waubay, SD
(Attn: Connie Mueller)
Western Area Power Administration; Billings, MT
(Attn: Matt Marsh)
SDDGFP; Pierre, SD
(Attn: Silka Kempema)
USFWS HAPET; Bismarck, ND

2013 U.S. Fish and Wildlife Service (USFWS) Revised Voluntary Guidelines for Communication Tower Design, Siting, Construction, Operation, Retrofitting, and Decommissioning –

Suggestions Based on Previous USFWS Recommendations to FCC Regarding WT Docket No. 03-187, FCC 06-164, Notice of Proposed Rulemaking, "Effects of Communication Towers on Migratory Birds" (2007), Docket No. 08-61, FCC's Antenna Structure Registration Program (2011), Service 2012 Wind Energy Guidelines, and Service 2013 Eagle Conservation Plan Guidance

Submitted by:

Albert M. Manville, II, Ph.D., C.W.B.
Senior Wildlife Biologist & Avian-Structural Lead
Division of Migratory Bird Management, U.S. Fish & Wildlife Service
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Last updated: September 27, 2013

[Comm Tower 2013 Revised Guidance-to FCC-AMM.docx]

1. Collocation of the communications equipment on an existing communication tower or other structure (e.g., billboard, water and transmission tower, distribution pole, or building mount) is strongly recommended. Depending on tower load factors and communication needs, from 6 to 10 providers should collocate on an existing tower or structure provided that frequencies do not overlap/"bleed" or where frequency length or broadcast distance requires higher towers. New towers should be designed structurally and electronically to accommodate the applicant's antenna, and antennas of at least 2 additional users – ideally 6 to 10 additional users, if possible – unless the design would require the addition of lights and/or guy wires to an otherwise unlit and/or unguyed tower. This recommendation is intended to reduce the number of towers needed in the future.

2. If collocation is not feasible and a new tower or towers are to be constructed, it is strongly recommended that the new tower(s) should be not more than 199 feet above ground level (AGL), and that construction techniques should not require guy wires. Such towers should be unlighted if Federal Aviation Administration (FAA) regulations and lighting standards (FAA 2007, Patterson 2012, FAA 2013 lighting circular anticipated update) permit. Additionally, the Federal Communications Commission (FCC) through recent rulemaking now requires that new towers ≥ 450 ft AGL contain no red-steady lights. FCC also recommends that new towers 350-450 ft AGL also contain no red-steady lights, and they will eventually recommend that new towers < 350 ft AGL convert non-flashing lights to flash with existing flashing lights. LED lights are being suggested as replacements for all new construction and for retrofits, with the intent of future synchronizing the flashes. Given these dynamics, the Service recommends using lattice tower or monopole structures for all towers < 200 ft AGL and for taller towers where feasible. The Service considers the less than 200 ft AGL option the "gold standard" and suggests that this

is the environmentally preferred industry standard for tower placement, construction and operation – i.e., towers that are unlit, unguyed, monopole or lattice, and less than 200 ft AGL.

3. If constructing multiple towers, the cumulative impacts of all the towers to migratory birds – especially to Birds of Conservation Concern (FWS 2008) and threatened and endangered species, as well as the impacts of each individual tower, should be considered during the development of a project.

4. The topography of the proposed tower site and surrounding habitat should be clearly noted, especially in regard to surrounding hills, mountains, mountain passes, ridge lines, rivers, lakes, wetlands, and other habitat types used by raptors, Birds of Conservation Concern, and state and federally listed species, and other birds of concern. Active raptor nests, especially those of Bald and Golden Eagles, should be noted, including known or suspected distances from proposed tower sites to nest locations. Nest site locations for Golden Eagles may vary between years, and unoccupied, inactive nests and nest sites may be re-occupied over multiple years. The Service's 2013 Eagle Conservation Plan Guidance, Module 1, Land-based Wind Energy, Version 2, available on our website, is a useful document (USFWS 2013).

5. If at all possible, new towers should be sited within existing "antenna farms" (i.e., clusters of towers), in degraded areas (e.g., strip mines or other heavily industrialized areas), in commercial agricultural lands, in Superfund sites, or other areas where bird habitat is poor or marginal. Towers should not be sited in or near wetlands, other known bird concentration areas (e.g., state of federal refuges, staging areas, rookeries, and Important Bird Areas), in known migratory, daily movement flyways, areas of breeding concentration, in habitat of threatened or endangered species, or key habitats for Birds of Conservation Concern (FWS 2008). Disturbance can result in effects to bird populations which may cumulatively affect their survival. The Service has recommended some disturbance-free buffers, e.g., 0.5 mi around raptor nests during the nesting season, and 1-mi disturbance free buffers for Ferruginous Hawks and Bald Eagles during nesting season in Wyoming (FWS WY Ecological Services Field Office, referenced in Manville 2007:23). The effects of towers on "prairie grouse," "sage grouse," and grassland and shrub-steppe bird species should also be considered since tall structures have been shown to result in abandonment of nest site areas and leks, especially for "prairie grouse" (Manville 2004). The issue of buffers is currently under review, especially for Bald and Golden Eagles. Additionally, towers should not be sited in areas with a high incidence of fog, mist, and low cloud ceilings.

6. If taller (> 199 ft AGL) towers requiring lights for aviation safety must be constructed, the minimum amount of pilot warning and obstruction avoidance lighting required by the FAA should be used. Unless otherwise required by the FAA, only white strobe or red strobe lights (red preferable since it is generally less displeasing to the human eye at night), or red flashing incandescent lights should be used at night, and these should be the minimum number, minimum intensity (< 2,000 candela), and minimum number of flashes per minute (i.e., longest duration between flashes/"dark phase") allowable by the FAA. The use of solid (non-flashing) warning lights at night should be avoided (Patterson 2012, Gehring et al. 2009) – see recommendation #2 above. Current research indicates that solid red lights attract night-migrating birds at a much higher rate than flashing lights (Gehring et al. 2009, Manville 2007, 2009). Recent research

indicates that use of white strobe, red strobe, or red flashing lights alone provides significant reductions in bird fatalities (Patterson 2012, Gehring et al. 2009).

7. Tower designs using guy wires for support, which are proposed to be located in known raptor or waterbird concentrations areas, daily movement routes, major diurnal migratory bird movement routes, staging areas, or stopover sites, should have daytime visual markers or bird deterrent devices installed on the wires to prevent collisions by these diurnally moving species. The efficacy of bird deterrents on guy wires to alert night migrating species has yet to be scientifically validated. For guidance on markers, see Avian Power Line Interaction Committee (APLIC). 2006. *Suggested Practices for Avian Protection on Power Lines -- State of the Art in 2006.* Edison Electric Institute, APLIC, and the California Energy Commission. Washington, DC, and Sacramento, CA. 207 pp, and APLIC. 2012. *Reducing Avian Collisions with Power Lines -- the State of the Art in 2012.* Edison Electric Institute and APLIC. Washington, DC. 159 pp. Also see www.aplic.org, www.energy.ca.gov, or call 202-508-5000.

8. Towers and appendant facilities should be designed, sited, and constructed so as to avoid or minimize habitat loss within and adjacent to the tower "footprint." However, a larger tower footprint is preferable to the use of guy wires in construction. Several shorter, un-guyed towers are preferable to one, tall guyed, lighted tower. Road access and fencing should be minimized to reduce or prevent habitat fragmentation, disturbance, and the creation of barriers, and to reduce above ground obstacles to birds in flight.

9. If, prior to tower design, siting and construction, if it has been determined that a significant number of breeding, feeding and roosting birds, especially of Birds of Conservation Concern (FWS 2008), state or federally-listed bird species, and eagles are known to habitually use the proposed tower construction area, relocation to an alternate site is highly recommended. If this is not an option, seasonal restrictions on construction are advised in order to avoid disturbance, site and nest abandonment, especially during breeding, rearing and other periods of high bird activity.

10. Security lighting for on-ground facilities, equipment and infrastructure should be motion- or heat-sensitive, down-shielded, and of a minimum intensity to reduce nighttime bird attraction and eliminate constant nighttime illumination, but still allow safe nighttime access to the site (USFWS 2012, Manville 2011).

11. Representatives from the USFWS or researchers from the Research Subcommittee of the Communication Tower Working Group should be allowed access to the site to evaluate bird use; conduct dead-bird searches; place above ground net catchments below the towers (Manville 2002); and to perform studies using radar, Global Position System, infrared, thermal imagery, and acoustical monitoring, as necessary. This will allow for assessment and verification of bird movements, site use, avoidance, and mortality. The goal is to acquire information on the impacts of various tower types, sizes, configurations and lighting protocols.

12. Towers no longer in use, not re-licensed by the FCC for use, or determined to be obsolete should be removed from the site within 12 months of cessation of use, preferably sooner.

13. In order to obtain information on the usefulness of these guidelines in preventing bird strikes and better understanding impacts from habitat fragmentation, please advise USFWS personnel of the final location and specifications of the proposed tower, and which measures recommended in these guidelines were implemented. If any of these recommended measures cannot be implemented, please explain why they are not feasible. This will further advise USFWS in identifying any recurring problems with the implementation of the guidelines, which may necessitate future modifications.

Reference Sources:

Federal Aviation Administration. 2007. Obstruction marking and lighting. Advisory Circular AC 70/7460-1K. U.S. Department of Transportation.

Gehring, J., P. Kerlinger, and A.M. Manville, II. 2009. Communication towers, lights and birds: successful methods of reducing the frequency of avian collisions. Ecological Applications 19(2): 505-514. Ecological Society of America.

Gehring, J., P. Kerlinger, and A.M. Manville, II. 2011. The role of tower height and guy wires on avian collisions with communication towers. Journal of Wildlife Management 75(4): 848-855. The Wildlife Society.

Manville, A.M., II. 2002. Protocol for monitoring the impact of cellular telecommunication towers on migratory birds within the Coconino, Prescott, and Kaibab National Forests, Arizona. Protocol requested by U.S. Forest Service. 9 pp.

Manville, A.M., II. 2004. Prairie grouse leks and wind turbines: U.S. Fish and Wildlife Service justification for a 5-mile buffer from leks; additional grassland songbird recommendations. Division of Migratory Bird Management, USFWS, Arlington, VA, peer-reviewed briefing paper. 17 pp.

Manville, A.M., II. 2007. Comments of the U.S. Fish and Wildlife Service Submitted Electronically to the FCC on 47 CFR Parts 1 and 17, WT Docket No. 03-187, FCC 06-164, Notice of Proposed Rulemaking, "Effects of Communication Towers on Migratory Birds." February 2, 2007. 32 pp.

Manville, A.M., II. 2009. Towers, turbines, power lines, and buildings – steps being taken by the U.S. Fish and Wildlife Service to avoid or minimize take of migratory birds at these structures. Pages 262-272 *In* T.D. Rich, C. Arizmendi, D. Demarest, and C. Thompson (eds.). Tundra to Tropics: Connecting Habitats and People. Proceedings 4th International Partners in Flight Conference, McAllen, TX.

Manville, A.M., II. 2011. Comments of the U.S. Fish and Wildlife Service's Division of Migratory Bird Management Filed Electronically on WT Docket No. 08-61 and WT Docket No. 03-187, Regarding the Environmental Effects of the Federal Communication's Antenna Structure Registration Program. January 14, 2011. 12 pp.

Patterson, J.T., Jr. 2012. Evaluation of new obstruction lighting techniques to reduce avian fatalities. DOT/FAA/TC-TN12/9, Federal Aviation Administration, U.S. Department of Transportation. 28 pp, plus appendices.

U.S. Fish and Wildlife Service. 2000. Service Guidance on the Siting, Construction, Operation, and Decommissioning of Communication Towers. September 14, 2000. http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

U.S. Fish and Wildlife Service. 2008. Birds of Conservation Concern 2008. United States Department of Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, VA. 85 pp. http://www.fws.gov/migratorybirds/>

U.S. Fish and Wildlife Service. 2012. U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines. March, 82 pp.

U.S. Fish and Wildlife Service. 2013. Eagle Conservation Plan Guidance, Module 1, Land-based Wind Energy, Version 2. Division of Migratory Bird Management. April, 103 pp.

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Kely Mertz

Subject:	Information included: Crowned Ridge project discussion
Location:	Conference Line
Start:	Thu 4/20/2017 12:00 PM
End:	Thu 4/20/2017 1:00 PM
Show Time As:	Tentative
Recurrence:	(none)
Meeting Status:	Not yet responded
Organizer:	Kely Mertz
Required Attendees:	Kempema, Silka; Natoma Hansen; Natalie_Gates@fws.gov; Mueller, Connie; Wells, Kimberly; Tyler.Williams@nexteraenergy.com; patrick.flowers@xcelenergy.com

Good morning,

Below, please find the agenda and call-in information for the call. We are also attaching a project overview, which we will walk through during the call. We understand the late circulation and do not expect review prior to the call.

We look forward to talking tomorrow.
Thank you,
Kely

Call-in Information
305-552-3001
11855446#

Agenda

I. Introductions
II. Project overview
III. Current studies
IV. PUC process
V. USFWS easements
VI. Questions



Memorandum

Date: April 19, 2017

Re: Crowned Ridge II Project Background

PROJECT OVERVIEW

Crowned Ridge Wind, LLC, an indirect subsidiary of NextEra Energy Resources, LLC (NEER), plans to develop a 600-megawatt (MW) wind facility known as the Crowned Ridge Wind Energy Facility (the project) in Deuel, Grant, and Codington Counties. The northern 300 MW will produce energy sold to Xcel through a Power Purchase Agreement. The southern 300 MW is a build-own-transfer project, with Xcel Energy (Xcel) as the ultimate owner-operator (Figure 1). The project's point of interconnection will be Otter Tail Power's Big Stone South 230-kilovolt (kV) substation near Big Stone City, South Dakota. Construction is anticipated to commence in early 2019, and the project is scheduled to achieve commercial operation on or before the end of 2019. For purposes of discussion, the northern 300 MW can be referenced as Crowned Ridge I, and the southern 300 MW can be referenced as Crowned Ridge II.

STUDIES AND SURVEYS

NEER has completed numerous studies in the general vicinity of the project area (Table 1). NEER has coordinated with the U.S. Fish and Wildlife Service and South Dakota Game, Fish and Parks multiple times (2005, 2007, 2009, 2010, 2015, 2017) to request information regarding ecologically significant areas (e.g., easements) and endangered, threatened, or special status species (e.g., eagles) in this general area of South Dakota.

Table 1. Surveys and Studies Completed or in Progress for the Crowned Ridge Wind Energy Facility Project Area and Vicinity

Survey/Study Date	Survey/ Study Description	Description or Summary of Results	Federal or State Listed Species Observed? If Y, describe.
Fall 2007	Critical Issues Analysis (CIA) Bemis Wind Resource Area (WRA)	Recommended additional investigations; identified potential constraints.	NA
Mar 2007 – Jun 2008	Avian Surveys – Spring (Bemis WRA)	Identified 27 active raptor nests (mostly red-tailed hawks); several leks.	Y (11 South Dakota state-sensitive species)
Jun 2008	Native Prairie Surveys (Bemis WRA)	Delineated grassland, native and tame, and potential Dakota skipper habitat.	N
Aug – Nov 2008	Avian Surveys – Fall (Bemis WRA)	Documented avian species.	Y (12 South Dakota sensitive species)
Jun – Jul 2009	Native Prairie Surveys (Crowned Ridge WRA)	Delineated native and tame grassland and potential Dakota skipper habitat.	N

Table 1. Surveys and Studies Completed or in Progress for the Crowned Ridge Wind Energy Facility Project Area and Vicinity (Continued)

Survey/Study Date	Survey/ Study Description	Description or Summary of Results	Federal or State Listed Species Observed? If Y, describe.
2013	CIA (Crowned Ridge Wind Energy Center [WEC])	Recommended additional investigations and identified potential constraints or resources for consideration.	NA
Aug – Nov 2014	Avian Surveys – Fall (Crowned Ridge WEC)	Documented avian species.	N
Mar – Nov 2014; Nov – Mar 2015	Eagle Survey (Crowned Ridge WEC)	Documented eagle presence and use.	NA
2015	Dakota Skipper Habitat Evaluation (Crowned Ridge WEC)	Identified approximately five areas (ranging from 39 to 193 acres each and comprising 3% of the Project Area) of potential Dakota skipper habitat in the Project Area.	N
Summer 2015	Northern long-eared bat (NLEB) summer bat habitat assessment (Crowned Ridge Transmission Line Route)	Identified marginal potential suitable NLEB roosting habitat.	NA
Aug – Oct 2015; April – Oct 2016	Bat acoustic survey (Crowned Ridge WEC)	Documented bat activity.	NA
Apr, May 2017	Aerial Raptor Survey (Crowned Ridge Wind Energy Facility [WEF])	Identified raptor nests within project area plus 2- and 10-mile buffers. April complete.	TBD
April – Nov 2017	Avian point count surveys (Crowned Ridge WEF)	In progress. April point count complete.	TBD
Apr – Nov 2017	Bat Acoustic monitoring (Crowned Ridge WEF)	In progress.	TBD

Notes:

N = No.

NA = Not Applicable.

TBD = To Be Determined.

Y = Yes.

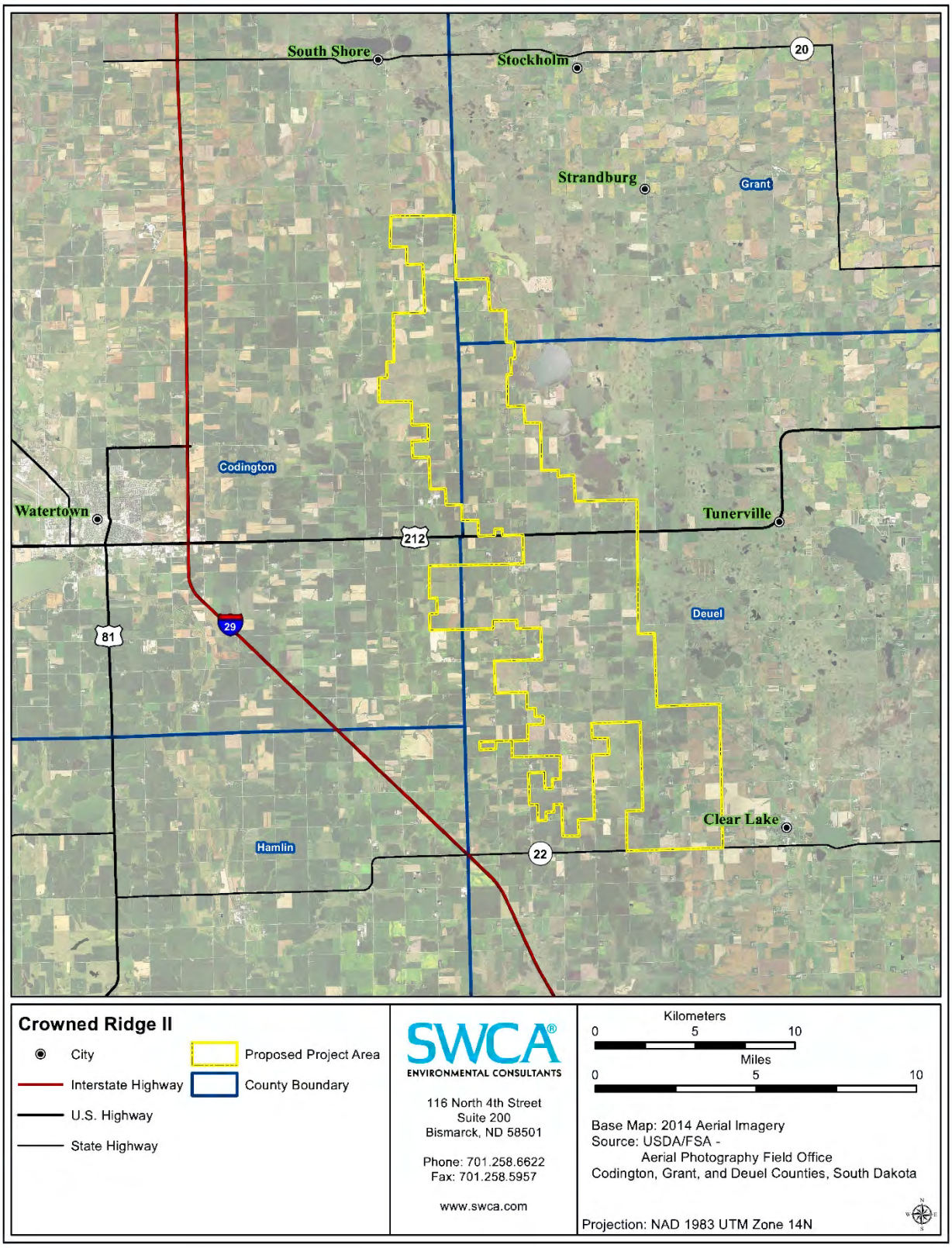


Figure 1. Crowned Ridge Wind Energy Facility, Crowned Ridge II, South Dakota.

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Scott Phillips

From: Zonna Barnes
Sent: Friday, June 16, 2017 5:02 PM
To: Paige Olson; Scott Phillips; Carolyn.Stewart@nexteraenergy.com; Richard.Estabrook@nexteraenergy.com; Tyler.Wilhelm@nexteraenergy.com; Kimberly.Wells@nexteraenergy.com
Cc: Norma Crumbley; Stephen Sabatke
Subject: RE: Crowned Ridge Project Meeting
Attachments: Cultural Resources_overview-methods_memo_swca_14Jun2017.docx

Hi all,
In preparation for the call on Monday morning, the cultural resource overview document is attached.

Thanks!
Zonnie

-----Original Appointment-----
From: Zonna Barnes
Sent: Monday, June 12, 2017 5:07 PM
To: Zonna Barnes; Paige Olson; Scott Phillips; Carolyn.Stewart@nexteraenergy.com; Richard.Estabrook@nexteraenergy.com; Tyler.Wilhelm@nexteraenergy.com; Kimberly.Wells@nexteraenergy.com
Cc: Norma Crumbley; Stephen Sabatke
Subject: Crowned Ridge Project Meeting
When: Monday, June 19, 2017 9:00 AM-10:00 AM (UTC-07:00) Mountain Time (US & Canada).
Where: 866.740.1260 Access Code: 9951661

9 am (MDT)/10 am (CDT)

Conference Call information:
1-866-740-1260
Access code: 9951661

Memorandum

Date: June 14, 2017

Re: Crowned Ridge Wind Energy Facility Overview and Cultural Resources Review

PROJECT OVERVIEW

Crowned Ridge Wind, LLC, an indirect subsidiary of NextEra Energy Resources, LLC (NEER), plans to develop a 600-megawatt (MW) wind facility known as the Crowned Ridge Wind Energy Facility (the project) in Deuel, Grant, and Codington Counties. The northern 300 MW will produce energy sold to Xcel Energy (Xcel) through a Power Purchase Agreement. The southern 300 MW is a build-own-transfer project, with Xcel as the ultimate owner-operator (Figures 1 and 2). The project's point of interconnection will be Otter Tail Power's Big Stone South 230-kilovolt (kV) substation near Big Stone City, South Dakota. Construction is anticipated to commence in early 2019, and the project is scheduled to achieve commercial operation on or before the end of 2019. For purposes of discussion, the northern 300 MW can be referenced as Crowned Ridge I, and the southern 300 MW can be referenced as Crowned Ridge II.

CULTURAL RESOURCE REVIEW

Cultural resources review for the project is to meet the requirements of the South Dakota Public Utilities Commission (PUC) for project permitting. No federal involvement is triggered for the project that would require review under Section 106 of the National Historic Preservation Act. NEER has engaged the Sisseton-Wahpeton Oyate of the Lake Traverse Reservation (SWO), HDR, Inc. (HDR), and SWCA Incorporated (SWCA) to conduct the tribal resource, archaeological, and historic—or collectively "cultural resource"—review for the project. SWCA is leading and coordinating this combined effort.

Existing Knowledge Bases

Records searches from the South Dakota Archaeological Research Center (SARC) databases indicate 562 cultural resources previously recorded within the vicinity of the project by 103 previous surveys (Table 1). Identification of tribal resources, such as sacred sites, Traditional Cultural Properties (TCPs), sites of religious importance, and historic properties, will be identified by SWO and may overlap with sites identified by others in the SARC databases. SWO is also working with NEER to lead outreach to other concerned tribes. As a result, the Spirit Lake Tribe and the Yankton Sioux Tribe are anticipated to participate in field survey efforts.

Field Survey

A Level III intensive inventory of tribal, archaeological, and historic resources of the project area will be conducted including all turbine locations, collection lines, roads, 230-kV substations, and 230-kV transmission lines connecting the project to the Otter Tail Power 230-kV Big Stone Substation. Resource specialists from SWCA, HDR, SWO, and other engaged tribes will cover these areas with systematic pedestrian transects spaced no more than 30 meters (m) apart for an intensive survey of cultural resources.

Table 1. Previously Recorded Cultural Resources in the Project Vicinity per SARC Databases

Cultural Resource Category	Quantity Identified
Archaeological Sites	118
Historic Districts	1
Historic Bridges	49
Cemeteries	11
Historic Structures	383
Total	**562**

During the inventory, any previously recorded sites will be re-evaluated and re-recorded as necessary. Newly discovered cultural resources will be mapped to scale and recorded in accordance with South Dakota State Historic Preservation Officer (SHPO) guidelines. Global positioning system shapefiles will be created and additionally used to assist NEER in planning project design in relation to cultural resources.

Principal Investigators from this team will evaluate the significance of all identified historic and prehistoric resources in terms of eligibility for the National Register of Historic Places and in relation to tribal significance. While evaluations of significance for an archaeological resource might use information from subsurface testing of both sites and isolated finds, subsurface testing will largely be limited to historical archaeological sites and excluded from potentially tribally significant resources that may be alternately assessed through nonintrusive means.

Based upon the PUC permits required for project components, NEER anticipates that up to four phases of cultural resources reporting may be required: one each for the Off-site and On-site Gen-ties, and one each for Crowned Ridge I and II. The Off-Site Gen-tie will connect from the northern end of the project to the Big Stone South 230- kV substation and is to begin PUC permitting by August 2017. The On-site Gen-tie will connect between Crown Ridge I and II, and these project components are to begin PUC permitting by October 2017.

Reporting

The team will prepare Level III intensive inventory reports to current SHPO standards. Reporting will include a project description, environmental setting, cultural setting, background research results, research design, methods, results of investigations, recommendations, and references cited. The report will provide recommendations regarding the management of cultural resources identified in the project area, with particular recommendations for avoidance, minimization, and other mitigation, as needed, for significant (National Register of Historic Places–eligible) cultural resources. The information will assist NEER with micrositing, focusing upon the avoidance of effects to cultural resources to the extent achievable. An unanticipated discovery plan will also be drafted in consultation with NEER and the SHPO. This plan will detail specific actions to take during the construction phase of the project should any cultural resource discoveries be identified.

This memorandum was prepared for NEER by SWCA.

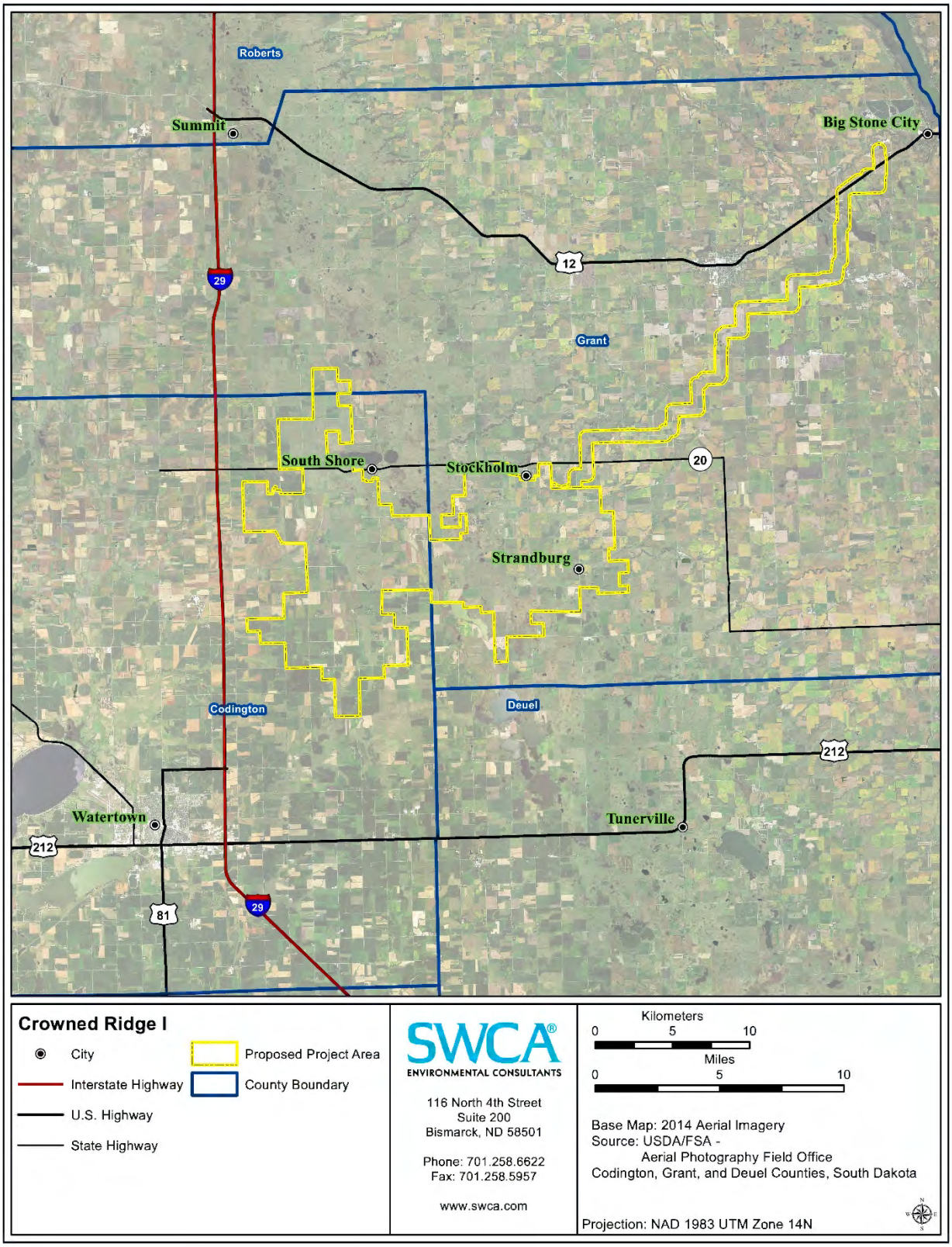


Figure 1. Crowned Ridge Wind Energy Facility, Crowned Ridge I, South Dakota.

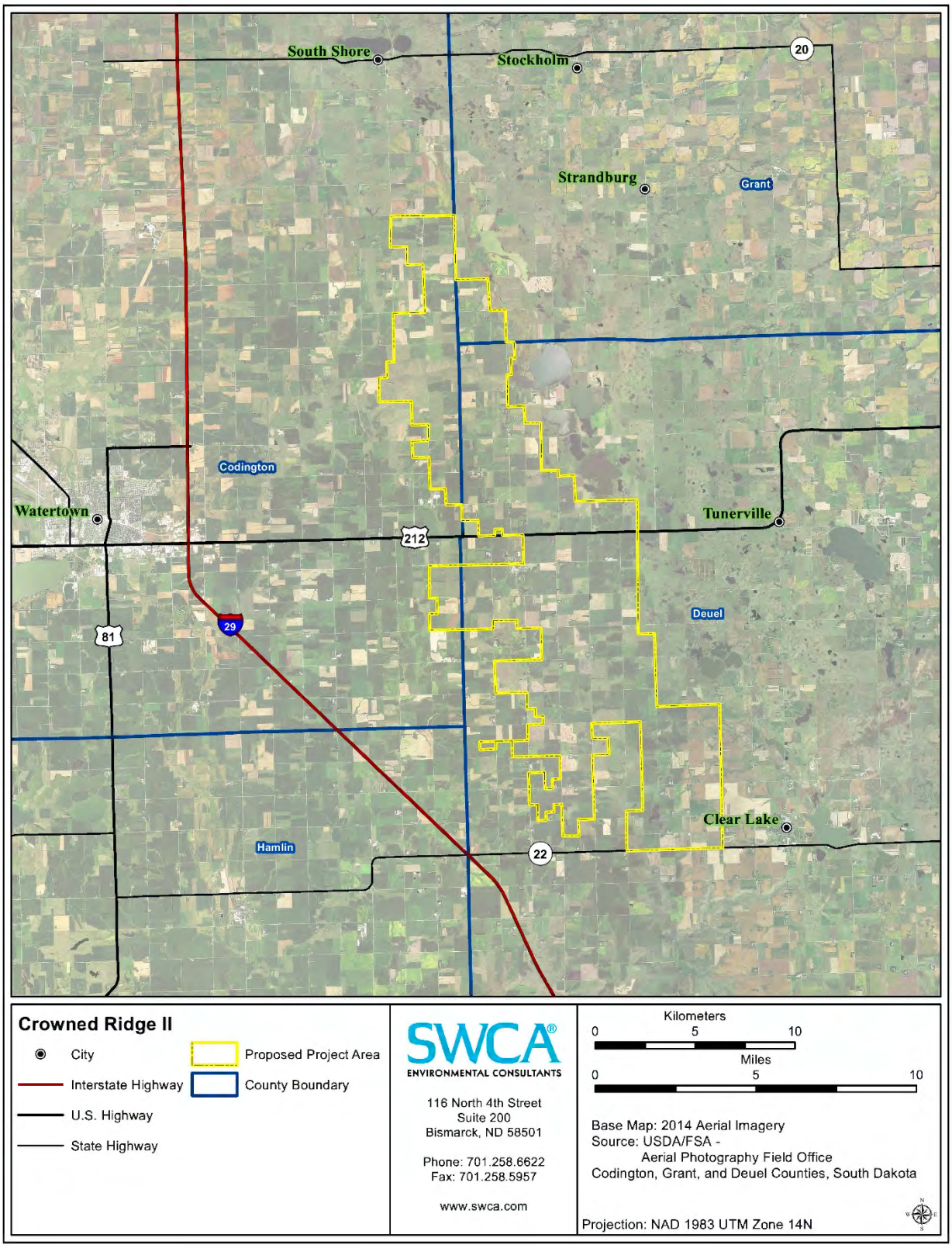


Figure 2. Crowned Ridge Wind Energy Facility, Crowned Ridge II, South Dakota.

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From:	Kely Mertz
To:	Runia, Travis
Subject:	RE: Lek data
Date:	Thursday, June 15, 2017 10:53:00 AM
Attachments:	Generalized_Polygon.zip

Travis,
Attached is the general area of interest, which is confidential at this time.
Thank you!
Kely

From: Runia, Travis [mailto:Travis.Runia@state.sd.us]
Sent: Thursday, June 15, 2017 8:43 AM
To: Kely Mertz <KMertz@swca.com>
Subject: RE: Lek data

Hi Kely,

Do you have a shapefile of the area of interest? I understand you might not be able to share the exact project boundary.

We usually respond to these requests by providing any lek data we may have, but we also let the developer know what surveys have been completed in the area. Our survey foot print is quite small, so many times we do not have any known lek locations in the proposed project area, but it is because surveys have not been conducted.

Thanks,

Travis Runia | *Senior Upland Game Biologist*
South Dakota Department of Game, Fish and Parks
895 3rd St. SW | Huron, SD 57350
605.353.8477 | Travis.Runia@state.sd.us

From: Kely Mertz [mailto:KMertz@swca.com]
Sent: Thursday, June 15, 2017 7:39 AM
To: Runia, Travis
Subject: FW: [EXT] Lek data

Good morning Travis,
I was inquiring about current data regarding lek locations, and Casey indicated you might have more information. Is this data that your agency has, and can share? This is in reference to ongoing coordination with SDGFP and USFWS regarding a potential wind project in eastern South Dakota.
Thank you in advance,

Kely

Kely Mertz
Senior Project Manager

200 W. 22nd Street, Suite 220
Lombard, IL 60148
Office 630.705.1762
Cell 614.580.6715
Visit Our Website: http://www.swca.com

From: Heimerl, Casey [mailto:Casey.Heimerl@state.sd.us]
Sent: Thursday, June 15, 2017 8:36 AM
To: Kely Mertz <KMertz@swca.com>
Subject: RE: Lek data

Hi Kely,

We do not keep lek data in our Natural Heritage Database. I recommend you contact our upland gamebird biologist to see what he may be able to provide. His email is Travis.Runia@state.sd.us

~Casey

From: Kely Mertz [mailto:KMertz@swca.com]
Sent: Thursday, June 15, 2017 7:15 AM
To: Heimerl, Casey
Subject: [EXT] Lek data

Hi Casey,
We are interested in the most current information regarding lek data also. Can we make that request under the same data use agreement form, or would we need to do another request separately? I would need to provide you with a slightly updated shapefiles and buffer.
Thank you,
Kely

Kely Mertz
Senior Project Manager

200 W. 22nd Street, Suite 220
Lombard, IL 60148
Office 630.705.1762
Cell 614.580.6715
Visit Our Website: http://www.swca.com

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From:	Kely Mertz
To:	Runia, Travis
Cc:	Heimerl, Casey
Subject:	RE: Lek data
Date:	Tuesday, July 11, 2017 9:44:00 AM

This is very helpful, thank you Travis!
Kely

From: Runia, Travis [mailto:Travis.Runia@state.sd.us]
Sent: Tuesday, July 11, 2017 9:43 AM
To: Kely Mertz <KMertz@swca.com>
Cc: Heimerl, Casey <Casey.Heimerl@state.sd.us>
Subject: RE: Lek data

Hi Kely,

We have very limited survey effort for prairie grouse leks in your project area. However, see below the information for 4 recent lek locations.

2014 – STGR – 11 males - -96.877056, 44.960364
2016 – GPCH – 25 birds - -96.879337, 45.161802
2016 – Unknown Species – 6 birds - -96.912922, 45.131501
2016 – Unknown Species – 20 birds - -96.872471, 45.129682

Thanks,

Travis Runia | *Senior Upland Game Biologist*
South Dakota Department of Game, Fish and Parks
895 3rd St. SW | Huron, SD 57350
605.353.8477 | Travis.Runia@state.sd.us

From: Kely Mertz [mailto:KMertz@swca.com]
Sent: Monday, July 10, 2017 12:52 PM
To: Runia, Travis
Subject: RE: [EXT] Lek data

Good afternoon, Travis –
I was just following up to see if you had any lek data available for the area of interest I provided in June?
Thank you!
Kely

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July 12, 2017

Silka Kempema
South Dakota Game Fish and Parks
523 East Capitol Avenue
Pierre, SD 57501

Re: Crowned Ridge I and II Wind Energy Projects in Codington, Deuel, and Grant Counties, South Dakota

Dear Ms. Kempema:

SWCA Environmental (SWCA) is writing on behalf of NextEra Energy Resources, LLC (NEER), to request information regarding ecologically sensitive areas and federally and state listed endangered, threatened, or special concern species occurrences in reference to the proposed Crowned Ridge Wind, LLC and Crowned Ridge Wind II, LLC projects in Codington, Deuel, and Grant counties, South Dakota.

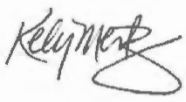
The two projects are adjacent and will total 600 megawatts (MW). The northern 300 MW and northern gen-tie are known as the Crowned Ridge I project. The southern 300 MW and southern (on-site) gen-tie is known as the Crowned Ridge II project. The projects' point of interconnection will be Otter Tail Power's Big Stone South 230-kilovolt substation near Big Stone City, South Dakota. Construction is anticipated to commence in late 2018, and the projects are scheduled to achieve commercial operation on or before the end of 2019.

We have provided Shapefiles and a figure to facilitate your review, and we greatly appreciate your ongoing efforts to treat the projects and their locations as confidential at this time. Please note that the area provided is larger than what ultimately will be needed to develop the projects. However, querying this area will allow NEER to accommodate micro-siting adjustments to avoid sensitive resources to the extent possible.

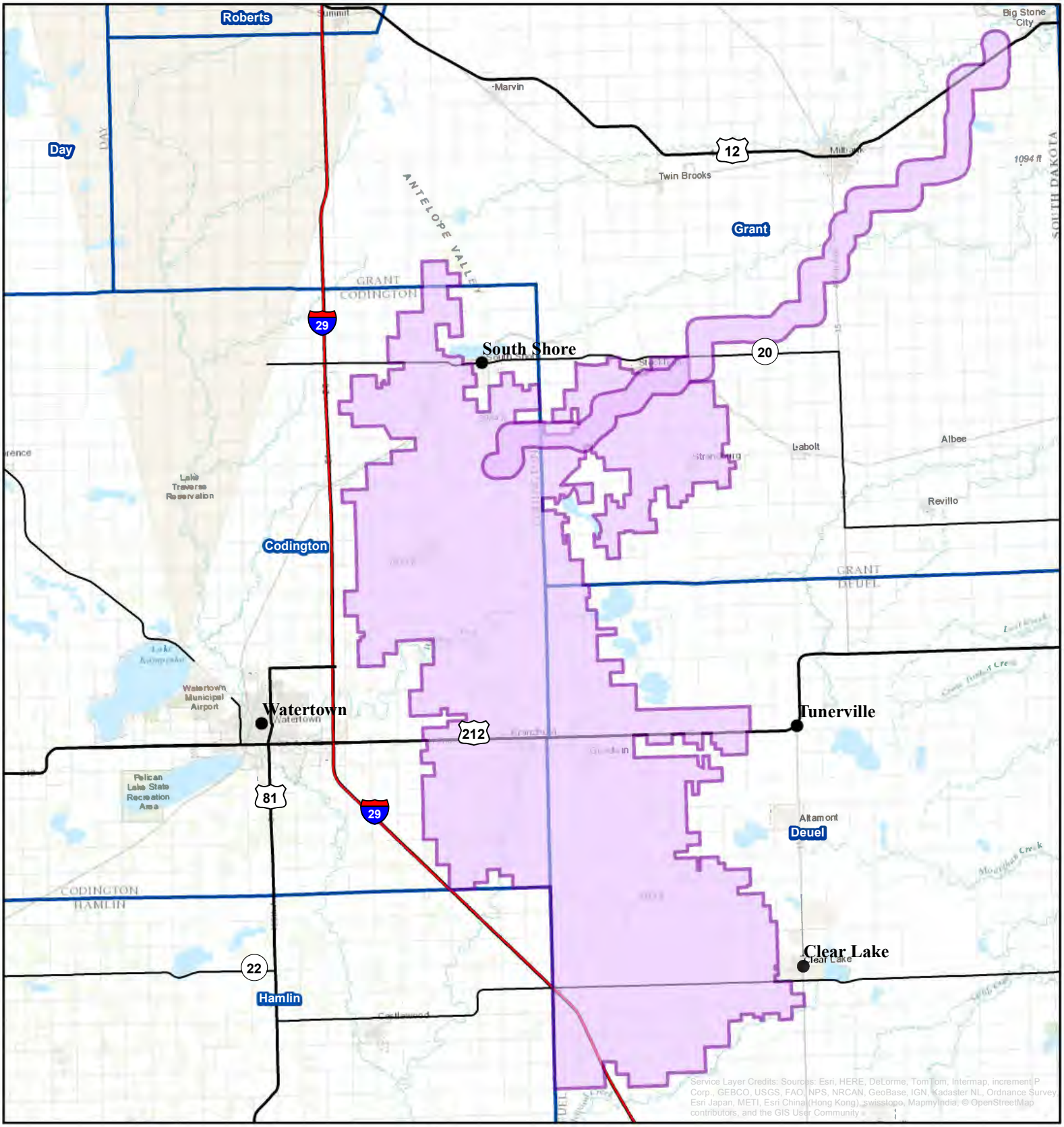
NEER has coordinated with the South Dakota Game, Fish, and Parks and US Fish and Wildlife Service (USFWS) since 2005 regarding potential wind energy development in this general region. Recent coordination includes our April 20, 2017 conference calls with you and the USFWS. As you are aware from this past and ongoing coordination, NEER's goal is to perform a thorough analysis of environmental resources using the best available information.

Should you have any questions or require additional information, please do not hesitate to contact me at 614.580.6715 or kmertz@swca.com. Thank you for your assistance.

Sincerely,



Kely Mertz
Senior Project Manager



Crowned Ridge I and II Wind Projects

- City
- County Boundary
- Interstate Highway
- U.S. Highway
- State Highway
- Area of Interest

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Suite 200
Bismarck, ND 58501

Phone: 701.258.6622
Fax: 701.258.5957

www.swca.com

Kilometers
0 5 10

Miles
0 5 10

Base Map: USGS 7.5' Topographic Map
Source: Esri ArcGIS Online service
Codington, Grant, and
Deuel Counties, South Dakota

000264

Projection: NAD 1983 UTM Zone 14N

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Lombard, Illinois 60148
Tel 630.705.1762
www.swca.com

July 12, 2017

Natalie Gates
US Fish and Wildlife Service
420 S. Garfield Avenue, Suite 400
Pierre, SD 57501

Re: Crowned Ridge I and II Wind Energy Projects in Codington, Deuel, and Grant Counties, South Dakota

Dear Ms. Gates:

SWCA Environmental (SWCA) is writing on behalf of NextEra Energy Resources, LLC (NEER), to request information regarding ecologically sensitive areas and federally and state listed endangered, threatened, or special concern species occurrences in reference to the proposed Crowned Ridge Wind, LLC and Crowned Ridge Wind II, LLC projects in Codington, Deuel, and Grant counties, South Dakota.

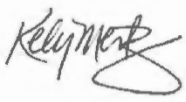
The two projects are adjacent and will total 600 megawatts (MW). The northern 300 MW and northern gen-tie are known as the Crowned Ridge I project. The southern 300 MW and southern (on-site) gen-tie is known as the Crowned Ridge II project. The projects' point of interconnection will be Otter Tail Power's Big Stone South 230-kilovolt substation near Big Stone City, South Dakota. Construction is anticipated to commence in late 2018, and the projects are scheduled to achieve commercial operation on or before the end of 2019.

We have provided Shapefiles and a figure to facilitate your review, and we greatly appreciate your ongoing efforts to treat the projects and their locations as confidential at this time. Please note that the area provided is larger than what ultimately will be needed to develop the projects. However, querying this area will allow NEER to accommodate micro-siting adjustments to avoid sensitive resources to the extent possible.

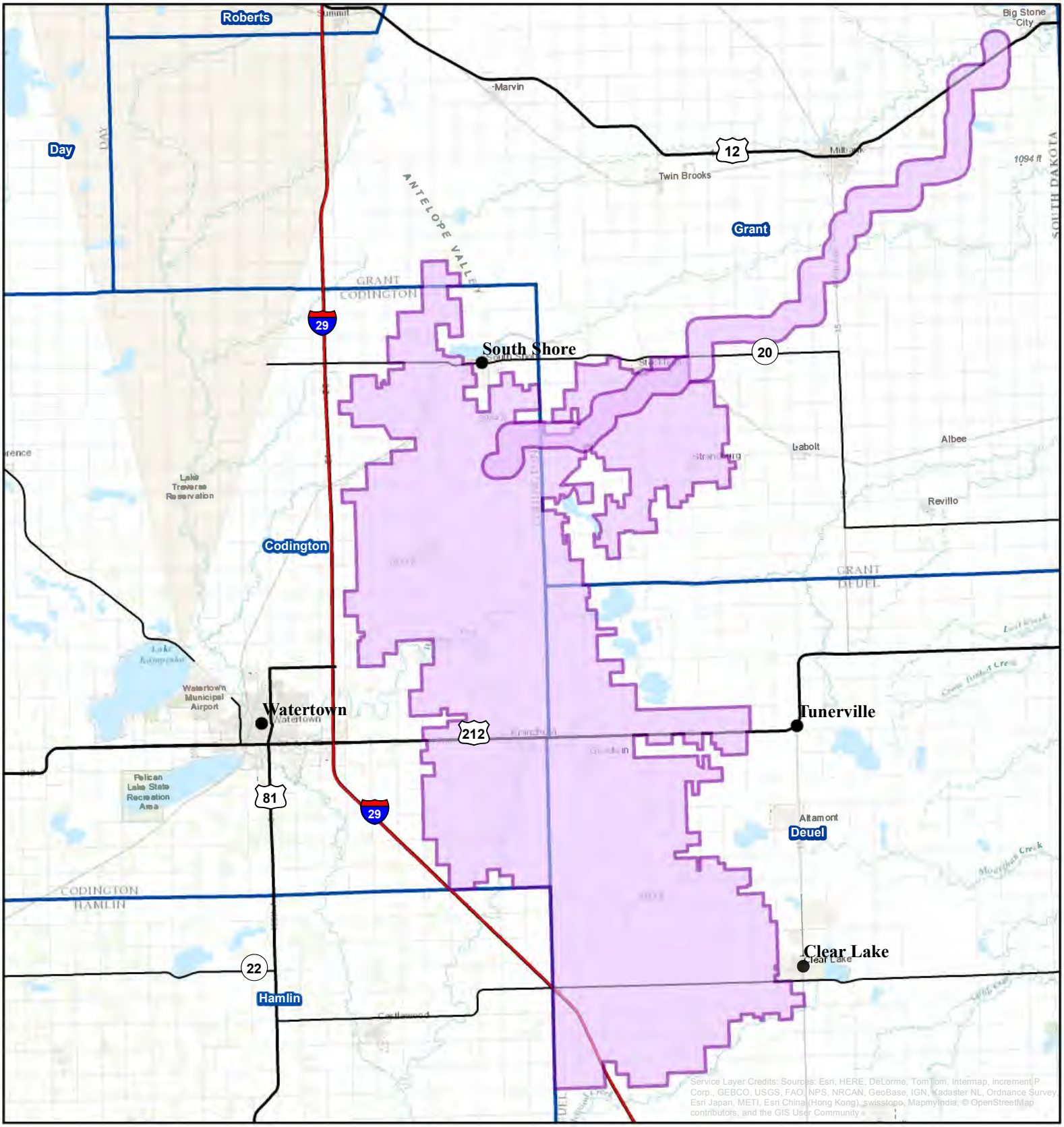
NEER has coordinated with the US Fish and Wildlife Service and South Dakota Game, Fish, and Parks (SDGFP) since 2005 regarding potential wind energy development in this general region. Recent coordination includes our April 20, 2017 conference calls with you and the SDGFP. As you are aware from this past and ongoing coordination, NEER's goal is to perform a thorough analysis of environmental resources using the best available information.

Should you have any questions or require additional information, please do not hesitate to contact me at 614.580.6715 or kmertz@swca.com. Thank you for your assistance.

Sincerely,



Kely Mertz
Senior Project Manager



Crowned Ridge I and II Wind Projects

- City
- County Boundary
- Interstate Highway
- U.S. Highway
- State Highway
- Area of Interest

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Fax: 701.258.5957

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Kilometers
0 5 10

Miles
0 5 10

Base Map: USGS 7.5' Topographic Map
Source: Esri ArcGIS Online service
Codington, Grant, and
Deuel Counties, South Dakota

000267

Projection: NAD 1983 UTM Zone 14N

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Kely Mertz

From: Heimerl, Casey <Casey.Heimerl@state.sd.us>
Sent: Tuesday, August 01, 2017 11:57 AM
To: Kely Mertz
Cc: Kempema, Silka
Subject: RE: Data request - Crowned Ridge projects
Attachments: SDNHD_8-1-17.zip; Invoice SDNHP-08-01-17-01.pdf; EOdatafields.pdf

Hi Kely,

Attached is a zipped shapefile of the Element Occurrence within your request area along with an invoice for your data request.

The SDNHD tracks species at risk. These species are those that are legally designated as either state or federally threatened or endangered (legally protected) or rare. Rare species are those that are declining and restricted to limited habitat, peripheral to a jurisdiction, isolated or disjunct due to geographic or climatic factors, or that are classified as such due to lack of survey data. A list of all monitored species can be found at http://gfp.sd.gov/wildlife/threatened-endangered.

I also included a description of the data fields included in the attribute table of the shapefile.

Please note that many places in South Dakota have not been surveyed for rare or protected species and the absence of any additional species from the database does not preclude its presence.

If you have any question please feel free to contact me,

~Casey

From: Kely Mertz [mailto:KMertz@swca.com]
Sent: Monday, July 31, 2017 10:03 AM
To: Heimerl, Casey
Subject: RE: [EXT] Data request - Crowned Ridge projects

Hi Casey,
Yes, we are fine with the fees.
Thank you,
Kely

From: Heimerl, Casey [mailto:Casey.Heimerl@state.sd.us]
Sent: Monday, July 31, 2017 9:32 AM
To: Kely Mertz <KMertz@swca.com>
Subject: RE: Data request - Crowned Ridge projects

Hi Kely,

Silka forwarded me your request. I can conduct a search of our Natural Heritage Database and provide you with any records of rare, threatened or endangered species within the project areas. Silka will be providing you with a review of the projects.

Before I proceed with the data search, I want to make sure you are aware of the fees associated with data requests. Fees include $30/hour of staff time required and $30 per database search. If needed, I can provide you with a cost estimate for your request.

Thanks,

~Casey

From: Kely Mertz [mailto:KMertz@swca.com]
Sent: Wednesday, July 12, 2017 10:15 AM
To: Kempema, Silka
Subject: [EXT] Data request - Crowned Ridge projects

Good morning Silka,

Attached please find a data request, and accompanying figure and shapefiles for the Crowned Ridge I and II projects.

Please let me know if you have any questions.
Thank you!
Kely

Kely Mertz
Senior Project Manager

200 W. 22nd Street, Suite 220
Lombard, IL 60148
Office 630.705.1762
Cell 614.580.6715
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EO Data Fields

FIELD	DEFINITION
EO_ID	Element Occurrence ID - Unique identifier for the EO record in the Biotics database system; used as the primary key.
EO_NUM	Element Occurrence Number - A number identifying the particular occurrence in a subnation.
SNAME	Subnational (state) recognized scientific name.
SCOMNAME	Subnational (state) recognized common name.
GNAME	Global Scientific Name - The standard global (i.e., rangewide) scientific name (genus and species) adopted for use by the NatureServe Central Databases based on selected standard taxonomic references.
GCOMNAME	Global Common Name - Species: The common name of an element adopted for use by NatureServe. Associations: A colloquial name for the association. Note: Common names have not been tracked for all plants. Names for other groups may be incomplete. Many elements have several common names, often in different languages. Spellings of common names follow no standard conventions and are not systematically edited.
NAME_CAT_1	Broad zoological, botanical or ecological category for the species to which the Scientific Name applies.
G_RANK	Global Rank - The NatureServe Conservation Status of a species from a global (i.e., rangewide) perspective, characterizing the relative rarity or imperilment of the species or community. The basic global ranks are: GX - Presumed Extinct, GH - Possibly Extinct, G1 - Critically Imperiled, G2 – Imperiled, G3 – Vulnerable, G4 - Apparently Secure, and G5 – Secure. For more detailed definitions and additional information, please see: http://www.natureserve.org/explorer/granks.htm.
S_RANK	Subnational Conservation Rank - The conservation status of a species from the subnational jurisdiction perspective, characterizing the relative rarity or imperilment of the species. Together these values provide national distribution data. The basic subnational conservation ranks are: SX - Presumed Extirpated, SH - Possibly Extirpated (Historical), S1 – Critically Imperiled, S2 – Imperiled, S3 – Vulnerable, S4 - Apparently Secure, S5 – Secure, SNR – Rank not yet assessed, SU – Unrankable, SHB – State Hybrid, SNA – Rank Not Applicable. For more detailed definitions and additional information, please see: http://www.natureserve.org/explorer/nsranks.htm.
CONFIDENCE	Confidence Extent - Indicator whether the full extent of the Element is known (i.e., has been determined through field survey) at that location and, therefore, is represented by the Element Occurrence (EO).
BASIC_EO_RANK	EO Rank Codes - Value that indicates the relative value of the Element Occurrence (EO) with respect to other occurrences of the Element, based on an assessment of estimated viability (i.e., probability of persistence) for species. In other words, EO ranks provide an assessment of the likelihood that if current conditions prevail the occurrence will persist for a defined period of time, typically 20-100 years. EO ranks may be used effectively in conjunction with NatureServe Conservation Status Ranks for the Element to guide which occurrences should be recorded and mapped, and to help prioritize EOs for purposes of conservation planning or action, both locally and rangewide. The basic EORANKs are: A – Excellent, B – Good, C – Marginal / Fair, D – Poor, E – Verified Extant, F – Failed to Find, X – Extirpated, H – Historic (possibly extirpated), U – Unrankable, NR – Not Ranked.

FIRST_OBS_DATE	First Observation Date - Date that the Element Occurrence (EO) was first reported at the site. If the EO is known from only one field report, then the date entered in this field should be the same as in the Last Observation Date field.
LAST_OBS_DATE	Last Observation Date - The date that the Element Occurrence (EO) was last observed to be extant at the site. Note that the last observation date is not necessarily the date the site was last visited (i.e., the survey date) or the date on which the occurrence was assigned an EO rank (i.e., the EO rank date). However, for E-ranked (extant) EOs, the last observation date should be the same as the date on which the occurrence was ranked.
EO_DATA	EO Data - Data collected on the biology of this EO, including the number of individuals, vigor, habitat, soils, associated species, particular characteristics, etc.
GEN_DESC	General Description - A general (capsule) description or word picture of the area where the Element Occurrence (EO) is located (i.e., the physical setting/context surrounding the EO).
DIRECTIONS	Direction to Element Occurrence
STATE_STAT	State Protection Status, i.e. ST=State Threatened, SE=State Endangered
FED_STAT	Federal Protection Status, i.e. LT=Federally Threatened, LE=Federally Endangered, C=Candidate Species

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From:	Kely Mertz
To:	"Heimerl, Casey"
Subject:	Request for nest data
Date:	Friday, April 20, 2018 9:44:00 AM
Attachments:	PROJECT_AREA_BUFFER_20180419.zip

Hi Casey,

We would like to submit an updated request (current area of interest attached) for raptor nest data. Could you please review and let me know if you have any questions?

Thank you,
Kely

From: Kely Mertz
Sent: Tuesday, April 4, 2017 10:35 AM
To: Heimerl, Casey <Casey.Heimerl@state.sd.us>
Subject: Request for nest data (shapefiles 2 of 2)

Casey,

The attached shapefiles depict a corridor (2 of 2 project shapefiles) for which we would like to request nest data. Please let me know if you have any questions.

Thank you,
Kely

Kely Mertz
Senior Project Manager

200 W. 22nd Street, Suite 220
Lombard, IL 60148
Office 630.705.1762
Cell 614.580.6715
Visit Our Website: http://www.swca.com

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From: Heimerl, Casey
To: Kely Mertz
Subject: RE: Request for nest data
Date: Tuesday, April 24, 2018 11:32:00 AM
Attachments: SDNHP-4-24-18.zip

Hi Kely,

Attached is an updated shapefile of raptor records. I will waive the fee since there are only a few additional records from last year. The data use agreement that you signed last year is also good for another year.

Please let me know if you have any questions,

~Casey

From: Kely Mertz [mailto:KMertz@swca.com]
Sent: Tuesday, April 24, 2018 9:17 AM
To: Heimerl, Casey
Subject: FW: [EXT] Request for nest data

Hi Casey,
Sorry about that, not sure what happened. Can you see if this file works?
Thank you,
Kely

From: Mike Sobiech
Sent: Tuesday, April 24, 2018 10:16 AM
To: Kely Mertz <KMertz@swca.com>
Subject: RE: Request for nest data

Interesting. This contains the shapefile.

Mike Sobiech
GIS Lead/OSR - Bismarck

From: Kely Mertz
Sent: Tuesday, April 24, 2018 9:14 AM
To: Mike Sobiech <MSobiech@swca.com>
Subject: FW: Request for nest data

Mike,
Casey says this folder is empty when she opens it?

From: Kely Mertz
Sent: Friday, April 20, 2018 9:45 AM

To: 'Heimerl, Casey' <Casey.Heimerl@state.sd.us>
Subject: Request for nest data

Hi Casey,

We would like to submit an updated request (current area of interest attached) for raptor nest data. Could you please review and let me know if you have any questions?

Thank you,
Kely

From: Kely Mertz
Sent: Tuesday, April 4, 2017 10:35 AM
To: Heimerl, Casey <Casey.Heimerl@state.sd.us>
Subject: Request for nest data (shapefiles 2 of 2)

Casey,

The attached shapefiles depict a corridor (2 of 2 project shapefiles) for which we would like to request nest data. Please let me know if you have any questions.

Thank you,
Kely

Kely Mertz
Senior Project Manager

200 W. 22nd Street, Suite 220
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Office 630.705.1762
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Dakota Skipper (*Hesperia dacotae*) and Poweshiek Skipperling (*Oarisma poweshiek*) Survey Report for the Crowned Ridge I Wind Facility, Codington and Grant Counties, South Dakota

NOVEMBER 2018

PREPARED FOR

Crowned Ridge Wind, LLC

PREPARED BY

SWCA Environmental Consultants

DAKOTA SKIPPER *(HESPERIA DACOTAE*) AND POWESHIEK SKIPPERLING (*OARISMA POWESHIEK*) SURVEY REPORT FOR THE CROWNED RIDGE I WIND FACILITY, CODINGTON AND GRANT COUNTIES, SOUTH DAKOTA

Prepared for

Crowned Ridge Wind, LLC
700 Universe Boulevard
Juno Beach, Florida 33408

Prepared by

SWCA Environmental Consultants
116 North 4th Street
Bismarck, North Dakota 58501
(701) 258-6622
www.swca.com

SWCA Project No. 44511

November 2018

CONTENTS

1 Introduction 1
2 Methods 1
3 Results 3
4 Discussion 6
5 Literature Cited 11

Attachments

Attachment A.U.S. Fish and Wildlife Concurrence Letter

Figures

Figure 1. Project location and study area. 2
Figure 2. Potentially suitable habitat as identified through desktop assessment within the study area. 4
Figure 3. Field-assessed suitable habitat and adult presence/absence survey locations within the Crowned Ridge I study area. 5

Tables

Table 1. Survey Locations and Dates when First, Second, and Third Adult Protocol Presence/Absence Survey Rounds were Completed 7
Table 2. Butterfly Species Observed during Dakota Skipper and Poweshiek Skipperling Adult Presence/Absence Surveys, Crowned Ridge I Project 9
Table 3. Flowering Plant Species and Total Approximate Stem Counts Observed during Field Surveys 10

1 INTRODUCTION

Crowned Ridge Wind, LLC, an indirect, wholly owned subsidiary of NextEra Energy Resources, LLC (NextEra), plans to develop an approximately 300-megawatt (MW) wind facility known as the Crowned Ridge I Wind Energy Facility (the project) in Codington and Grant Counties, South Dakota (project boundary, Figure 1). The project will produce energy sold to Xcel Energy through a Power Purchase Agreement. A new approximately 34-mile transmission line will be constructed to connect the wind facility to Otter Tail Power's Big Stone South 230-kilovolt (kV) substation near Big Stone City, South Dakota. Construction is anticipated to commence in early 2019, and the project is scheduled to achieve commercial operation at or before the end of 2019. At the time of this study, the study area included approximately 58,548 acres (study area, Figure 1).

The U.S. Fish and Wildlife Service (USFWS) indicates the federally threatened Dakota skipper (*Hesperia dacotae*) and federally endangered Poweshiek skipperling (*Oarisma poweshiek*) butterflies have potential to occur in Codington and Grant Counties. Therefore, NextEra contracted SWCA Environmental Consultants (SWCA) to conduct adult presence/absence protocol surveys for these two species within the study area. The purpose of this report is to document the methods and results of the surveys.

2 METHODS

To identify potentially suitable habitat for Dakota skippers and Poweshiek skipperlings, SWCA first downloaded and assessed plant community data from South Dakota State University (Bauman et al. 2016). These data were used to identify potentially undisturbed or native grasslands throughout the study area. Next, data developed in the first layer were overlaid with the National Land Cover Dataset to identify additional areas of potentially suitable habitat that the initial dataset did not identify. SWCA then completed an aerial photography interpretation at a ratio of roughly 1:20,000 m to determine areas of disturbance (agricultural fields, development, open water, etc.). Disturbed areas were omitted from the dataset. Results of the desktop assessment were reviewed and approved by one of SWCA's federally permitted Dakota skipper biologists.

SWCA then completed field surveys to verify results of the desktop habitat assessment. SWCA completed surveys between August 2017 and June 2018, in areas identified during the desktop assessment as potentially suitable and where landowner access was granted. Qualified biologists experienced with grassland plant identification completed these surveys based on habitat characteristics for Dakota skippers and Poweshiek skipperlings as outlined in the published literature (Rigney 2013; Royer and Marrone 1992a, 1992b; Selby 2013; Skadsen 2003; USFWS 2014, 2016, 2018).

Biologists determined the presence of suitable Dakota skipper and Poweshiek skipperling habitat based on Type A and Type B habitat types described by the USFWS (2016). The Type A suitable habitat areas typically contain death camas (*Zigadenus elegans*), candle anemone (*Anemone cylindrica*), prairie lily (*Lilium philadelphicum*), black-eyed Susan (*Rudbeckia hirta*), and big bluestem (*Andropogon gerardii*). Typical Type B suitable habitat areas are characterized by big bluestem, little bluestem (*Schizachyrium scoparium*), and sideoats grama (*Bouteloua curtipendula*), with scattered purple prairie clover (*Dalea purpurea*), purple coneflower (*Echinacea angustifolia*), and prairie coneflower (*Ratibida columnifera*). Type B habitat may have other dominant native species, such as porcupine grass (*Hesperostipa spartea*) and prairie dropseed (*Sporobolus heterolepis*) present.

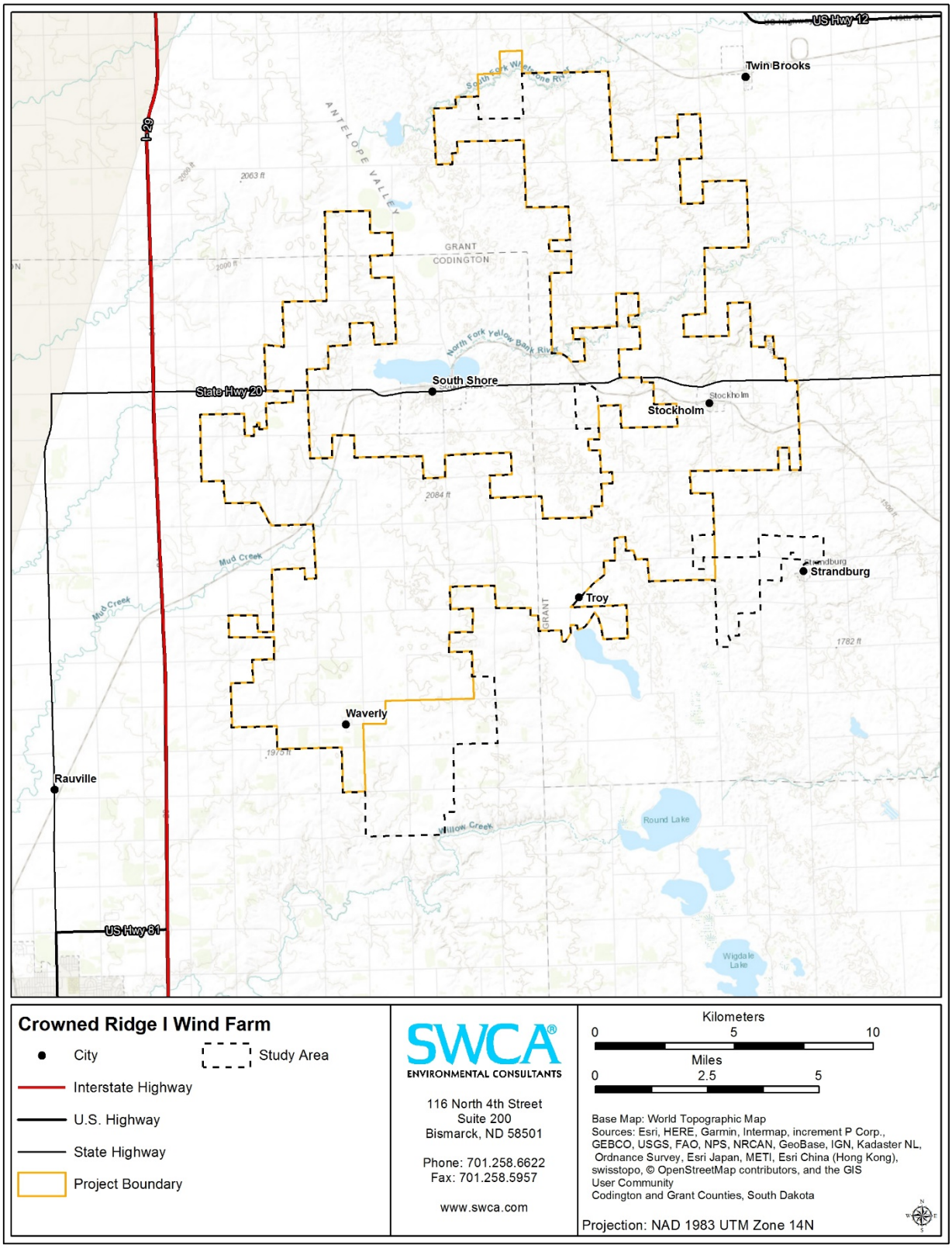


Figure 1. Project location and study area.

Biologists concluded that habitat was not suitable for Dakota skippers and Poweshiek skipperlings if the habitat being assessed was: in a wetland that did not have requisite Dakota skipper or Poweshiek skipperling plant species, or if the grassland was cultivated, lacked species richness, was qualitatively assessed as occurring in small or isolated patches, and/or was dominated by non-native upland species. These species include smooth brome (*Bromus inermis*), clover (*Trifolium* spp.), orchardgrass (*Dactylis glomerata*), or timothy (*Phleum pratense*). Relict native grassland areas may contain a high composition of porcupine grass (*Hesperostipa comata*) and some native forbs, but requisite Dakota skipper or Poweshiek skipperling plant species may not be present.

SWCA then identified eligible adult presence/absence survey areas as areas of field-verified suitable habitat where the habitat limited workable space around proposed turbine locations. Of the eligible survey area, SWCA identified a subset of areas in which to complete adult presence/absence surveys (prioritizing the largest areas) (Table 1, Figures 2–3).

Within the adult presence/absence survey areas, SWCA completed three rounds of Dakota skipper and Poweshiek skipperling adult presence/absence surveys between June 28 and July 12, 2018, with 48 hours' spacing between each survey round. The surveys fell within the adult flight period of both species. Dr. David Lightfoot, an SWCA ecologist listed on SWCA's Scientific Recovery Permit for the Dakota skipper and Poweshiek skipperling (Permit Number TE64070B-1), led the surveys. Additional surveyors worked under direct supervision of Dr. Lightfoot.

SWCA followed the 2018 Dakota Skipper Survey Protocol (USFWS 2018) and used a modified "Pollard-style random walk" method to conduct the surveys (Royer et al. 1998). Prior to the survey, and per SWCA's federal permit conditions, SWCA obtained USFWS concurrence with proposed survey methods (Attachment A). Surveyors walked with insect nets at approximately 35 m per minute within the survey areas (see Figure 2). Surveyors scanned the area within a 5-m box (5 m on each side, within 5 m of the ground, or 5 m to the front) as they walked. Global positioning system (GPS) coordinates would have been recorded if Dakota skippers, Poweshiek skipperlings, or other sensitive butterfly species had been observed. SWCA recorded all observed butterfly species and conducted a general count of flowering plants.

SWCA conducted surveys between 10:00 a.m. and 5:30 p.m., Central Daylight Time. All surveys were conducted within the environmental constraints listed below, as outlined by the USFWS (2018).

- No surveys during fog, drizzle, or rain.
- No surveys at times of sustained or gusting winds that average greater than 30 km (19 miles) per hour measured over a 30-second period at a height of 1.2 to 1.8 m (4–6 feet) above ground level (Beaufort Scale of 5 or greater).
- No surveys when temperature in the shade at ground level measures less than 21 degrees Celsius (°C) (70 degrees Fahrenheit [°F]) when cloud cover is less than 50% or less than 30°C (86°F) when cloud cover is 50% or more.

3 RESULTS

Results of the desktop assessment indicated that there were approximately 20,242 acres of potentially suitable habitat within the entire Crowned Ridge I study area (Figure 2). Field surveys indicated only approximately 1,038 acres of suitable habitat were present in areas surveyed (Figure 3). Of the field-verified suitable habitat, 127.5 acres was selected for adult Dakota skipper and Poweshiek skipperling presence/absence surveys based on the criteria described in the Methods section of this report (see Figure 3).

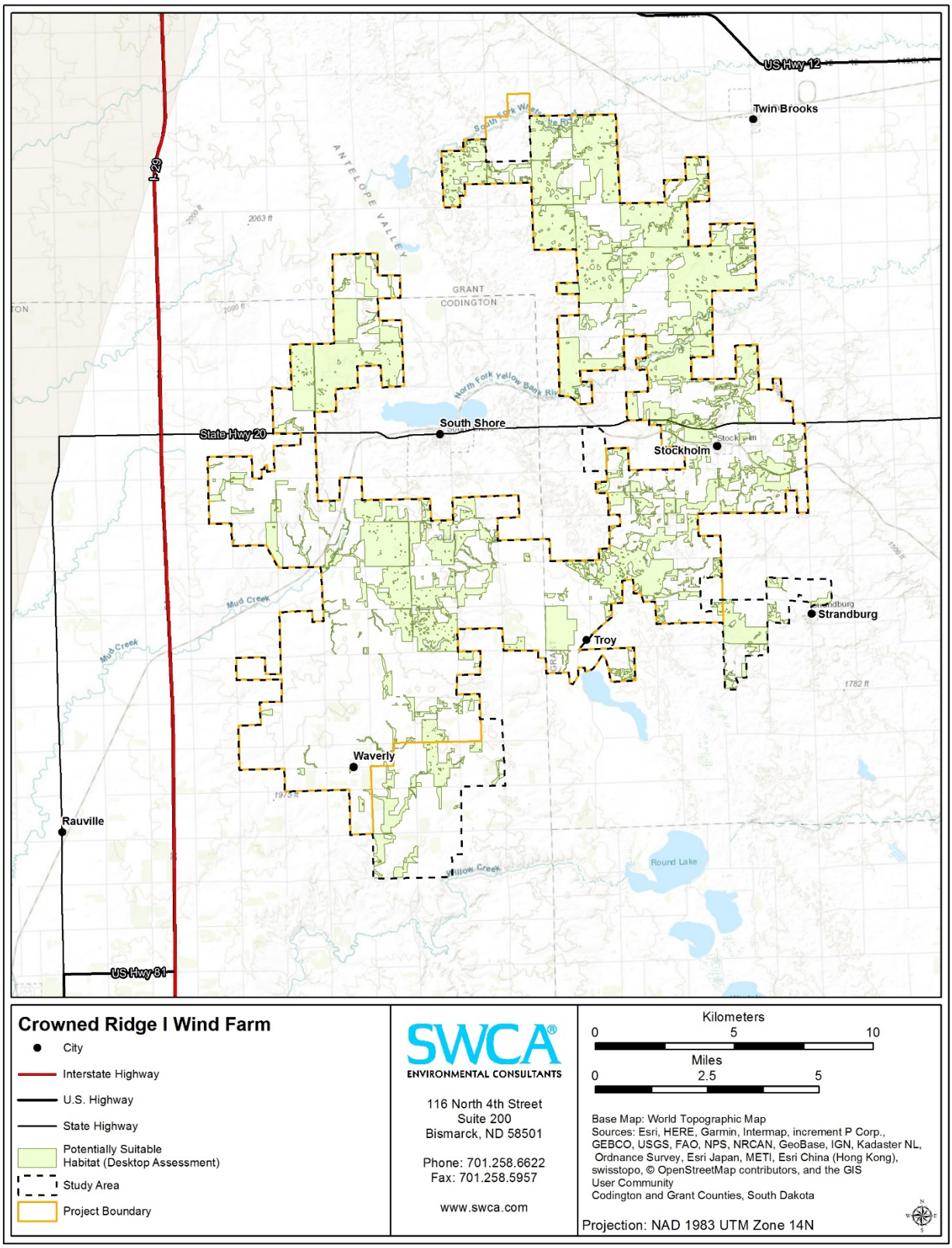


Figure 2. Potentially suitable habitat as identified through desktop assessment within the study area.

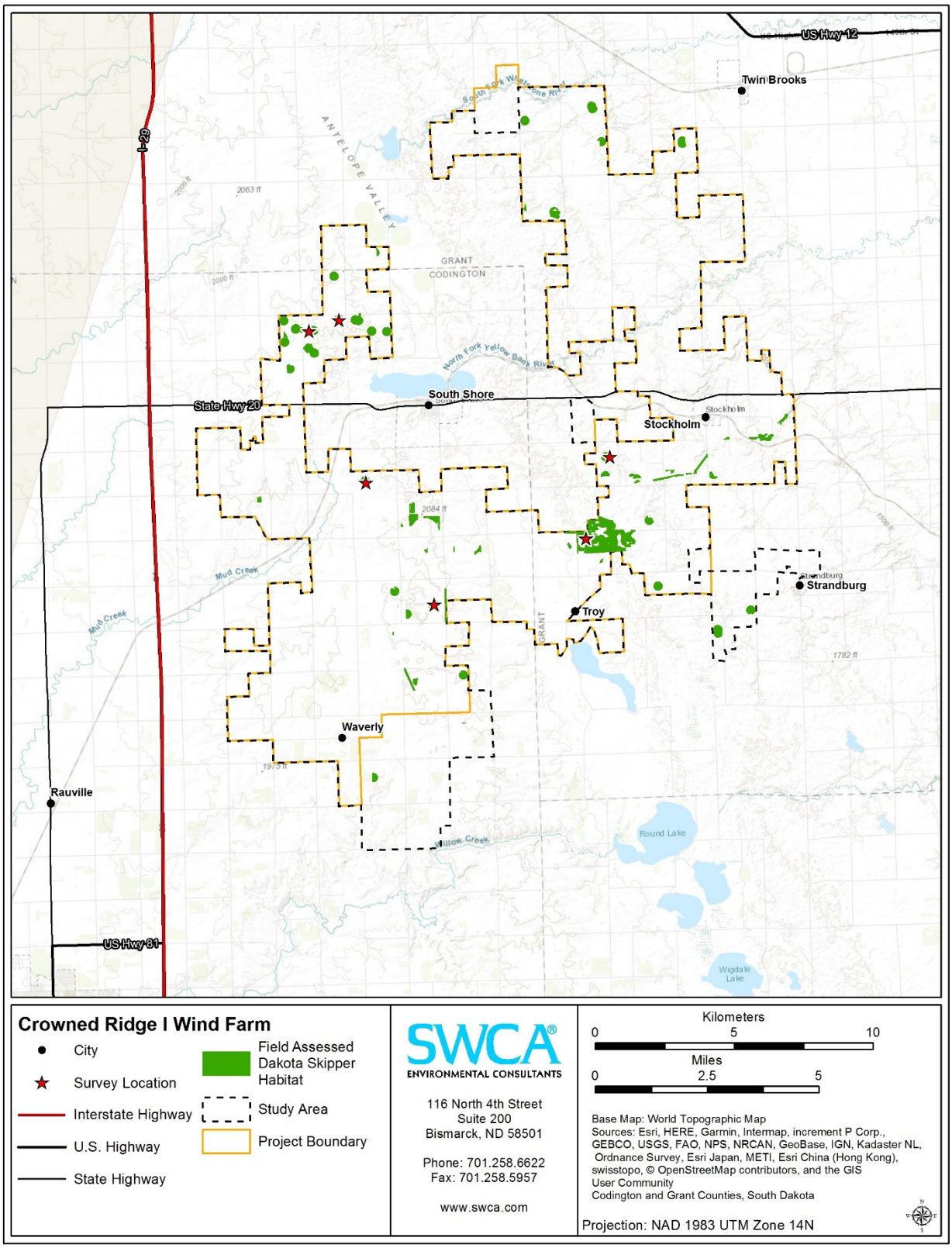


Figure 3. Field-assessed suitable habitat and adult presence/absence survey locations within the Crowned Ridge I study area.

SWCA biologists typically assessed the habitat identified during the desktop review as marginal, with a relatively low potential for Dakota skipper and Poweshiek skipperling population (either adult or larval) maintenance. Eligible survey areas were characterized by few, scattered nectar species; occurred in small, isolated patches; and/or lacked requisite species diversity. Eligible survey areas primarily had prairie coneflower, occasionally a few stems of purple coneflower and thistle (*Cirsium spp.),* along with scattered pockets of big bluestem. The eligible survey area sites primarily were dominated by smooth brome and Kentucky bluegrass (*Poa pratensis*). However, regardless of their marginal nature, the areas did qualify as suitable habitat. Type A and Type B habitat areas throughout the eligible survey areas typically were dominated by big bluestem, little bluestem, sideoats grama, prairie coneflower, and a few purple coneflowers.

No Dakota skippers or Poweshiek skipperlings were observed during adult protocol surveys. Sixteen butterfly species were observed during the adult surveys (Table 2). The most frequently observed species were regal fritillary (*Speyeria idalia,* n = 885), common wood nymph (*Cercyonis pegala nephele*, n = 267), and clouded sulfur (*Colias philodice*, n = 231). These species, and meadow fritillary (*Boloria bellona*), were observed on all 9 survey days. July 9, 2018, had the highest number of total butterfly observations (n = 693), and July 5, 2018, had the lowest number of observations (n = 31).

During the adult presence/absence surveys, SWCA biologists observed nine species of flowering plants within the eligible survey areas (Table 3). The dominant flowering plants observed were western yarrow (*Achillia millefolium*), daisy fleabane (*Erigeron annuus*), and black-eyed Susan. No observations were made of flowering purple coneflower, which is the Dakota skipper's main nectar plant.

4 DISCUSSION

No Dakota skippers or Poweshiek skipperlings were observed during the surveys. As described above, while the eligible survey areas were considered representative of the best quality habitat available within the study area, they were all marginal habitat. Several areas appeared recently to have been sprayed with herbicide. Because available habitat in the study area is very limited, the available habitat is considered marginal, and no Dakota skippers or Poweshiek skipperlings were documented during surveys, it is unlikely that impacts to either species will result from the project.

Table 1. Survey Locations and Dates when First, Second, and Third Adult Protocol Presence/Absence Survey Rounds were Completed

Site (Turbine ID)	Location (Section, Township, Range)	Survey Acres	6/28	6/29	7/5	7/6	7/7	7/8	7/9	7/10	7/11	7/12	Dominant Plant Species
CR-ALT3	S8, T119N, R51W	16.83	–	–	–	–	1st	–	–	2nd	–	3rd	Porcupine grass Little bluestem Smooth brome Kentucky bluegrass Black-eyed Susan
CR-66	S8, T119N, R51W	21.61	1st	–	–	–	2	–	–	3rd	–	–	Smooth brome Kentucky bluegrass Needle and thread grass Green needle grass Indian grass Little bluestem Black-eyed Susan Daisy fleabane Prairie coneflower Western yarrow
CR-12	S28, T119N, R51W	18.02	–	1st	–	2nd	–	–	3rd	–	–	–	Smooth brome Timothy Needle and thread grass Indian grass Black-eyed Susan Daisy fleabane Death camas Yellow coneflower
CR-32	S10, T118N, R51W	24.32	1st	–	–	2nd	–	–	3rd	–	–	–	Smooth brome Kentucky bluegrass Big bluestem Indian grass Needle and thread grass Black-eyed Susan *Pasture appears sprayed by herbicide. Forbs wilted/dying off.

Site (Turbine ID)	Location (Section, Township, Range)	Survey Acres	6/28	6/29	7/5	7/6	7/7	7/8	7/9	7/10	7/11	7/12	Dominant Plant Species
CR-117	S5, T119N, R50W	26.81	1st	–	–	2nd	–	–	3rd	–	–	–	Smooth brome Indian grass Green needle grass Intermediate wheatgrass Porcupine grass Big bluestem Daisy fleabane Prairie coneflower Black-Eyed Susan *Appeared to have been recently sprayed with herbicide. Strong odor observed.
CR-09	S29, T119N, R50W	19.92	–	1st	2nd	–	–	3rd	–	–	–	–	Smooth brome Kentucky bluegrass Indian grass Little bluestem *Pasture appeared to have been recently sprayed with herbicide. No forbs observed.
	Total	**127.51**											

Table 2. Butterfly Species Observed during Dakota Skipper and Poweshiek Skipperling Adult Presence/Absence Surveys, Crowned Ridge I Project

Species		Survey Date (2018)									Total
Common Name	**Scientific Name**	**6/28**	**6/29**	**7/5**	**7/6**	**7/7**	**7/8**	**7/9**	**7/10**	**7/12**	
Monarch	*Danaus plexippus*	29	1	2	10	1	1	8	1	0	**53**
Regal fritillary	*Speyeria idalia*	29	51	10	247	37	27	360	58	66	**885**
Common wood nymph	*Cercyonis pegala nephele*	32	3	3	61	10	1	144	5	8	**267**
Meadow fritillary	*Boloria bellona*	15	9	9	63	6	1	32	12	9	**156**
American lady	*Vanessa virginiensis*	1	0	0	0	0	0	0	0	0	**1**
Black swallowtail	*Papilio polyxenes asterius*	1	0	0	1	1	0	1	1	0	**5**
Peck's skipper	*Polites peckius*	0	0	0	5	2	0	1	4	1	**13**
Long-dash skipper	*Polites mystic dacotah*	24	20	3	5	0	0	2	0	0	**54**
Tawny-edged skipper	*Polites themistocles*	0	0	0	0	1	0	1	0	0	**2**
Clouded sulphur	*Colias philodice*	28	2	3	65	4	2	116	3	8	**231**
Variegated fritillary	*Euptoieta claudia*	0	3	0	12	0	0	23	0	2	**40**
Checkered white	*Pontia protodice*	7	0	0	2	1	0	2	1	0	**13**
Red admiral	*Vanessa atalanta rubria*	9	0	0	0	0	0	1	0	0	**10**
Melissa blue	*Lycaeides melissa*	9	0	1	1	0	0	2	0	0	**13**
Common ringlet	*Coenonympha tullia*	2	0	0	0	0	0	0	0	0	**2**
Northern crescent	*Phyciodes selenis*	0	0	0	0	0	0	0	1	1	**2**
Total		**186**	**89**	**31**	**472**	**63**	**32**	**693**	**86**	**95**	**1,747**

Table 3. Flowering Plant Species and Total Approximate Stem Counts Observed during Field Surveys

Plant Species	Scientific Name	Stem Count
Prairie lily	*Lilium philadelphicum*	2
Thistle	*Cirsium* spp.	5
Death camas	*Zigadenus elegans*	20
Goldenrod	*Solidago* spp.	28
Purple prairie clover	*Dalea purpurea*	66
Yellow coneflower	*Ratibida pinnata*	221
Black-eyed Susan	*Rudbeckia hirta*	290
Daisy fleabane	*Erigeron annuus*	750
Western yarrow	*Achillia millefolium*	1,150

000293

5 LITERATURE CITED

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———. 1992b. *Conservation Status of the Dakota Skipper (*Hesperia dacotae*) in North and South Dakota*. Denver, Colorado: U.S. Fish and Wildlife Service.

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Skadsen, D.R. 2003. *Dakota Skipper Population Surveys for CCAA Development in the State of South Dakota.* Report 2003-20. Pierre: South Dakota Department of Game, Fish, and Parks Wildlife Division.

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———. 2016. *Guidance for Interagency Cooperation Under Section 7(a)(2) of the Endangered Species Act for the Dakota Skipper, Dakota Skipper Critical Habitat, and Poweshiek Skipperling Critical Habitat,* Version 1.1. U.S. Fish and Wildlife Service.

———. 2018. 2018 Dakota Skipper (*Hesperia dacotae*) North Dakota Survey Protocol. U.S. Fish and Wildlife Service, Mountain-Prairie Region. Available at: www.fws.gov/midwest/endangered/insects/dask/index.html. Accessed June 2018.

ATTACHMENT A

U.S. Fish and Wildlife Concurrence Letter

SWCA
ENVIRONMENTAL CONSULTANTS
Sound Science. Creative Solutions.®

116 North 4th Street, Suite 200
Bismarck, North Dakota 58501
Tel 701.258.6622 Fax 701.258.5957
www.swca.com

June 14, 2018

Charlene Bessken
U.S. Fish and Wildlife Service
Ecological Services Office
420 South Garfield Avenue, Suite 400
Pierre, South Dakota 57501

Re: Notification for Dakota Skipper and Poweshiek skipperling Surveys at a Potential Wind Farm Project in Codington, Grant, and Deuel Counties, South Dakota

Dear Ms. Bessken:

SWCA Environmental Consultants (SWCA) is submitting this notification and approval request to the U.S. Fish and Wildlife Service (USFWS) South Dakota Ecological Services Office for Dakota skipper (*Hesperia dacotae*) and Poweshiek skipperling (*Oarisma poweshiek*) butterfly surveys at a potential wind farm project in Codington, Grant, and Deuel Counties, South Dakota, during the 2018 adult flight period, per the requirements of SWCA's Scientific Recovery Permit for these two species (TE64070B-1; enclosed).

The wind farm project has a potential construction start date of 2019. SWCA currently is working with our client, NextEra Energy Resources (NextEra) to identify the need and final location for surveys. SWCA's master service agreement with NextEra is enclosed with this letter. SWCA has met all prior reporting requirements for surveys of these species during past years; copies of the annual reports can be provided upon request. Please review and provide a concurrence letter to SWCA for these surveys.

The surveys will be conducted between approximately June 25 and July 15 by SWCA's Mr. Jake Powell who is listed on SWCA's permit. The survey protocols will follow the 2018 Dakota skipper survey protocols (https://www.fws.gov/midwest/endangered/insects/dask/index.html). The surveys will be conducted on field verified suitable habitat. The protocols will include three surveys, separated by 48 hours, conducted under the environmental conditions outlined in the protocol. Table 1 provides the legal location and acreage of the potentially suitable habitat. All areas are within Codington, Grant, and Deuel Counties, South Dakota. Final survey locations depend, in part, on results of habitat surveys that are currently ongoing, and on land access. Please note that not all areas listed in Table 1 will be surveyed. The total area where adult protocol surveys will be conducted is likely to be approximately 100 acres.

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Table 1. Legal location and acreage details

Section	Township	Range	Acres (ac)
28, 29	119N	50W	37.0
27, 28	119N	50W	25.0
32, 5	119N, 118N	50W	48.4
33	118N	51	45.8
6, 1	117N	50W, 51W	49.7
25	118N	51	7.4
9, 10	118N	51	70.7
11, 14	117N	51W	54.9
5, 8, 9	119N	51W	74.6
9	119N	51W	47.5
7, 8	119N	51W	79.0
18	119N	51W	77.7
29	119N	50W	42.0
28	119N	51W	54.6
33	119N	50W	26.8
10	118N	51	62.4
9, 10	118N	51	50.9
22	118N	51	48.8
14, 23	118N	51	59.7
7, 8	119N	51	77.7
1	117N	51	42.5
18	117N	50	20.7
18	117N	50	29.4
			1,133.3

SWCA appreciates your time and consideration on this request. Please let me know if there are any questions. I can be contacted at jpowell@swca.com or 307-429-8922.

Sincerely,



Jake Powell

Senior Ecologist, SWCA Environmental Consultants

Enclosures: NextEra Master Service Agreement, SWCA USFWS Scientific Recovery Permit

NATIVE ENDANGERED SPECIES RECOVERY
ENDANGERED WILDLIFE

Permit Number: TE64070B-1

Effective: 03/12/2018 Expires: 12/31/2023

Issuing Office:

Department of the Interior
U.S. FISH & WILDLIFE SERVICE
Endangered Species Permit Office
5600 American Boulevard, West, Suite 990
Bloomington, MN 55437-1458
permitsR3ES@fws.gov

Chief - Endangered Species

Permittee:
SWCA, INC
dba SWCA ENVIRONMENTAL CONSULTANTS
116 NORTH 4TH STREET, SUITE 200
BISMARCK, ND 58501
U.S.A.

Name and Title of Principal Officer:
SARAH BAER - DIRECTOR

Authority: Statutes and Regulations: 16 USC 1539(a); 50 CFR 17.22, 50 CFR 13.

Location where authorized activity may be conducted:
Throughout the range of the species in the States of Iowa, Michigan, Minnesota, North Dakota, South Dakota and Wisconsin.

Reporting requirements:
ANNUAL REPORT DUE: 01/31
See permit conditions for reporting requirements

Authorizations and Conditions:

Scientific Recovery Permit number TE64070B-1 replaces Sub-permit no. 17-20 issued on 06/29/2017. Sub-permit 17-20 is invalid as of 3/12/2018.

A. General Conditions set out in Subpart B of 50 CFR 13, and specific conditions contained in Federal regulations cited above, are hereby made a part of this permit. All activities authorized herein must be carried out in accord with and for the purposes described in the application submitted. Continued validity, or renewal of this permit is subject to complete and timely compliance with all applicable conditions, including the filing of all required information and reports.

B. The validity of this permit is also conditioned upon strict observance of all applicable foreign, state, local, tribal, or other federal law. Necessary state and/or local permits where applicable, must also be acquired and observed; this permit is invalid without such permits.

C. Valid for use by Kenneth J. Kingsley, David Lightfoot, and Jake Powell. Field assistants not named on this

permit may conduct activities pursuant to this permit only under the direct supervision of a named permittee listed below. "On-sight" supervision is defined as having the authorized individual at a distance that would allow this individual to immediately assist a supervised individual, as needed, while they are conducting an authorized activity.

D. ACCEPTANCE OF THIS PERMIT SERVES AS EVIDENCE THAT THE PERMITTEE AND ITS AUTHORIZED AGENTS UNDERSTAND AND AGREE TO ABIDE BY THE TERMS OF THIS PERMIT AND ALL SECTIONS OF TITLE 50 CODE OF FEDERAL REGULATIONS, PARTS 13 AND 17, PERTINENT TO ISSUED PERMITS. SECTION 11 OF THE ENDANGERED SPECIES ACT OF 1973, AS AMENDED, PROVIDES FOR CIVIL AND CRIMINAL PENALTIES FOR FAILURE TO COMPLY WITH PERMIT CONDITIONS.

E. Permittee is authorized to take (capture, handle, and release) the following species for scientific research (presence/absence surveys, studies to document habitat use, and population monitoring) aimed at recovery of the species:

Dakota skipper (*Hesperia dacotae*)
Poweshiek skipperling (*Oarisma poweshiek*)
Rusty patched bumble bee (*Bombus affinis*)

F. Activities are authorized at the following locations:

F.1. Locations within Region 3 of the USFWS: Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, and Wisconsin, upon receipt of written concurrence from the Field Supervisor, as outlined in Condition G.

F.2. Locations within Region 5 of the USFWS: Maine, Massachusetts, Virginia, and West Virginia, upon receipt of written concurrence from the Field Supervisor, as outlined in Condition G.

F.3. Locations within Region 6 of the USFWS: North Dakota and South Dakota upon receipt of written concurrence from the Field Supervisor, as outlined in Condition G.

G. Permittee shall notify and request approval from the USFWS Field Supervisor for the state in which activities are proposed to occur at least fifteen (15) days prior to conducting any activities. Contact information is available at: <https://www.fws.gov/midwest/endangered/permits/index.html> (located under 1. Recovery and Interstate Commerce Permits, For Fish and Wildlife Permit Holders). Your request for this site-specific approval must be in writing and must indicate:

G.1. Species for which proposed activities are being conducted.

G.2. Location of proposed activities, including project site, county, and state.

G.3. A full description of activities (i.e., proposed project, purpose and need, surveys, methods, etc.)

G.4. Dates when the project is proposed to take place.

G.5. Evidence that Permittee has received any required contracts to complete the activities.

G.6. Whether all prior annual reporting requirements have been fulfilled.

G.7. You may proceed with activities only upon receipt of written concurrence from the applicable USFWS Field Supervisor. *Your concurrence letter must be carried with this permit to authorize site-specific activities.*

H. Permittees must adhere to the following conditions for all species:

H.1. Accidental mortality, may not exceed one (1) specimen per species. In the event that this number is met, all species activities for this permit must cease (e.g. One rusty patched bumble is accidentally killed, all activities associated with Rusty patched bumble bee must cease, but activities associated with Dakota skippers and Poweshiek skipperlings may continue.). You must contact the Minnesota/Wisconsin Ecological Services Field Office (Condition L.2.) within two (2) business days and explain the incident and its circumstances. Your initial contact may be made by telephone; however, a written explanation must be provided within five (5) days of the incident to the following USFWS offices: Regional Recovery Permits Coordinator, Bloomington, Minnesota (Condition L.1.), the Minnesota/Wisconsin Ecological Services Field Office (Condition L.2.), and the Field Office for the state in which the activity occurred (Condition M.). Following mortality or injury of a species you may not resume activities, for that species, authorized by this permit without written permission of the U.S. Fish and Wildlife Service, Minnesota/Wisconsin Ecological Services Field Office (Condition L.2.).

H.2. Any individuals found dead or killed accidentally (during authorized activities) may be salvaged. Prior to collecting specimen(s), you must photograph to document the condition. For Dakota skipper and Poweshiek skipperling specimens, also see additional procedures in Condition I.10. You must preserve the specimen(s) using standard museum practices including proper identification and indices [include date, complete scientific and common names, and geographic location (township, range, section, and UTM) where salvaged]. All specimens obtained under this permit remain the property of the United States Government and must clearly be identified as such. All specimens shall be sent to a public scientific or educational facility or museum in the state where the individuals were collected along with a copy of the permit(s) under which they were collected. When agreed upon in writing by the Minnesota/Wisconsin Ecological Services Field Office (Condition L.2.), specimens may be sent out of state to an alternate specialized educational facility or museum within the United States. A list of specimens collected (if any), pertinent location data, and the facility where specimen is curated shall be provided in your annual and final reports (Conditions K.1.e and K.2.g.)

H.3. Upon any new discovery location, permittee shall notify the U.S. Fish and Wildlife Service Field Supervisors (Condition M.) and the Minnesota/Wisconsin Ecological Services Field Office (Condition L.2.) in writing of where the new discovery location occurred (previously undocumented sites only) within

fourteen (14) days of discovery unless otherwise specified by the Field Supervisor(s).

I. In addition to Condition H. permittees must adhere to the following conditions for Dakota skipper and Poweshiek skipperling:

I.1. To the extent practicable, identification of Dakota skippers and Poweshiek skipperlings shall be done in a manner that avoids capture.

I.2. Any specimens that must be captured for identification shall be handled in a manner that minimizes the likelihood of injury.

I.3. If it is necessary to capture specimens to facilitate identification, you may capture them in a soft butterfly net. All reasonable efforts must be made to allow the butterfly to walk freely inside the net and to avoid direct contact with the butterfly. This may be done, for example, by holding the net upside down and holding the bottom of the net upwards to allow the butterfly to walk up into the net - a pouch may be created in the upside-down net to facilitate close inspection by pinching the net below the butterfly while ensuring its free movement inside the net.

I.4. Captured butterflies may also be placed inside plastic jars by carefully coaxing them from the net into the jar. The jar must contain some type of tissue (preferred), paper towel, or soft cloth that the butterfly may stand or walk on while in the jar to facilitate visual inspection.

I.5. Any captured Dakota skippers or Poweshiek skipperlings shall be released as near to the capture site as possible and as soon as is practicable. Temporary holding of specimens for the purpose of species identification shall not exceed 5 minutes.

I.6. No mutilation (e.g., leg removal) or marking schemes are authorized.

I.7. Handling affects the behavior of some butterflies after their release. Permittee shall observe post-release behavior of any Dakota skippers or Poweshiek skipperlings that are captured and released. The behavior of each captured and released butterfly will be noted and reported annually as described in Condition K.1.c.

I.8. Collection of voucher specimens of Dakota skipper: This may occur only when the species is encountered in a county where it has not been previously recorded. A list of counties where the Dakota skipper has been documented can be found online at <https://www.fws.gov/midwest/endangered/insects/dask/pdf/CntyOccurrencesDASKNov2017.pdf> . In new counties, only one voucher specimen is permitted and collection of a female is discouraged if a male could be vouchered instead. In addition, dead or dying specimens (from natural causes) may be collected for voucher specimens regardless of geographic area, adhering to Conditon H.2. Upon approval and review by the Minnesota/Wisconsin Ecological Services Field Office (Condition L.2.), any individuals accidentally killed or lethally injured may also be collected as voucher specimens. The number, location, cause of death (if known), sex, and any other information relevant to voucher specimen must be reported in the annual report as described in Condition K.1.d.

I.9. The collection of voucher specimens of Powesheik skipperlings is strictly prohibited except for circumstances identified in Condition H.2.

I.10. If collection of a voucher specimen of Dakota skipper (Conditions H.2. and I.9.) and/or Powesheik skipperling (Condition H.2.) occurs, please adhere to the following protocol: For each vouchered specimen, clip two legs and place in a 30mL or smaller vial filled with 95-100% ethanol (EtOH; not isopropyl alcohol). The remainder of the specimen shall be preserved according to the conditions noted in H.2., making note on the identification tag that two legs were removed and sent to the Minnesota/Wisconsin Field Office. The vial with legs should also have all proper identification and indices [include date collected, complete scientific and common names, and geographic location (township, range, section, and UTM) where salvaged, and a note identifying the specimen as property of the United States Government]. Double bag the vial and ship in a strong outer container with enough absorbent material to soak up any ethanol that might accidentally leak. Include a copy of permit(s) under which the sample(s) was collected when shipping vials. Label the outer shipping box "Samples. This package conforms to 49 CFR 173.4" Ship this package to the Minnesota/Wisconsin Field Office as soon as possible.

J. In addition to Condition H. permittees must adhere to the following conditions for rusty patched bumble bee:

J.1. Rusty patched bumble bees may be captured with aerial hand nets following the methodology, guidelines, and best practices included in the "Survey Protocols for the Rusty Patched Bumble Bee (*Bombus affinis*)" (Survey Protocols). Survey Protocols are available online at: <https://www.fws.gov/midwest/endangered/insects/rpbb/guidance/>. Note that you must use the most up-to-date version of the Survey Protocol, available on the USFWS website page on February 28th of each year.

J.2. For areas believed to be unoccupied by rusty patched bumble bee (See map online at: <https://www.fws.gov/midwest/endangered/insects/rpbb/guidance/>), you are authorized to take (capture, release, and accidental mortality) only in the event that the species is captured accidental to lawful survey activities directed at other species (if using lethal survey methods such as bee bowl, pan, or cup traps, malaise traps, or blue vane traps). This permit does not authorize any activities for the specific purpose of lethal capture of rusty patched bumble bee. If rusty patched bumble bees are identified at a survey site, all lethal survey methods shall cease within a two (2) mile area and permittee shall contact the U.S. Fish and Wildlife Service in accordance with Condition H.1. Should accidental mortality occur you must document the capture and collect information outlined in Condition K.2.f. on the captured individual.

J.3. For a permittee using approved, lethal protocols in areas where the lethal protocols are allowed (Condition J.2.), all rusty patched bumble bees need to be identified from samples annually, in time to be included in the annual report due January 31. In some cases, accidental mortality may not be discovered until specimens are identified by a bee taxonomist. In these cases the permit holder and/or taxonomists must take an initial look through samples to identify rusty patch bumble bees in order to include this information in the annual report. In the event that one or more rusty patched bumblebees are identified in a sample, all lethal survey activities must cease within two (2) miles of the capture location. The Minnesota/Wisconsin Ecological Services Field Office (Condition L.2.) must be contacted within two (2) business days of discovery of the specimen and the circumstances of collection. Initial contact may be made by telephone, however, a written explanation must be provided within five (5) days of the identification to the following USFWS offices: Regional Recovery Permits Coordinator, Bloomington, Minnesota (Condition L.1.), the Minnesota/Wisconsin Ecological Services Field Office (Condition L.2.), the Field Office for the state in which the activity occurred (Condition M.).

J.4. The collection of a voucher specimen of Rusty patched bumble bee is strictly prohibited except for circumstances identified in Condition H.2.

K. An annual report of all activities conducted under the authority of this permit is due by January 31 following each year this permit is in effect. In addition, copies of all publications and reports resulting from work conducted under this permit must be submitted as they become available. Failure to furnish any reports required by this permit is cause for permit revocation and/or denial of future permit applications.

K.1. Reporting requirements for Dakota Skipper and Poweshiek skipperling:

K.1.a A complete discussion of field procedures, data collection methods, results, and conclusions.

K.1.b. The date and location (state, county, locality, geographic coordinates, site characteristics) where each species was encountered.

K.1.c. A complete discussion of post-capture behavior, including, at a minimum, whether the specimen:

K.1.c.1. Flew to and perched on herbaceous vegetation, low shrubs, or to out-of-sight location in herbaceous vegetation (e.g., into plant litter or duff layer or into bases of grasses).

K.1.c.2. Flew into tall shrubs or trees and out-of-sight.

K.1.c.3. Flew away - did not see butterfly perch or fly into vegetation; or,

K.1.c.4. Post-release behavior unknown.

K.1.d. A complete description of injuries and/or mortalities to listed species while in your possession, the dates of occurrence, location, cause of death (if known), any circumstances surrounding the incidents, sex, numeric estimates of the mortalities broken down by lifestage (e .g., eggs, larvae, pupae, adults), and a description of any steps taken to reduce the likelihood that such injuries and/or mortalities will occur in the future.

K.1.e. Any other data you may have collected for individual butterflies, such as evidence of damage or injury, mortalities, locations where salvaged specimens are being kept.

K.1.f. Copies of any separate reports and/or publications resulting from work conducted under the authority of this permit.

K.1.g. Copies of all site specific authorization letters required under Condition G.

K.2. Reporting requirements for rusty patched bumble bee:

K.2.a. A description of locations (date, time, geographic locations (state, county, and geographic

coordinates using latitude and longitude in decimal degrees)) of areas surveyed, even if no rusty patched bumble bees were encountered.

K.2.b. The date, time, geographic locations (state, county, and geographic coordinates using latitude and longitude in decimal degrees) of any rusty patched bumble bees encountered. While not required, we appreciate receiving information for other *Bombus* species captured, as this information could help indicate suitable habitat for rusty patched bumble bee.

K.2.c. A description of the habitat conditions where the surveys took place (e.g., floral diversity and abundance, management practices and potential stressors).

K.2.d. A description of field procedures, data collection methods, and survey effort.

K.2.e. Photographs of the identifying characteristics for each individual federally-listed species. Photographs of other *Bombus* species observed are encouraged.

K.2.f. A complete description of injuries or mortalities to listed species while in your possession, the dates of occurrence, location of occurrence, any circumstances surrounding the incidents, and a description of any steps taken to reduce the likelihood that such injuries and/or mortalities will occur in the future.

K.2.g. Any other data you may have collected for individual rusty patched bumble bees, such as evidence of damage or injury, mortalities, locations where salvaged specimens are being kept.

K.2.h. Copies of any separate reports and/or publications resulting from work conducted under the authority of this permit.

K.2.i. Copies of all site specific authorization letters required under Condition G.

If no activities occurred over the course of the year, indication of such shall be submitted as an annual report.

L. Copies of your reports shall be sent to the offices listed below. When possible, electronic copies shall be submitted in lieu of hard copies in MS Word, Portable Document Format, Rich Text Format, or other file format that is compatible with the receiving office.

L.1. Regional Recovery Permits Coordinator

U.S. Fish and Wildlife Service - Midwest Region (Region 3)

Ecological Services - Endangered Species

5600 American Blvd. W., Suite 990

Bloomington, Minnesota 55437-1458

(612/713-5343; fax 612/713-5292)

permitsR3ES@fws.gov

L.2. Minnesota/Wisconsin Ecological Services Field Office

U.S. Fish and Wildlife Service - Midwest Region (Region 3)

Ecological Services - Endangered Species

4101 American Blvd. E.

Bloomington, MN 55425

(952/252-0052; fax 952/646-2873)

L.3. Regional Recovery Permits Coordinator

U.S. Fish and Wildlife Service - Northeast Region (Region 5)

Ecological Services - Endangered Species

300 Westgate Center Drive

Hadley, Massachusetts 01035-9589

(703/358-2402; fax 413/253-8482)

permitsR5ES@fws.gov

L.4. Regional Recovery Permits Coordinator

U.S. Fish and Wildlife Service - Mountain Prairie Region (Region 6)

Ecological Services - Endangered Species

P.O. Box 25486, DFC, MS 60120

Denver, Colorado 80225

(719/628-2670)

permitsR6ES@fws.gov

M. Additionally, based on geographic area where surveys were conducted, reports and publications shall be submitted to the offices listed under Field Office Contact Information at: <https://www.fws.gov/midwest/endangered/permits/index.html>.

All correspondence related to this permit should reference the permit number shown above. Any questions you may have regarding this permit should be directed to Carlita Payne, the Region 3 Endangered Species Permits Coordinator at (612) 713-5339.

cc: FWS/Region 5 and 6 (Attn: Regional Recovery Permits Coordinator)
FWS/ES/ Endangered Species Coordinators IA-IL, IN, MI, MN-WI, OH
DNR, Endangered Species Coordinators IA, IL, MI, MN, OH, IN, WI

Vendor Information

SWCA INC
3033 N CENTRAL AVENUE, STE 145
PHOENIX AZ 85012

Vendor Number: 3000046714
Phone Number: 602-274-3831
Fax Number: 6022743958

Contract Number 4600016659

Contract Date: 03/12/2017

Incoterm:
Payment Terms: Net 48 Days

Validity Start date: 03/20/2017
Validity End Date: 02/28/2022

General Information

Questions of a commercial or contractual nature may be directed to DEPTULA JEFFREY JOHN Jeff.Deptula@nee.com, at (561) 681-3096

Ship To, Invoice To and Sales Tax information will be specified on each individual PO release against this Contract.

This ENTERPRISE AGREEMENT ("EA") is entered into by and between NextEra Energy Resources, LLC ("NextEra"), and the legal entity named in the "Vendor Information" section above on this EA ("Supplier"). In this EA, NextEra and Supplier are sometimes referred to collectively as the "Parties" and individually as a "Party."
For good and valuable consideration of one U.S. Dollar ($1.00), the receipt and sufficiency of which is hereby acknowledged by the Parties, the Parties do hereby agree as follows:
NextEra or any of its affiliated companies (each, a "NextEra Party") may, from time to time during the validity of this EA as described above (the "Term"), contract with Supplier for Supplier to provide specific material(s), equipment or service(s) as described in a purchase order release referencing this EA (each, a "Purchase Order Release").

Each Purchase Order Release will incorporate and be subject to the terms and conditions referenced below.
The Parties expressly acknowledge and agree that, upon execution, acknowledgment or acceptance by Supplier of a Purchase Order Release, (i) each such Purchase Order Release creates a separate contractual relationship solely between the NextEra Party executing such Purchase Order Release (such NextEra Party is hereinafter referred to as the "Purchaser") and Supplier in relation to the materials, equipment and/or services described in such Purchase Order Release (the "Work"), except for any rights afforded to any NextEra Party under the Purchase Order Release, and (ii) Supplier will look solely to Purchaser for payment for the Work and the fulfillment of all other obligations of the Purchaser under the Purchase Order Release.

THIS EA SHALL NOT BE CONSTRUED AS ANY (AND NEXTERA MAKES NO) REPRESENTATION, WARRANTY, COVENANT OR GUARANTEE OF ANY MINIMUM QUANTITY OF MATERIAL, EQUIPMENT OR SERVICES TO BE PROCURED OR SECURED FROM SUPPLIER BY NEXTERA OR ANY OTHER NEXTERA PARTY UNDER THIS EA OR ANY PURCHASE ORDER RELEASE OR OTHERWISE.

THIS EA SHALL BE GOVERNED BY AND CONSTRUED IN ACCORDANCE WITH THE LAWS OF THE STATE OF FLORIDA (REGARDLESS OF CHOICE OF LAW RULES APPLICABLE UNDER THE LAWS OF FLORIDA OR ANY OTHER JURISDICTION).

IN ANY LITIGATION ARISING FROM OR RELATED TO THIS EA, EACH PARTY HEREBY KNOWINGLY, VOLUNTARILY AND INTENTIONALLY WAIVES THE RIGHT IT MAY HAVE TO A TRIAL BY JURY WITH RESPECT TO ANY LITIGATION BASED HEREON, OR ARISING OUT OF, UNDER OR IN CONNECTION WITH THIS EA, OR ANY COURSE OF CONDUCT, COURSE OF DEALING,

Authorized Signature : /S/ Jeffrey John Deptula
Ben Brodbeck
Digitally signed by Ben Brodbeck
DN: cn=Ben Brodbeck, o=Florida Power Light, ou=ISC, email=benjamin.brodbeck@fpl.com, c=US
Date: 2017.03.15 15:23:52 -04'00'

Date: 03/12/2017

Either party hereto may choose to transmit its order, release, or acknowledgment documents electronically by EDI, email, or facsimile (fax). The parties agree that any such document transmitted via EDI, email, or fax will be considered original and signed by a party when received electronically by the other party. Neither party will contest the validity or enforceability of such documents based upon their electronic delivery or signature.

Contract Number: 4600016659
Vendor Name: SWCA INC

General Information

STATEMENTS (WHETHER ORAL OR WRITTEN) OR ACTIONS OF EITHER PARTY TO THIS EA. THIS PROVISION IS A MATERIAL INDUCEMENT FOR NEXTERA AND SUPPLIER TO ENTER INTO THIS EA. EACH PARTY AGREES THAT FINAL JUDGMENT IN ANY SUCH ACTION OR PROCEEDING SHALL BE CONCLUSIVE AND MAY BE ENFORCED IN ANY OTHER JURISDICTION BY SUIT ON THE JUDGMENT OR IN ANY OTHER MANNER PROVIDED BY APPLICABLE LAW.

In no event will either Party, or their respective parents, affiliates, successors or assigns, or its or their applicable shareholders, partners, assigns, directors, officers, agents or employees or representatives, be liable to the other Party under or in relation to this EA for consequential, special, exemplary, indirect, punitive or incidental losses or damages, including loss of use, cost of capital, loss of goodwill, lost revenues or loss of profit

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USE / PURPOSE:
This EA shall be used for the specific Work as detailed in the "Description of Work" section below.

This EA shall commence on 3/20/17 and shall terminate on 2/28/2022 (the "Term").

SCOPE /DESCRIPTION OF WORK:
This EA is the Supplier's authority to furnish the necessary supervision, labor, equipment, materials, services and Consumables to perform the environmental services as listed below on behalf of the Purchaser:

In supporting the environmental services department development projects, the Supplier shall be capable of identifying and assisting with all necessary environmental permitting activities on a federal, state and local level in all areas of the United States that develops projects. This involves detailed local knowledge of the relevant permitting processes as well as applicable laws, ordinances, regulations, best management practices, and standards that must be addressed depending on the technology to be deployed and location. Supplier should have competent working knowledge and practical experience with applicable regulations and key entitlement agencies.

Excellent project management and communication skills with staff are critical. Project schedule software, as well as mapping software is essential (e.g., GIS, Google earth and other geographic tools). Environmental desktop studies, research into environmental issues specific to projects and substantial report writing will be required. Some project work may require intensive field work in often remote locations.

The range of services for supporting development projects includes, but is not limited to, the following:

Project Management
* Cost estimating
* Record keeping and management (e.g., administrative record, agency correspondence)
* Document management
* Expert Witness Support (noise, visual, shadow flicker, EMF)
* Public Outreach support (open houses, public meetings, stakeholder consultations)

Early Stage Development Support
* Development site selection and constraints analysis
* Preliminary routing (linear facilities)
* Environmental Critical Issues Analysis and/or Fatal Flaws Analysis (see template for content)
* Phase I/II Environmental Site Assessment (including updates for project financing as needed)

Permitting Support
* Federal Processes (e.g., NEPA EIS/EA)
* State Processes (e.g., PSC, PUC, CEQA)
* Provincial Processes (e.g., Canada REA)
* Local permitting support (CUP, SUP, etc.)

Contract Number: 4600016659
Vendor Name: SWCA INC

General Information

Air
* Air quality studies and/or monitoring
* Air emissions modeling
* New Source Permitting
* Greenhouse gas emissions modeling/inventory

Biological Resources
* Avian studies and/or monitoring (pre- and post- construction)
* Bat studies and/or monitoring (pre- and post- construction)
* Other Wildlife studies and/or monitoring (pre- and post- construction)
* Listed Species strategy/permitting
* Plant studies and/or monitoring (pre- and post- construction)
* Mitigation strategy/planning
* Species Relocation
* Consultation with US Fish and Wildlife Service and state-specific wildlife agencies

Cultural and Architectural History Resources
* Cultural resource studies/archaeology desktop studies and field surveys
* Architectural History studies
* Tribal consultation and ethnographic studies
* Consultation with State Historic Preservation Office
* Historic Preservation and Mitigation
* Unanticipated Discoveries Plan for construction compliance

Environmental Compliance
* Environmental mitigation support
* Drafting of environmental compliance plans
* Construction worker training programs targeting environmental issues
* Onsite Construction compliance support
* Decommissioning compliance support

Geological Resources
* Soil/sediment surveys and testing

Acquisition Due Diligence
* Assistance in document review and data gap analysis
* Risk assessments

Wetlands and water resources (ground water and surface water)
* Water quantity and quality studies and/or monitoring
* Formal Wetlands delineation
* Jurisdictional wetlands permitting
* Consultation with US Army Corps of Engineers for jurisdictional waters and/or state environmental agencies
* Storm water pollution prevention plan (SWPPP)
* Spill Prevention, Control, and Countermeasure (SPCC) Plan
* FEMA Floodplain permitting
* Water quantity and quality studies

Noise, Shadow Flicker, and Visual
* Acoustic receptor modeling, mapping, pre-and post- construction monitoring and technical studies
* Shadow flicker modeling studies
* Visual simulations

Contract Number: 4600016659
Vendor Name: SWCA INC

General Information

* Preparation of glint-glare studies

All Work shall be in accordance with the requirements identified in the following documents incorporated into and made a part of this EA:

TERMS AND CONDITIONS:
All Work performed under this Purchase Document (Release) shall be performed in accordance with the terms and conditions of the following exhibits:
STANDARD PURCHASER TERMS AND CONDITIONS FOR CONSULTING SERVICES (NON FLORIDA), REV. 12/15/16
NextEra Supplier Code of Conduct date 8/21/14
NextEra Contractor Safety Requirements Rev. 11/13/11
NextEra Safe & Secure Workplace Requirements Rev 4/7/15

COMPANY REPRESENTATIVE:
All Work shall be subject to the approval and acceptance of the Purchaser's Company Representative, as identified in each Purchase Document (Release).

The Supplier's Company Representative is:
Mr. Steve Stielstra
Office number: 650-440-4160, x6402
Mobile number: 650-868-6861
Email: sstielstra@swca.com

SCHEDULE / DELIVERY:
All Work performed under this Contract shall be performed in accordance with the schedule requirements identified in each Purchase Document (Release)..

SCHEDULE OF COSTS / PRICING / COMPENSATION:
Labor Services shall be confirmed based on the rates listed below.
* No overtime or double time is authorized for the Work.

Equipment rental shall be per the attached Supplier's Rate Sheet "SWCA Equipment Rates_Standard_PDS"

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* Automobile mileage shall be reimbursed at current GSA rate.

* Reasonable customary travel and living expenses, when authorized by Purchaser, shall be reimbursed at cost or at the IRS/GSA Per Diem rate as approved by Purchaser.

* For Purchaser pre-approved additional materials, third party rentals or leases, Supplier shall be paid at cost plus five (5) percent.

* For Purchaser pre-approved additional subcontracted work with affiliate companies of Supplier will be invoiced at actual cost with no adder.

Pricing is firm for the original Term of this Contract.

AUTHORIZATION/WORK INSTRUCTIONS:
Authority to commence Work on site will be issued via a Purchase Document (Release) serving as Notice to Proceed, Notice of Commencement, or its equivalent.

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NOTE: Purchaser does have the option to do a conventional release in lieu of E Receiving.
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Contract Number: 4600016659
Vendor Name: SWCA INC

General Information

INVOICING:
Supplier shall perform electronic confirmations in lieu of submitting actual invoices for work performed.
Electronic confirmations shall be submitted by Supplier via the FPL.com Supplier Portal and shall include any applicable, or required, attachments (documentation of charges, lien waivers, etc.).
Electronic confirmations shall be reviewed by FPL personnel. Electronic confirmations which are entered incorrectly or without proper documentation shall be rejected, with explanation, and returned to Supplier for re-submittal by Supplier.

Electronic Invoices must itemize charges with supporting documentation for all applicable billing rates and any other costs authorized by the Purchase Document (Release).
Failure to comply shall result in invoice processing delays at the expense of the Supplier.

All expenses invoiced in excess of $25.00 must be accompanied by the original receipt.

SALES TAX:
Sales tax applicability shall be set forth in each Purchase Document (Release).

SPECIAL/OUT OF SCOPE INSTRUCTIONS:
Changes in the scope of a Purchase Document (Release) will be performed only upon approval by the Purchaser's Company Representative and receipt of an authorized Change Form.
Purchaser reserves the right to bid each identified out of scope task via any method at its discretion.

Payment terms for all Supplier invoices shall be net 48 days for electronic funds transfer (FEDI).

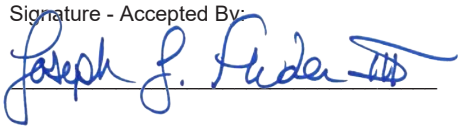
INSURANCE:
It is understood and agreed that the Supplier is not covered by any Purchaser provided insurance program. See the attached terms and conditions for insurance requirements. If specifically requested by Purchaser, the Supplier must provide proof of insurance via an ACORD form or other Certificate of Insurance before commencement of on-site Work.

ATTACHMENTS:
STANDARD PURCHASER TERMS AND CONDITIONS FOR CONSULTING SERVICES (NON FLORIDA), REV. 12/15/16
NextEra Supplier Code of Conduct date 8/21/14
NextEra Contractor Safety Requirements Rev. 11/13/11
NextEra Safe & Secure Workplace Requirements Rev 4/7/15
Rate Sheet "SWCA Equipment Rates_Standard_PDS"

ACKNOWLEDGEMENT:
You are required to sign and submit an acknowledgement copy of this Contract prior to beginning Work. FAILURE TO RETURN THIS ACKNOWLEDGEMENT SHALL RESULT IN PAYMENT OF YOUR INVOICES BEING DELAYED.

As a duly authorized representative, the undersigned acknowledges and accepts the terms of this Contract, its attachments and references.

Signature - Accepted By:



Name: Joseph J. Fluder III

Title: Chief Operating Officer

United States Department of the Interior

FISH AND WILDLIFE SERVICE
South Dakota Ecological Services

420 South Garfield Avenue, Suite 400
Pierre, South Dakota 57501-5408

IN REPLY REFER TO:
TE64070B-1 Skipper
Permit

June 18, 2018

Jake Powell, Senior Ecologist
SWCA Environmental Consultants
1892 South Sheridan Avenue
Sheridan, Wyoming 82801

Dear Mr. Powell:

This letter provides your site specific authorization per condition F.3 of Federal Endangered Species Permit No. TE64070B-1. Under this condition you are to notify the U.S. Fish and Wildlife Service (Service) Field Supervisor for the state in which activities are proposed to occur at least 30 days prior to conducting any activities.

The information required under condition F.3 was provided to the Service in a letter dated June 14, 2018. In summary, SWCA is working with NextEra Energy Resources (NextEra) to identify the need and final location for surveys for Dakota skipper and Poweshiek skipperling in Codington, Grant, and Deuel counties, South Dakota, during the 2018 adult flight period. Surveys will be conducted between approximately June 25 and July 15 by Mr. Jake Powell. The survey protocols will follow the 2018 Dakota skipper survey protocols (https://wwww.fws.gov/midwest/endangered/insects/dask/index.html). The surveys will be conducted on field verified suitable habitat.

All survey activities should conform to the conditions of your Service permit TE64070B-1. Please report your data from this survey to the USFWS South Dakota Field Office .

As stated in your permit, your concurrence letter must be carried with this permit to authorize site-specific activities. If you have any questions, please feel free to call Charlene Bessken at 605-224-8693 x 231.

Sincerely,

Scott Larson

Scott V. Larson
Field Supervisor
South Dakota Field Office

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Technical Memorandum

To: Crowned Ridge Wind I, LLC

From: SWCA Environmental Consultants

Date: November 28, 2018

Re: **Crowned Ridge I Raptor Nest Aerial Surveys / SWCA Project No. 44511**

INTRODUCTION

Crowned Ridge Wind, LLC, an indirect, wholly owned subsidiary of NextEra Energy Resources, LLC (NEER), plans to develop an approximately 300-megawatt wind facility known as the Crowned Ridge I Wind Energy Facility (the project) in Grant and Codington Counties, South Dakota (see project boundary, Figure 1). SWCA Environmental Consultants (SWCA) completed raptor nest aerial surveys for the project during 2017 and 2018. At the time of the 2017 survey, the study area included approximately 69,433 acres (ac) (28,099 hectares [ha]) (Figure 1). At the time of the 2018 survey, the study area as provided to SWCA on March 20, 2018, included approximately 57,126 ac (23,118 ha) (Figure 2).

SWCA performed two raptor nest aerial surveys in 2017 and one in 2018 to identify nesting raptors and to provide NEER spatial and species information for use during its turbine siting process to minimize the potential for impacts during construction and operation. SWCA completed surveys on April 5 and 6, 2017, June 8 and 9, 2017, and April 25 and 26, 2018. All raptor nests were surveyed within the study areas and a 2-mile (mi) (3.2-kilometer [km]) buffer. The study areas plus a 10-mi (16-km) buffer were surveyed to search specifically for eagle nests. SWCA used fixed-wing aerial survey methods following recommendations contained in the U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines[1] and Eagle Conservation Plan Guidance.[2]

METHODS

Two avian biologists and an experienced wildlife survey pilot conducted the raptor nest aerial surveys in a Cessna 172. The first nest survey in 2017 was conducted April 5 and 6 just prior to leaf-out to provide the best opportunity for nest detection. The second 2017 nest survey was conducted on June 8 and 9 (near most eagle and other large raptor fledge dates) to determine activity and productivity, if possible, of previously identified nests. Nest surveys in 2018 were completed April 25 and 26 to better determine status during a single survey period and avoid visibility issues due to canopy closure encountered during 2017. SWCA documented all raptor nests identified within the study area and associated 2-mi (3.2-km) buffer and all eagle nests identified within the study area and associated 10-mi (16-km) buffer. The study

[1] U.S. Fish and Wildlife Service. 2012. *Land-Based Wind Energy Guidelines*. Wind Turbine Guidelines Advisory Committee. Washington, D.C.: U.S. Department of the Interior, U.S. Fish and Wildlife Service.

[2] U.S. Fish and Wildlife Service. 2013. *Eagle Conservation Plan Guidance, Module 1 – Land-Based Wind Energy, Version 2*. Washington, D.C.: U.S. Department of the Interior, U.S. Fish and Wildlife Service, Division of Migratory Bird Management.

area and 2-mi (3.2-km) buffer survey were conducted by flying pre-established linear north–south transects at 0.5-mi (800-m) intervals at an altitude of 300 to 700 feet (ft) (91–213 meters [m]) above ground level, depending on terrain and flight safety issues. Transects within the 2-mi buffer were pre-established in ArcGIS software and loaded in a global positioning system (GPS) unit for guidance during the survey. The study area and 10-mi (16-km) buffer survey were conducted by flying roaming, east–west transects at 1.0- to 3.5-mi (1.6–5.6-km) intervals across the entire survey area at an altitude of 300 to 700 ft above ground level, with a focus on suitable eagle nesting habitat (Figures 3 and 4).

SWCA identified suitable eagle nesting habitat during a preliminary ArcGIS software desktop analysis to guide the nest survey. Additional areas of suitable eagle nesting habitat identified during the survey also were investigated for presence of eagle nests. Characteristics of suitable eagle nesting habitat include wooded riparian corridors, utility structures, and stands of large trees capable of supporting an eagle nest. Potential nest locations detected within the 2-mi (3.2-km) and 10-mi (16-km) buffers were observed until raptor nest status (nest/no nest, active/inactive, etc.) could be confirmed.

DATA ANALYSIS

Data recorded at each raptor nest location included nest substrate, condition (i.e., good, fair, or poor), and status (i.e., occupied or unoccupied); raptor species using occupied nests; number of adults, eggs, and/or nestlings, if observed; behavior (e.g., incubating, perched at nest, flying nearby); and GPS location. A summary of all nests detected is presented in the section below. All eagle nest data recorded during the raptor nest aerial survey are presented in Attachments 1 and 2. See Figure 5 for detected raptor nest locations in the 2-mi buffer during each survey year, and Figure 6 for eagle nest locations detected in the 10-mi buffer during each survey year.

Though all nests observed during the aerial nest survey were documented, it is possible that nests of certain species (e.g., American kestrel [*Falco sparverius*], prairie falcon [*Falco mexicanus*], and northern harrier [*Circus cyaneus*]) were not located due to the nature of aerial surveys. This is primarily due to the height and speed at which aerial surveys are conducted, and because of the nest structure and preferred substrate of these species (i.e., built in small cavities along rock outcrops or in trees, or built on the ground nestled in tall grasslands).

RESULTS

2017 Non-Eagle Raptor Nests

The April 2017 aerial raptor nest surveys identified 22 non-eagle raptor nest structures within the 2-mi buffer (Figure 5). Eight of these nests were considered occupied due to the presence of an adult in incubation position; five of these nests were located within the study area (Table 1). Fourteen nests were considered unoccupied due to a lack of an attending/incubating adult, nestlings, or eggs at the time of the survey. The non-eagle raptor nests were of medium size, built with sticks, and located in small- to medium-sized deciduous trees. Given that the nest survey was conducted just prior to leaf-out, it was difficult to determine the exact species of a nest tree. The species composition of the occupied non-eagle raptor nests consisted of one great-horned owl (*Bubo virginianus*), three red-tailed hawks (*Buteo jamaicensis*), and one Swainson's hawk (*Buteo swainsoni*). The sixteen unoccupied nests were consistent in size and composition to those made by a *Buteo* species.

Visibility of the raptor nests was extremely restricted due to dense foliage (i.e., deciduous trees had fully leafed out). As such no new nests not already documented during April surveys were discovered during the June 2017 nest status survey. Only eagle nests located during the April survey were observed from the aircraft during the June survey (discussed below).

2018 Non-Eagle Raptor Nests

The April 2018 aerial raptor nest survey identified 47 non-eagle raptor nest structures within the 2-mi buffer (Figure 5). Sixteen nests were considered occupied due to the presence of an adult in incubation position; eight of these nests were located within the study area (Table 1). Thirty-one nests were considered unoccupied due to a lack of an attending/incubating adult, nestlings, or eggs at the time of the survey. Of the 16 active non-eagle raptor nests, one (No. 122-2018, red-tailed hawk nest) was located within the 2-mi buffer of *both* the Crowned Ridge I and Crowned Ridge II study areas. The non-eagle raptor nests were of medium size, built with sticks, and located in small- to medium-sized deciduous trees. Given that the nest survey was conducted just prior to leaf-out, it was difficult to determine the exact species of a nest tree. The species composition of occupied non-eagle raptor nests consisted of three great-horned owl nests and nine red-tailed hawk nests. The 31 unoccupied nests were consistent in size and composition to those made by a *Buteo* species.

Table 1. Occupied Non-Eagle Raptor Nests within the Study Area and 2-mi Buffer

Nest No.	Nesting Species	Nest Condition	Nest Contents	Location	Coordinates
2017 Nest Surveys					
52-2017	Red-tailed hawk	Good	Incubating adult	Within study area	45.1365 N, -96.9746 W
34-2017	Great-horned owl	Good	Incubating adult	Within study area	45.0240 N, -96.9853 W
47-2017	Red-tailed hawk	Good	Incubating adult	Within study area	45.0598 N, -96.9681 W
48-2017	Red-tailed hawk	Good	Incubating adult	Within study area	45.0788 N, -97.0094 W
49-2017	Red-tailed hawk	Good	Incubating adult	Within study area	45.0637 N, -97.0019 W
06-2017	Red-tailed hawk	Good	Incubating adult	2-mi buffer	45.1178 N, -96.7304 W
50-2017	Red-tailed hawk	Good	Incubating adult	2-mi buffer	45.1745 N, -97.0048 W
51-2017	Swainson's hawk	Good	Incubating adult	2-mi buffer	45.1749 N, -96.9806 W
2018 Nest Surveys					
33-2018	Red-tailed hawk	Good	Incubating adult	Within study area	45.0446 N, -96.9510 W
34-2018	Red-tailed hawk	Good	Incubating adult	Within study area	45.0562 N, -96.9345 W
134-2018	Great-horned owl	Good	Incubating adult	Within study area	45.1063 N, -96.8274 W
137-2018	Red-tailed hawk	Good	Incubating adult	Within study area	45.0447 N, -96.8213 W
139-2018	Great-horned owl	Good	Incubating adult	Within study area	45.1427 N, -96.8053 W
142-2018	Red-tailed hawk	Good	Incubating adult	Within study area	45.1419 N, -96.7969 W
145-2018	Red-tailed hawk	Good	Incubating adult	Within study area	45.0948 N, -96.7877 W
152-2018	Red-tailed hawk	Good	Incubating adult	Within study area	45.1682 N, -96.7754 W
80-2018	Red-tailed hawk	Good	Incubating adult	2-mi buffer	45.0225 N, -97.0363 W
82-2018	Great-horned owl	Good	Incubating adult	2-mi buffer	45.1032 N, -96.9498 W
96-2018	Red-tailed hawk	Good	Incubating adult	2-mi buffer	45.0874 N, -97.0615 W
97-2018	Red-tailed hawk	Good	Incubating adult	2-mi buffer	45.0335 N, -97.0145 W
122-2018	Red-tailed hawk	Good	Incubating adult	2-mi buffer	45.0032 N, -96.8694 W
141-2018	Great-horned owl	Good	Incubating adult	2-mi buffer	45.0195 N, -96.8057 W
158-2018	Red-tailed hawk	Good	Incubating adult	2-mi buffer	45.1538 N, -96.7554 W
160-2018	Red-tailed hawk	Good	Incubating adult	2-mi buffer	45.1030 N, -96.7440 W

2017 Bald Eagle Nests

No bald eagle nests were observed within the study area during 2017 surveys. Two occupied bald eagle (*Haliaeetus leucocephalus*) nests were observed within the 2-mi buffer (Table 2; Figure 6). The two

occupied bald eagle nests were identified as such due to the presence of an adult in incubation position. The detected eagle nests within the 2-mi buffer were found in medium- to large-sized eastern cottonwood (*Populus deltoides*) trees approximately 0.10 mi (0.16 km), and approximately 1.6 mi (2.6 km) outside of the study area. No bald eagle nests were identified within the 10-mi buffer (outside of the 2-mi buffer [Figure 6]) except those identified within the 2-mi buffer of the Crowned Ridge II study area.

No new nests not already documented during April surveys were discovered during the June 2017 survey. Of the two active bald eagle nests observed in April, both were still active and contained one eaglet each and observations of a nearby adult were recorded.

2018 Bald Eagle Nests

No bald eagle nests were observed within the study area during 2018 surveys. Two occupied bald eagle nests and one (likely) unoccupied eagle nest were observed within the 2-mi buffer (Table 2 and Figure 6). The two occupied bald eagle nests were identified as such due to the presence of an adult in incubation position. Unoccupied Nest No. 87-2018 was the same as occupied Nest No. 42-2017 identified during 2017 surveys. Occupied Nest No. 04-2018 was the same as occupied Nest No. 05-2017 identified during 2017 surveys. Eagle Nest No. 124-2018 and Nest No. 87-2018 were in the 2-mi buffer of both the Crowned Ridge I and Crowned Ridge II study areas.

Three occupied bald eagle nests were identified within the 10-mi buffer (outside the 2-mi buffer) (Figure 6, Table 3). Occupied Nest No. 89-2018 appears to be in the same territory as unoccupied (destroyed) Nests No. 43-2017 and No. 45-2017 identified during 2017 surveys. The remaining two nests identified within the 10-mi buffer during the 2018 survey were previously undetected and/or new nest structures. Given that the nest survey was conducted just prior to leaf-out, it was difficult to determine the exact species of a nest tree. Bald eagle nests located within the 10-mi buffer of the Crowned Ridge I study area and within the 2-mi buffer of Crowned Ridge II were not included in this analysis (see *Crowned Ridge II Aerial Raptor Nest Surveys Technical Memorandum*).

Table 2. Bald Eagle Nests within the 2-mi Buffer (and Outside the Study Area)

Nest No.	Survey Year	Status	Nest Condition	Nest Contents	Nest Coordinates
05-2017*	2017	Occupied	Sticks – intact	1 nestling	45.1172 N, -96.9126 W
42-2017†	2017	Occupied	Sticks – intact	1 nestling	45.0236 N, -96.8553 W
04-2018*	2018	Occupied	Sticks – excellent	Incubating adult	45.1172 N, -96.9126 W
87-2018†	2018	Unoccupied	Excellent	Empty	45.0238 N, -96.8553 W
124-2018	2018	Occupied	Sticks – excellent	Incubating adult	44.7947 N, -96.9330 W

* Indicates same nest site between years

† Indicates same nest site between years

Table 3. Bald Eagle Nests within the 10-mi Buffer (and Outside the Study Area and 2-mi Buffer)

Nest No.	Survey Year	Status	Nest Condition	Nest Contents	Nest Coordinates
89-2018	2018	Occupied	Excellent	1 nesting	45.2750 N, -97.0030 W
93-2018*	2018	Occupied	Excellent	Incubating adult	45.2710 N, -96.5420 W
163-2018*	2018	Occupied	Excellent	Incubating adult	45.0313 N, -97.2456 W

* Located 1.3 to 5.8 kilometers outside of 10-mi (16-km) buffer but on waterways that cross the study area 10-mi buffer

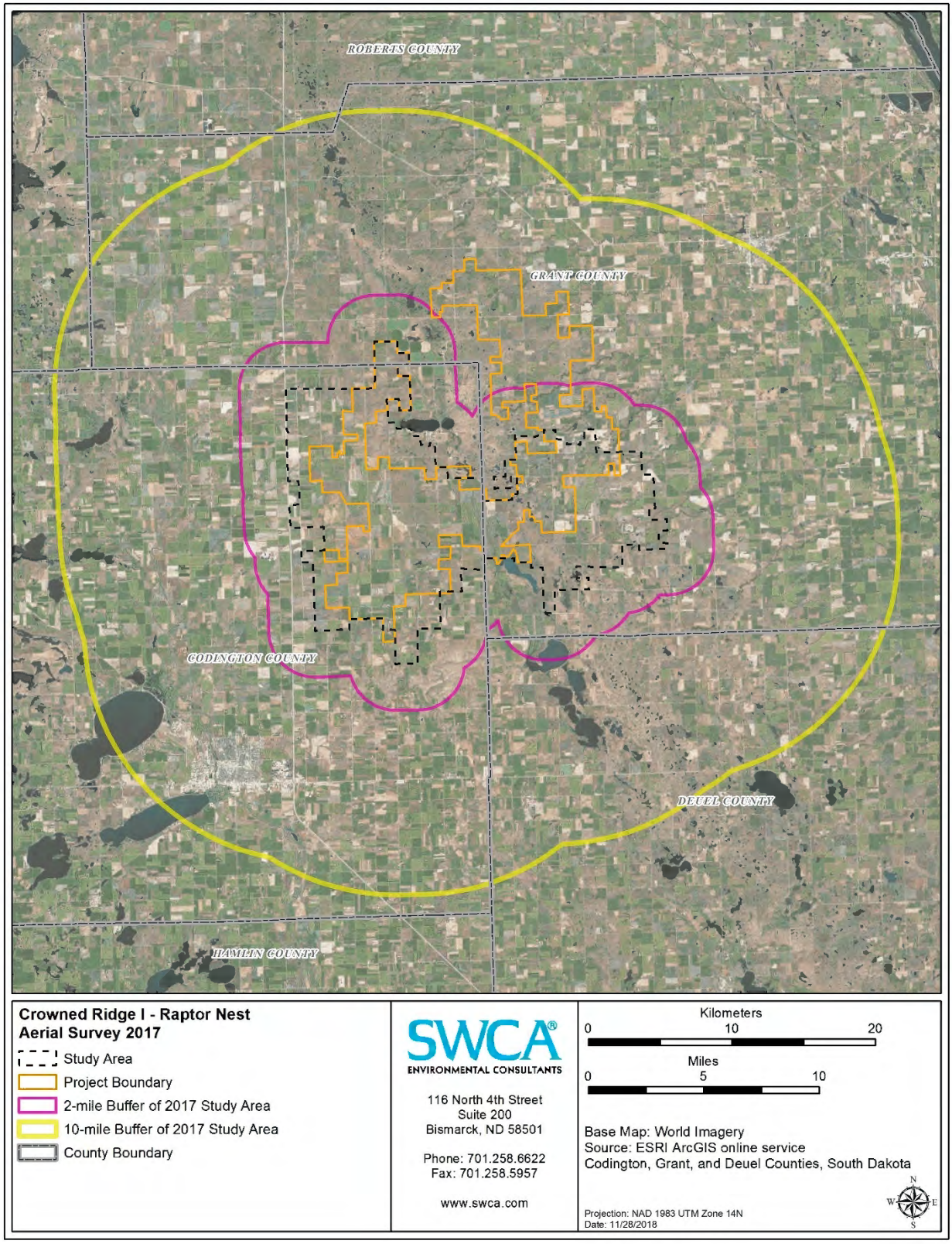


Figure 1. Study areas, 2017.

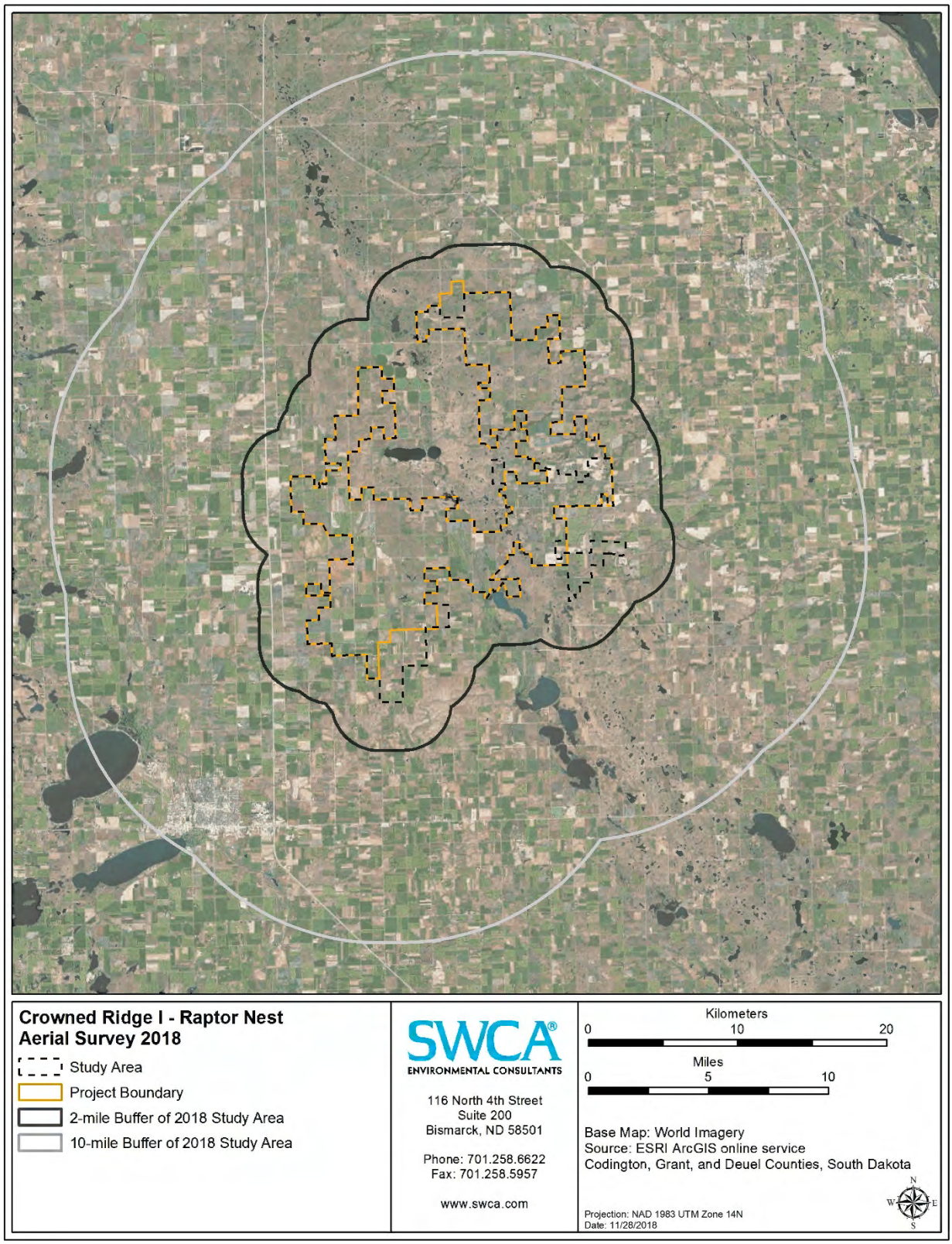


Figure 2. Study areas, 2018.

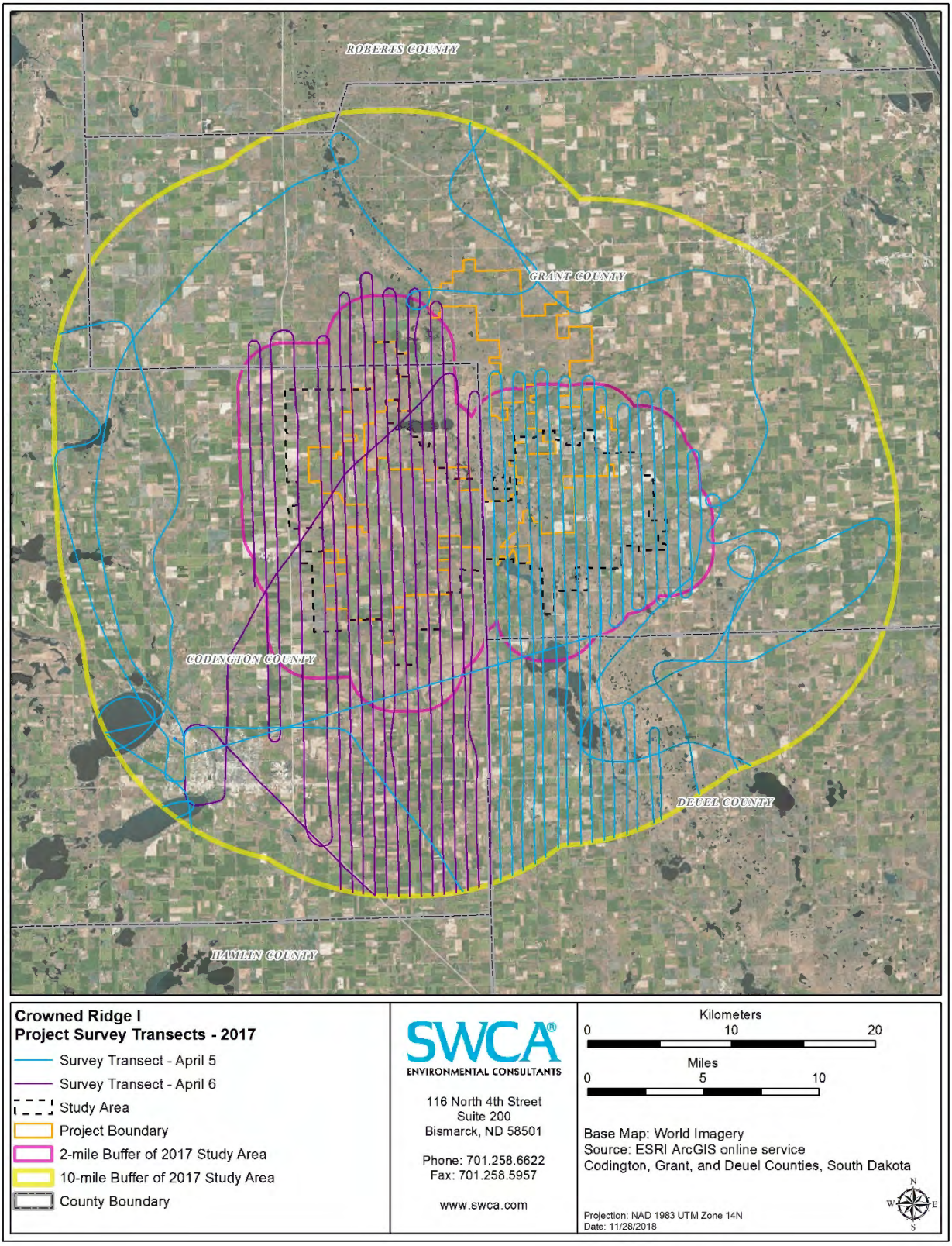


Figure 3. Survey transects, 2017.

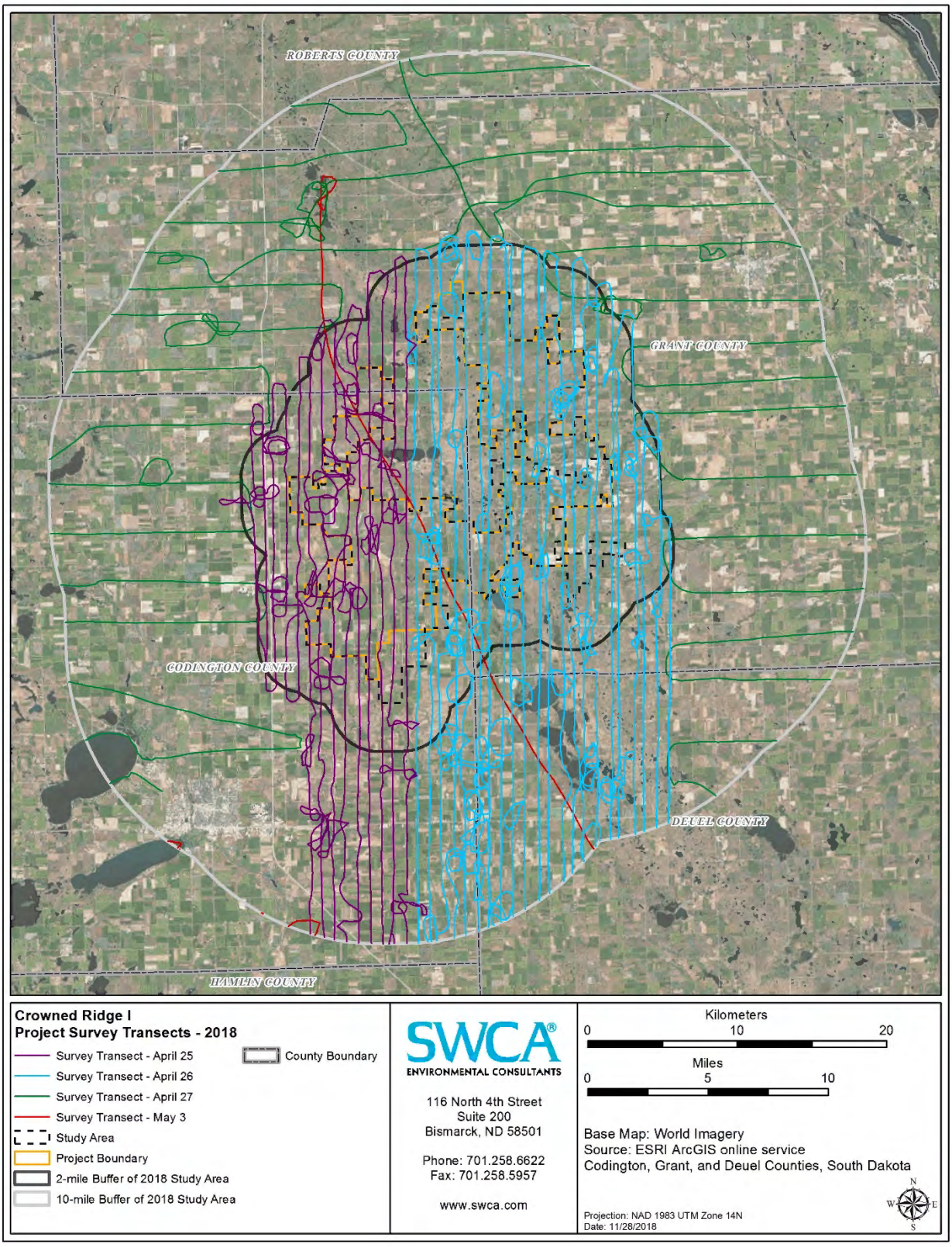


Figure 4. Survey transects, 2018.

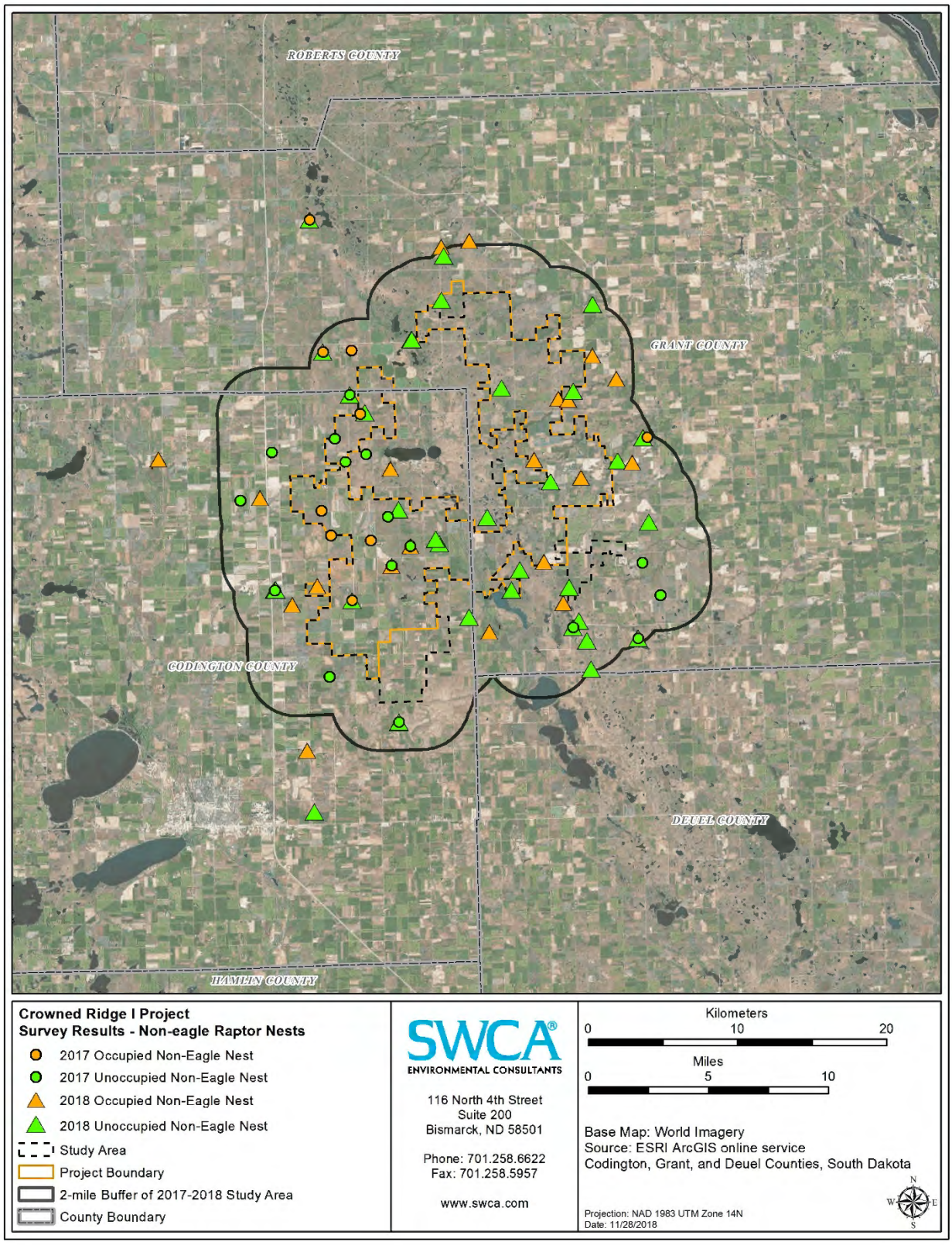


Figure 5. Survey results: non-eagle raptor nests.

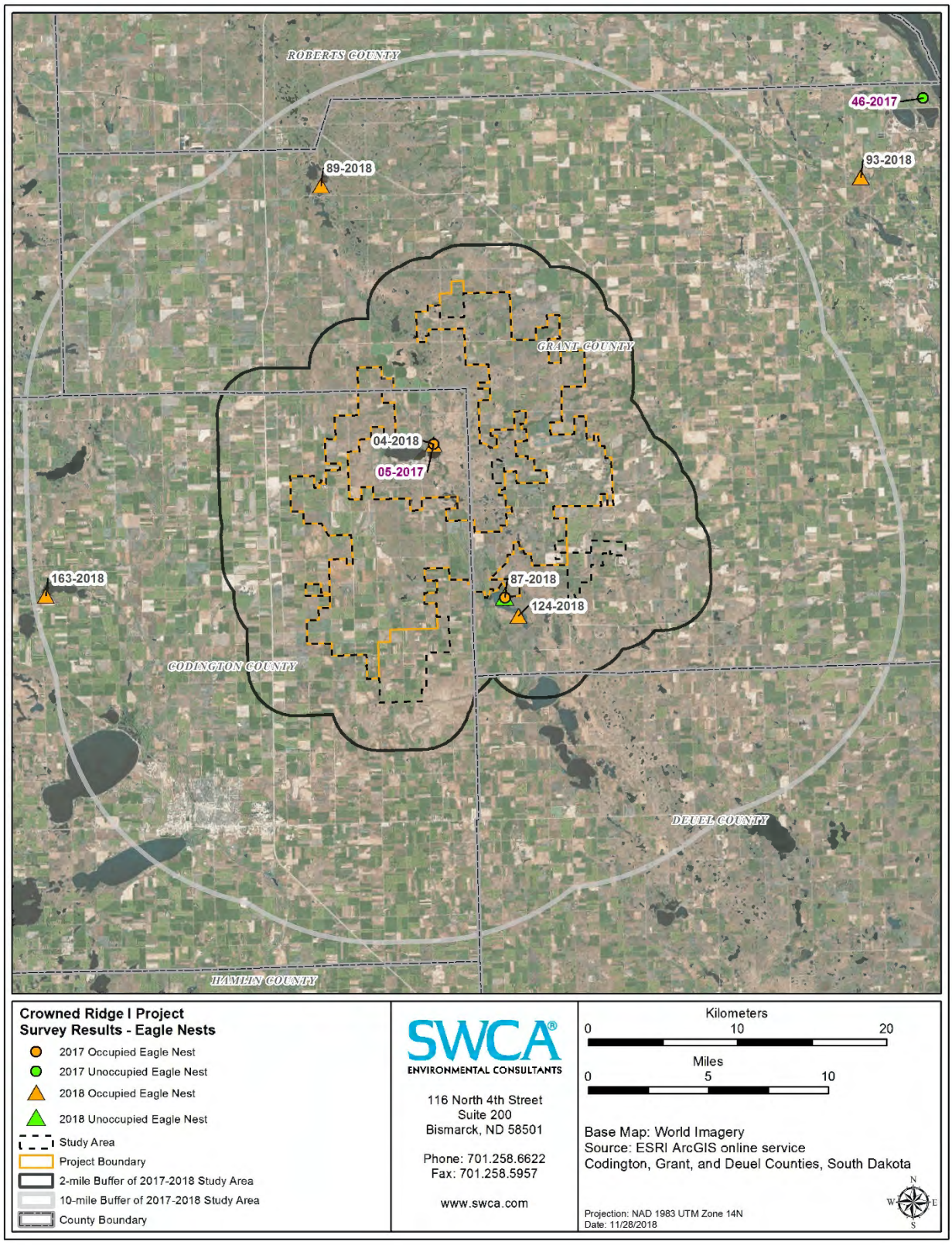


Figure 6. Survey results: eagle nests.

ATTACHMENT 1. 2017 Crowned Ridge I Raptor Nest Survey Data

Nest No.	Status	Species	Study Area	Study Area Proximity	Latitude	Longitude
53-2017	Active	Swainson's Hawk	CRI	10-mi	45.2544	-97.0135
43-2017	Destroyed	Unoccupied Stick Nest	CRI	10-mi	45.2744	-97.0027
45-2017	Destroyed	Unoccupied Stick Nest	CRI	10-mi	45.2750	-97.0030
03-2017	Inactive	Unoccupied Stick Nest	CRI	10-mi	45.0223	-96.7234
15-2017	Inactive	Unoccupied Stick Nest	CRI	10-mi	44.9967	-96.7430
46-2017	Inactive	Unoccupied Stick Nest	CRI	10-mi	45.3176	-96.4869
05-2017	Active	Bald Eagle	CRI	2-mi	45.1172	-96.9126
42-2017	Active	Bald Eagle	CRI & CRII	2-mi	45.0236	-96.8553
06-2017	Active	Red-tailed Hawk	CRI	2-mi	45.1178	-96.7304
50-2017	Active	Red-tailed Hawk	CRI	2-mi	45.1745	-97.0048
51-2017	Active	Swainson's Hawk	CRI	2-mi	45.1749	-96.9806
01-2017	Inactive	Unoccupied Stick Nest	CRI	2-mi	45.0043	-96.7980
14-2017	Inactive	Unoccupied Stick Nest	CRI	2-mi	45.1149	-97.0505
20-2017	Inactive	Unoccupied Stick Nest	CRI	2-mi	45.0860	-97.0784
22-2017	Inactive	Unoccupied Stick Nest	CRI	2-mi	45.0424	-96.7376
23-2017	Inactive	Unoccupied Stick Nest	CRI	2-mi	44.9786	-97.0061
25-2017	Inactive	Unoccupied Stick Nest	CRI	2-mi	45.0315	-97.0508
13-2017	Inactive	Unoccupied Stick Nest	CRI & CRII	2-mi	44.9500	-96.9480
34-2017	Active	Great Horned Owl	CRI	Within	45.0240	-96.9853
47-2017	Active	Red-tailed Hawk	CRI	Within	45.0598	-96.9681
48-2017	Active	Red-tailed Hawk	CRI	Within	45.0788	-97.0094
49-2017	Active	Red-tailed Hawk	CRI	Within	45.0637	-97.0019
52-2017	Active	Red-tailed Hawk	CRI	Within	45.1365	-96.9746
35-2017	Inactive	Red-tailed Hawk	CRI	Within	45.0446	-96.9510
36-2017	Inactive	Red-tailed Hawk	CRI	Within	45.0562	-96.9345
37-2017	Inactive	Red-tailed Hawk	CRI	Within	45.0741	-96.9532
39-2017	Inactive	Red-tailed Hawk	CRI	Within	45.1075	-96.9878
40-2017	Inactive	Red-tailed Hawk	CRI	Within	45.1218	-96.9966
41-2017	Inactive	Red-tailed Hawk	CRI	Within	45.1482	-96.9829
38-2017	Inactive	Swainson's Hawk	CRI	Within	45.1120	-96.9703

ATTACHMENT 2. 2018 Crowned Ridge I Raptor Nest Survey Data

Nest No.	Status	Species	Study Area	Study Area Proximity	Latitude	Longitude
111-2018	Active	Red-tailed Hawk	CR	10-mi	45.2362	-96.9019
117-2018	Active	Red-tailed Hawk	CR	10-mi	45.2394	-96.8778
89-2018	Active	Bald Eagle	CRI	10-mi	45.2750	-97.0030
93-2018	Active	Bald Eagle	CRI	10-mi	45.2710	-96.5420
163-2018	Active	Bald Eagle	CRI	10-mi	45.0313	-97.2456
164-2018	Active	Great-horned Owl	CRI	10-mi	45.1122	-97.1473
14-2018	Inactive	Unknown	CRI	10-mi	44.9967	-96.7430
72-2018	Inactive	Unknown	CRI	10-mi	45.2544	-97.0135
98-2018	Active	Red-tailed Hawk	CRI & II	10-mi	44.9343	-97.0264
99-2018	Inactive	Unknown	CRI & II	10-mi	44.8972	-97.0215
151-2018	Inactive	Unknown	CRI & II	10-mi	44.9789	-96.7835
158-2018	Active	Red-tailed Hawk	CR	2-mi	45.1538	-96.7554
102-2018	Inactive	Unknown	CR	2-mi	45.1807	-96.9294
104-2018	Inactive	Unknown	CR	2-mi	45.1807	-96.9287
110-2018	Inactive	Unknown	CR	2-mi	45.2040	-96.9026
112-2018	Inactive	Unknown	CR	2-mi	45.2307	-96.8996
162-2018	Inactive	Unknown	CR	2-mi	45.1178	-96.7338
05-2018	Gone		CR	2-mi	45.1178	-96.7304
04-2018	Active	Bald Eagle	CRI	2-mi	45.1172	-96.9126
82-2018	Active	Great-horned Owl	CRI	2-mi	45.1032	-96.9498
141-2018	Active	Great-horned Owl	CRI	2-mi	45.0195	-96.8057
80-2018	Active	Red-tailed Hawk	CRI	2-mi	45.0225	-97.0363
96-2018	Active	Red-tailed Hawk	CRI	2-mi	45.0874	-97.0615
97-2018	Active	Red-tailed Hawk	CRI	2-mi	45.0335	-97.0145
160-2018	Active	Red-tailed Hawk	CRI	2-mi	45.1030	-96.7440
21-2018	DNLO	Unknown	CRI	2-mi	45.0424	-96.7376
00-2018	Inactive	Unknown	CRI	2-mi	45.0043	-96.7980
12-2018	Inactive	Unknown	CRI	2-mi	44.9500	-96.9480
24-2018	Inactive	Unknown	CRI	2-mi	45.0315	-97.0508
39-2018	Inactive	Unknown	CRI	2-mi	45.1482	-96.9829
69-2018	Inactive	Unknown	CRI	2-mi	45.1745	-97.0048
94-2018	Inactive	Unknown	CRI	2-mi	45.0315	-97.0497
118-2018	Inactive	Unknown	CRI	2-mi	45.0723	-96.8683
140-2018	Inactive	Unknown	CRI	2-mi	45.0288	-96.8005
146-2018	Inactive	Unknown	CRI	2-mi	45.0083	-96.7928
147-2018	Inactive	Unknown	CRI	2-mi	44.9961	-96.7865
153-2018	Inactive	Unknown	CRI	2-mi	45.1041	-96.7562
161-2018	Inactive	Unknown	CRI	2-mi	45.0666	-96.7308
22-2018	Unknown	Unknown	CRI	2-mi	44.9786	-97.0061
36-2018	Gone	-	CRI	2-mi	45.1120	-96.9703

Nest No.	Status	Species	Study Area	Study Area Proximity	Latitude	Longitude
66-2018	Gone	-	CRI	2-mi	45.0637	-97.0019
67-2018	Gone	-	CRI	2-mi	45.0635	-96.9985
70-2018	Gone	-	CRI	2-mi	45.1749	-96.9806
77-2018	Gone	-	CRI	2-mi	45.1808	-96.9756
78-2018	Gone	-	CRI	2-mi	45.0277	-97.0096
124-2018	Active	Bald Eagle	CRI & II	2-mi	45.0123	-96.8440
122-2018	Active	Red-tailed Hawk	CRI & II	2-mi	45.0032	-96.8694
127-2018	Inactive	Unknown	CRI & II	2-mi	45.0279	-96.8495
128-2018	Inactive	Unknown	CRI & II	2-mi	45.0399	-96.8418
87-2018	Inactive	Prob. Bald Eagle	CRI & II	Within	45.0238	-96.8553
134-2018	Active	Great-horned Owl	CR	Within	45.1063	-96.8274
139-2018	Active	Great-horned Owl	CR	Within	45.1427	-96.8053
145-2018	Active	Great-horned Owl	CR	Within	45.0948	-96.7877
142-2018	Active	Red-tailed Hawk	CR	Within	45.1419	-96.7969
152-2018	Active	Red-tailed Hawk	CR	Within	45.1682	-96.7754
123-2018	Inactive	Unknown	CR	Within	45.1499	-96.8531
143-2018	Inactive	Unknown	CR	Within	45.1469	-96.7921
33-2018	Active	Red-tailed Hawk	CRI	Within	45.0446	-96.9510
34-2018	Active	Red-tailed Hawk	CRI	Within	45.0562	-96.9345
137-2018	Active	Red-tailed Hawk	CRI	Within	45.0447	-96.8213
32-2018	Inactive	Unknown	CRI	Within	45.0240	-96.9853
83-2018	Inactive	Unknown	CRI	Within	45.1373	-96.9703
101-2018	Inactive	Unknown	CRI	Within	45.0781	-96.9437
108-2018	Inactive	Unknown	CRI	Within	45.0571	-96.9095
109-2018	Inactive	Unknown	CRI	Within	45.0597	-96.9126
138-2018	Inactive	Unknown	CRI	Within	45.0926	-96.8139
38-2018	Gone		CRI	Within	45.1218	-96.9966
62-2018	Gone		CRI	Within	45.0611	-96.9243
63-2018	Gone		CRI	Within	45.0598	-96.9681
64-2018	Gone		CRI	Within	45.1000	-96.9943
65-2018	Gone		CRI	Within	45.0788	-97.0094
71-2018	Gone		CRI	Within	45.1365	-96.9746
116-2018	Inactive	Unknown	CRI & II	Within	45.0122	-96.8862
58-2018	Gone		CRI & II	Within	44.9729	-96.8838
60-2018	Gone		CRI & II	Within	45.0014	-96.9039

Avian Use Survey Report for the Proposed Crowned Ridge I Wind Facility, Grant and Codington Counties, South Dakota

November 2018

PREPARED FOR

Crowned Ridge Wind, LLC

PREPARED BY

SWCA Environmental Consultants

AVIAN USE SURVEY REPORT FOR THE PROPOSED CROWNED RIDGE I WIND FACILITY, GRANT AND CODINGTON COUNTIES, SOUTH DAKOTA

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SWCA Project No. 44511

November 2018

CONTENTS

Contents ..... **i**
Figures i
Tables i
1 Introduction **1**
2 Methods **1**
2.1 Large Bird Use Surveys 1
2.2 Small Bird Use Surveys 3
3 Data Analysis **3**
4 Results **4**
4.1 Large Bird Use 4
4.1.1 Species 5
4.1.2 Seasonality 7
4.1.3 Flight Height 8
4.1.4 Behavior 9
4.1.5 Time of Day 10
4.1.6 Eagle Observations 11
4.2 Small Bird Use 11
4.2.1 Species 12
4.2.2 Seasonality 14
4.2.3 Flight Height 16
4.2.4 Behavior and Initial Detection 18
4.2.5 Time of Day 19
4.2.6 Vegetation Type 19
5 Discussion **22**
5.1 Large Bird Use Surveys 22
5.2 Small Bird Surveys 23
6 Literature Cited **24**

Figures

Figure 1. Project location and study area showing point count survey plots. 2

Tables

Table 1. Number and Relative Abundance of Large Bird Observations by Point Count Location 4
Table 2. Total Large Bird Species Composition, Abundance, and Occurrence 6
Table 3. Number of Large Bird Species Observations by Month 7
Table 4. Number of Large Bird Observations Per Flight Height Bin 8
Table 5. Number and Frequency of Large Bird Observations Per Type of Behavior 10
Table 6. Number of Large Bird Observations and Surveys by Hour Per Month 10
Table 7. Number and Relative Abundance of Small Bird Observations Per Point Count Location 11
Table 8. Total Small Bird Species Composition, Abundance, and Occurrence 13
Table 9. Number of Small Bird Observations by Month 15
Table 10. Number of Small Bird Observations Per Flight Height Bin 16
Table 11. Number and Frequency of Small Bird Observations Per Type of Behavior 18
Table 12. Number of Small Bird Observations and Surveys by Hour Per Month 19

000332

Table 13. Habitat Type, Number of Species, and Number of Observations Per Point Count Location 19
Table 14. Number of Observations per Species per Habitat Type 21

1 INTRODUCTION

Crowned Ridge Wind, LLC, an indirect, wholly owned subsidiary of NextEra Energy Resources, LLC, plans to develop an approximately 300-megawatt (-MW) wind facility known as the Crowned Ridge I Wind Energy Facility (the project) in Grant and Codington Counties, South Dakota. The project will produce energy sold to Xcel Energy through a power purchase agreement. A new transmission line will be constructed to connect the wind facility to Otter Tail Power's Big Stone South 230-kilovolt (-kV) substation near Big Stone City, South Dakota. Construction is anticipated to commence in early 2019, and the Project is scheduled to achieve commercial operation at or before the end of 2019. This report addresses the study area comprising approximately 58,548 acres of land as provided to SWCA on March 21, 2017.

Crowned Ridge Wind, LLC, contracted SWCA Environmental Consultants (SWCA) to conduct large and small bird use surveys in the study area. The objectives of the surveys were to characterize the activity, spatial distribution, and relative abundance of avian species in the study area. This report summarizes the methods and results of large and small bird use surveys conducted from April 1, 2017, through November 30, 2017, in the study area.

2 METHODS

2.1 Large Bird Use Surveys

SWCA developed the large bird use survey protocols in accordance with recommendations set forth in the U.S. Fish and Wildlife Service's (USFWS's) *Land-Based Wind Energy Guidelines* (USFWS 2012) and *Eagle Conservation Plan Guidance Module 1 – Land-based Wind Energy Version 2* (ECPG) (USFWS 2013). The purpose of these studies is to characterize the activity, spatial distribution, and relative abundance of diurnal raptors and other large bird species using the study area. The survey data is useful to identify potential high-use areas in the study area that may be avoided during project design to avoid and minimize potential risk to large birds.

Large birds generally are defined as those the size of waterfowl or larger and include raptors, vultures, waterfowl, herons, pelicans, and corvids. Federally listed species, state-listed species, and large flocks of small birds also were considered target groups during large bird use surveys.

SWCA used a spatially balanced sampling design to establish 29 circular point count locations, each with a survey area of 800 meters (m) (2,625 feet) in radius, throughout the study area provided by the proponent on March 21, 2017 (Figure 1). This sampling method captures the variability in habitat and vegetation conditions, topography, and potential turbine numbers and densities within the study area. These locations allowed for more than 30% survey coverage of the study area, exceeding recommendations in the ECPG (USFWS 2013). Point count locations were micro-sited in the field to minimize obstructed views of the surrounding terrain and corresponding airspace.

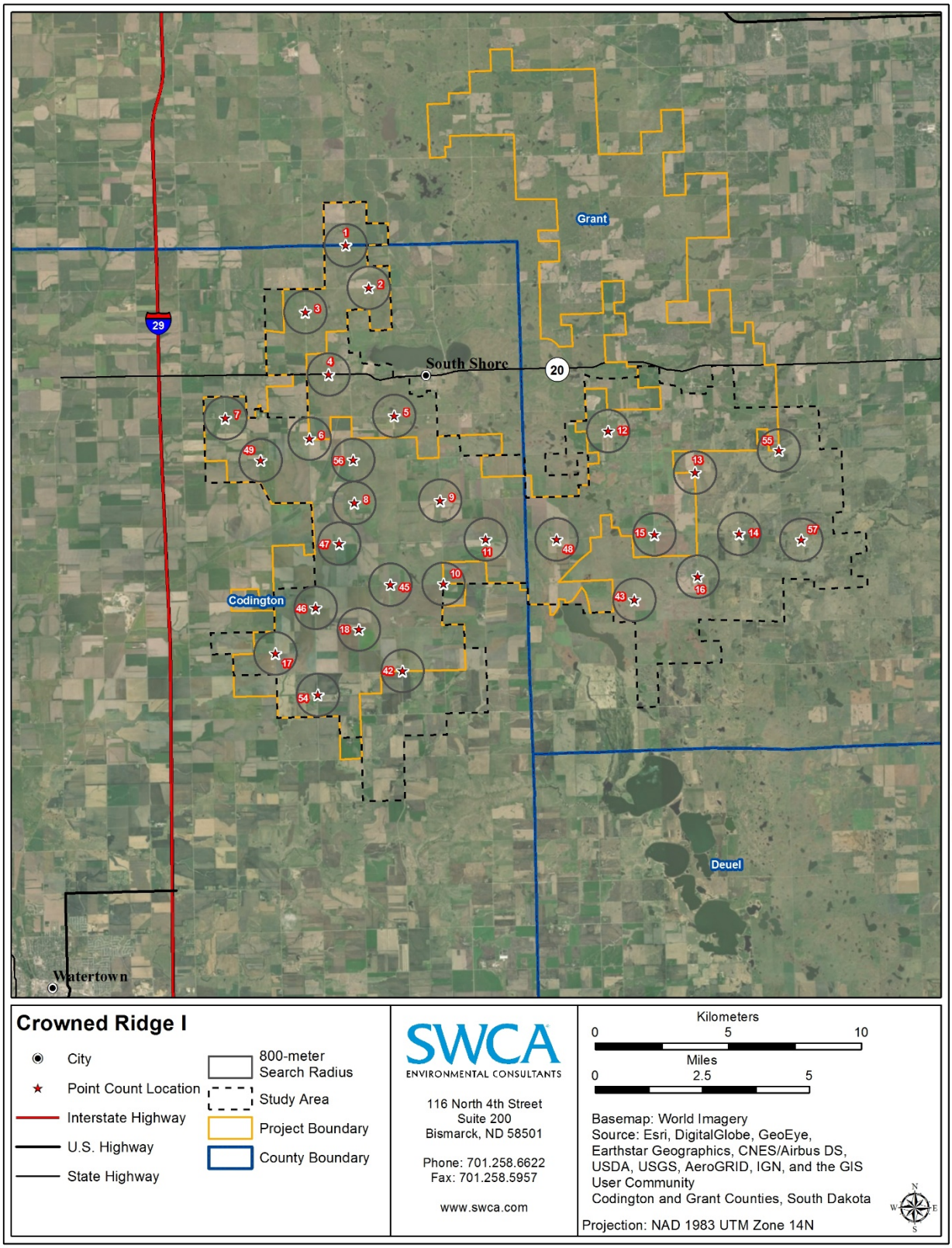


Figure 1. Project location and study area showing point count survey plots.

SWCA completed surveys of each of the 29 point count locations once a month for 8 months (232 surveys total for the project). The surveys lasted for 1 hour per survey date at each of the 29 point count locations, in accordance with ECPG guidance (USFWS 2013: Technical Appendix C). The schedule was designed and implemented to provide survey coverage across all hours for each of the point count locations in accordance with ECPG guidance. The schedule also was designed such that multiple large bird use surveys conducted on any given day were separated spatially to increase the likelihood of independent observations.

SWCA collected the following data for each large bird observation within the 800-m-radius survey areas: species, age, sex, number of individuals, distance to bird(s), azimuth to bird(s), estimated flight height within three bins (0–30 m [0–98 feet], 30–200 m [98–656 feet], and 200+ m [656+ feet]), flight direction, beginning and ending time of presence within the point count location, flight time (recorded as number of seconds), behavioral activity, and interactions with other birds. SWCA also collected flight pathway information per recommendations in Strickland et al. (2011) and the ECPG (USFWS 2013). Flight pathway data were collected for raptor species. Flight pathways within the point count location 800m survey area were digitally recorded using ArcGIS Collector software. This software allowed biologists to record the flight path as a spatial data layer, which overlaid aerial imagery displaying relevant landforms in each survey area. The data was uploaded and analyzed using geographic information system (GIS) software.

2.2 Small Bird Use Surveys

SWCA developed the small bird use survey protocols in accordance with recommendations set forth in the USFWS's *Land-Based Wind Energy Guidelines* (USFWS 2012). The purpose of small bird use surveys is to characterize the activity, spatial distribution, and relative abundance of passerine and other small bird species using the study area. To understand small bird use in the study area across all daylight hours, SWCA conducted small bird point count surveys in conjunction with the large bird use surveys.

Small birds generally are defined as those smaller in size than a crow and include passerine species. Federally listed species, state-listed species, and large flocks of small birds also were considered target groups during small bird use surveys. The small bird use surveys were conducted at the same point count locations as the large bird use surveys (see Figure 1). The biologists recorded all birds detected within a 100-m-radius (328-foot-radius) of each location for 10 minutes before beginning the large bird use surveys.

SWCA collected the following data for each observation made during the small bird use surveys: species, number of observations by species, age and sex, behavior, method of detection (visual or auditory), estimated distance from the observer to each bird, time each bird or group of birds was detected within the point count location survey area, temperature, wind speed and direction, cloud cover, and precipitation. In addition, the biologists recorded large bird species observed outside of the 100-m-radius survey areas as incidental observations during the small bird surveys.

3 DATA ANALYSIS

Data collected during the large bird use surveys allow for robust analysis of large bird use in the study area. Analysis of these data provides the following metrics: species composition, diversity, and abundance; relative abundance and frequency of observations per guild and species; eagle and raptor use (number of observations/60-minute-survey/800-m-radius survey plot) and minutes (eagle flight minutes within 800-m-radius survey plot up to 200 m [656 feet] in height); large bird use (large bird observations/survey period/800-m-radius survey plot); comparisons of use below, in, and above the rotor swept area; vegetation type near observations; and notable behavior or flight patterns. In addition, analysis has the potential to identify potential high-use areas in the study area that may be avoided during project design to avoid or minimize the potential risk to birds.

The small bird point count survey data were analyzed to measure different indices of abundance for the project. Analysis of small bird use survey data provides the following metrics: species composition, diversity, and abundance; frequency of observations per guild and species; small bird use (number of observations/8-minute survey/100-m-radius survey plot); comparisons of use below, in, and above the rotor-swept area; and notable behavior patterns observed during the survey. Small bird use also was compared between seasons to understand the relative use by individuals and species between seasons.

4 RESULTS

4.1 Large Bird Use

SWCA performed 232 surveys across the 29 point count locations in the study area from April 1, 2017, through November 30, 2017. In total, large bird use surveys were conducted for 13,920 survey minutes (232 survey hours). The survey efforts were evenly distributed across the 29 point count locations. All point count locations were surveyed for 60 minutes monthly for 8 months.

No large birds were observed during 86 (37.1%) of the 232 surveys. During the remaining 146 surveys, SWCA recorded 356 large bird observations (Table 1). The number of observations per point count locations ranged from three to 26 (mean = 12.3, standard deviation = 6.9). Relative abundance (i.e., the percentage of total large bird observations made at an individual point count location) ranged from 1.1% to 7.3% (see Table 1).

Table 1. Number and Relative Abundance of Large Bird Observations by Point Count Location

Point Count Location	Number of Observations	Relative Abundance*
CR01	9	2.5
CR02	18	5.1
CR03	17	4.8
CR04	14	3.9
CR05	26	7.3
CR06	10	2.8
CR07	10	2.8
CR08	9	2.5
CR09	11	3.1
CR10	22	6.2
CR11	12	3.4
CR12	13	3.7
CR13	13	3.7
CR14	26	7.3
CR15	23	6.5
CR16	25	7.0
CR17	6	1.7
CR18	8	2.2

Point Count Location	Number of Observations	Relative Abundance*
CR42	4	1.1
CR43	8	2.2
CR45	15	4.2
CR46	3	0.8
CR47	7	2.0
CR48	11	3.1
CR49	8	2.2
CR54	6	1.7
CR55	9	2.5
CR56	6	1.7
CR57	7	2.0
Total	356	100.0

* Relative abundance is expressed as the percentage of total large bird observations (n=356) recorded at an individual point count location.

4.1.1 Species

The 356 large bird observations consisted of 35 species (Table 2). Twelve raptor species were recorded: American kestrel (*Falco sparverius*), Cooper's hawk (*Accipiter cooperii*), ferruginous hawk (*Buteo regalis*), merlin (*Falco columbarius*), northern harrier (*Circus cyaneus*), peregrine falcon (*Falco peregrinus*), prairie falcon (*Falco mexicanus*), rough-legged hawk (*Buteo lagopus*), red-shouldered hawk (*Buteo lineatus*), red-tailed hawk (*Buteo jamaicensis*), sharp-shinned hawk (*Accipiter striatus*), and Swainson's hawk (*Buteo swainsoni*).

The 23 non-raptor species recorded were American crow (*Corvus brachyrhynchos*), American white pelican (*Pelecanus erythrorhynchos*), blue-winged teal (*Spatula discors*), California gull (*Larus californicus*), Canada goose (*Branta canadensis*), double-crested cormorant (*Phalacrocorax auritus*), Franklin's gull (*Leucophaeus pipixcan*), gadwall (*Mareca strepera*), great blue heron (*Ardea herodias*), great egret (*Ardea alba*), greater prairie-chicken (*Tympanuchus cupido*), greater yellowlegs (*Tringa melanoleuca*), marbled godwit (*Limosa fedoa*), mallard (*Anas platyrhynchos*), northern pintail (*Anas acuta*), ring-billed gull (*Larus delawarensis*), ring-necked pheasant (*Phasianus colchicus*), snow goose (*Chen caerulescens*), sharp-tailed grouse (*Tympanuchus phasianellus*), turkey vulture (*Cathartes aura*), Wilson's snipe (*Gallinago delicata*), wild turkey (*Meleagris gallopavo*), and wood duck (*Aix sponsa*).

Northern harrier (*Circus cyaneus*) and red-tailed hawk (*Buteo jamaicensis*) each accounted for 50 observations (14.0% of total observations). Swainson's hawk (*Buteo swainsoni*) accounted for nine observations (2.5% of total observations), and American kestrel (*Falco sparverius*) accounted for six observations (1.7% of total observations). Collectively, these four species accounted for 115 observations (32.3% of total observations).

SWCA recorded northern harrier during 36 of the 232 surveys (15.5% of total surveys), red-tailed hawk during 36 surveys (15.5% of total surveys), Swainson's hawk during six surveys (2.6% of total surveys), and American kestrel during five surveys (2.2% of total surveys) (see Table 2). SWCA determined the frequency of species occurrence during the 232 large bird surveys, with 19 of the 35 large bird species (54.3%) observed during more than 1% of the 232 surveys and 16 of the 35 large bird species (45.7%) observed during less than 1% of the 232 surveys.

SWCA's biologists recorded four large bird species recognized by the USFWS as birds of conservation concern (BCC) within the study area: ferruginous hawk, peregrine falcon, prairie falcon, and marbled godwit (USFWS 2008). No bald eagles (*Haliaeetus leucocephalus*) or golden eagles (*Aquila chrysaetos*) were observed within the study area. No state or federally listed species were observed.

Table 2. Total Large Bird Species Composition, Abundance, and Occurrence

Large Bird Species	Abundance*	Relative Abundance†	Number of Surveys During Which Species Was Recorded	Frequency of Occurrence‡
American crow	4	1.1	4	1.7
American kestrel	6	1.7	5	2.2
American white pelican	20	5.6	17	7.3
Blue-winged teal	2	0.6	2	0.9
California gull	1	0.3	1	0.4
Canada goose	39	11.0	35	15.1
Cooper's hawk	2	0.6	2	0.9
Double-crested cormorant	6	1.7	5	2.2
Ferruginous hawk	4	1.1	4	1.7
Franklin's gull	46	12.9	21	9.1
Gadwall	2	0.6	2	0.9
Great blue heron	3	0.8	3	1.3
Great egret	2	0.6	2	0.9
Greater prairie-chicken	1	0.3	1	0.4
Greater yellowlegs	1	0.3	1	0.4
Marbled godwit	3	0.8	2	0.9
Mallard	27	7.6	22	9.5
Merlin	3	0.8	2	0.9
Norther harrier	50	14.0	36	15.5
Peregrine falcon	1	0.3	1	0.4
Northern pintail	2	0.6	2	0.9
Prairie falcon	4	1.1	4	1.7
Ring-billed gull	21	5.9	17	7.3
Rough-legged hawk	5	1.4	3	1.3
Ring-necked pheasant	11	3.1	11	4.7
Red-shouldered hawk	1	0.3	1	0.4
Red-tailed hawk	50	14.0	36	15.5
Snow goose	2	0.6	2	0.9
Sharp-shinned hawk	1	0.3	1	0.4
Sharp-tailed grouse	1	0.3	6	2.6
Swainson's hawk	9	2.5	6	2.6
Turkey vulture	21	5.9	16	6.9

Large Bird Species	Abundance*	Relative Abundance†	Number of Surveys During Which Species Was Recorded	Frequency of Occurrence‡
Wilson's snipe	1	0.3	1	0.4
Wild turkey	3	0.8	3	1.3
Wood duck	1	0.3	1	0.4
Total	356	100	-	62.9

* Abundance = total number of observations per species.

† Relative abundance = the percentage of large bird observations (n=356) recorded at an individual point count location.

‡ Frequency = percentage of all surveys (n=232) during which the species or group was recorded.

§ The total number of surveys with at least one large bird observation (regardless of number of species) is 146.

¶ The percentage of surveys with at least one large bird or flock observation (146 of 232 = 62.9 %).

4.1.2 Seasonality

Monthly totals for large bird species observed during the study period are provided in Table 3. Large bird observations varied considerably between months, ranging from 1 to 31 observations per month. The two lowest monthly totals occurred in October and November (see Table 3).

Canada goose was the only species recorded each month. Seasonal occurrence of migratory species is evident for several species. For example, biologists recorded Swainson's hawk during the species' expected breeding season in July and migratory season in August and September. Conversely, biologists recorded rough-legged hawk (*Buteo lagopus*) only during its expected migratory and overwintering season in November.

Table 3. Number of Large Bird Species Observations by Month

Large Bird Species	2017							
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
American crow	1	1	1	0	0	1	0	0
American kestrel	0	0	0	1	1	2	0	2
American white pelican	0	0	5	10	5	0	0	0
Blue-winged teal	0	0	0	1	1	0	0	0
California gull	0	0	0	1	0	0	0	0
Canada goose	5	6	4	2	4	4	6	8
Cooper's hawk	0	0	1	0	0	1	0	0
Double-crested cormorant	0	0	1	1	1	2	1	0
Ferruginous hawk	1	2	0	0	0	1	0	0
Franklin's gull	0	0	0	0	15	31	0	0
Gadwall	0	0	0	0	0	0	2	0
Great blue heron	0	0	1	0	1	1	0	0
Great egret	0	0	1	0	0	1	0	0
Greater prairie-chicken	0	0	0	0	0	1	0	0
Greater yellowlegs	0	0	0	0	0	1	0	0

Large Bird Species	2017							
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Marbled godwit	0	0	3	0	0	0	0	0
Mallard	12	5	7	2	0	0	1	0
Merlin	0	0	0	0	0	0	3	0
Norther harrier	8	10	8	6	2	13	3	0
Peregrine falcon	0	0	1	0	0	0	0	0
Northern pintail	1	1	0	0	0	0	0	0
Prairie falcon	0	0	0	0	4	0	0	0
Ring-billed gull	5	0	10	6	0	0	0	0
Rough-legged hawk	0	0	0	0	0	0	0	5
Ring-necked pheasant	1	0	2	3	2	2	0	1
Red-shouldered hawk	0	0	1	0	0	0	0	0
Red-tailed hawk	8	7	1	6	10	17	1	0
Snow goose	0	0	0	0	0	0	0	2
Sharp-shinned hawk	0	0	0	0	0	1	0	0
Sharp-tailed grouse	0	1	0	0	0	0	0	0
Swainson's hawk	0	0	0	1	1	7	0	0
Turkey vulture	0	0	2	6	4	9	0	0
Wilson's snipe	0	0	0	0	0	1	0	0
Wild turkey	1	0	0	1	0	0	0	1
Wood duck	0	0	0	0	0	1	0	0
Total	43	33	49	47	51	97	17	19

4.1.3 Flight Height

The estimated flight height upon initial detection of an observation was recorded to characterize raptor use within the zone between 0 to 200 m aboveground, which the USFWS recognizes as a zone with potential for collisions between raptors and wind turbine infrastructure. Two-hundred nine flight observations out of the total flight 356 observations (58.7% of total observations) were of large birds flying within this zone (Table 4). However, 172 of the observations (48.3% of total observations) were of large birds flying below 30 m aboveground and therefore may be considered outside the rotor-swept zone for wind turbine models typically used at commercial wind energy facilities (31–200 m). A total of 147 flight observations (41.3% of total observations) were of large birds flying above 200 m aboveground. A total of 37 observations (10.4% of total observations) were of large birds flying within the rotor-swept zone.

Table 4. Number of Large Bird Observations Per Flight Height Bin

Large Bird Species	Flight Height Bin (meters)		
	0–30	31–200	>200
American crow	3	0	1
American kestrel	4	0	2
American white pelican	2	6	12

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Large Bird Species	Flight Height Bin (meters)		
	0–30	31–200	>200
Blue-winged teal	2	0	0
California gull	1	0	0
Canada goose	18	2	19
Cooper's hawk	0	0	2
Double-crested cormorant	2	0	4
Ferruginous hawk	1	1	2
Franklin's gull	4	12	30
Gadwall	1	0	1
Great blue heron	1	0	2
Great egret	1	0	1
Greater prairie-chicken	1	0	0
Greater yellowlegs	0	0	1
Marbled godwit	2	0	1
Mallard	26	0	1
Merlin	2	0	1
Norther harrier	42	1	7
Peregrine falcon	0	0	1
Northern pintail	2	0	0
Prairie falcon	0	0	4
Ring-billed gull	19	0	2
Rough-legged hawk	1	0	4
Ring-necked pheasant	11	0	0
Red-shouldered hawk	0	0	1
Red-tailed hawk	15	7	28
Snow goose	0	1	1
Sharp-shinned hawk	0	0	1
Sharp-tailed grouse	1	0	0
Swainson's hawk	1	2	6
Turkey vulture	4	5	12
Wilson's snipe	1	0	0
Wild turkey	3	0	0
Wood duck	1	0	0
Total	**172**	**37**	**147**

4.1.4 Behavior

Large bird observations per type of behavior are provided in Table 5. Most of the observations (163 of 356; 45.8%) were of large birds exhibiting the behavior of powered flight. The biologists recorded large

birds demonstrating the behavior of circle soaring (64; 18.0%), gliding (31; 8.7%), soaring (12; 3.4%), and hovering (five; 1.4%). Eighty-one observations (22.8%) were of large birds exhibiting non-flight behavior (e.g., calling, foraging, perching).

Table 5. Number and Frequency of Large Bird Observations Per Type of Behavior

Behavior	Number of Observations	Frequency (percent)
Circle soaring	64	18.0
Gliding	31	8.7
Powered flight	163	45.8
Hovering	5	1.4
Soaring	12	3.4
Calling	13	3.7
Foraging	54	15.2
Perched	14	3.9
Total	356	100.0

4.1.5 Time of Day

SWCA's biologists conducted the surveys between 6:00 a.m. and 5:00 p.m., with hourly average number of large bird observations ranging from 1.4 to 3.6 per survey (Table 6). The biologists recorded very few observations in the early morning (6:00 a.m.) and early evening (4:00 p.m.) hours relative to other hours. The 10:00 a.m., 11:00 a.m., 12:00 p.m., and 5:00 p.m. hours were associated with an uptick in observations per survey, which averaged 3.2, 3.6, 3.4, and 3.5, respectively. Table 6 provides the total number of observations for each survey hour, number of surveys per hour, and average number of observations per survey in each hour during the study period.

Table 6. Number of Large Bird Observations and Surveys by Hour Per Month

Month	6:00 a.m.	7:00 a.m.	8:00 a.m.	9:00 a.m.	10:00 a.m.	11:00 a.m.	12:00 p.m.	1:00 p.m.	2:00 p.m.	3:00 p.m.	4:00 p.m.	5:00 p.m.
April	0	10	10	8	0	5	3	1	1	3	2	0
May	1	3	3	1	0	6	4	3	1	8	3	0
June	0	5	4	8	5	2	2	8	5	2	4	4
July	5	1	3	3	7	0	7	2	7	4	5	3
August	3	6	2	5	6	2	21	4	0	6	2	0
September	6	6	5	11	14	22	4	13	13	15	4	0
October	4	1	3	1	1	1	0	0	3	0	3	0
November	0	1	2	1	6	9	0	0	0	0	0	0
Number of observations per hour	18	29	31	34	38	47	41	31	27	33	20	7

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Month	6:00 a.m.	7:00 a.m.	8:00 a.m.	9:00 a.m.	10:00 a.m.	11:00 a.m.	12:00 p.m.	1:00 p.m.	2:00 p.m.	3:00 p.m.	4:00 p.m.	5:00 p.m.
Number of surveys per hour	9	15	20	14	12	13	12	12	12	11	14	2
Average number of observations per survey	2.0	1.9	1.6	2.4	3.2	3.6	3.4	2.6	2.3	3.0	1.4	3.5

4.1.6 Eagle Observations

During the 8-month study period, the biologists did not record golden eagles, bald eagles, or any unknown eagle species as incidental or large bird observations. Thus, no areas in the study area were identified as potential high-use areas for eagles.

4.2 Small Bird Use

SWCA performed 232 surveys across the 29 point count locations in the study area from April 1, 2017, through November 30, 2017. The survey efforts were evenly distributed across the 29 point count locations. All locations were surveyed for 10 minutes per survey for eight survey sessions. The small bird use surveys took place before the large bird use surveys at each point count location.

No small birds were observed during 37 of the surveys (15.9% of total surveys). During the remaining 195 surveys, SWCA biologists recorded 644 observations (Table 7). The number of observations per point count location ranged from 11 to 44 (mean = 22.2, standard deviation = 7.9). Relative abundance (i.e., the percentage of total small bird observations made at an individual point count location) ranged from 1.7% to 6.8% (see Table 7).

Table 7. Number and Relative Abundance of Small Bird Observations Per Point Count Location

Point Count Location	Number of Observations	Relative Abundance*
CR01	22	3.4
CR02	20	3.1
CR03	29	4.5
CR04	17	2.6
CR05	19	3.0
CR06	11	1.7
CR07	39	6.1
CR08	18	2.8
CR09	17	2.6
CR10	18	2.8
CR11	14	2.2
CR12	22	3.4
CR13	15	2.3
CR14	29	4.5

Point Count Location	Number of Observations	Relative Abundance*
CR15	24	3.7
CR16	24	3.7
CR17	25	4.0
CR18	16	2.5
CR42	27	4.2
CR43	20	3.1
CR45	26	4.0
CR46	15	2.3
CR47	20	3.1
CR48	37	5.8
CR49	44	6.8
CR54	13	2.0
CR55	27	4.2
CR56	19	3.0
CR57	16	2.5
Total	644	100.0

*Relative abundance = the percentage of total small bird observations (n=644) recorded at an individual point count location.

4.2.1 Species

The 644 total small bird observations consisted of 54 species and individuals that could not be identified to species but were placed in two generic categories (unknown sparrow and unknown blackbird species) (Table 8). Western meadowlark (*Sturnella neglecta*) accounted for 113 of the 644 observations (17.5% of total observations), followed by red-winged blackbird *(Agelaius phoeniceus)* with 95 observations (14.7% of total observations), and American robin *(Turdus migratorius)* with 30 observations (4.7% total observations). Collectively, these three species accounted for 238 (36.9%) of all observations.

SWCA recorded western meadowlark during 85 of the 232 surveys (36.6% of total surveys), followed by red-winged blackbird during 62 surveys (26.7% of total surveys), and American robin during 26 surveys (11.2% of total surveys). SWCA detected the frequency of species occurrence during the 232 small bird surveys, with 34 of the 55 small bird species (61.8%) observed during more than 1% of the 232 surveys and 21 of 55 of the small bird species (38.2%) observed during less than 1% of the 232 surveys (see Table 8).

SWCA's biologists recorded four small bird species recognized by the USFWS as BCC within the study area: the chestnut-collard longspur (*Calcarius ornatus*), grasshopper sparrow (*Ammodramus savannarum*), willow flycatcher (*Empidonax traillii*), red-headed woodpecker (*Melanerpes erythrocephalus*) (USFWS 2008). No observations of federally threatened red knots occurred during the 8-month survey period.

Table 8. Total Small Bird Species Composition, Abundance, and Occurrence

Small Bird Species	Abundance*	Relative Abundance†	*Number of Surveys During Which Species Was Recorded*	Frequency of Occurrence‡
American goldfinch	30	4.7	25	10.8
American robin	30	4.7	26	11.2
American tree sparrow	7	1.1	7	3.0
Barn swallow	30	4.7	22	9.5
Black-billed magpie	2	0.3	2	0.9
Brown headed cowbird	28	4.3	24	10.3
Blue-headed vireo	1	0.2	1	0.4
Blue jay	5	0.8	3	1.3
Bobolink	20	3.1	14	6.0
Brewer's blackbird	12	1.9	12	5.2
Brown thrasher	2	0.3	2	0.9
Clay-colored sparrow	9	1.4	9	3.9
Cedar waxwing	4	0.6	4	1.7
Chestnut-collared longspur	2	0.3	2	0.9
Chipping sparrow	6	0.9	6	2.6
Cliff swallow	12	1.9	11	4.7
Common grackle	14	2.2	12	5.2
Common nighthawk	2	0.3	2	0.9
Common yellowthroat	2	0.3	2	0.9
Dickcissel	8	1.2	8	3.4
Downy woodpecker	2	0.3	2	0.9
Eastern kingbird	15	2.3	15	6.5
European starling	8	1.2	8	3.4
Field sparrow	3	0.5	3	1.3
Grasshopper sparrow	23	3.6	22	9.5
Horned lark	14	2.2	14	6.0
House sparrow	2	0.3	2	0.9
House wren	2	0.3	2	0.9
Killdeer	30	4.7	26	11.2
Lapland longspur	3	0.5	3	1.3
Lincoln's sparrow	1	0.2	1	0.4
Mourning dove	16	2.5	15	6.5
Northern flicker	3	0.5	3	1.3
Northern Rough-wing swallow	5	0.8	5	2.2
Orange-crowned oriole	1	0.2	1	0.4
Orchard oriole	1	0.2	1	0.4

Small Bird Species	Abundance*	Relative Abundance†	*Number of Surveys During Which Species Was Recorded*	Frequency of Occurrence‡
Pine warbler	1	0.2	1	0.4
Red-headed woodpecker	1	0.2	1	0.4
Rusty blackbird	1	0.2	1	0.4
Red-winged blackbird	95	14.8	62	26.7
Savannah sparrow	21	3.2	17	7.4
Sedge wren	2	0.3	2	0.9
Song sparrow	21	3.3	19	8.2
Tree swallow	5	0.8	5	2.2
Unknown sparrow spp.	3	0.5	3	1.3
Unknown blackbird spp.	2	0.3	2	0.9
Upland sandpiper	3	0.5	3	1.3
Vesper sparrow	7	1.1	7	3.0
Western kingbird	2	0.3	2	0.9
Western meadowlark	113	17.5	85	36.6
Willow flycatcher	1	0.2	1	0.4
Willet	1	0.2	1	0.4
White-rumped sandpiper	1	0.2	11	4.7
Yellow warbler	1	0.2	1	0.4
Yellow-headed blackbird	5	0.8	5	2.2
Yellow-rumped warbler	3	0.5	2	0.9
Total	644	100	195§	84.1¶

* Abundance refers to the total number of observations per species or group.

† Relative abundance is expressed as the percentage of small bird observations (n=644) recorded at an individual point count location.

‡ Frequency is expressed as the percentage of all surveys (n=232) during which the species or group was recorded.

§ The total number of surveys with at least one small bird observation (regardless of number of species) is 195 and is not the sum of individual species.

¶ The percentage of surveys with at least one small bird observation (195 of 232 = 84.1%).

4.2.2 Seasonality

Table 9 provides monthly totals for the small bird species observed across all point count locations during the study period. The total number of small bird observations per month varied considerably between months, ranging from 18 to 143. The two lowest monthly totals occurred during the late-fall and winter period in October and November (see Table 9). No species were recorded during all 8 months of the survey period; however, western meadowlark, red-winged blackbird, and horned lark were recorded during 7 of the 8 months.

Table 9. Number of Small Bird Observations by Month

Small Bird Species	2017							
	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov
American goldfinch	0	0	4	5	11	10	0	0
American robin	4	3	4	6	7	3	3	0
American tree sparrow	0	0	1	0	0	0	0	6
Barn swallow	0	4	2	10	5	9	0	0
Black-billed magpie	0	0	0	0	0	0	1	1
Brown headed cowbird	0	6	15	7	0	0	0	0
Blue-headed vireo	0	0	0	0	0	1	0	0
Blue jay	0	3	2	0	0	0	0	0
Bobolink	0	3	16	1	0	0	0	0
Brewer's blackbird	0	0	0	4	3	0	3	2
Brown thrasher	0	1	0	0	1	0	0	0
Clay-colored sparrow	0	0	1	2	2	3	1	0
Cedar waxwing	0	0	0	0	1	1	1	1
Chestnut-collared longspur	0	0	0	1	0	1	0	0
Chipping sparrow	0	2	2	2	0	0	0	0
Cliff swallow	0	2	2	6	0	2	0	0
Common grackle	1	0	4	2	5	2	0	0
Common nighthawk	0	0	1	1	0	0	0	0
Common yellowthroat	0	0	1	0	0	1	0	0
Dickcissel	0	0	1	7	0	0	0	0
Downy woodpecker	0	0	0	0	0	1	0	1
Eastern kingbird	0	0	2	6	7	0	0	0
European starling	0	0	0	2	1	5	0	0
Field sparrow	1	0	1	0	0	0	0	1
Grasshopper sparrow	0	9	4	9	1	0	0	0
Horned lark	1	1	4	3	1	3	0	1
House sparrow	0	0	0	0	1	1	0	0
House wren	0	0	0	1	0	1	0	0
Killdeer	12	7	6	4	1	0	0	0
Lapland longspur	1	0	0	0	0	0	0	2
Lincoln's sparrow	0	0	0	0	0	1	0	0
Mourning dove	0	1	2	5	2	6	0	0
Northern flicker	0	0	2	0	0	1	0	0
Northern Rough-wing swallow	0	0	0	4	1	0	0	0
Orange-crowned oriole	0	0	0	0	0	1	0	0
Orchard oriole	0	0	0	1	0	0	0	0
Pine warbler	0	0	0	1	0	0	0	0

Small Bird Species	2017							
	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov
Red-headed woodpecker	1	0	0	1	0	0	0	0
Rusty blackbird	0	0	0	0	0	1	0	0
Red-winged blackbird	29	29	24	5	3	2	3	0
Savannah sparrow	0	0	6	3	2	8	2	0
Sedge wren	0	0	1	1	0	0	0	0
Song sparrow	1	7	3	4	5	1	0	0
Tree swallow	0	3	2	0	0	0	0	0
Unknown sparrow spp.	0	0	0	1	0	0	0	0
Unknown blackbird spp.	0	0	0	0	0	4	0	0
Upland sandpiper	0	2	1	0	0	0	0	0
Vesper sparrow	0	2	1	2	2	0	0	0
Western kingbird	0	0	1	1	0	0	0	0
Western meadowlark	25	26	25	6	6	21	4	0
Willow flycatcher	0	0	0	1	0	0	0	0
Willet	0	0	0	0	1	0	0	0
White-rumped sandpiper	0	0	0	0	0	1	0	0
Yellow warbler	0	0	0	0	1	0	0	0
Yellow-headed blackbird	0	1	2	2	0	0	0	0
Yellow-rumped warbler	0	0	0	0	0	0	0	3
Total species observed/month	76	112	143	116	70	91	18	18

4.2.3 Flight Height

The estimated flight height upon initial detection of an observation was recorded to characterize small bird use within the zone between 0 to 200 m aboveground, which the USFWS recognizes as a zone with potential for collisions between avian species and wind turbine infrastructure. Eighteen flight observations of the of the total 644 flight observations (2.8% of total observations) were of small birds flying in the 31 to 200 m aboveground zone (Table 10). Most of the flight observations (625, 97.0% of total observations) were of small birds flying below 30 m and therefore may be considered outside the rotor-swept zone for wind turbine models typically used at commercial wind energy facilities (31–200 m). Only one observation of small birds flying above 200 m was made.

Table 10. Number of Small Bird Observations Per Flight Height Bin

Small Bird Species	Flight Height Bin (meters)		
	0–30	31–200	>200
American goldfinch	29	1	0
American robin	30	0	0
American tree sparrow	7	0	0
Barn swallow	28	1	1
Black-billed magpie	2	0	0

Small Bird Species	Flight Height Bin (meters)		
	0–30	31–200	>200
Brown headed cowbird	27	1	0
Blue-headed vireo	0	1	0
Blue jay	5	0	0
Bobolink	20	0	0
Brewer's blackbird	12	0	0
Brown thrasher	2	0	0
Clay-colored sparrow	9	0	0
Cedar waxwing	4	0	0
Chestnut-collared longspur	2	0	0
Chipping sparrow	6	0	0
Cliff swallow	11	1	0
Common grackle	11	3	0
Common nighthawk	2	0	0
Common yellowthroat	2	0	0
Dickcissel	8	0	0
Downy woodpecker	2	0	0
Eastern kingbird	15	0	0
European starling	8	0	0
Field sparrow	3	0	0
Grasshopper sparrow	23	0	0
Horned lark	13	1	0
House sparrow	0	2	0
House wren	2	0	0
Killdeer	30	0	0
Lapland longspur	3	0	0
Lincoln's sparrow	1	0	0
Mourning dove	16	0	0
Northern flicker	3	0	0
Northern Rough-wing swallow	5	0	0
Orange-crowned oriole	1	0	0
Orchard oriole	1	0	0
Pine warbler	1	0	0
Red-headed woodpecker	1	0	0
Rusty blackbird	0	1	0
Red-winged blackbird	95	0	0
Savannah sparrow	20	1	0
Sedge wren	1	1	0
Song sparrow	20	1	0

Small Bird Species	Flight Height Bin (meters)		
	0–30	31–200	>200
Tree swallow	5	0	0
Unknown sparrow spp.	3	0	0
Unknown blackbird spp.	2	0	0
Upland sandpiper	3	0	0
Vesper sparrow	7	0	0
Western kingbird	2	0	0
Western meadowlark	109	4	0
Willow flycatcher	1	0	0
Willet	1	0	0
White-rumped sandpiper	1	0	0
Yellow warbler	1	0	0
Yellow-headed blackbird	5	0	0
Yellow-rumped warbler	3	0	0
Total	625	18	1

4.2.4 Behavior and Initial Detection

During the small bird use surveys, the biologists recorded the method by which each bird was initially detected (visual or aural detection) and the bird's behavior upon initial detection. Most of the observations (250 of 644, or 38.8 %) were of calling individuals (Table 11). Powered flight was the next most frequently observed behavior, totaling 206 (32.0%) of the observations. The remaining flight categories (circle soaring, gliding, hovering, and soaring) accounted for one observation. Of the 644 observations, 306 (47.5 %) were made by aural detection (e.g., singing).

Table 11. Number and Frequency of Small Bird Observations Per Type of Behavior

Behavior	Number of Observations	Frequency (percent)
Calling	250	38.8
Copulating	0	0.0
Circle Soaring	0	0.0
Displaying	2	0.3
Foraging	33	5.1
Gliding	0	0.0
Hovering	1	0.2
Perched	86	13.4
Powered flight	206	32.0
Singing	66	10.3
Total	644	100.0

4.2.5 Time of Day

The highest average number of small bird observations by hour for the 232 small bird surveys was during the 1:00 p.m. hour, which averaged 4.9 small bird observations per hour. The number of observations across hours was slightly skewed toward the morning hours of 6:00 a.m., 7:00 a.m., and 8:00 a.m., which averaged 4.8, 4.4, and 4.3 observations per survey hour, respectively, during the 8-month study. The average number of observations was evenly distributed across the remaining hours. Table 12 presents the total number of observations for each hour, the number of surveys per hour, and the average number of observations per survey in each hour during the study period.

Table 12. Number of Small Bird Observations and Surveys by Hour Per Month

Month	6 a.m.	7 a.m.	8 a.m.	9 a.m.	10 a.m.	11 a.m.	12 p.m.	1 p.m.	2 p.m.	3 p.m.	4 p.m.	5 p.m.
April	0	20	5	13	0	8	4	6	1	11	9	0
May	0	18	17	7	7	13	7	21	0	12	10	0
June	0	20	9	22	24	4	20	16	6	10	9	3
July	19	10	13	13	5	10	6	9	14	7	7	3
August	15	13	17	2	2	7	3	1	3	7	7	0
September	24	17	11	11	5	4	3	0	0	10	6	0
October	0	2	1	1	0	2	0	4	0	0	1	0
November	0	1	4	1	1	2	4	4	0	0	0	0
Number of observations per hour	58	101	77	70	44	50	47	61	24	57	49	6
Number of surveys per hour	12	23	18	19	12	17	18	20	8	16	16	2
Average number of observations per survey	4.8	4.4	4.3	3.7	3.7	2.9	2.6	4.9	3.0	3.6	3.1	3.0

4.2.6 Vegetation Type

Table 13 presents the dominant National Landcover Dataset (U.S. Geological Survey 2014) habitat type and the number of species and observations for each of the 29 100-m-radius point count locations. Biologists recorded approximately 25% more species (54) and made approximately 62.4% more observations (402) in point count locations dominated by tallgrass prairie than species (41) and observations (242) in survey plots located in an agricultural setting. Species richness based on habitat type ranged from 9 to 22 species per point count location.

Table 13. Habitat Type, Number of Species, and Number of Observations Per Point Count Location

Survey Plot	Habitat Type	Number of Species	Number of Observations
CR01	Tallgrass prairie	15	22
CR02	Tallgrass prairie	22	20
CR03	Tallgrass prairie	9	29

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Survey Plot	Habitat Type	Number of Species	Number of Observations
CR04	Tallgrass prairie	10	17
CR05	Tallgrass prairie	8	19
CR06	Agriculture	9	11
CR07	Agriculture	18	39
CR08	Tallgrass prairie	10	18
CR09	Tallgrass prairie	14	17
CR10	Tallgrass prairie	11	18
CR11	Agriculture	11	14
CR12	Tallgrass prairie	14	22
CR13	Agriculture	9	15
CR14	Agriculture	13	29
CR15	Tallgrass prairie	11	24
CR16	Tallgrass prairie	12	24
CR17	Tallgrass prairie	16	26
CR18	Agriculture	13	16
CR42	Agriculture	17	27
CR43	Tallgrass prairie	12	20
CR45	Tallgrass prairie	16	26
CR46	Agriculture	13	15
CR47	Agriculture	12	20
CR48	Tallgrass prairie	15	37
CR49	Tallgrass prairie	21	44
CR54	Agriculture	9	13
CR55	Agriculture	14	27
CR56	Tallgrass prairie	9	19
CR57	Agriculture	10	16
Summary	Agriculture	41	242
	Tallgrass prairie	54	402

Forty-five of the 54 (83.3%) species had an equal or higher number of observations in tallgrass prairie point count locations than in agriculture locations (Table 14). Four species—rusty blackbird (*Euphagus carolinus*), unknown sparrow (*Passer spp*.), yellow warbler (*Setophaga petechial*), and yellow-rumped warbler (*Setophaga coronate*)—were observed only on agriculture-dominated point count locations; however, there were only eight observations total of those species.

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Table 14. Number of Observations per Species per Habitat Type

Small Bird Species	Number of Observations	
	Agriculture	Tallgrass Prairie
American goldfinch	10	20
American robin	12	18
American tree sparrow	2	5
Barn swallow	17	13
Black-billed magpie	1	1
Brown headed cowbird	10	18
Blue-headed vireo	0	1
Blue jay	0	5
Bobolink	4	16
Brewer's blackbird	6	6
Brown thrasher	0	2
Clay-colored sparrow	5	4
Cedar waxwing	1	3
Chestnut-collared longspur	1	1
Chipping sparrow	0	6
Cliff swallow	4	8
Common grackle	7	7
Common nighthawk	0	2
Common yellowthroat	1	1
Dickcissel	4	4
Downy woodpecker	0	2
Eastern kingbird	6	9
European starling	5	3
Field sparrow	2	1
Grasshopper sparrow	3	20
Horned lark	9	5
House sparrow	1	1
House wren	0	2
Killdeer	15	15
Lapland longspur	1	2
Lincoln's sparrow	0	1
Mourning dove	10	6
Northern flicker	1	2
Northern Rough-wing swallow	2	3
Orange-crowned oriole	0	1
Orchard oriole	0	1
Pine warbler	0	1

Small Bird Species	Number of Observations	
	Agriculture	Tallgrass Prairie
Red-headed woodpecker	0	1
Rusty blackbird	1	0
Red-winged blackbird	34	61
Savannah sparrow	7	14
Sedge wren	0	2
Song sparrow	11	10
Tree swallow	3	2
Unknown sparrow spp.	3	0
Unknown blackbird spp.	0	2
Upland sandpiper	1	2
Vesper sparrow	3	4
Western kingbird	1	1
Western meadowlark	33	80
Willow flycatcher	0	1
Willet	0	1
White-rumped sandpiper	0	1
Yellow warbler	1	0
Yellow-headed blackbird	1	4
Yellow-rumped warbler	3	0
Total	242	402

5 DISCUSSION

Numerous studies have been conducted across the United States to allow for better prediction of the potential of avian mortality associated with wind energy facilities. Multiple variables could affect avian species' risk at wind energy facilities, including vegetation type(s) and habitat suitability, overall landscape and geographic characteristics, avian population densities, migration paths, or a species' use of an area. The objective of the avian point count surveys for this project was to characterize the activity, spatial distribution, and relative abundance of avian species within the study area.

5.1 Large Bird Use Surveys

The large bird use survey results are summarized below:

- SWCA conducted monthly surveys at 29 point count locations from April 1, 2017, to November 30, 2017.
- In all, 232 surveys were completed for a total of 13,920 survey-minutes.
- A total of 356 large bird observations were recorded during 146 of the 232 surveys.
- Twelve raptor species and 23 non-raptor species were recorded.

- Flight altitudes for 209 of the 356 observations occurred within the potential for collision zone (0–200 m aboveground); however, 172 of the 209 observations (48.3%) occurred below 30 m aboveground, which is outside the typical turbine rotor-swept area (31–200 m).
- No golden eagle, bald eagle, or unidentified eagle observations were recorded across the 29 survey plots. Thus, no areas in the study area were identified as potential eagle high-use areas.
- Biologists recorded four large bird species recognized by the USFWS as BCC species within the study area: ferruginous hawk, peregrine falcon, prairie falcon, and marbled godwit.
- All species observed during the 8-month survey period were typical for the region and seasons.

5.2 Small Bird Surveys

The small bird use survey results are summarized below:

- SWCA conducted monthly surveys at 29 point count locations from April 1, 2017 to November 30, 2017.
- In all, 232 surveys were completed.
- A total of 644 observations were recorded during 185 of the 232 surveys.
- Fifty-five species were identified during the surveys.
- Flight altitudes for 643 of the 644 observations occurred within the 0–200 m aboveground zone; however, 625 of these 643 observations (97.2%) occurred below 30 m, which is outside the typical turbine rotor-swept area (31–200 m).
- Western meadowlark accounted for 113 (17.5%) of the 644 observations. Three species (western meadowlark, red-winged blackbird, and American robin) accounted for 238 (36.9%) of the 644 observations.
- The biologists recorded higher numbers of species (54 versus 41) and observations (242 versus 402) in survey plots dominated by tallgrass prairie than in plots in an agricultural setting.
- The biologists recorded four small bird species recognized by the USFWS as BCC within the study area: the chestnut-collard longspur, grasshopper sparrow, willow flycatcher, and red-headed woodpecker.
- All species observed during the 8-month survey period were typical for the region and seasons.

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Bat Habitat Assessment, Proposed Crowned Ridge I Wind Facility, Grant and Codington Counties, South Dakota

NOVEMBER 2018

PREPARED FOR

Crowned Ridge Wind, LLC

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November 2018

CONTENTS

1 Introduction 1
1.1 Project Overview 1
1.2 Environmental Setting 1
2 Bats of south dakota 3
2.1 Species of Conservation Concern 3
3 Habitat availability 5
4 Conclusion 12
5 Literature Cited 14

Figures

Figure 1. Location of the study areas. 2
Figure 2. Aerial photography within the study areas. 6
Figure 3. USGS land cover within the study areas. 7
Figure 4. Water resources within the study areas. 9
Figure 5. Forest patch size analysis within the study areas, indicating areas of suitable northern long-eared bat habitat. 10
Figure 6. Karst geology within the study areas. 11

Tables

Table 1. Ecology and Distribution of Bat Species with Potential to Occur in Grant and Codington Counties, South Dakota 4
Table 2. Land Cover Classifications within the Wind Array Study Area, Grant and Codington Counties, South Dakota 5
Table 3. Land Cover Classifications within the Transmission Line Study Area, Grant and Codington Counties, South Dakota 5
Table 4. Habitat Availability and Suitability, and Seasonal Likelihood of Occurrence for Bats with Potential to Occur within the Study Areas, Grant and Codington Counties, South Dakota 12

1 INTRODUCTION

1.1 Project Overview

Crowned Ridge Wind, LLC, an indirect, wholly-owned subsidiary of NextEra Energy Resources, LLC, plans to develop an approximately 300-megawatt (MW) wind facility known as the Crowned Ridge I Wind Energy Facility (the project) in Grant and Codington Counties, South Dakota (see project boundary, Figure 1). The project will produce energy sold to Xcel Energy through a Power Purchase Agreement. A new transmission line will be constructed to connect the wind facility to Otter Tail Power's Big Stone South 230-kilovolt (kV) substation near Big Stone City, South Dakota (Figure 1). For the purposes of this assessment, the wind array study area consists of 58,548 acres, and the transmission line study area consists of the center line of the proposed route with a 150-foot buffer, plus a 200-foot buffer at all turns (Figure 1). Construction of the Crowned Ridge 1 project is anticipated to commence in early 2019, and the project is scheduled to achieve commercial operation at or before the end of 2019.

The purpose of this report is to assess the availability and suitability of bat habitat within the study areas, to determine the potential for presence of state-listed and federally listed bat species, and to provide context for regulations relative to those species.

1.2 Environmental Setting

Ecoregions are delineated based upon the continuity of natural resource availability, vegetation communities, and other factors (Bryce et al. 1998). The U.S. Environmental Protection Agency and the Commission for Environmental Cooperation (CEC) defined a hierarchy of ecoregions at various scales, with Level I ecoregions being the coarsest level defined at the global scale, through Level III at the national scale (CEC 1997). Bryce et al. (1998) defined smaller Level IV ecoregions at a regional scale within the Level III ecoregions for the states of North Dakota and South Dakota.

The project is located within the Level IV Prairie Coteau, Prairie Coteau Escarpment, and Big Sioux Basin ecoregions, which are subdivisions of the Level III Northern Glaciated Plains ecoregion (Bryce et al. 1998). The Prairie Coteau ecoregion resulted from stagnant glacial ice melting beneath a layer of sediment, and is dominated by tightly undulating, hummocky landscape with no drainage pattern. There are large chains of lakes and scattered semi-permanent or seasonal wetlands (Bryce et al. 1998). The Prairie Coteau Escarpment is a small but unique ecosystem rising from the Missouri River valley to the Prairie Coteau. The elevation, broken topography, and precipitation patterns provide for deciduous forests along riparian corridors, and streams provide habitats and oxygenated water unique to this area of eastern South Dakota (Bryce et al. 1998). The Big Sioux Basin ecoregion is within the surrounding Prairie Coteau ecoregion and differs from that region in that it has a well-defined drainage network and gentler topography (Bryce et al. 1998).

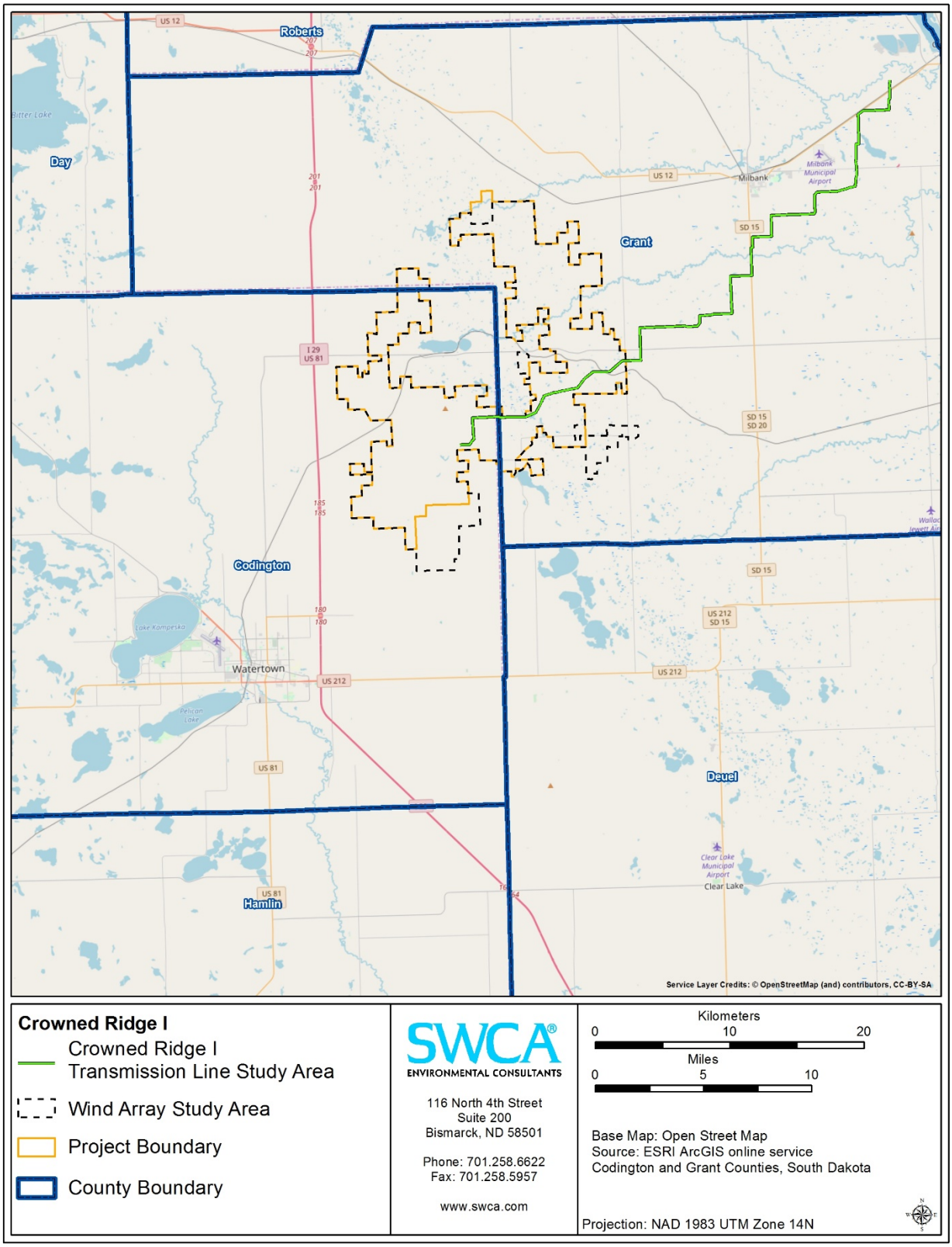


Figure 1. Location of the study areas.

2 BATS OF SOUTH DAKOTA

Several sources were reviewed to identify bat species with potential to occur within Grant and Codington Counties, South Dakota, including the South Dakota Bat Working Group; the South Dakota Department of Game, Fish, and Parks (SDGFP) *South Dakota Wildlife Action Plan* (SDWAP; SDGFP 2014); the Annotated Checklist of Bats from South Dakota (Jones and Genoways 1967); NatureServe (Hammerson 2015a–d); and the *Guide to Mammals of the Plains States* (Jones et al. 1985) (Table 1). The U.S. Fish and Wildlife Service (USFWS) Threatened and Endangered Species List; the Threatened, Endangered, and Candidate Species list of South Dakota; and the SDWAP were cross-referenced with the list of bat species with potential to occur within Grant and Codington Counties to identify 1) state-listed or federally listed species, and 2) species described in the SDWAP as having established, state-specific, non-regulatory conservation recommendations.

2.1 Species of Conservation Concern

For the purposes of this assessment, “species of conservation concern” is defined as those that are currently listed as threatened or endangered at the State or Federal level and those that are listed in the South Dakota Wildlife Action Plan (SDWAP).

The northern long-eared bat was listed as a threatened species with a 4(d) rule on April 2, 2016 (USFWS 2016) and is the only currently federally listed species with potential to occur within the study areas. However, USFWS confirmed that there are no known northern long-eared bat hibernacula or maternity roost trees in Grant and Codington Counties. Additionally, based on their records, USFWS stated that while the species could occur in these counties, it is likely to only be a migrant, rather than a resident species (USFWS personal communication, 2018).

The northern long-eared bat 4(d) rule includes take prohibitions for specific activities in specific geographic areas. Purposeful take of northern long-eared bats without a permit is prohibited throughout the range of the species; however, incidental take without a permit is prohibited only within the “White-Nose Syndrome Zone.” The White-Nose Syndrome Zone is defined as all counties within 150 miles of a confirmed white-nose syndrome-positive county; the study areas are within the White-Nose Syndrome Zone (USFWS 2016). Within the White-Nose Syndrome Zone, tree-clearing activities that occur in June or July and within 150 feet of a known maternity roost tree, and that result in incidental take without a permit, are prohibited. Incidental take without a permit that results from tree-clearing activities within 0.25 mile of a known northern long-eared bat hibernaculum at any time of year also is prohibited. There currently is no prohibition of incidental take of northern long-eared bats that results from operation of a wind energy generation facility.

The SDWAP includes the northern long-eared bat and silver-haired bats (*Lasionycteris noctivagans*) as “species of greatest conservation need” indicating that they are “species with characteristics that make them vulnerable” (SDGFP 2014). The SDWAP is an assessment of South Dakota's fish and wildlife and associated habitat that provides conservation measures for long-term preservation of species of conservation concern (SDGFP 2014). The intent of the plan is to foster voluntary partnerships between governmental agencies, tribes, organizations, and private entities to help prevent fish and wildlife from becoming endangered. Listing on the SDWAP does not convey any regulatory status or authority.

Table 1. Ecology and Distribution of Bat Species with Potential to Occur in Grant and Codington Counties, South Dakota

Common Name	Scientific Name	Status	Species Ecology
Red bat	*Lasiurus borealis*	-	Red bats are a common species throughout their range and are found throughout South Dakota in both coniferous and deciduous forested areas (Jones and Genoways 1967). It is hypothesized that red bats migrate to South Dakota in April and leave the state in late August or early September (Swier 2003).
Silver-haired bat	*Lasionycteris noctivagans*	State: *Rare, SDWAP**	Silver-haired bats are relatively uncommon throughout their range and erratically distributed (Kunz 1982). Jones and Genoways (1967) suggested the silver-haired bat was a migrant only; however, Swier (2003) captured individuals in July, showing that some are likely summer residents. The species roosts in trees under bark, in cavities, and snags (Mattson et al. 1996), typically in cottonwood forests in eastern South Dakota (Swier 2003). Silver-haired bats migrate great distances in spring and early fall (Kunz 1982).
Hoary bat	*Lasiurus cinereus*	-	Hoary bats are South Dakota's largest bats and are widespread, though usually not found in great densities (Jones and Genoways 1967; Shump and Shump 1982). Hoary bats roost in trees generally near a water source (Swier 2003) and forage at higher altitude, relative to other bat species. The species migrates south for the winter, leaving in late August and returning in early June (Turner 1974).
Northern long-eared bat	*Myotis septentrionalis*	Federal: *Threatened* State: *Rare, SDWAP**	Within South Dakota, the northern long-eared bat is likely restricted to large, riparian forests along the Missouri River (Swier 2003). USFWS considers the species potentially present state-wide, however there are no records of the species from Grant, Codington, or the adjacent counties (USFWS personal communication 2018). Typically found near water and dense forest conditions, both coniferous and riparian; roost sites consist of exfoliating bark and tree cavities, open buildings, and caves or mines; winter hibernacula are frequently caves or mines (SDGFP 2014). During the summer, northern long-eared bats roost in trees with cracks, crevices, or exfoliating bark, and human-made structures (USFWS 2016). The species hibernates in caves or cave-like structures during the winter (USFWS 2016).
Little brown bat	*Myotis lucifugus*	-	Little brown bats are considered a common species and a generalist capable of exploiting many habitats. The species is historically commonly found throughout South Dakota (Higgins et al. 2000; Jones et al. 1985). Foraging and roosting areas are selected opportunistically (Fenton and Barclay 1980), though deciduous forests and urban areas appear to support the species more often (Swier 2003). Little brown bat roosts include human-made structures, trees, caves, and mines (Fenton and Barclay 1980) and the species forages over water (Swier 2003). The species migrates between summer maternity grounds and hibernacula in spring and fall (Fenton and Barclay 1980).
Big brown bat	*Eptesicus fuscus*	-	Big brown bats are common throughout nearly all of the United States, including South Dakota (Nowak and Paradiso 1983). Though forested areas are frequently used as foraging and roosting habitat, the big brown bat has become closely associated with urban areas and roosts in human-made structures (Nowak and Paradiso 1983). It is hypothesized that big brown bats summer in eastern South Dakota and migrate west to hibernate, though Swier (2003) recorded big brown bats in eastern South Dakota year-round.

* SDWAP: Species is addressed in the South Dakota Wildlife Action Plan.

3 HABITAT AVAILABILITY

The wind array study area and transmission line study area consist of 58,548 and 689 acres of primarily herbaceous and cultivated crop landcover, respectively. Topography is gently rolling, with more hills towards the eastern edge. Aerial photography and the National Land Cover Dataset (NLCD) (Homer et al. 2015) were used to determine the quantities and distribution of land cover types within the study areas (Tables 2 and 3; Figures 2 and 3).

Table 2. Land Cover Classifications within the Wind Array Study Area, Grant and Codington Counties, South Dakota

Land Cover Type	Area (acres)	Percent Composition
Herbaceous	26,763.93	45.71%
Cultivated Crops	22,054.20	37.67%
Hay/Pasture	5,967.38	10.19%
Developed, Open Space	1,860.80	3.18%
Emergent Herbaceous Wetlands	918.17	1.57%
Deciduous Forest	374.35	0.64%
Open Water	282.95	0.48%
Developed, Medium Intensity	198.25	0.34%
Developed, Low Intensity	47.35	0.08%
Shrub/Scrub	37.36	0.06%
Developed, High Intensity	24.50	0.04%
Woody Wetlands	15.65	0.03%
Barren Land	1.88	<0.01%
Evergreen Forest	1.33	<0.01%
Total	**58,548.10**	**100.00%**

Table 3. Land Cover Classifications within the Transmission Line Study Area, Grant and Codington Counties, South Dakota

Land Cover Type	Area (acres)	Percent Composition
Cultivated Crops	302.18	43.83%
Developed, Open Space	141.81	20.57%
Herbaceous	131.56	19.08%
Hay/Pasture	74.45	10.80%
Emergent Herbaceous Wetlands	21.35	3.10%
Deciduous Forest	8.04	1.17%
Open Water	5.43	0.79%
Developed, Low Intensity	3.82	0.55%
Shrub/Scrub	0.81	0.12%
Woody Wetlands	0.01	<0.01%
Total	**689.47**	**100.00%**

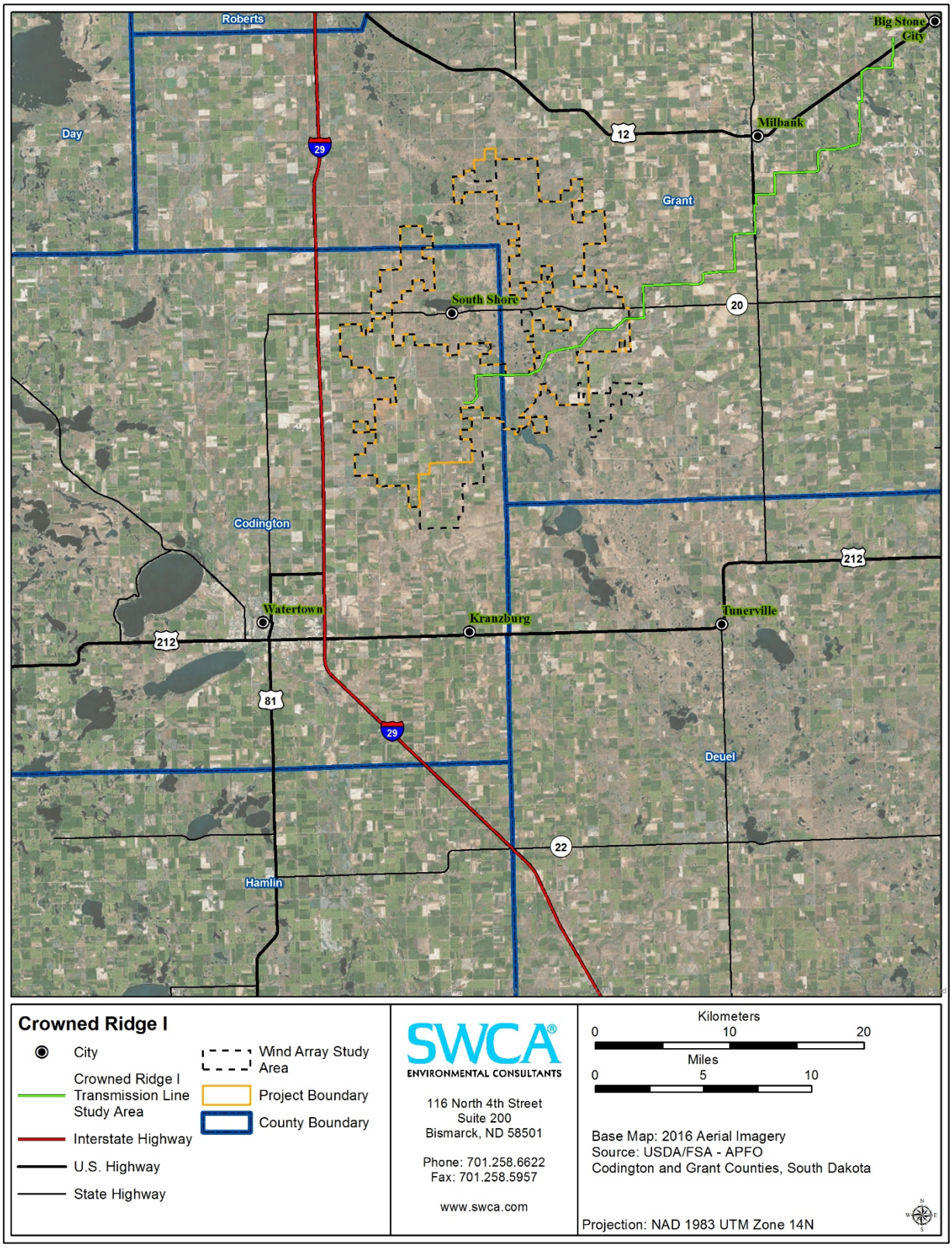


Figure 2. Aerial photography within the study areas.

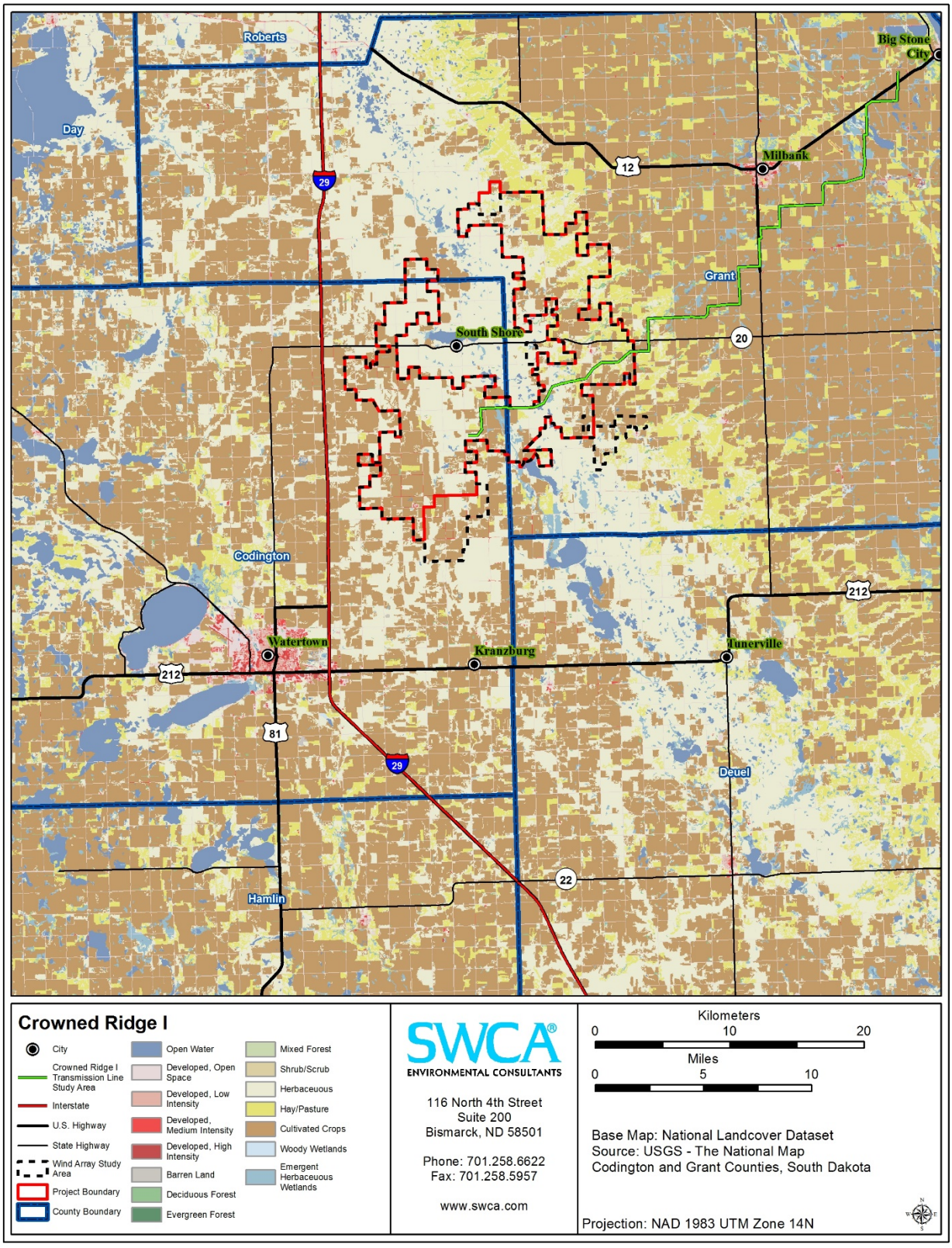


Figure 3. USGS land cover within the study areas.

The National Wetlands Inventory (USFWS 2012) and National Hydrography Dataset (U.S. Geological Survey [USGS] 2009) were reviewed to determine the quantity and distribution of water sources and suitable foraging areas throughout the study areas (Figure 4). There are several wetlands and other waterbodies throughout the study areas, though the numerous large lakes present in this region are primarily outside of the study areas. Streams within the study areas are generally small, headwater streams. These waterbodies can provide foraging grounds and water resources for all bat species. However, when compared to the water resources available outside of the study areas, there are overall fewer and smaller features available within the study areas.

Overall, forested area is extremely limited within the study areas. According to NLCD, forested area (deciduous forest, woody wetlands, and evergreen forest) comprises only 391.33 acres, or 0.67 percent of the wind array study area, and 8 acres, or 1.2 percent, within the transmission line study area. These areas consist primarily of tree lines, small woodlots, and minimal riparian corridors. Forested areas are small and fragmented throughout the study areas. This lack of forested area reduces the availability of summer habitat for forest-dwelling bat species. Each of the species with potential to occur within the study areas are considered forest-dwelling species, though they exist on a spectrum of facultative to obligate forest species. The big brown bat and little brown bat are well-adapted to urban settings and are likely to roost in human-made structures, though they naturally roost and forage in forested habitat; the red bat, silver-haired bat, and hoary bat are able forage in urban settings, but they roost in forested habitat; and the northern long-eared bat is a forest obligate species that roosts and forages almost exclusively in forested habitat.

Beyond being forest-obligate species, northern long-eared bats are considered a forest interior species. White et al. (2017) noted that the species rarely forages more than a few meters away from forest edges, indicating that they are unlikely to use open areas. A study of northern long-eared bats within a managed forest in West Virginia found that this species forages in areas with forest patch sizes between 114 and 161 acres (Owen et al. 2003). Research conducted in Michigan and Prince Edward Island, Canada, within a landscape dominated by agricultural activity showed that northern long-eared bats may use woodlots as small as 15 acres (Foster and Kurta 1999; Henderson and Broders 2008).

For the purposes of this assessment, NLCD land cover data was combined with a manual review of aerial photography to identify forested areas mis-identified by NLCD. Forest patches smaller than 15 acres were considered unsuitable for northern long-eared bats. Forest patches between 15 and 114 acres were considered suitable and of moderate quality, and forest patches greater than 114 acres were considered suitable and of high quality. Using these criteria, 815 acres of forested habitat is unsuitable for use by northern long-eared bats, 246 acres of forested habitat is of moderate quality for northern long-eared bats, and 341 acres of forested habitat is of high quality for northern long-eared bats within the wind array study area (Figure 5). Thirteen acres of forested habitat is unsuitable for use by northern long-eared bats, 21 acres of forested habitat is of moderate quality for northern long-eared bats, and 9 acres of forested habitat is of high quality for northern long-eared bats within the transmission line study area (see Figure 5).

Three of the six bat species that may be present within the study areas hibernate in caves or cave-like structures during the winter. SWCA Environmental Consultants (SWCA) reviewed cave and karst mapping to determine the likelihood of such features occurring within the study areas. There is a slim band of carbonate that runs through the eastern portion of the wind array study area, and an additional two thin bands crossed by the transmission line study area (Figure 6). These areas are underlain by minerals that are prone to cave formation; however, no caves were identified during the desktop analysis.

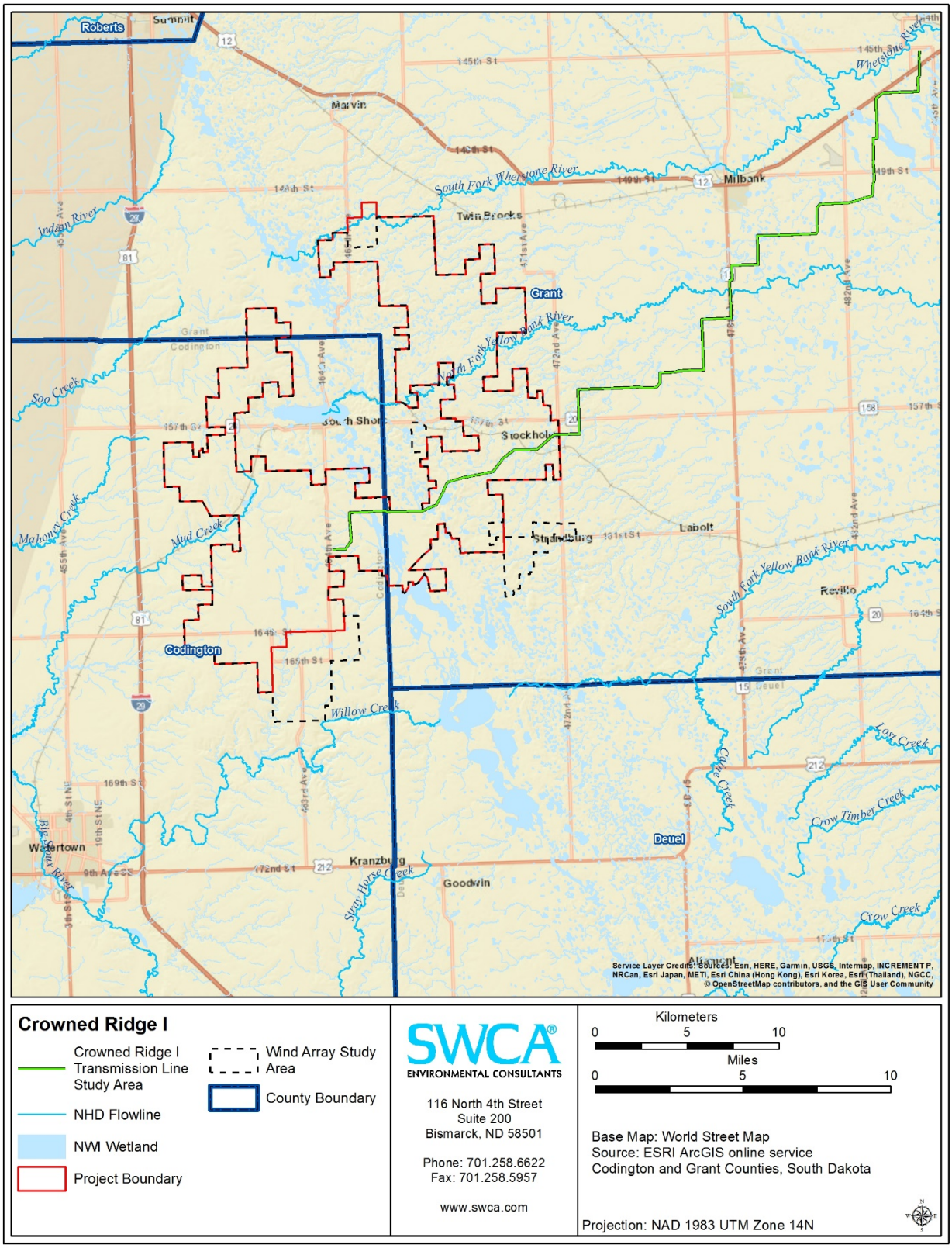


Figure 4. Water resources within the study areas.

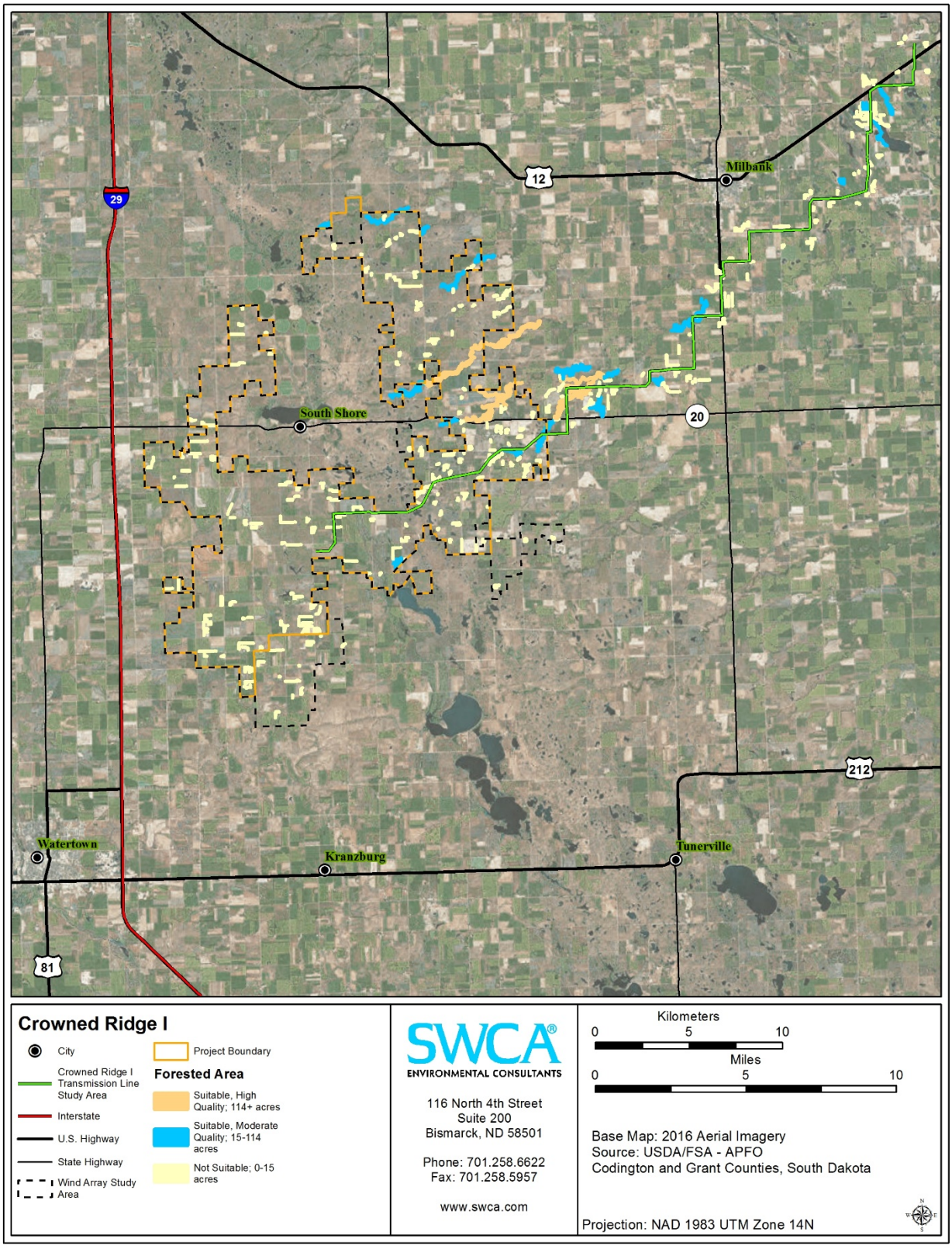


Figure 5. Forest patch size analysis within the study areas, indicating areas of suitable northern long-eared bat habitat.

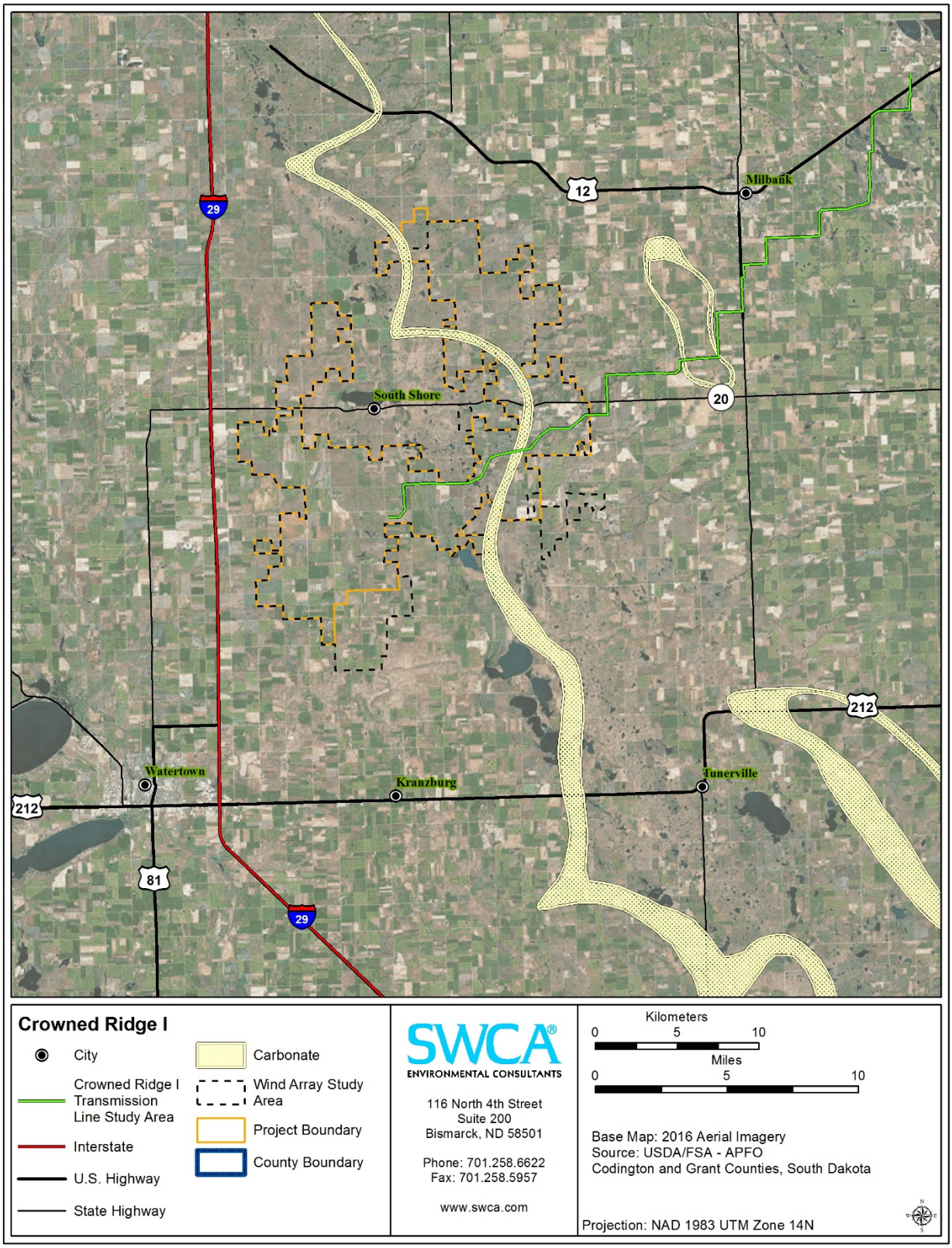


Figure 6. Karst geology within the study areas.

4 CONCLUSION

For bats with potential to occur within Grant and Codington Counties, SWCA cross-referenced species requirements with availability of suitable habitat for each species, reviewed occurrence records, and coordinated with USFWS to determine seasonal likelihood of occurrence for each species (Table 4).

The only federally listed species with potential to occur within the study areas is the northern long-eared bat. There is limited suitable habitat for the northern long-eared bat within the study areas, typically in the form of wooded riparian corridors, small woodlots, and isolated forest patches. The habitat available within the study areas is similar in availability and density to the surrounding landscape, indicating that there is no regionally unique habitat that could serve as an attractant for northern long-eared bats to the study areas.

The USFWS has stated that there is very low likelihood of northern long-eared bats occurring within the study areas as a summer resident. There is potential for the northern long-eared bat to occur within the study areas as a migrant during the spring and fall, though migration behavior of the species is poorly understood.

The northern long-eared bat currently is listed as a threatened species. However, due to the 4(d) rule, there is no prohibition on incidental take that results from operation of a wind energy generation facility. There are prohibitions on unpermitted incidental take that result from tree clearing in certain areas at certain times of year. However, because there are no known maternity roost trees or hibernacula within Grant and Codington Counties, those restrictions would not apply to construction of this project.

Table 4. Habitat Availability and Suitability, and Seasonal Likelihood of Occurrence for Bats with Potential to Occur within the Study Areas, Grant and Codington Counties, South Dakota

Common Name	Likelihood of Occurrence	Habitat Availability/Suitability in the Study Areas	Seasonal Likelihood of Occurrence			
			Spring	Summer	Fall	Winter
Red bat	High	There is limited forested habitat within the study areas. However, red bats are generalists and common throughout their range and may be present as summer residents and as seasonal migrants. Though there is a high likelihood of occurrence, the lack of habitat is likely to limit summer resident population size.	High	High	High	Very Low
Silver-haired bat	Medium	Silver-haired bats are distributed sporadically throughout their range. Available data indicate that summer residents in the region are uncommon, though population distribution throughout their range is poorly studied. Summer habitat is limited within the study areas. However, the species may migrate through the study areas in the spring and fall.	Moderate	Low	Moderate	Very Low
Hoary bat	High	There is limited suitable habitat within the study areas. However, hoary bats have a large home range and can forage over great distances each night. The species may occur in the study areas as summer residents and as seasonal migrants. Though there is a high likelihood of occurrence, the lack of habitat is likely to limit summer resident population size.	High	High	High	Very Low

Common Name	Likelihood of Occurrence	Habitat Availability/Suitability in the Study Areas	Seasonal Likelihood of Occurrence			
			Spring	Summer	Fall	Winter
Northern long-eared bat	Low	The study areas are within the range of the northern long-eared bat, but publicly available data indicate that the species has not been documented in Grant or Codington Counties. Coordination with USFWS determined that northern long-eared bats are considered a potential migrant in this region of South Dakota, with very low likelihood of summer residency. Records suggest that the species is limited to the southern reaches of the Missouri River and the Black Hills within South Dakota. Additionally, suitable habitat for northern long-eared bats is extremely limited within the study areas. The species may occur in the study areas during spring and fall as a migrant, is very unlikely to be present as a summer resident. There is little potential for suitable winter habitat to occur within the study areas. If such habitat is available, individuals typically remain underground for the duration of the season, and therefore do not have potential to occur on the landscape.	Low	Very Low	Low	None
Little brown bat	Medium	There is limited natural habitat within the study areas, though the species is well adapted to developed areas and human-made structures. However, eastern little brown bat populations have declined precipitously due to white-nose syndrome, limiting the likelihood of presence of this species within the study areas.	Low	Low	Low	None
Big brown bat	High	Big-brown bats are common throughout their range. Though there is limited natural habitat available within the study areas, their adaptation to live in developed areas and within human-made structures increases their likelihood of presence. This species is likely able to use the barns, houses, and other human-made structures available throughout the study areas.	High	High	High	Moderate

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Pre-Construction Bat Acoustic Study, Proposed Crowned Ridge I Wind Facility, Grant and Codington Counties, South Dakota

NOVEMBER 2018

PREPARED FOR

Crowned Ridge Wind, LLC

PREPARED BY

SWCA Environmental Consultants

PRE-CONSTRUCTION BAT ACOUSTIC STUDY, PROPOSED CROWNED RIDGE I WIND FACILITY, GRANT AND CODINGTON COUNTIES, SOUTH DAKOTA

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SWCA Project No. 44511

November 2018

CONTENTS

1 Introduction 1
1.1 Project Overview 1

2 Site Characterization 1
2.1 Environmental Setting 1

3 Methods 3
3.1 Desktop Review 3
3.2 Field Survey 3
3.2.1 Acoustic Detectors 3
3.2.2 Acoustic Analysis 4

4 Results 5
4.1 Desktop Review 5
4.2 Field Survey 6
4.2.1 Acoustic Analysis 6

5 Discussion 8

6 Literature Cited 9

Figures

Figure 1. General location of the proposed project showing acoustic detector unit locations. 2

Tables

Table 1. SM4 Unit Locations (latitude, longitude, height) within the Crowned Ridge I Study Area 4
Table 2. Bat Species Comprising Probable Frequency Groups in the Crowned Ridge I Study Area 4
Table 3. Ecology and Distribution of Bat Species Likely to Occur in Codington and Grant Counties 5
Table 4. Bat Passes Recorded at Unit CR1-A within the Proposed Crowned Ridge I Study Area, April 6 through December 1, 2017 6
Table 5. Bat Passes Recorded at Unit CR1-B within the Proposed Crowned Ridge I Study Area, April 6 through November 29, 2017 6
Table 6. Total Number of Bat Passes Recorded at Units CR1-A and CR1-B Combined within the Proposed Crowned Ridge I Study Area, April 6 through December 1, 2017 7
Table 7. Relative Bat Activity Recorded at Units CR1-A and CR1-B Combined within the Proposed Crowned Ridge I Study Area, April 6 through December 1, 2017 7

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1 INTRODUCTION

1.1 Project Overview

Crowned Ridge Wind, LLC, an indirect, wholly-owned subsidiary of NextEra Energy Resources, LLC, plans to develop an approximately 300-megawatt (MW) wind facility known as the Crowned Ridge I Wind Energy Facility (the project) in Grant and Codington Counties, South Dakota (see project boundary, Figure 1). The project will produce energy sold to Xcel Energy through a Power Purchase Agreement. A new transmission line will be constructed to connect the wind facility to Otter Tail Power's Big Stone South 230-kilovolt (kV) substation near Big Stone City, South Dakota (Figure 1). Construction is anticipated to commence in early 2019, and the project is scheduled to achieve commercial operation on or before the end of 2019.

The U.S. Fish and Wildlife Service (USFWS) has developed voluntary guidance that includes measures intended to address potential concerns to bird and bat species as related to wind energy facilities. This voluntary guidance is outlined in the *Land-Based Wind Energy Guidelines* (WEGs) (USFWS 2012). Crowned Ridge Wind, LLC requested that SWCA Environmental Consultants (SWCA) conduct long-term, passive monitoring acoustic bat surveys in 2017. The purpose of this report is to document the methods and results of acoustic bat studies within a 58,548-acre study area (Figure 1) in consideration of the WEGs.

2 SITE CHARACTERIZATION

2.1 Environmental Setting

Ecoregions are delineated based on the continuity of natural resource availability, vegetation communities, and other factors (Bryce et al. 1998). The U.S. Environmental Protection Agency and the Commission for Environmental Cooperation (CEC) defined a hierarchy of ecoregions at various scales, with Level I ecoregions being the coarsest level defined at the global scale, through Level III at the national scale (CEC 1997). Bryce et al. (1998) defined smaller Level IV ecoregions at a regional scale within the Level III ecoregions for the states of North and South Dakota.

The project is located within the Level IV Prairie Coteau and Big Sioux Basin ecoregions, which are subdivisions of the Level III Northern Glaciated Plateau ecoregion (Bryce et al. 1998). The Prairie Coteau ecoregion resulted from stagnant glacial ice melting beneath a layer of sediment, and it is dominated by a tightly undulating, hummocky landscape with no drainage pattern. This ecoregion has large chains of lakes and scattered semi-permanent or seasonal wetlands (Bryce et al. 1998). The Big Sioux Basin ecoregion is within the surrounding Prairie Coteau ecoregion and differs from that region in that it has a well-defined drainage network and gentler topography (Bryce et al. 1998).

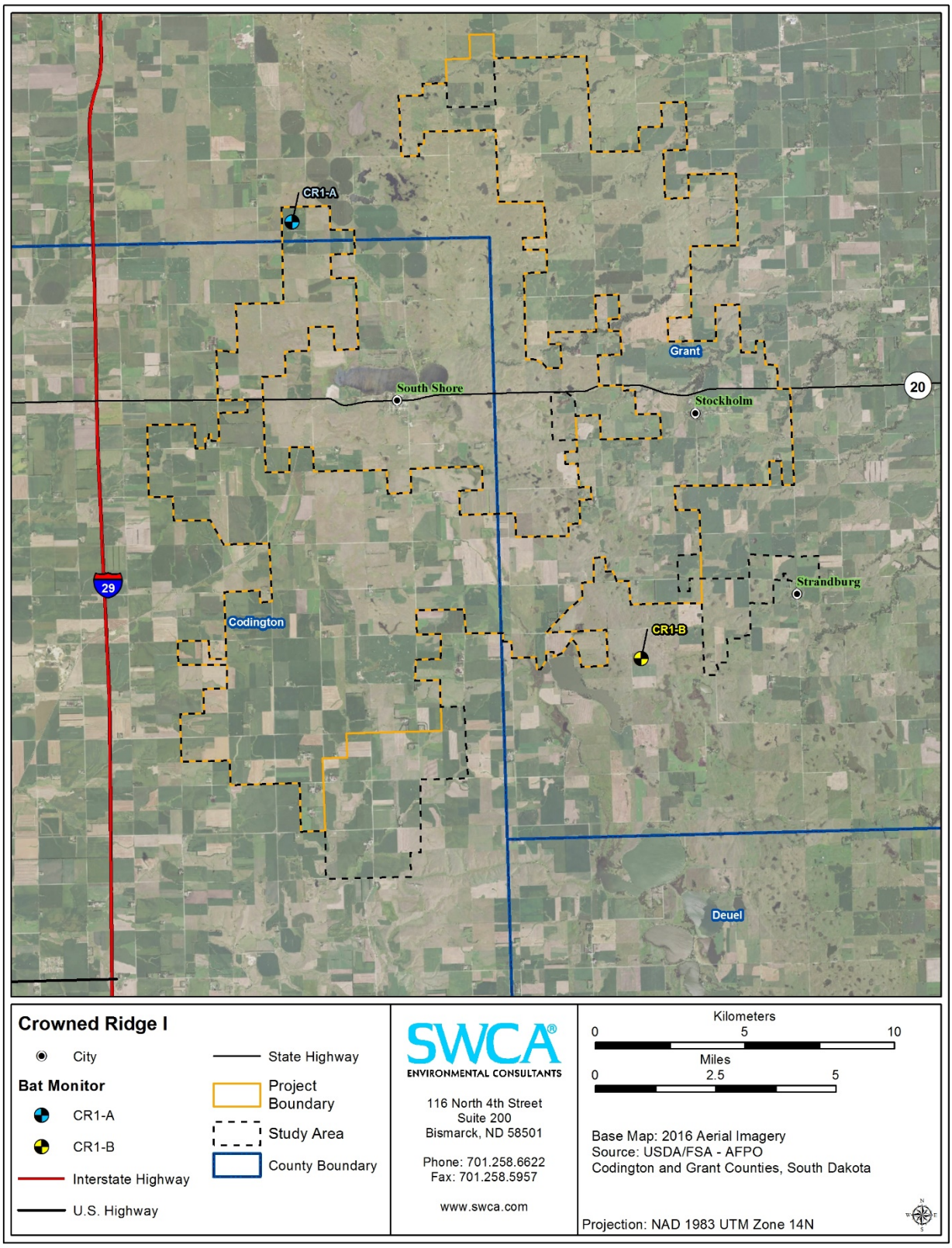


Figure 1. General location of the proposed project showing acoustic detector unit locations.

3 METHODS

Most bats emit vocalizations (calls) and interpret the echo patterns (a system called echolocation) for orientation and for catching prey in complete darkness (Griffin 1944). These echolocation calls may range from 11 kilohertz (kHz) to 212 kHz (Fenton and Bell 1981; Fullard and Dawson 1997). The implementation of devices that can detect and record sounds upward of 200 kHz has become a useful and economically feasible tool for monitoring bats at wind energy facilities (Arnett et al. 2008).

3.1 Desktop Review

Several sources were reviewed to identify bat species with potential to occur within Grant and Codington Counties, South Dakota. These are as follows:

- South Dakota Bat Working Group
- South Dakota Game, Fish and Parks (SDGFP) *South Dakota Wildlife Action Plan* (SDWAP; SDGFP 2014)
- *Annotated Checklist of Bats from South Dakota* (Jones and Genoways 1967)
- NatureServe (Hammerson 2015a–d)
- *Guide to Mammals of the Plains States* (Jones et al. 1985)

The USFWS threatened and endangered species list (USFWS 2017); the threatened, endangered, and candidate species list of South Dakota (SDGFP 2017); and the SDWAP (SDGFP 2014) were cross referenced with the list of bat species with potential to occur within Grant and Codington Counties to identify currently protected species; and those with established, state-specific conservation recommendations. This analysis was narrowed down to include those species that may be present in the study area.

3.2 Field Survey

3.2.1 Acoustic Detectors

Although zero-crossing recording methods, which record the frequency of the single loudest soundwave detected, have historically been the standard in the field of bat acoustic monitoring, new technology allows for recording the full spectrum of sound created when a bat echolocates. The Song Meter SM4BAT FS (SM4) developed by Wildlife Acoustics is a bat detection system that uses a broadband microphone and data storage unit to detect and record ultrasonic sounds in the full spectrum. However, the conventional wisdom within the field, and in SWCA's experience, is that although recording in full spectrum collects the best data, processing and analysis in zero-crossing format yield the most accurate results. Therefore, all full-spectrum call files were converted into zero-crossing files prior to analysis.

Two SM4 units (SD2 compact flash units, Wildlife Acoustics) were installed in the study area: CR1-A and CR1-B (see Figure 1, Table 1). The locations of the SM4 units were determined by initial project meteorological (met) tower placement and habitat distribution on properties to which legal access had been obtained, and the units were spaced to provide maximum coverage of habitat types within the study area.

Table 1. SM4 Unit Locations (latitude, longitude, height) within the Crowned Ridge I Study Area

Unit	Latitude	Longitude	Approximate Height (m)
CR1-A	45.160311	-96.971421	4
CR1-B	45.026333	-96.828580	50

Unit CR1-A was placed on a project met tower by climbing a ladder and securing the microphone to the tower at a height of approximately 4 meters (m) above ground. The microphone was connected to the SM4 unit with a microphone cable, and the SM4 unit was secured to the tower. Unit CR1-B's microphone was elevated to approximately 50 m on a met tower using a preinstalled pulley system. The unit was similarly secured to the base of the met tower and connected using a 50-m cable. These locations were representative of the larger region and the study area, which is primarily dominated by herbaceous cover-types such as row-crops, pasture, hay, and native prairie. SM4 unites were set to record bat activity at least 30 minutes before sunset and through the night until at least 30 minutes after sunrise the following day. The units began collecting data on April 6, 2017, and concluded on November 29 and December 1, 2017, for CR1-A and CR1-B, respectively. CR1-B experienced equipment malfunction and did not record between October 27 and November 8, 2017, likely because of extremely low temperature.

3.2.2 Acoustic Analysis

SWCA used Kaleidoscope, BCID, and Analook analysis software to calculate the number of "bat passes." A *bat pass* is defined as a sequence of echolocation calls that are separated by greater than 1 second (O'Farrell et al. 1999; White and Gehrt 2001). A bat pass is a commonly used metric for interpreting bat activity at a site; however, the number of bat passes cannot be translated into the abundance of bats, because a single bat foraging near a bat detector can record multiple passes.

Bat species produce echolocation calls based on their ecological niche requirements, which may demand different frequency bandwidth, call note duration, and other characteristics. These parameters can be assessed in the sonograms to facilitate species identification. However, intraspecific variation based on confounding factors (e.g., habitat, presence of other bats) can make species identification difficult or impossible (Barclay and Brigham 2004), with *Myotis* bat species generally recognized as being the most difficult to differentiate. Furthermore, the microphones cannot discriminate between bat calls and other ultrasonic sounds (e.g., rain, insects, electrical or mechanical [collectively called noise]). Therefore, post-survey data analysis also includes separating files with bat calls from files containing noise.

Bat passes were then identified to species, when possible. Many species have similar, overlapping echolocation signatures, and bat calls can vary depending on habitat or activity; therefore, species differentiation is not always possible (Barclay 1999), particularly when only portions of the calls are recorded. As a result, SWCA categorized unidentifiable calls according to high and low frequency groups (≥ 35 kilohertz [kHz] and < 35 kHz, respectively; Table 2).

Table 2. Bat Species Comprising Probable Frequency Groups in the Crowned Ridge I Study Area

Low Frequency Group (< 35 kHz)	High Frequency Group (≥ 35 kHz)	*Myotis* Species
Hoary bat (*Lasiurus cinereus*)	Eastern red bat (*Lasiurus borealis*)	Northern long-eared bat (*Myotis septentrionalis*)
Silver-haired bat (*Lasionycteris noctivagans*)	–	Little brown bat (*Myotis lucifugus*)
Big brown bat (*Eptesicus fuscus*)	–	–

000387

4 RESULTS

4.1 Desktop Review

Using the sources outlined in section 3.1, Table 3 presents those bat species that are likely to occur in the study area.

Table 3. Ecology and Distribution of Bat Species Likely to Occur in Codington and Grant Counties

Common Name	Scientific Name	Status	Species Ecology
Red bat	*Lasiurus borealis*	–	Red bats are a common species throughout their range and are found throughout South Dakota in both coniferous and deciduous forested areas (Jones and Genoways 1967). It is hypothesized that red bats migrate to South Dakota in April and leave the state in late August or early September (Swier 2003).
Silver-haired bat	*Lasionycteris noctivagans*	State: rare, SDWAP*	Silver-haired bats are relatively uncommon throughout their range and erratically distributed (Kunz 1982). Jones and Genoways (1967) suggest the silver-haired bat is a migrant only; however, Swier (2003) captured individuals in July, showing that some are likely summer residents. The species roosts in trees under bark, in cavities, and snags (Mattson et al. 1996), typically in cottonwood forests in eastern South Dakota (Swier 2003). Silver-haired bats migrate great distances in spring and early fall (Kunz 1982).
Hoary bat	*Lasiurus cinereus*	–	Hoary bats are South Dakota's largest bats and are widespread, though they are usually not found in great densities (Jones and Genoways 1967; Shump and Shump 1982). Hoary bats roost in trees generally near a water source (Swier 2003) and forage at higher altitude, relative to other bat species. The species migrates south for the winter, leaving in late August and returning in early June (Turner 1974).
Northern long-eared bat	*Myotis septentrionalis*	Federal: threatened State: rare, SDWAP*	Within South Dakota, the northern long-eared bat is likely restricted to large, riparian forests along the Missouri River (Swier 2003). USFWS considers the species potentially present state-wide, however there are no records of the species from Grant, Codington, or the adjacent counties (USFWS personal communication 2018). The species is typically found near water and dense forest conditions, both coniferous and riparian; roost sites consist of exfoliating bark and tree cavities, open buildings, and caves or mines; winter hibernacula are frequently caves or mines (SDGFP 2014). During the summer, northern long-eared bats roost in trees with cracks, crevices, or exfoliating, as well as human-made structures (USFWS 2016). The species hibernates in caves or cave-like structures during the winter (USFWS 2016).
Little brown bat	*Myotis lucifugus*	–	Little brown bats are considered a common species and a generalist capable of exploiting many habitats. The species is historically commonly found throughout South Dakota (Higgins et al. 2000; Jones et al. 1985). Foraging and roosting areas are selected opportunistically (Fenton and Barclay 1980), though deciduous forests and urban areas appear to support the species more often (Swier 2003). Little brown bat roosts include human-made structures, trees, caves, and mines (Fenton and Barclay 1980) and forage over water (Swier 2003). The species migrates between summer maternity grounds and hibernacula in spring and fall (Fenton and Barclay 1980).

000388

Common Name	Scientific Name	Status	Species Ecology
Big brown bat	*Eptesicus fuscus*	–	Big brown bats are common throughout nearly all of the United States, including South Dakota (Nowak and Paradiso 1983). Though forested areas are frequently used as foraging and roosting habitat, the big brown bat has become closely associated with urban areas and roosts in human-made structures (Nowak and Paradiso 1983). It is hypothesized that big brown bats summer in eastern South Dakota and migrate west to hibernate, though Swier (2003) recorded big brown bats in eastern South Dakota year-round.

* SDWAP: Species is addressed in the SDWAP.

4.2 Field Survey

4.2.1 Acoustic Analysis

RAW TOTAL ACOUSTIC CALLS

From April 6 through December 1, 2017, 757 bat passes were recorded by the CR1-A and CR1-B units (Tables 4 through 6). The CR1-A and CR1-B units recorded for 237 and 227 nights, respectively.

Table 4. Bat Passes Recorded at Unit CR1-A within the Proposed Crowned Ridge I Study Area, April 6 through December 1, 2017

Month	Hoary Bat	Low Frequency Group	Red Bat	*Myotis* Species	Total
April	1	17	0	0	18
May	3	22	1	0	26
June	12	12	1	0	25
July	50	65	22	0	137
August	13	43	15	0	71
September	0	22	5	0	27
October	0	3	0	0	3
November	1	0	0	0	1
Total	**80**	**184**	**44**	**0**	**308**

Table 5. Bat Passes Recorded at Unit CR1-B within the Proposed Crowned Ridge I Study Area, April 6 through November 29, 2017

Month	Hoary Bat	Low Frequency Group	Red Bat	*Myotis* Species	Total
April	0	16	0	0	16
May	0	6	0	0	6
June	16	9	1	0	26
July	60	60	22	0	142

Month	Hoary Bat	Low Frequency Group	Red Bat	*Myotis* Species	Total
August	67	79	29	0	175
September	29	49	6	0	84
October	0	0	0	0	0
November	0	0	0	0	0
Total	**172**	**219**	**58**	**0**	**449**

Table 6. Total Number of Bat Passes Recorded at Units CR1-A and CR1-B Combined within the Proposed Crowned Ridge I Study Area, April 6 through December 1, 2017

Month	Hoary Bat	Low Frequency Group	Red Bat	*Myotis* Species	Total
April	1	33	0	0	34
May	3	28	1	0	32
June	28	21	2	0	51
July	110	125	44	0	279
August	80	122	44	0	246
September	29	71	11	0	111
October	0	3	0	0	3
November	1	0	0	0	1
Total	**252**	**403**	**102**	**0**	**757**

BAT ACTIVITY

The CR1-A and CR1-B units recorded for 237 and 227 nights, respectively, during the survey period, resulting in activity levels of 1.29 passes per detector-night for CR1-A, and 1.97 bat passes per detector-night for CR1-B. The mean activity level for the study area during the survey period was 1.63. However, bat activity varied by season (Table 7).

Table 7. Relative Bat Activity Recorded at Units CR1-A and CR1-B Combined within the Proposed Crowned Ridge I Study Area, April 6 through December 1, 2017

Season	Hoary Bat	Low Frequency Group	Red Bat	*Myotis* Species	Total Bat Activity by Season
Spring (April 6–May 15)	0.03	0.67	0.01	0.00	0.71
Summer (May 16–July 15)	0.41	0.40	0.04	0.00	0.85
Fall (July 16–September 30)	1.32	1.97	0.63	0.00	3.92
Winter (October 1–December 1)	0.01	0.03	0.00	0.00	0.04
Total Bat Activity by Species or Group	**0.54**	**0.87**	**0.22**	**0.00**	**1.63**

Overall, bat activity was low within the study area. Given the heavily agricultural landscape and lack of roosting or foraging habitat within the Crowned Ridge I study area, this low level of activity is unsurprising and likely suggests that the area is not a heavily used migration corridor for bats. Because of the lack of tree cover, it is also likely that the study area has a very small or absent resident bat population, which is supported by the relatively low levels of bat activity in the summer. Potential resident bats might be expected to collect near the small towns in the region, where insects and consistent water sources are more readily available.

Nearly 80% of the calls recorded occurred in the fall. Although the dynamics of bat migration are not fully understood, however, one factor that could contribute to this difference is recruitment of juveniles into the fall migration population.

5 DISCUSSION

Numerous studies have been conducted across the United States to allow for better prediction of the risk of bat mortality associated with wind energy facilities. Multiple variables could affect bat species' risk at wind energy facilities, including vegetation type(s) and habitat suitability, overall landscape and geographic characteristics, bat population densities, migration paths, or a species' use of an area. Specific objectives of these bat studies were to gain an understanding of occurrence and use of the study area by bats and a relative activity index in support of monitoring recommendations provided in the WEGs.

Seasonal differences in the data collected suggest that the study area experiences limited bat migration in spring; however, if 2017 data are indicative of an overall pattern, spring bat populations are sparse when compared with other regions of the United States. The highest levels of activity observed correlated with fall migration, though even these spikes of activity were low when compared with other fall migration events. Overall, the level of bat activity may suggest that bat use of the study area is relatively low. For comparison, Jain (2005) documented a mean activity level in 2003 and 2004 of 34.88 and 36.57 per detector-night, respectively, in Iowa. Because of the lack of suitable roosting and foraging habitat in the study area, the number of bats is likely much lower than what might be observed in other, more ecologically diverse, parts of the country.

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Final Report
Crowned Ridge Wind Farm
Sound Study
Codington and Grant Counties, SD

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TABLE OF CONTENTS

1. INTRODUCTION 3
2. BACKGROUND AND COUNTY REGULATIONS 3
3. STUDY METHODOLOGY 4
4. RESULTS OF ANALYSIS 7
5. CONCLUSIONS 9
APPENDIX A: CROWNED RIDGE WIND ENERGY PROJECT SITE OVERVIEW MAP 10
APPENDIX B: WIND TURBINE COORDINATES 12
APPENDIX C: TABLE OF SOUND RESULTS 17
APPENDIX D: STANDARD RESOLUTION SOUND MAPS 30

LIST OF TABLES

Table 1: Crowned Ridge wind energy project wind turbine specifications. 6
Table 2: Codington County property boundary realistic sound distribution 8
Table 3: Grant County occupied structure realistic sound distribution 8
Table 4: Summary of sound pressure level predictions. 9

Report Update

EAPC bears no responsibility to update this report for any changes occurring subsequent to the final issuance of this report.

Revision History

Revision No.	Revision Purpose	Date	Revised By
0	Original	1/22/2019	J. Haley

Executive Summary

EAPC was hired to provide estimates of the potential sound impacts for a proposed wind turbine layout in Codington and Grant Counties of the Crowned Ridge wind farm project in northeastern South Dakota. The scope of this report includes all proposed turbines included in the Crowned Ridge wind farm project that will be permitted separately through the South Dakota Public Utilities Commission. Locations of area existing residences and a wind turbine layout using a mixture of wind turbines manufactured by General Electric (GE) were provided to EAPC by Crowned Ridge Wind, LLC. A computer model was built combining digital elevation data with the information supplied by Crowned Ridge Wind, LLC to generate sound models for the site. The resulting models were then used to perform sound calculations for the 150 turbines. Based on the calculations, site-wide realistic sound maps were produced.

The Crowned Ridge wind farm project was modeled for all counties within the turbine layout and is described in this report as one project. However, for purposes of organization and because of the differences in compliance criteria, the modeling and results of the study are presented individually for each county. The noise ordinances of Codington and Grant Counties are not the same. For Codington County the noise limit is 50 dBA at the property boundary of occupied non-participating landowners. For Grant County the noise limit is 45 dBA at a distance of 25 feet from the perimeter of non-participating occupied structures and 50 dBA at participating occupied structures.

The scope of this study also includes sound impacts that are not regulated by county ordinances including participating and non-participating occupied structures and participating parcel boundaries in Codington County. The turbine array was arranged so that the sound pressure level at all non-participating occupied structures in both counties would be 45 dBA or less and participating occupied structures in both counties would be 50 dBA or less. For all turbines, Low Noise Trailing Edge (LNTE) blades were used to reduce the sound pressure levels in order to achieve compliance with county regulations by increasing the flexibility in turbine locations to meet setback requirements.

The model is based on a number of conservative assumptions. It assumes that the wind turbines are always emitting the maximum sound pressure level with an additional 2 dBA added to the wind turbine noise emission profiles. It is also assumed that each wind turbine is always downwind of each receptor and the atmospheric conditions are most favorable for sound transmission. Also in particular for Grant County, the sound pressure level was calculated at a distance of 50 feet from the perimeter of structures instead of 25 feet. This is also a conservative assumption because the noise levels will be higher at 50 feet than 25 feet.

<u>Crowned Ridge Codington County Turbines</u>
Codington County's current Ordinance #68 Zoning Ordinance Section 5.22.03.12.a notes that the applicable sound limit is 50 dBA at an occupied non-participating property line, which is what has been evaluated in this report for Codington County. Codington County does not have a specific ordinance for sound pressure levels at a participating property boundary;

although not required by the county, the sound pressure levels at participating property boundaries and occupied structures within 2 kilometers of a wind turbine were also evaluated. There is also no ordinance for sound pressure levels at any participating or non-participating occupied structures.

Within the Crowned Ridge Project, for Codington County, an evaluation of the sound impacts at 61 occupied land parcel boundaries (30 participating and 31 non-participating) within Codington County was performed. The 61 (30 participating and 31 non-participating) land parcel boundaries that the existing residences were modeled using an area-type sound sensor so that the highest sound pressure level at the property line could be calculated.

In Codington County, the maximum sound pressure level at a non-participating property boundary is 48.8 dBA, therefore, the project, as modeled, is in compliance with Codington County's allowable sound pressure levels as described in Section 5.03, paragraph 12 of the Codington County Zoning Ordinance #68, which is 50 dBA. The maximum sound pressure level at a participating property boundary is 53.6 dBA.

There are 71 occupied structures (37 participating and 34 non-participating) in Codington County within 2 kilometers of a wind turbine, which were modeled using a point-type sound sensor so that the highest sound pressure level at the perimeter of the structures could be calculated. In Codington County, the maximum sound pressure level at the perimeter of a non-participating occupied structure was 45 dBA. The maximum sound pressure level at a participating occupied structure was 47.9 dBA.

Therefore, the project as modeled, is in compliance with Codington County's allowable sound pressure levels as described in the current Codington County Ordinance.

Crowned Ridge Grant County Turbines

Grant County's current Ordinance 2016-01C, Section 1211.04, paragraph 14 of the current Grant County Zoning Ordinance sets the limit at 45 dBA at a distance of 25 feet from the perimeter of non-participating occupied structures and 50 dBA for participating occupied structures.

For Grant County, an evaluation of the noise impacts at 57 (17 participating and 40 non-participating) occupied structures within 2 kilometers within Grant County was performed. The 57 occupied structures were modeled using a point-type sound sensor so that the highest sound pressure level 25 feet from the perimeter of the structures could be calculated. In Grant County, the maximum sound pressure level 25 feet from the perimeter of a non-participating occupied structure is 43 dBA, and 45.3 dBA for a participating occupied structure.

Based upon the results presented above, the project as modeled, is in compliance with Grant County's allowable sound pressure levels as described in the current Grant County Ordinance.

1. INTRODUCTION

EAPC was hired to conduct sound studies for the regional development of the Crowned Ridge wind farm project located in Codington and Grant Counties in northeastern South Dakota. The regional development's layout consists of 137 GE 2.3 MW wind turbines with a hub height of 90 meters (including 20 alternate turbine locations) and 13 GE 2.3 MW wind turbines with a hub height of 80 meters for a total of 150 wind turbines. The locations of the proposed wind turbines were supplied by Crowned Ridge Wind, LLC.

From the database of existing residences and coordinates supplied by Crowned Ridge Wind, LLC, 71 occupied structures (37 participating and 34 non-participating) in Codington County and 57 occupied structures (17 participating and 40 non-participating) in Grant County were found to be within 2 kilometers of a wind turbine and were included in the sound models. Additionally, 61 occupied land parcels (30 participating and 31 non-participating) were found to be within 2 kilometers of a wind turbine in Codington County, in line with the Codington County ordinance (see below). At a distance of 2 kilometers from a turbine base, the sound pressure level will be less than 35 dBA (considerably less than ordinance limits) so there is no need to include land parcels or structures beyond that distance. Land parcels were not modeled for Grant County as they are not a part of the Grant County ordinance.

The area of interest for this study is located in Codington and Grant Counties near the town of Watertown in northeastern South Dakota. The surrounding terrain has a change in elevation across the project site ranging from 475 to 621 meters (1,558 to 2,037 feet) at the wind turbine base. The region's vegetation is comprised primarily of prairie grass and agricultural land. The project overview map can be found in Appendix A.

2. BACKGROUND AND COUNTY REGULATIONS

To determine if the layout provided would be compliant for the Crowned Ridge Project and in line with each county's regulations, detailed sound scenarios were analyzed using a computer model. The scenarios assumed that the wind turbines were operating at a wind speed that resulted in the loudest sound being emitted, which is conservative because the turbines would not actually be operating at maximum sound output levels at all times.

Codington County's current Ordinance #68 Zoning Ordinance Section 5.22.03, paragraph 12.a) prescribes sound limits for wind turbine projects as follows:

"12.a) Noise level generated by wind energy system shall not exceed 50 dBA, average A-weighted sound pressure including constructive interference level effects at the property line of existing off-site non participating residences, businesses, and buildings owned and/or maintained by a governmental entity."

Therefore, Codington County's only applicable sound limit is 50 dBA at an occupied non-participating property line, which is what has been evaluated in this report for Codington County. Although not required by the county, the sound pressure levels at participating property boundaries and participating and non-participating occupied structures (i.e., residences, business, and buildings) within 2 kilometers of a wind turbine were also evaluated.

Grant County's current Ordinance 2016-01C, Section 1211.04, paragraph 14 prescribes sound limits for wind turbine projects as follows:

"14.) Noise. Noise level shall not exceed 45 dBA, average A-weighted Sound pressure including constructive interference effects measured twenty-five (25) feet from the perimeter of existing off-site non-participating residences, businesses, buildings owned and/or maintained by a governmental entity."

"Noise level shall not exceed 50 dBA, average A-weighted Sound pressure including constructive interference effects measured twenty-five (25) feet from the perimeter of participating residences, businesses, and buildings owned and/or maintained by a governmental entity."

Therefore, Grant County's current applicable sound limit is 45 dBA for all non-participating, and 50 dBA for all participating, existing off-site residences, businesses, and buildings owned and/or maintained by a governmental entity. For purposes of this report, these residences, businesses, and buildings will hereafter be referred to as occupied structures.

3. *STUDY METHODOLOGY*

This sound analysis was performed utilizing windPRO[1], which has the ability to calculate detailed sound maps across an entire area of interest or at site-specific locations using sound sensitive receptors.

The analysis used the ISO 9613-2 "Attenuation of sound during propagation outdoors, Part 2" sound calculation model with "General" ground attenuation and an attenuation factor of 0.5, which represents typical mixed vegetation (i.e., prairie grass, weeds, brush) and crop cover. Realistic sound pressure levels were calculated at 1.5 m AGL at the participating and non-participating existing occupied structures and occupied parcel boundaries (Codington County only). The term "realistic" in this case, means that some amount of ground attenuation is accounted for.

The inputs and assumptions for the windPRO sound calculation include the following:

[1] windPRO is the world's leading software tool for designing wind farms, including sound analysis.

- Turbine Coordinates
- Turbine Specifications
- Turbine Sound Emission Data
- Sound Receptor Coordinates
- Participation Status
- USGS Digital Elevation Model (DEM) (height contour data)
- Uncertainty Factor
- Meteorological Conditions
- Ground Attenuation

Turbine Coordinates: The location of a wind turbine in relation to a sound receptor is one of the most important factors in determining sound impacts. Sound pressure levels drop as they travel farther from the source of emission. The attenuation comes from atmospheric absorption as well as from absorption by the ground cover between the turbine and the receptor. The sound pressure waves can also be reflected by hard or smooth surfaces such as ice or water. Sound is also absorbed by trees and reflected by structures such as buildings or walls, although these effects (trees and buildings) are ignored in the model.

Turbine Specifications: GE Wind turbine specifications from the manufacturer were supplied to EAPC by Crowned Ridge Wind, LLC. Wind turbine specifications included in the model were the power curves, blade types (standard and low noise), hub heights and operational rotational speed of the rotor. For all turbines, Low Noise Trailing Edge (LNTE) blades were used to reduce the sound pressure levels in order to achieve compliance with county regulations by increasing the flexibility in turbine locations to meet setback requirements.

Turbine Sound Emission Data: Sound emission data including 1/3rd octave data supplied by the manufacture is used assuming the loudest sound pressure levels are being emitted at the hub height of the turbine. A safety margin of 2 dBA was added to the wind turbine noise emission profiles for the analysis in order to produce more conservative results, meaning that the model will predict higher sound pressure levels.

According to the GE sound documentation provided to EAPC by Crowned Ridge Wind, LLC, the loudest normal operating sound pressure level emitted from the GE 2.3-116, the loudest normal operating sound pressure level emitted is 107.5 at 10 m/s and higher at hub height. Since the value is reported at hub height, it is the same value for both 80 meter and 90 meter hub-height turbines.

The specifications for the GE wind turbine models used in this study are included in Table 1 below. The table of wind turbine coordinates is included in Appendix B.

Table 1: Crowned Ridge wind energy project wind turbine specifications.

Crowned Ridge wind energy project wind turbine specifications							
Manufacturer	Model	Hub Height (m)	Rotor Dia. (m)	Cut-In Wind Speed (m/s)	Cut-Out Wind Speed (m/s)	Max. Sound Press. Level (dBA)	Max. Sound Press. Level LNTE (dBA)
General Electric	GE 2.3	80	116	3	22	107.5	106
General Electric	GE 2.3	90	116	3	22	107.5	106

Sound Receptor Coordinates: As with the wind turbine coordinates, the elevation, and distance of a sound receptor in relation to the wind turbines are the main factors in determining the sound impacts. EAPC was provided with coordinates for all existing residences, and occupied structures found to be located within 2 kilometer of the 150 proposed wind turbine locations by Crowned Ridge.

In Grant County, where the point of compliance is 25 feet from the perimeter of the structure, a ring of receptors was modeled 50 feet from the perimeter in order to capture sound levels that would conservatively represent the sound pressure levels 25 feet away from the perimeter.

Receptor Participation Status: A database indicating the participation status of the land parcels and the structures within the wind farm boundary were supplied to EAPC by Crowned Ridge Wind, LLC.

USGS Digital Elevation Model (DEM) (height contour data): For this study, 3 m resolution USGS National Elevation Database (NED) DEM's were used to construct 10-foot interval height contour lines for the windPRO sound model. The height contour information is important to the sound calculation since it allows the model to place the wind turbines and the sound receptors at the correct elevations.

Uncertainty Factor: No uncertainty factor was provided by the wind turbine manufacturer. In this situation, it is common practice based on experience and studies to add 2 dBA to the sound pressure levels of each wind turbine. For this analysis, the 2 dBA were added to all wind turbine noise emission profiles.

Meteorological Conditions: A temperature of 10^{o} C (50^{o} F) and a relative humidity of 70% were assumed for the analysis. These conditions represent an atmospheric "worst case" scenario where sound waves will travel farther with less atmospheric absorption. This will lead to more conservative (higher predicted sound levels) results.

All wind turbines are assumed to be operating simultaneously at maximum sound output levels. All turbines are assumed to be downwind of all receptors, which is another conservative (higher predicted sound pressure levels) assumption.

Ground Attenuation: A ground attenuation factor of 0.5 was assumed for this analysis. It represents "mixed ground" consisting of half hard and half soft (porous) ground cover, which is slightly conservative and will result in higher predicted sound levels since the ground cover includes native prairie and agricultural crop land.

No other sources of sound attenuation such as trees, air turbulence or wind shadow effects were assumed in the analysis.

Wind Turbines from Adjacent Projects: The Crowned Ridge II project is adjacent to the Crowned Ridge project. Because sound impacts are cumulative, there will be impacts from the Crowned Ridge II project that will be additive to the impacts from the Crowned Ridge project. The Crowned Ridge II wind turbine array was included in the model to capture the full sound impacts on the receptors, which are included in the current Crowned Ridge tabular results; however, the sound iso-line maps only show the sound emissions from the Crowned Ridge array.

4. *Results of Analysis*

Although modeled as one project, the noise ordinances of the two counties are not the same. For Codington County, the noise limit is 50 dBA at the property boundary of occupied non-participating landowners. Codington County does not have a specific ordinance for sound pressure levels at a participating property boundary; although not required by the county, the sound pressure levels at participating property boundaries and occupied structures within 2 kilometers of a wind turbine were also evaluated. There is also no ordinance for sound pressure levels at any participating or non-participating occupied structures. For Grant County, the noise limit is 45 dBA at a distance of 25 feet from the perimeter of non-participating occupied structures and 50 dBA at participating occupied structures. Because of the differences in compliance criteria, the results of the study are presented individually for each county.

<u>Crowned Ridge Codington County Turbines</u>

For the Crowned Ridge Codington County Turbines, the sound study indicates that the highest sound pressure level at a non-participating property boundary is 48.8 dBA. Therefore, the project would be in compliance with Codington County's allowable sound pressure levels as described in Section 5.22.03 paragraph 12 of Ordinance #68. Table 2 shows the distribution of sound pressure levels for the project. The maximum sound pressure level at a participating property boundary is 53.6 dBA; however, as there is no county ordinance for participating property boundaries. This information is provided for transparency.

Table 2: Codington County property boundary realistic sound distribution

Realistic Sound (dBA)	Non-Participating Property Boundary	Participating Property Boundary
0 to 25	0	0
25 to 30	0	0
30 to 35	0	0
35 to 40	9	2
40 to 45	10	2
45 to 50	11	11
50+	0	16

Crowned Ridge Grant County Turbines

For Grant County, the sound study indicates that the highest sound pressure level at a distance of 25 feet from the perimeter of a non-participating occupied structure is 43 dBA. The highest sound pressure level at a distance of 25 feet from the perimeter of a participating occupied structure is 45.3 dBA. Therefore the project would be in compliance with Grant County's allowable sound pressure levels as described in Section 1211.04, paragraph 14 of the current Grant County Zoning Ordinance 2016-01C. Table 3 shows the distribution of sound pressure levels for the project.

Table 3: Grant County occupied structure realistic sound distribution

Realistic Sound (dBA)	Non-Participating Occupied Structures	Participating Occupied Structures
0 to 25	0	0
25 to 30	0	0
30 to 35	5	0
35 to 40	17	5
40 to 45	18	9
45 to 50	0	3
+50	0	0

Crowned Ridge Project Summary

The summary results for the Crowned Ridge Project are shown in table 4 below. The full table of results from the sound study can be found in Appendix C. Table C-1 lists the results sorted by receptor number and Table C-2 lists the results sorted by sound impacts

(dBA) from highest to lowest. The tabular results include the cumulative impacts from Crowned Ridge and Crowned Ridge II windfarms. The maps showing the sound impact iso-lines for the Crowned Ridge wind farm are in Appendix D.

Table 4: Summary of sound pressure level predictions.

County	Feature	Noise Limit (dBA)	Maximum Predicted (dBA)
Codington	Participating Occupied Structures	N/A	47.9
	Non-Participating Occupied Structures	N/A	45
	Participating Occupied Parcel Boundary Lines	N/A	53.6
	Non-participating Occupied Parcel Boundary Lines	50	48.8
Grant	Participating Occupied Structures	50	45.3
	Non-Participating Occupied Structures	45	43

5. *CONCLUSIONS*

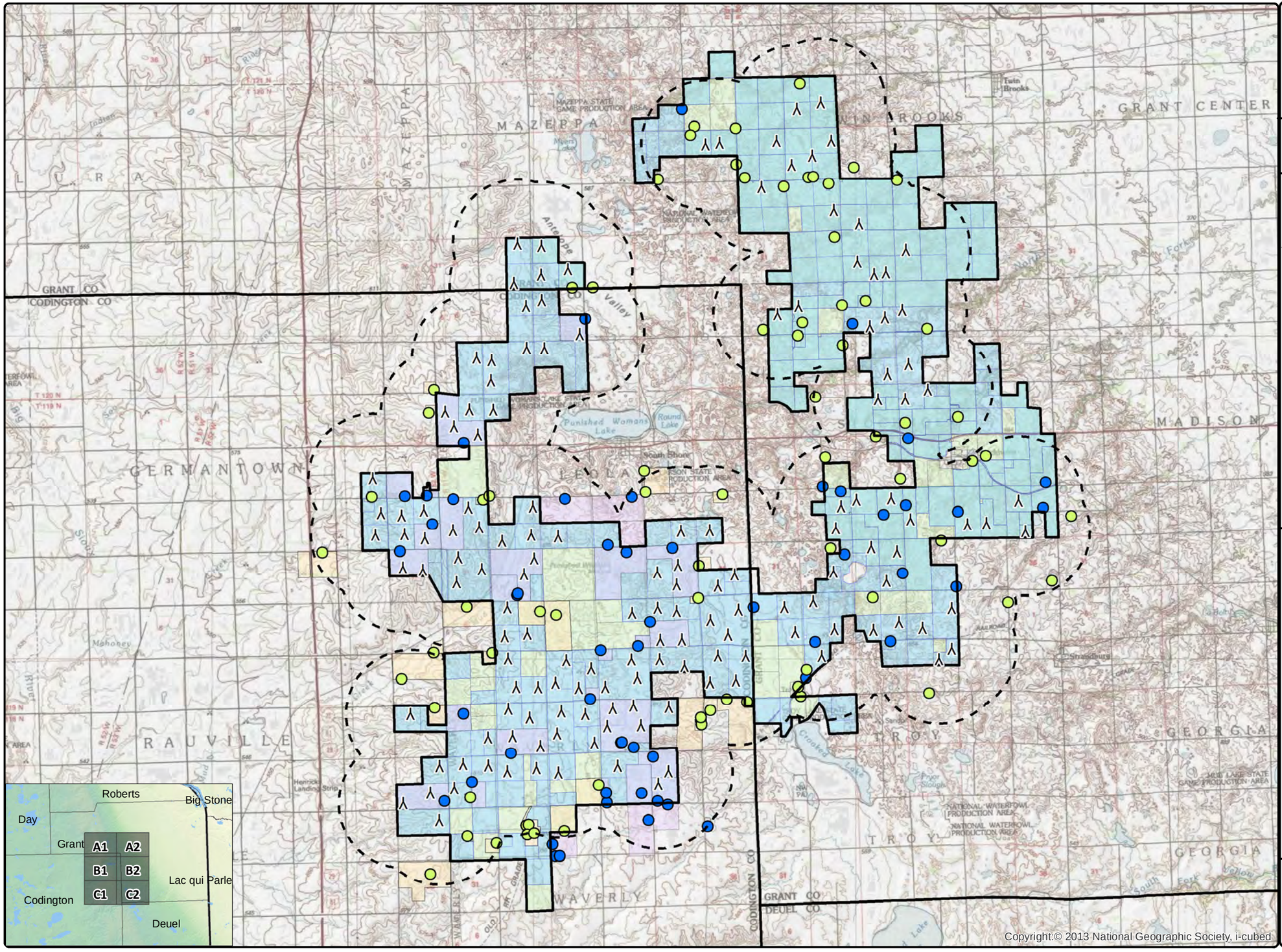
The conservative results of this sound study indicate that the Crowned Ridge Project is in compliance with both Codington and Grant County ordinances.

For Codington County, of the 61 property boundaries modeled, the highest sound pressure level at a non-participating property boundary is 48.8 dBA and none measured more than 50 dBA. Therefore the Crowned Ridge wind farms would be in compliance with Codington County Ordinance #68.

For Grant County, the sound study indicates that the highest sound pressure level 25 feet from the perimeter of a non-participating occupied structure is 43 dBA. The highest sound pressure level 25 feet from the perimeter of a participating occupied structure is 45.3 dBA. Therefore the project would be in compliance with the current Grant County Ordinance 2016-01C.

The results of this study are inherently conservative due to the fact that the turbines were modeled as though they were always operating at maximum sound emission levels and in all cases, an additional 2 dBA was added to the sound level being emitted by the turbine during the modeling stage and not to the results of the sound modeling. The turbines were also modeled as though they were always downwind of each receptor, and atmospheric conditions were modeled to be most favorable for sound transmission. In addition, the receptors in Grant County were modeled 50 feet from the perimeter of the structures where the ordinance specifies 25 feet. Noise levels will be higher farther away from the perimeter.

APPENDIX A: CROWNED RIDGE WIND ENERGY PROJECT SITE OVERVIEW MAP



0 0.75 1.5 3 Mile

EAPC WIND ENERGY

www.eapc.net | 701.775.3000

Crowned Ridge Wind Farm
Project Overview Map

Client

SWCA Environmental Consultants

Project Description

Wind turbine layout with land parcels within the project footprint and existing occupied strucures and occupied Codington County land parcels within 2 km of a wind turbine.

Location: Watertown, SD

Project #: 20174430

Issue Dates

#	Description	Date
1	Original	2019.01.15

Drawn By: AS | *Checked By: JH*

Legend

- Crowned Ridge Turbines
- 2 km Turbine Buffer
- County Lines
- CR1 Project Boundary
- Non-Participants
- Participants
- Participating Codington Parcels
- Non-Part. Codington Parcels
- Participating Land Parcels
- Non-Participating Land Parcels

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APPENDIX B: WIND TURBINE COORDINATES

Crowned Ridge Wind Farm
GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14

WTG	Turbine Type	Easting (m)	Northing (m)	Base Elev. AMSL (m)	Sound Profile
CRI-1	GE2.3 116RD 90HH r2.madE	659,443	5,003,083	610.2	LNTE
CRI-2	GE2.3 116RD 90HH r2.madE	660,185	5,003,010	598.1	LNTE
CRI-3	GE2.3 116RD 90HH r2.madE	661,008	5,002,288	584.2	LNTE
CRI-4	GE2.3 116RD 90HH r2.madE	660,173	5,002,120	602.4	LNTE
CRI-5	GE2.3 116RD 90HH r2.madE	659,337	5,001,862	609.9	LNTE
CRI-6	GE2.3 116RD 90HH r2.madE	660,193	5,001,329	610.4	LNTE
CRI-7	GE2.3 116RD 90HH r2.madE	659,705	5,001,146	618.0	LNTE
CRI-8	GE2.3 116RD 90HH r2.madE	661,380	5,000,282	588.3	LNTE
CRI-9	GE2.3 116RD 90HH r2.madE	659,731	4,999,855	613.3	LNTE
CRI-10	GE2.3 116RD 90HH r2.madE	660,280	4,999,837	615.0	LNTE
CRI-11	GE2.3 116RD 90HH r2.madE	658,170	4,999,546	611.0	LNTE
CRI-12	GE2.3 116RD 90HH r2.madE	658,644	4,999,460	615.0	LNTE
CRI-13	GE2.3 116RD 90HH r2.madE	658,622	4,998,843	613.3	LNTE
CRI-14	GE2.3 116RD 90HH r2.madE	657,947	4,997,935	618.3	LNTE
CRI-15	GE2.3 116RD 90HH r2.madE	658,688	4,997,924	618.9	LNTE
CRI-16	GE2.3 116RD 90HH r2.madE	657,203	4,997,856	611.9	LNTE
CRI-17	GE2.3 116RD 90HH r2.madE	657,476	4,997,410	611.1	LNTE
CRI-18	GE2.3 116RD 90HH r2.madE	658,217	4,997,154	618.0	LNTE
CRI-19	GE2.3 116RD 90HH r2.madE	654,954	4,995,804	601.1	LNTE
CRI-20	GE2.3 116RD 90HH r2.madE	659,920	4,994,924	594.4	LNTE
CRI-21	GE2.3 116RD 90HH r2.madE	657,925	4,994,896	617.1	LNTE
CRI-22	GE2.3 116RD 90HH r2.madE	656,543	4,994,796	616.5	LNTE
CRI-23	GE2.3 116RD 90HH r2.madE	655,208	4,994,717	594.5	LNTE
CRI-24	GE2.3 116RD 90HH r2.madE	655,852	4,994,652	609.0	LNTE
CRI-25	GE2.3 116RD 90HH r2.madE	658,251	4,994,286	606.0	LNTE
CRI-26	GE2.3 116RD 90HH r2.madE	665,405	4,994,191	578.3	LNTE
CRI-27	GE2.3 116RD 90HH r2.madE	657,442	4,994,187	621.0	LNTE
CRI-28	GE2.3 116RD 90HH r2.madE	664,517	4,994,168	579.0	LNTE
CRI-29	GE2.3 116RD 90HH r2.madE	655,940	4,994,069	606.9	LNTE
CRI-30	GE2.3 116RD 90HH r2.madE	659,871	4,994,052	593.6	LNTE
CRI-31	GE2.3 116RD 90HH r2.madE	655,030	4,994,051	603.0	LNTE
CRI-32	GE2.3 116RD 90HH r2.madE	660,704	4,993,998	606.0	LNTE
CRI-33	GE2.3 116RD 90HH r2.madE	656,566	4,993,941	618.0	LNTE
CRI-34	GE2.3 116RD 90HH r2.madE	658,966	4,993,856	599.6	LNTE
CRI-35	GE2.3 116RD 90HH r2.madE	657,602	4,993,347	607.5	LNTE
CRI-36	GE2.3 116RD 90HH r2.madE	659,966	4,993,319	594.0	LNTE
CRI-37	GE2.3 116RD 90HH r2.madE	664,419	4,993,110	587.2	LNTE
CRI-38	GE2.3 116RD 90HH r2.madE	658,338	4,992,981	600.5	LNTE
CRI-39	GE2.3 116RD 90HH r2.madE	656,507	4,992,958	609.0	LNTE
CRI-40	GE2.3 116RD 90HH r2.madE	655,889	4,993,035	603.0	LNTE
CRI-41	GE2.3 116RD 90HH r2.madE	663,782	4,992,883	597.2	LNTE

Crowned Ridge Wind Farm
GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
continued

WTG	Turbine Type	Easting (m)	Northing (m)	Base Elev. AMSL (m)	Sound Profile
CRI-43	GE2.3 116RD 90HH r2.madE	666,181	4,992,815	577.8	LNTE
CRI-44	GE2.3 116RD 90HH r2.madE	665,665	4,992,460	576.0	LNTE
CRI-46	GE2.3 116RD 90HH r2.madE	664,387	4,992,505	591.0	LNTE
CRI-48	GE2.3 116RD 90HH r2.madE	663,794	4,991,782	587.5	LNTE
CRI-49	GE2.3 116RD 90HH r2.madE	664,385	4,991,685	581.6	LNTE
CRI-50	GE2.3 116RD 90HH r2.madE	662,999	4,991,622	612.0	LNTE
CRI-51	GE2.3 116RD 90HH r2.madE	666,299	4,991,723	575.3	LNTE
CRI-52	GE2.3 116RD 90HH r2.madE	665,426	4,991,398	575.6	LNTE
CRI-53	GE2.3 116RD 90HH r2.madE	659,750	4,990,981	598.7	LNTE
CRI-54	GE2.3 116RD 90HH r2.madE	665,979	4,990,946	573.7	LNTE
CRI-55	GE2.3 116RD 90HH r2.madE	659,045	4,990,899	597.0	LNTE
CRI-56	GE2.3 116RD 90HH r2.madE	664,548	4,990,794	591.9	LNTE
CRI-57	GE2.3 116RD 90HH r2.madE	663,874	4,990,787	600.1	LNTE
CRI-58	GE2.3 116RD 90HH r2.madE	665,663	4,990,303	585.0	LNTE
CRI-59	GE2.3 116RD 90HH r2.madE	666,523	4,990,291	573.0	LNTE
CRI-60	GE2.3 116RD 90HH r2.madE	659,155	4,990,208	593.9	LNTE
CRI-61	GE2.3 116RD 90HH r2.madE	662,982	4,990,178	612.0	LNTE
CRI-62	GE2.3 116RD 90HH r2.madE	660,954	4,990,155	600.8	LNTE
CRI-63	GE2.3 116RD 90HH r2.madE	664,627	4,989,977	588.7	LNTE
CRI-64	GE2.3 116RD 90HH r2.madE	663,858	4,990,188	604.5	LNTE
CRI-65	GE2.3 116RD 90HH r2.madE	661,732	4,989,898	609.0	LNTE
CRI-66	GE2.3 116RD 90HH r2.madE	663,165	4,989,613	614.9	LNTE
CRI-67	GE2.3 116RD 90HH r2.madE	666,226	4,989,531	574.8	LNTE
CRI-68	GE2.3 116RD 90HH r2.madE	665,420	4,989,461	585.0	LNTE
CRI-69	GE2.3 116RD 80HH r2.madE	660,621	4,989,453	605.4	LNTE
CRI-70	GE2.3 116RD 90HH r2.madE	662,171	4,989,319	611.0	LNTE
CRI-71	GE2.3 116RD 80HH r2.madE	659,405	4,989,320	607.4	LNTE
CRI-72	GE2.3 116RD 80HH r2.madE	660,087	4,989,309	606.0	LNTE
CRI-73	GE2.3 116RD 90HH r2.madE	661,344	4,989,297	609.8	LNTE
CRI-74	GE2.3 116RD 90HH r2.madE	663,041	4,988,744	615.0	LNTE
CRI-75	GE2.3 116RD 90HH r2.madE	664,137	4,988,702	609.0	LNTE
CRI-76	GE2.3 116RD 90HH r2.madE	662,399	4,988,667	615.0	LNTE
CRI-77	GE2.3 116RD 80HH r2.madE	659,158	4,988,642	612.0	LNTE
CRI-78	GE2.3 116RD 80HH r2.madE	660,811	4,988,558	604.2	LNTE
CRI-79	GE2.3 116RD 90HH r2.madE	656,125	4,988,485	595.0	LNTE
CRI-80	GE2.3 116RD 90HH r2.madE	661,552	4,988,481	608.8	LNTE
CRI-81	GE2.3 116RD 90HH r2.madE	659,825	4,988,365	606.5	LNTE
CRI-82	GE2.3 116RD 90HH r2.madE	663,271	4,988,133	613.0	LNTE
CRI-83	GE2.3 116RD 90HH r2.madE	662,227	4,988,103	606.5	LNTE
CRI-84	GE2.3 116RD 80HH r2.madE	660,677	4,987,880	600.5	LNTE
CRI-85	GE2.3 116RD 90HH r2.madE	659,295	4,987,798	612.0	LNTE

Crowned Ridge Wind Farm
GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
continued

WTG	Turbine Type	Easting (m)	Northing (m)	Base Elev. AMSL (m)	Sound Profile
CRI-86	GE2.3 116RD 90HH r2.madE	658,534	4,987,759	613.3	LNTE
CRI-87	GE2.3 116RD 90HH r2.madE	661,830	4,987,596	609.0	LNTE
CRI-88	GE2.3 116RD 90HH r2.madE	660,157	4,987,492	603.0	LNTE
CRI-89	GE2.3 116RD 80HH r2.madE	657,758	4,986,926	614.9	LNTE
CRI-90	GE2.3 116RD 80HH r2.madE	658,545	4,986,881	612.0	LNTE
CRI-91	GE2.3 116RD 80HH r2.madE	657,023	4,986,868	612.0	LNTE
CRI-92	GE2.3 116RD 80HH r2.madE	660,039	4,986,804	606.9	LNTE
CRI-93	GE2.3 116RD 80HH r2.madE	659,133	4,986,700	608.0	LNTE
CRI-94	GE2.3 116RD 80HH r2.madE	660,716	4,986,660	600.7	LNTE
CRI-95	GE2.3 116RD 90HH r2.madE	657,488	4,986,184	612.0	LNTE
CRI-96	GE2.3 116RD 90HH r2.madE	656,744	4,986,037	609.0	LNTE
CRI-97	GE2.3 116RD 80HH r2.madE	655,899	4,985,715	592.6	LNTE
CRI-98	GE2.3 116RD 90HH r2.madE	657,015	4,985,192	609.0	LNTE
CRI-99	GE2.3 116RD 90HH r2.madE	672,521	4,990,188	556.7	LNTE
CRI-100	GE2.3 116RD 90HH r2.madE	668,885	4,990,286	585.0	LNTE
CRI-101	GE2.3 116RD 90HH r2.madE	672,921	4,990,513	544.6	LNTE
CRI-102	GE2.3 116RD 90HH r2.madE	668,059	4,991,023	580.9	LNTE
CRI-103	GE2.3 116RD 90HH r2.madE	669,279	4,991,115	582.0	LNTE
CRI-104	GE2.3 116RD 90HH r2.madE	672,009	4,991,151	555.0	LNTE
CRI-105	GE2.3 116RD 90HH r2.madE	670,488	4,991,091	571.7	LNTE
CRI-106	GE2.3 116RD 90HH r2.madE	671,278	4,991,335	567.0	LNTE
CRI-107	GE2.3 116RD 90HH r2.madE	667,723	4,991,800	582.0	LNTE
CRI-108	GE2.3 116RD 90HH r2.madE	672,917	4,991,775	541.2	LNTE
CRI-109	GE2.3 116RD 90HH r2.madE	670,897	4,992,616	557.3	LNTE
CRI-111	GE2.3 116RD 90HH r2.madE	671,220	4,993,526	550.6	LNTE
CRI-112	GE2.3 116RD 90HH r2.madE	670,419	4,993,665	561.0	LNTE
CRI-113	GE2.3 116RD 90HH r2.madE	675,201	4,994,165	497.6	LNTE
CRI-114	GE2.3 116RD 90HH r2.madE	669,318	4,994,256	561.8	LNTE
CRI-115	GE2.3 116RD 90HH r2.madE	673,402	4,994,374	516.4	LNTE
CRI-116	GE2.3 116RD 90HH r2.madE	671,642	4,994,527	531.0	LNTE
CRI-117	GE2.3 116RD 90HH r2.madE	669,488	4,994,930	545.6	LNTE
CRI-118	GE2.3 116RD 90HH r2.madE	669,961	4,995,134	540.3	LNTE
CRI-119	GE2.3 116RD 90HH r2.madE	674,992	4,995,107	492.0	LNTE
CRI-120	GE2.3 116RD 90HH r2.madE	671,034	4,995,179	536.2	LNTE
CRI-121	GE2.3 116RD 90HH r2.madE	670,629	4,998,259	531.0	LNTE
CRI-122	GE2.3 116RD 90HH r2.madE	671,475	4,998,261	517.8	LNTE
CRI-123	GE2.3 116RD 90HH r2.madE	672,180	4,998,561	505.0	LNTE
CRI-124	GE2.3 116RD 90HH r2.madE	670,926	4,999,036	523.3	LNTE
CRI-125	GE2.3 116RD 90HH r2.madE	671,580	4,999,340	509.8	LNTE
CRI-126	GE2.3 116RD 90HH r2.madE	670,382	5,000,519	516.0	LNTE
CRI-127	GE2.3 116RD 90HH r2.madE	670,845	5,000,795	507.4	LNTE

Crowned Ridge Wind Farm
GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
continued

WTG	Turbine Type	Easting (m)	Northing (m)	Base Elev. AMSL (m)	Sound Profile
CRI-128	GE2.3 116RD 90HH r2.madE	671,388	5,001,034	498.4	LNTE
CRI-129	GE2.3 116RD 90HH r2.madE	667,516	5,000,900	553.8	LNTE
CRI-130	GE2.3 116RD 90HH r2.madE	668,158	5,001,149	546.0	LNTE
CRI-131	GE2.3 116RD 90HH r2.madE	670,512	5,002,137	504.0	LNTE
CRI-132	GE2.3 116RD 90HH r2.madE	670,875	5,002,186	499.0	LNTE
CRI-133	GE2.3 116RD 90HH r2.madE	669,990	5,002,521	502.6	LNTE
CRI-134	GE2.3 116RD 90HH r2.madE	671,497	5,002,893	483.0	LNTE
CRI-Alt1	GE2.3 116RD 90HH r2.madE	673,995	4,994,412	508.0	LNTE
CRI-Alt2	GE2.3 116RD 90HH r2.madE	669,250	4,992,900	562.3	LNTE
CRI-Alt3	GE2.3 116RD 90HH r2.madE	668,624	4,991,988	581.3	LNTE
CRI-Alt4	GE2.3 116RD 90HH r2.madE	670,047	5,003,703	495.4	LNTE
CRI-Alt7	GE2.3 116RD 90HH r2.madE	669,265	5,004,141	504.3	LNTE
CRI-Alt8	GE2.3 116RD 90HH r2.madE	667,012	5,004,840	525.5	LNTE
CRI-Alt9	GE2.3 116RD 90HH r2.madE	667,945	5,005,534	511.0	LNTE
CRI-Alt11	GE2.3 116RD 90HH r2.madE	668,585	5,005,813	499.5	LNTE
CRI-Alt12	GE2.3 116RD 90HH r2.madE	665,718	5,006,213	532.5	LNTE
CRI-Alt14	GE2.3 116RD 90HH r2.madE	667,485	5,006,268	514.9	LNTE
CRI-Alt15	GE2.3 116RD 90HH r2.madE	669,174	5,006,282	480.8	LNTE
CRI-Alt16	GE2.3 116RD 90HH r2.madE	665,280	5,006,161	540.0	LNTE
CRI-Alt17	GE2.3 116RD 90HH r2.madE	668,112	5,007,271	490.7	LNTE
CRI-Alt18	GE2.3 116RD 90HH r2.madE	668,857	5,007,463	475.0	LNTE
CRI-Alt19	GE2.3 116RD 90HH r2.madE	663,816	4,986,314	613.1	LNTE
CRI-Alt20	GE2.3 116RD 90HH r2.madE	664,124	4,986,705	611.8	LNTE
CRI-Alt22	GE2.3 116RD 90HH r2.madE	662,551	4,986,877	614.6	LNTE
CRI-Alt42	GE2.3 116RD 90HH r2.madE	659,646	4,992,833	585.0	LNTE
CRI-Alt45	GE2.3 116RD 90HH r2.madE	657,553	4,992,576	599.8	LNTE
CRI-Alt47	GE2.3 116RD 90HH r2.madE	659,131	4,991,788	579.0	LNTE

APPENDIX C: TABLE OF SOUND RESULTS

Table C-1: Crowned Ridge Sound Level Tabular Results Sorted by Receptor ID
Realistic case sound results at land parcel boundaries and occupied structures
Results using GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
Codington County

Receptor ID	Participation Status	Type	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Sound (dB(A))	Distance to Nearest Turbine (ft)
CR1-C1-NP	Non-P	Boundary	657,276	4,983,921	590.3	36.4	4,203
CR1-C2-NP	Non-P	Boundary	658,435	4,984,609	601.8	37.6	5,036
CR1-C3-NP	Non-P	Boundary	657,812	4,984,785	603.1	39.4	2,936
CR1-C4-NP	Non-P	Boundary	659,890	4,985,620	605.4	40.5	3,914
CR1-C6-P	Participant	Boundary	663,383	4,994,502	591.0	38.4	3,878
CR1-C7-NP	Non-P	Boundary	661,266	4,985,387	591.0	46.6	1,253
CR1-C8-P	Participant	Boundary	661,277	4,984,852	597.6	43.1	2,139
CR1-C9-P	Participant	Boundary	665,421	4,985,265	609.0	49.5	1,079
CR1-C10-P	Participant	Boundary	662,869	4,985,477	601.4	52.2	610
CR1-C11-P	Participant	Boundary	664,444	4,985,206	608.6	52.0	738
CR1-C12-P	Participant	Boundary	662,067	4,985,677	604.9	45.3	1,591
CR1-C13-P	Participant	Boundary	664,410	4,986,207	615.0	53.3	591
CR1-C14-NP	Non-P	Boundary	657,803	4,986,003	609.0	46.1	1,191
CR1-C15-P	Participant	Boundary	663,047	4,985,700	612.8	51.1	692
CR1-C16-NP	Non-P	Boundary	661,642	4,985,677	597.0	48.8	948
CR1-C17-P	Participant	Boundary	658,017	4,986,369	606.4	45.2	1,837
CR1-C18-P	Participant	Boundary	664,126	4,986,525	610.2	52.4	597
CR1-C19-P	Participant	Boundary	660,393	4,987,529	607.7	50.1	761
CR1-C20-P	Participant	Boundary	662,024	4,987,612	604.8	51.0	682
CR1-C26-P	Participant	Boundary	658,015	4,987,993	606.0	43.5	1,867
CR1-C27-NP	Non-P	Boundary	656,658	4,988,484	587.2	42.1	1,752
CR1-C28-NP	Non-P	Boundary	665,432	4,989,009	583.9	44.9	1,483
CR1-C29-NP	Non-P	Boundary	666,496	4,989,001	573.9	42.7	1,952
CR1-C30-P	Participant	Boundary	661,978	4,989,318	613.3	51.3	718
CR1-C31-NP	Non-P	Boundary	665,639	4,989,013	584.6	44.5	1,637
CR1-C32-NP	Non-P	Boundary	657,187	4,989,566	573.0	38.1	4,970
CR1-C33-NP	Non-P	Boundary	657,126	4,990,843	567.0	38.0	5,856
CR1-C34-NP	Non-P	Boundary	658,763	4,990,247	589.7	45.8	1,286
CR1-C35-P	Participant	Boundary	661,955	4,990,153	606.0	47.2	1,112
CR1-C36-P	Participant	Boundary	663,564	4,990,731	610.7	48.2	1,033
CR1-C37-P	Participant	Boundary	663,879	4,990,574	594.0	51.1	699
CR1-C38-NP	Non-P	Boundary	660,955	4,990,468	591.2	47.3	1,027
CR1-C39-NP	Non-P	Boundary	659,741	4,991,242	583.2	48.5	856
CR1-C40-NP	Non-P	Boundary	658,706	4,991,231	579.8	44.9	1,555
CR1-C41-NP	Non-P	Boundary	664,801	4,991,929	577.1	46.1	1,585
CR1-C42-P	Participant	Boundary	659,828	4,992,807	580.5	51.1	604
CR1-C44-NP	Non-P	Boundary	665,447	4,992,972	578.2	44.4	1,801
CR1-C45-NP	Non-P	Boundary	653,821	4,993,552	572.0	36.5	4,291
CR1-C46-P	Participant	Boundary	656,678	4,992,970	611.5	51.4	561

Table C-1: Crowned Ridge Sound Level Tabular Results Sorted by Receptor ID
Realistic case sound results at land parcel boundaries and occupied structures
Results using GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
Codington County
continued

Receptor ID	Participation Status	Type	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Sound (dB(A))	Distance to Nearest Turbine (ft)
CR1-C47-P	Participant	Boundary	663,454	4,992,888	612.0	46.8	1,076
CR1-C48-P	Participant	Boundary	664,262	4,992,514	586.8	53.6	577
CR1-C49-P	Participant	Boundary	662,224	4,993,664	609.0	38.4	5,105
CR1-C50-P	Participant	Boundary	656,239	4,994,042	618.0	49.6	984
CR1-C51-P	Participant	Boundary	657,753	4,994,889	620.0	51.4	564
CR1-C52-NP	Non-P	Boundary	654,986	4,995,398	603.0	45.1	1,335
CR1-C53-NP	Non-P	Boundary	664,171	4,995,340	580.6	37.3	4,009
CR1-C54-NP	Non-P	Boundary	663,495	4,995,329	582.9	36.5	5,075
CR1-C55-P	Participant	Boundary	660,139	4,994,937	606.2	49.4	722
CR1-C56-P	Participant	Boundary	655,392	4,995,175	606.2	44.9	1,621
CR1-C57-P	Participant	Boundary	656,526	4,995,198	616.1	45.4	1,319
CR1-C58-P	Participant	Boundary	657,619	4,997,581	611.9	50.4	732
CR1-C59-P	Participant	Boundary	661,380	5,000,092	591.0	50.2	623
CR1-C60-NP	Non-P	Boundary	656,909	4,998,465	609.3	41.3	2,218
CR1-C61-NP	Non-P	Boundary	656,927	4,997,826	612.0	47.8	912
CR1-C62-NP	Non-P	Boundary	658,155	4,994,994	614.7	48.6	820
CR1-C63-NP	Non-P	Boundary	658,543	4,995,211	606.8	42.3	2,277
CR1-C64-P	Participant	Boundary	659,129	4,991,995	576.5	49.9	679
CR1-C65-NP	Non-P	Boundary	665,516	4,995,045	578.0	39.1	2,825
CR1-C70-NP	Non-P	Boundary	664,953	4,987,981	596.1	42.7	2,940
CR1-C71-NP	Non-P	Boundary	664,658	4,987,355	600.0	48.6	909
CR2-C150-P	Participant	Boundary	657,308	4,986,173	600.0	51.3	591
CR1-C1-NP	Non-P	Structure	656,743	4,983,525	595.9	34.9	4,203
CR1-C2-NP	Non-P	Structure	658,791	4,984,483	601.6	37.3	5,036
CR1-C3-NP	Non-P	Structure	657,888	4,984,697	604.2	38.8	2,936
CR1-C4-NP	Non-P	Structure	659,744	4,984,749	605.9	38.5	3,914
CR1-C5-NP	Non-P	Structure	659,958	4,984,794	605.2	38.8	5,659
CR1-C6-P	Participant	Structure	662,989	4,995,228	599.8	36.3	3,878
CR1-C7-NP	Non-P	Structure	660,893	4,984,861	593.2	41.3	1,253
CR1-C8-P	Participant	Structure	660,532	4,984,445	599.7	40.1	2,139
CR1-C9-P	Participant	Structure	665,352	4,985,004	609.0	47.7	1,079
CR1-C10-P	Participant	Structure	663,510	4,985,195	609.0	47.0	610
CR1-C11-P	Participant	Structure	664,111	4,985,679	609.0	47.9	738
CR1-C12-P	Participant	Structure	662,222	4,985,736	603.0	44.3	1,591
CR1-C12-1-P	Participant	Structure	662,199	4,986,047	606.0	43.6	2,818
CR1-C13-P	Participant	Structure	663,792	4,985,785	612.0	46.9	591
CR1-C14-NP	Non-P	Structure	657,982	4,985,894	609.0	43.4	1,191
CR1-C15-P	Participant	Structure	663,291	4,986,026	615.0	46.1	692

Table C-1: Crowned Ridge Sound Level Tabular Results Sorted by Receptor ID
Realistic case sound results at land parcel boundaries and occupied structures
Results using GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
Codington County
continued

Receptor ID	Participation Status	Type	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Sound (dB(A))	Distance to Nearest Turbine (ft)
CR1-C16-NP	Non-P	Structure	661,960	4,986,288	606.0	43.3	948
CR1-C17-P	Participant	Structure	658,031	4,986,373	609.1	45.1	1,837
CR1-C18-P	Participant	Structure	663,651	4,987,157	610.5	44.8	597
CR1-C19-P	Participant	Structure	659,243	4,987,276	611.5	46.4	761
CR1-C20-P	Participant	Structure	663,054	4,987,455	606.0	44.5	682
CR1-C21-P	Participant	Structure	660,756	4,984,086	594.8	42.0	2,388
CR1-C22-P	Participant	Structure	660,755	4,984,082	594.8	42.0	2,375
CR1-C23-P	Participant	Structure	660,619	4,984,078	596.0	41.5	2,523
CR1-C26-P	Participant	Structure	657,767	4,988,493	597.0	40.6	1,867
CR1-C27-NP	Non-P	Structure	656,876	4,988,683	583.0	40.0	1,752
CR1-C28-NP	Non-P	Structure	665,429	4,988,598	590.8	42.1	1,483
CR1-C29-NP	Non-P	Structure	666,572	4,988,867	575.9	41.4	1,952
CR1-C30-P	Participant	Structure	661,699	4,988,957	615.0	47.9	718
CR1-C31-NP	Non-P	Structure	665,939	4,988,950	585.4	43.4	1,637
CR1-C32-NP	Non-P	Structure	655,843	4,989,581	568.6	37.0	4,970
CR1-C33-NP	Non-P	Structure	656,839	4,990,404	569.8	37.3	5,856
CR1-C34-NP	Non-P	Structure	658,661	4,990,389	589.1	44.5	1,286
CR1-C35-P	Participant	Structure	662,025	4,990,475	609.0	43.9	1,112
CR1-C36-P	Participant	Structure	663,181	4,990,600	615.0	46.2	1,033
CR1-C37-P	Participant	Structure	663,563	4,991,342	605.1	46.5	699
CR1-C38-NP	Non-P	Structure	660,639	4,991,557	597.0	40.9	1,027
CR1-C39-NP	Non-P	Structure	660,144	4,991,670	588.0	42.2	856
CR1-C40-NP	Non-P	Structure	657,865	4,991,818	583.8	41.5	1,555
CR1-C41-NP	Non-P	Structure	665,053	4,992,084	576.1	45.0	1,585
CR1-C42-P	Participant	Structure	659,458	4,992,229	580.0	44.6	604
CR1-C44-NP	Non-P	Structure	665,076	4,993,095	578.2	44.0	1,801
CR1-C45-NP	Non-P	Structure	653,390	4,993,503	573.0	34.8	4,291
CR1-C46-P	Participant	Structure	655,802	4,993,540	609.7	45.9	561
CR1-C47-P	Participant	Structure	662,825	4,993,508	613.8	39.4	1,076
CR1-C48-P	Participant	Structure	664,247	4,993,646	588.0	44.7	577
CR1-C49-P	Participant	Structure	662,250	4,993,731	609.0	38.3	5,105
CR1-C50-P	Participant	Structure	656,806	4,994,388	621.0	46.7	984
CR1-C51-P	Participant	Structure	657,455	4,995,160	621.0	43.9	564
CR1-C52-NP	Non-P	Structure	654,924	4,995,231	603.0	44.0	1,335
CR1-C53-NP	Non-P	Structure	663,376	4,996,043	578.6	35.1	4,009
CR1-C54-NP	Non-P	Structure	663,421	4,995,376	583.4	36.3	5,075
CR1-C55-P	Participant	Structure	660,914	4,995,169	607.9	39.3	722
CR1-C56-P	Participant	Structure	655,953	4,995,244	606.0	43.9	1,621

Table C-1: Crowned Ridge Sound Level Tabular Results Sorted by Receptor ID
Realistic case sound results at land parcel boundaries and occupied structures
Results using GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
Codington County
continued

Receptor ID	Participation Status	Type	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Sound (dB(A))	Distance to Nearest Turbine (ft)
CR1-C57-P	Participant	Structure	656,628	4,995,266	615.0	44.2	1,319
CR1-C58-P	Participant	Structure	657,781	4,996,906	615.0	44.8	732
CR1-C59-P	Participant	Structure	661,548	5,000,754	584.1	42.5	623
CR1-C60-NP	Non-P	Structure	656,855	4,998,565	613.5	40.3	2,218
CR1-C61-NP	Non-P	Structure	656,690	4,997,831	612.0	43.1	912
CR1-C62-NP	Non-P	Structure	658,375	4,995,138	615.0	43.9	820
CR1-C63-NP	Non-P	Structure	658,566	4,995,254	612.6	41.9	2,277
CR1-C64-P	Participant	Structure	659,436	4,992,174	581.0	44.8	679
CR1-C65-NP	Non-P	Structure	665,805	4,995,305	579.0	37.3	2,825
CR1-C66-NP	Non-P	Structure	659,718	4,985,032	606.0	38.9	5,800
CR1-C67-NP	Non-P	Structure	659,789	4,985,057	606.0	39.0	5,791
CR1-C68-P	Participant	Structure	662,652	4,987,606	609.0	45.4	2,146
CR1-C69-P	Participant	Structure	662,685	4,987,619	609.0	45.3	2,185
CR1-C70-NP	Non-P	Structure	665,135	4,988,293	595.7	42.0	2,940
CR1-C71-NP	Non-P	Structure	665,137	4,988,378	594.6	42.1	909
CR1-C72-NP	Non-P	Structure	665,158	4,988,170	595.2	42.1	3,776
CR2-C150-P	Participant	Structure	657,178	4,985,788	612.0	46.1	591

Table C-1: Crowned Ridge Sound Level Tabular Results Sorted by Receptor ID
Realistic case sound results Structure occupied structures and accessory structures
Results using GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
Grant County
continued

Receptor ID	Participation Status	Type	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Sound (dB(A))	Distance to Nearest Turbine (ft)
CR1-G12-NP	Non-P	Structure	668,229	4,989,039	575.0	38.0	4,623
CR1-G13-NP	Non-P	Structure	672,216	4,989,142	558.0	37.2	3,576
CR1-G14-NP	Non-P	Structure	668,156	4,989,332	574.1	38.7	3,940
CR1-G15-P	Participant	Structure	668,396	4,989,607	576.0	40.0	2,746
CR1-G16-NP	Non-P	Structure	668,419	4,989,861	576.0	41.8	2,070
CR1-G18-P	Participant	Structure	668,678	4,990,722	585.0	45.1	1,585
CR1-G19-P	Participant	Structure	671,018	4,990,744	570.0	43.4	2,077
CR1-G21-P	Participant	Structure	666,766	4,991,807	577.1	44.9	1,555
CR1-G22-NP	Non-P	Structure	674,670	4,991,955	527.6	34.8	5,781
CR1-G23-NP	Non-P	Structure	670,471	4,992,104	560.1	42.5	2,185
CR1-G24-P	Participant	Structure	673,058	4,992,440	539.4	40.5	2,231
CR1-G25-P	Participant	Structure	671,391	4,992,858	549.0	43.8	1,804
CR1-G26-NP	Non-P	Structure	672,589	4,993,869	531.0	39.9	3,140
CR1-G27-NP	Non-P	Structure	676,630	4,994,642	480.8	33.9	4,944
CR1-G28-P	Participant	Structure	673,113	4,994,772	514.1	43.2	1,614
CR1-G32-P	Participant	Structure	669,477	4,995,401	546.0	45.1	1,545
CR1-G33-P	Participant	Structure	668,911	4,995,550	548.7	39.9	2,779
CR1-G34-NP	Non-P	Structure	671,320	4,995,798	531.0	40.8	2,238
CR1-G36-NP	Non-P	Structure	673,559	4,996,344	498.1	35.4	6,211
CR1-G37-NP	Non-P	Structure	668,998	4,996,452	549.0	36.6	5,246
CR1-G38-NP	Non-P	Structure	673,972	4,996,493	494.5	35.0	5,646
CR1-G41-P	Participant	Structure	671,563	4,997,050	497.7	37.9	3,983
CR1-G42-NP	Non-P	Structure	670,566	4,997,097	518.9	38.0	3,819
CR1-G43-NP	Non-P	Structure	661,141	5,001,721	584.2	42.7	1,909
CR1-G44-NP	Non-P	Structure	661,781	5,001,732	583.7	38.6	3,123
CR1-G59-P	Participant	Structure	675,755	4,994,888	488.3	39.6	2,605
CR1-G60-P	Participant	Structure	675,830	4,995,687	477.0	36.3	3,343
CR1-G65-P	Participant	Structure	671,496	4,994,973	537.0	45.3	1,539
CR1-G66-P	Participant	Structure	670,802	4,994,681	539.8	44.0	1,801
CR1-G67-P	Participant	Structure	669,597	4,993,440	555.8	43.2	2,106
CR1-G68-NP	Non-P	Structure	669,159	4,993,632	564.7	43.0	2,113
CR1-G77-NP	Non-P	Structure	676,031	4,992,629	503.1	33.2	5,728
CR1-G81-NP	Non-P	Structure	671,478	4,997,523	508.7	40.7	2,421
CR1-G105-NP	Non-P	Structure	668,696	4,998,325	549.0	35.2	6,345
CR1-G108-NP	Non-P	Structure	669,516	5,001,186	522.2	39.7	3,586
CR1-G109-NP	Non-P	Structure	667,064	5,000,425	566.4	40.0	2,152
CR1-G110-NP	Non-P	Structure	671,218	5,005,064	456.4	34.7	5,889
CR1-G113-NP	Non-P	Structure	666,228	5,005,549	537.0	40.2	2,746

Table C-1: Crowned Ridge Sound Level Tabular Results Sorted by Receptor ID
Realistic case sound results Structure occupied structures and accessory structures
Results using GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
Grant County
continued

Receptor ID	Participation Status	Type	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Sound (dB(A))	Distance to Nearest Turbine (ft)
CR1-G114-NP	Non-P	Structure	666,214	5,006,667	520.8	40.7	2,205
CR1-G115-NP	Non-P	Structure	664,933	5,006,731	544.6	40.4	2,188
CR1-G117-NP	Non-P	Structure	663,801	5,005,084	581.3	33.0	6,004
CR1-G124-P	Participant	Structure	669,843	5,000,605	525.0	42.7	1,791
CR1-G125-NP	Non-P	Structure	668,289	5,000,643	543.0	42.8	1,716
CR1-G126-NP	Non-P	Structure	672,157	5,000,446	484.3	39.3	3,176
CR1-G127-NP	Non-P	Structure	669,534	4,999,939	533.9	38.7	3,369
CR1-G128-NP	Non-P	Structure	670,242	5,001,314	513.0	42.8	2,612
CR1-G129-NP	Non-P	Structure	673,111	4,997,703	477.8	36.3	4,153
CR1-G130-NP	Non-P	Structure	668,147	5,000,233	549.0	39.3	3,005
CR1-G131-NP	Non-P	Structure	668,466	5,005,145	505.1	42.9	2,133
CR1-G132-NP	Non-P	Structure	669,098	5,004,948	501.0	40.6	2,703
CR1-G133-NP	Non-P	Structure	669,881	5,005,460	478.8	38.3	3,556
CR1-G135-NP	Non-P	Structure	668,616	5,005,161	504.2	42.5	2,142
CR1-G136-NP	Non-P	Structure	667,706	5,004,861	522.0	42.2	2,277
CR1-G137-NP	Non-P	Structure	666,501	5,005,136	529.5	41.5	1,939
CR1-G138-NP	Non-P	Structure	664,809	5,006,456	549.0	41.7	1,824
CR1-G139-NP	Non-P	Structure	668,199	5,008,062	475.9	39.8	2,612
CR1-G140-P	Participant	Structure	664,546	5,007,269	551.1	34.6	4,360

Table C-2: Crowned Ridge Sound Level Tabular Results Sorted by Sound Level
Realistic case sound results at land parcel boundaries and occupied structures
Results using GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
Codington County

Receptor ID	Participation Status	Type	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Sound (dB(A))	Distance to Nearest Turbine (ft)
CR1-C16-NP	Non-P	Boundary	661,642	4,985,677	597.0	48.8	948
CR1-C62-NP	Non-P	Boundary	658,155	4,994,994	614.7	48.6	820
CR1-C71-NP	Non-P	Boundary	664,658	4,987,355	600.0	48.6	909
CR1-C39-NP	Non-P	Boundary	659,741	4,991,242	583.2	48.5	856
CR1-C61-NP	Non-P	Boundary	656,927	4,997,826	612.0	47.8	912
CR1-C38-NP	Non-P	Boundary	660,955	4,990,468	591.2	47.3	1,027
CR1-C7-NP	Non-P	Boundary	661,266	4,985,387	591.0	46.6	1,253
CR1-C14-NP	Non-P	Boundary	657,803	4,986,003	609.0	46.1	1,191
CR1-C41-NP	Non-P	Boundary	664,801	4,991,929	577.1	46.1	1,585
CR1-C34-NP	Non-P	Boundary	658,763	4,990,247	589.7	45.8	1,286
CR1-C52-NP	Non-P	Boundary	654,986	4,995,398	603.0	45.1	1,335
CR1-C28-NP	Non-P	Boundary	665,432	4,989,009	583.9	44.9	1,483
CR1-C40-NP	Non-P	Boundary	658,706	4,991,231	579.8	44.9	1,555
CR1-C31-NP	Non-P	Boundary	665,639	4,989,013	584.6	44.5	1,637
CR1-C44-NP	Non-P	Boundary	665,447	4,992,972	578.2	44.4	1,801
CR1-C70-NP	Non-P	Boundary	664,953	4,987,981	596.1	42.7	2,940
CR1-C29-NP	Non-P	Boundary	666,496	4,989,001	573.9	42.7	1,952
CR1-C63-NP	Non-P	Boundary	658,543	4,995,211	606.8	42.3	2,277
CR1-C27-NP	Non-P	Boundary	656,658	4,988,484	587.2	42.1	1,752
CR1-C60-NP	Non-P	Boundary	656,909	4,998,465	609.3	41.3	2,218
CR1-C4-NP	Non-P	Boundary	659,890	4,985,620	605.4	40.5	3,914
CR1-C3-NP	Non-P	Boundary	657,812	4,984,785	603.1	39.4	2,936
CR1-C65-NP	Non-P	Boundary	665,516	4,995,045	578.0	39.1	2,825
CR1-C32-NP	Non-P	Boundary	657,187	4,989,566	573.0	38.1	4,970
CR1-C33-NP	Non-P	Boundary	657,126	4,990,843	567.0	38.0	5,856
CR1-C2-NP	Non-P	Boundary	658,435	4,984,609	601.8	37.6	5,036
CR1-C53-NP	Non-P	Boundary	664,171	4,995,340	580.6	37.3	4,009
CR1-C45-NP	Non-P	Boundary	653,821	4,993,552	572.0	36.5	4,291
CR1-C54-NP	Non-P	Boundary	663,495	4,995,329	582.9	36.5	5,075
CR1-C1-NP	Non-P	Boundary	657,276	4,983,921	590.3	36.4	4,203
CR1-C48-P	Participant	Boundary	664,262	4,992,514	586.8	53.6	577
CR1-C13-P	Participant	Boundary	664,410	4,986,207	615.0	53.3	591
CR1-C18-P	Participant	Boundary	664,126	4,986,525	610.2	52.4	597
CR1-C10-P	Participant	Boundary	662,869	4,985,477	601.4	52.2	610
CR1-C11-P	Participant	Boundary	664,444	4,985,206	608.6	52.0	738
CR1-C46-P	Participant	Boundary	656,678	4,992,970	611.5	51.4	561
CR1-C51-P	Participant	Boundary	657,753	4,994,889	620.0	51.4	564
CR1-C30-P	Participant	Boundary	661,978	4,989,318	613.3	51.3	718
CR2-C150-P	Participant	Boundary	657,308	4,986,173	600.0	51.3	591

Table C-2: Crowned Ridge Sound Level Tabular Results Sorted by Sound Level
Realistic case sound results at land parcel boundaries and occupied structures
Results using GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
Codington County
continued

Receptor ID	Participation Status	Type	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Sound (dB(A))	Distance to Nearest Turbine (ft)
CR1-C15-P	Participant	Boundary	663,047	4,985,700	612.8	51.1	692
CR1-C37-P	Participant	Boundary	663,879	4,990,574	594.0	51.1	699
CR1-C42-P	Participant	Boundary	659,828	4,992,807	580.5	51.1	604
CR1-C20-P	Participant	Boundary	662,024	4,987,612	604.8	51.0	682
CR1-C58-P	Participant	Boundary	657,619	4,997,581	611.9	50.4	732
CR1-C59-P	Participant	Boundary	661,380	5,000,092	591.0	50.2	623
CR1-C19-P	Participant	Boundary	660,393	4,987,529	607.7	50.1	761
CR1-C64-P	Participant	Boundary	659,129	4,991,995	576.5	49.9	679
CR1-C50-P	Participant	Boundary	656,239	4,994,042	618.0	49.6	984
CR1-C9-P	Participant	Boundary	665,421	4,985,265	609.0	49.5	1,079
CR1-C55-P	Participant	Boundary	660,139	4,994,937	606.2	49.4	722
CR1-C36-P	Participant	Boundary	663,564	4,990,731	610.7	48.2	1,033
CR1-C35-P	Participant	Boundary	661,955	4,990,153	606.0	47.2	1,112
CR1-C47-P	Participant	Boundary	663,454	4,992,888	612.0	46.8	1,076
CR1-C57-P	Participant	Boundary	656,526	4,995,198	616.1	45.4	1,319
CR1-C12-P	Participant	Boundary	662,067	4,985,677	604.9	45.3	1,591
CR1-C17-P	Participant	Boundary	658,017	4,986,369	606.4	45.2	1,837
CR1-C56-P	Participant	Boundary	655,392	4,995,175	606.2	44.9	1,621
CR1-C26-P	Participant	Boundary	658,015	4,987,993	606.0	43.5	1,867
CR1-C8-P	Participant	Boundary	661,277	4,984,852	597.6	43.1	2,139
CR1-C49-P	Participant	Boundary	662,224	4,993,664	609.0	38.4	5,105
CR1-C6-P	Participant	Boundary	663,383	4,994,502	591.0	38.4	3,878
CR1-C41-NP	Non-P	Structure	665,053	4,992,084	576.1	45.0	1,585
CR1-C34-NP	Non-P	Structure	658,661	4,990,389	589.1	44.5	1,286
CR1-C44-NP	Non-P	Structure	665,076	4,993,095	578.2	44.0	1,801
CR1-C52-NP	Non-P	Structure	654,924	4,995,231	603.0	44.0	1,335
CR1-C62-NP	Non-P	Structure	658,375	4,995,138	615.0	43.9	820
CR1-C14-NP	Non-P	Structure	657,982	4,985,894	609.0	43.4	1,191
CR1-C31-NP	Non-P	Structure	665,939	4,988,950	585.4	43.4	1,637
CR1-C16-NP	Non-P	Structure	661,960	4,986,288	606.0	43.3	948
CR1-C61-NP	Non-P	Structure	656,690	4,997,831	612.0	43.1	912
CR1-C39-NP	Non-P	Structure	660,144	4,991,670	588.0	42.2	856
CR1-C28-NP	Non-P	Structure	665,429	4,988,598	590.8	42.1	1,483
CR1-C71-NP	Non-P	Structure	665,137	4,988,378	594.6	42.1	909
CR1-C72-NP	Non-P	Structure	665,158	4,988,170	595.2	42.1	3,776
CR1-C70-NP	Non-P	Structure	665,135	4,988,293	595.7	42.0	2,940
CR1-C63-NP	Non-P	Structure	658,566	4,995,254	612.6	41.9	2,277
CR1-C40-NP	Non-P	Structure	657,865	4,991,818	583.8	41.5	1,555

Table C-2: Crowned Ridge Sound Level Tabular Results Sorted by Sound Level
Realistic case sound results at land parcel boundaries and occupied structures
Results using GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
Codington County
continued

Receptor ID	Participation Status	Type	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Sound (dB(A))	Distance to Nearest Turbine (ft)
CR1-C29-NP	Non-P	Structure	666,572	4,988,867	575.9	41.4	1,952
CR1-C7-NP	Non-P	Structure	660,893	4,984,861	593.2	41.3	1,253
CR1-C38-NP	Non-P	Structure	660,639	4,991,557	597.0	40.9	1,027
CR1-C60-NP	Non-P	Structure	656,855	4,998,565	613.5	40.3	2,218
CR1-C27-NP	Non-P	Structure	656,876	4,988,683	583.0	40.0	1,752
CR1-C67-NP	Non-P	Structure	659,789	4,985,057	606.0	39.0	5,791
CR1-C66-NP	Non-P	Structure	659,718	4,985,032	606.0	38.9	5,800
CR1-C3-NP	Non-P	Structure	657,888	4,984,697	604.2	38.8	2,936
CR1-C5-NP	Non-P	Structure	659,958	4,984,794	605.2	38.8	5,659
CR1-C4-NP	Non-P	Structure	659,744	4,984,749	605.9	38.5	3,914
CR1-C2-NP	Non-P	Structure	658,791	4,984,483	601.6	37.3	5,036
CR1-C33-NP	Non-P	Structure	656,839	4,990,404	569.8	37.3	5,856
CR1-C65-NP	Non-P	Structure	665,805	4,995,305	579.0	37.3	2,825
CR1-C32-NP	Non-P	Structure	655,843	4,989,581	568.6	37.0	4,970
CR1-C54-NP	Non-P	Structure	663,421	4,995,376	583.4	36.3	5,075
CR1-C53-NP	Non-P	Structure	663,376	4,996,043	578.6	35.1	4,009
CR1-C1-NP	Non-P	Structure	656,743	4,983,525	595.9	34.9	4,203
CR1-C45-NP	Non-P	Structure	653,390	4,993,503	573.0	34.8	4,291
CR1-C11-P	Participant	Structure	664,111	4,985,679	609.0	47.9	738
CR1-C30-P	Participant	Structure	661,699	4,988,957	615.0	47.9	718
CR1-C9-P	Participant	Structure	665,352	4,985,004	609.0	47.7	1,079
CR1-C10-P	Participant	Structure	663,510	4,985,195	609.0	47.0	610
CR1-C13-P	Participant	Structure	663,792	4,985,785	612.0	46.9	591
CR1-C50-P	Participant	Structure	656,806	4,994,388	621.0	46.7	984
CR1-C37-P	Participant	Structure	663,563	4,991,342	605.1	46.5	699
CR1-C19-P	Participant	Structure	659,243	4,987,276	611.5	46.4	761
CR1-C36-P	Participant	Structure	663,181	4,990,600	615.0	46.2	1,033
CR1-C15-P	Participant	Structure	663,291	4,986,026	615.0	46.1	692
CR2-C150-P	Participant	Structure	657,178	4,985,788	612.0	46.1	591
CR1-C46-P	Participant	Structure	655,802	4,993,540	609.7	45.9	561
CR1-C68-P	Participant	Structure	662,652	4,987,606	609.0	45.4	2,146
CR1-C69-P	Participant	Structure	662,685	4,987,619	609.0	45.3	2,185
CR1-C17-P	Participant	Structure	658,031	4,986,373	609.1	45.1	1,837
CR1-C18-P	Participant	Structure	663,651	4,987,157	610.5	44.8	597
CR1-C58-P	Participant	Structure	657,781	4,996,906	615.0	44.8	732
CR1-C64-P	Participant	Structure	659,436	4,992,174	581.0	44.8	679
CR1-C48-P	Participant	Structure	664,247	4,993,646	588.0	44.7	577
CR1-C42-P	Participant	Structure	659,458	4,992,229	580.0	44.6	604

Table C-2: Crowned Ridge Sound Level Tabular Results Sorted by Sound Level
Realistic case sound results at land parcel boundaries and occupied structures
Results using GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
Codington County
continued

Receptor ID	Participation Status	Type	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Sound (dB(A))	Distance to Nearest Turbine (ft)
CR1-C20-P	Participant	Structure	663,054	4,987,455	606.0	44.5	682
CR1-C12-P	Participant	Structure	662,222	4,985,736	603.0	44.3	1,591
CR1-C57-P	Participant	Structure	656,628	4,995,266	615.0	44.2	1,319
CR1-C35-P	Participant	Structure	662,025	4,990,475	609.0	43.9	1,112
CR1-C51-P	Participant	Structure	657,455	4,995,160	621.0	43.9	564
CR1-C56-P	Participant	Structure	655,953	4,995,244	606.0	43.9	1,621
CR1-C12-1-P	Participant	Structure	662,199	4,986,047	606.0	43.6	2,818
CR1-C59-P	Participant	Structure	661,548	5,000,754	584.1	42.5	623
CR1-C21-P	Participant	Structure	660,756	4,984,086	594.8	42.0	2,388
CR1-C22-P	Participant	Structure	660,755	4,984,082	594.8	42.0	2,375
CR1-C23-P	Participant	Structure	660,619	4,984,078	596.0	41.5	2,523
CR1-C26-P	Participant	Structure	657,767	4,988,493	597.0	40.6	1,867
CR1-C8-P	Participant	Structure	660,532	4,984,445	599.7	40.1	2,139
CR1-C47-P	Participant	Structure	662,825	4,993,508	613.8	39.4	1,076
CR1-C55-P	Participant	Structure	660,914	4,995,169	607.9	39.3	722
CR1-C49-P	Participant	Structure	662,250	4,993,731	609.0	38.3	5,105
CR1-C6-P	Participant	Structure	662,989	4,995,228	599.8	36.3	3,878

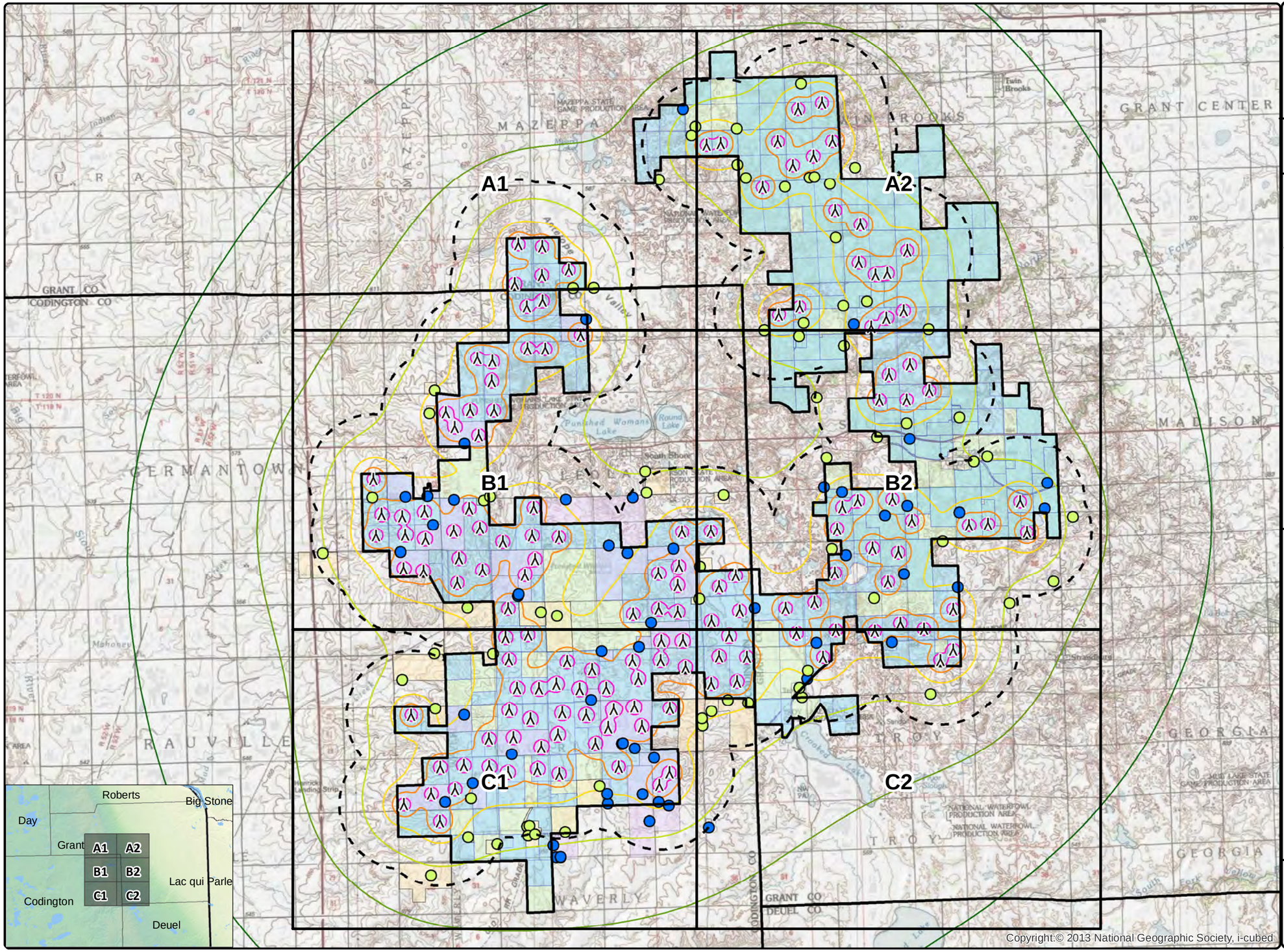
Table C-2: Crowned Ridge Sound Level Tabular Results Sorted by Sound Level
Realistic case sound results Structure occupied structures and accessory structures
Results using GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
Grant County
continued

Receptor ID	Participation Status	Type	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Sound (dB(A))	Distance to Nearest Turbine (ft)
CR1-G68-NP	Non-P	Structure	669,159	4,993,632	564.7	43.0	2,113
CR1-G131-NP	Non-P	Structure	668,466	5,005,145	505.1	42.9	2,133
CR1-G128-NP	Non-P	Structure	670,242	5,001,314	513.0	42.8	2,612
CR1-G125-NP	Non-P	Structure	668,289	5,000,643	543.0	42.8	1,716
CR1-G43-NP	Non-P	Structure	661,141	5,001,721	584.2	42.7	1,909
CR1-G23-NP	Non-P	Structure	670,471	4,992,104	560.1	42.5	2,185
CR1-G135-NP	Non-P	Structure	668,616	5,005,161	504.2	42.5	2,142
CR1-G136-NP	Non-P	Structure	667,706	5,004,861	522.0	42.2	2,277
CR1-G16-NP	Non-P	Structure	668,419	4,989,861	576.0	41.8	2,070
CR1-G138-NP	Non-P	Structure	664,809	5,006,456	549.0	41.7	1,824
CR1-G137-NP	Non-P	Structure	666,501	5,005,136	529.5	41.5	1,939
CR1-G34-NP	Non-P	Structure	671,320	4,995,798	531.0	40.8	2,238
CR1-G81-NP	Non-P	Structure	671,478	4,997,523	508.7	40.7	2,421
CR1-G114-NP	Non-P	Structure	666,214	5,006,667	520.8	40.7	2,205
CR1-G132-NP	Non-P	Structure	669,098	5,004,948	501.0	40.6	2,703
CR1-G115-NP	Non-P	Structure	664,933	5,006,731	544.6	40.4	2,188
CR1-G113-NP	Non-P	Structure	666,228	5,005,549	537.0	40.2	2,746
CR1-G109-NP	Non-P	Structure	667,064	5,000,425	566.4	40.0	2,152
CR1-G26-NP	Non-P	Structure	672,589	4,993,869	531.0	39.9	3,140
CR1-G139-NP	Non-P	Structure	668,199	5,008,062	475.9	39.8	2,612
CR1-G108-NP	Non-P	Structure	669,516	5,001,186	522.2	39.7	3,586
CR1-G126-NP	Non-P	Structure	672,157	5,000,446	484.3	39.3	3,176
CR1-G130-NP	Non-P	Structure	668,147	5,000,233	549.0	39.3	3,005
CR1-G14-NP	Non-P	Structure	668,156	4,989,332	574.1	38.7	3,940
CR1-G127-NP	Non-P	Structure	669,534	4,999,939	533.9	38.7	3,369
CR1-G44-NP	Non-P	Structure	661,781	5,001,732	583.7	38.6	3,123
CR1-G133-NP	Non-P	Structure	669,881	5,005,460	478.8	38.3	3,556
CR1-G42-NP	Non-P	Structure	670,566	4,997,097	518.9	38.0	3,819
CR1-G12-NP	Non-P	Structure	668,229	4,989,039	575.0	38.0	4,623
CR1-G13-NP	Non-P	Structure	672,216	4,989,142	558.0	37.2	3,576
CR1-G37-NP	Non-P	Structure	668,998	4,996,452	549.0	36.6	5,246
CR1-G129-NP	Non-P	Structure	673,111	4,997,703	477.8	36.3	4,153
CR1-G36-NP	Non-P	Structure	673,559	4,996,344	498.1	35.4	6,211
CR1-G105-NP	Non-P	Structure	668,696	4,998,325	549.0	35.2	6,345
CR1-G38-NP	Non-P	Structure	673,972	4,996,493	494.5	35.0	5,646
CR1-G22-NP	Non-P	Structure	674,670	4,991,955	527.6	34.8	5,781
CR1-G110-NP	Non-P	Structure	671,218	5,005,064	456.4	34.7	5,889
CR1-G27-NP	Non-P	Structure	676,630	4,994,642	480.8	33.9	4,944

Table C-2: Crowned Ridge Sound Level Tabular Results Sorted by Sound Level
Realistic case sound results Structure occupied structures and accessory structures
Results using GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
Grant County
continued

Receptor ID	Participation Status	Type	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Sound (dB(A))	Distance to Nearest Turbine (ft)
CR1-G77-NP	Non-P	Structure	676,031	4,992,629	503.1	33.2	5,728
CR1-G117-NP	Non-P	Structure	663,801	5,005,084	581.3	33.0	6,004
CR1-G65-P	Participant	Structure	671,496	4,994,973	537.0	45.3	1,539
CR1-G18-P	Participant	Structure	668,678	4,990,722	585.0	45.1	1,585
CR1-G32-P	Participant	Structure	669,477	4,995,401	546.0	45.1	1,545
CR1-G21-P	Participant	Structure	666,766	4,991,807	577.1	44.9	1,555
CR1-G66-P	Participant	Structure	670,802	4,994,681	539.8	44.0	1,801
CR1-G25-P	Participant	Structure	671,391	4,992,858	549.0	43.8	1,804
CR1-G19-P	Participant	Structure	671,018	4,990,744	570.0	43.4	2,077
CR1-G67-P	Participant	Structure	669,597	4,993,440	555.8	43.2	2,106
CR1-G28-P	Participant	Structure	673,113	4,994,772	514.1	43.2	1,614
CR1-G124-P	Participant	Structure	669,843	5,000,605	525.0	42.7	1,791
CR1-G24-P	Participant	Structure	673,058	4,992,440	539.4	40.5	2,231
CR1-G15-P	Participant	Structure	668,396	4,989,607	576.0	40.0	2,746
CR1-G33-P	Participant	Structure	668,911	4,995,550	548.7	39.9	2,779
CR1-G59-P	Participant	Structure	675,755	4,994,888	488.3	39.6	2,605
CR1-G41-P	Participant	Structure	671,563	4,997,050	497.7	37.9	3,983
CR1-G60-P	Participant	Structure	675,830	4,995,687	477.0	36.3	3,343
CR1-G140-P	Participant	Structure	664,546	5,007,269	551.1	34.6	4,360

APPENDIX D: STANDARD RESOLUTION SOUND MAPS



0 0.75 1.5 3 Mile

EAPC WIND ENERGY

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Crowned Ridge Wind Farm
Sound Pressure Iso-Lines
Overview Map

Client

SWCA Environmental Consultants

Project Description

Wind turbine layout with occupied structures and parcel boundaries within 2 km.

Predicted sound pressure levels at existing residences and land parcel boundaries.

Additional 2 dBA added.

Location: Watertown, SD
Project #: 20174430

Issue Dates

#	Description	Date
1	Original	2019.01.15

Drawn By: AS *Checked By: JH*

Legend

- Crowned Ridge Turbines
- 2 km Turbine Buffer
- County Lines
- CR1 Project Boundary
- Non-Participants
- Participants

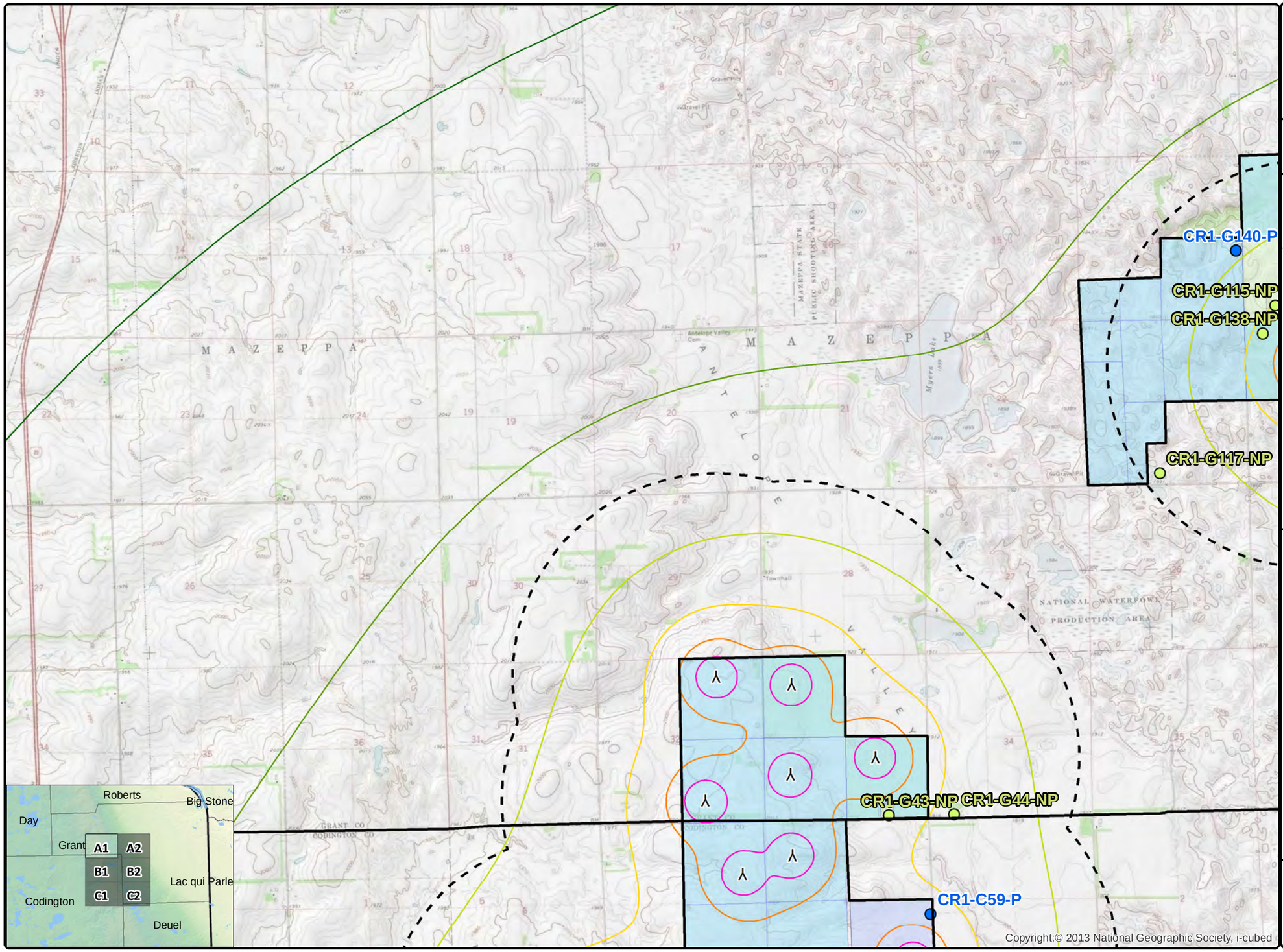
Sound Pressure (dBA)

- 25
- 30
- 35
- 40
- 45
- 50
- Participating Codington Parcels
- Non-Part. Codington Parcels
- Participating Land Parcels
- Non-Participating Land Parcels

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0 0.25 0.5 1 Mile

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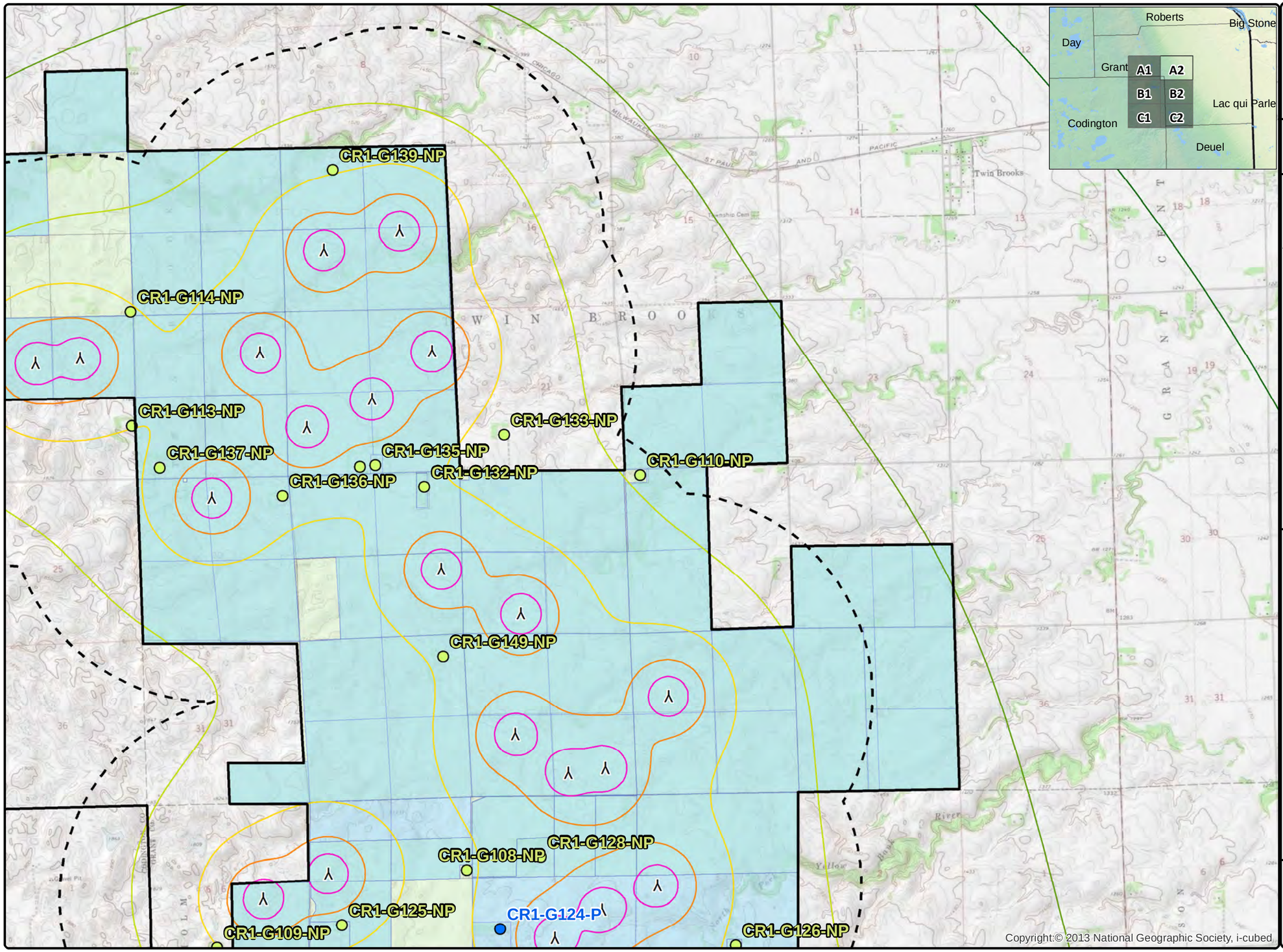
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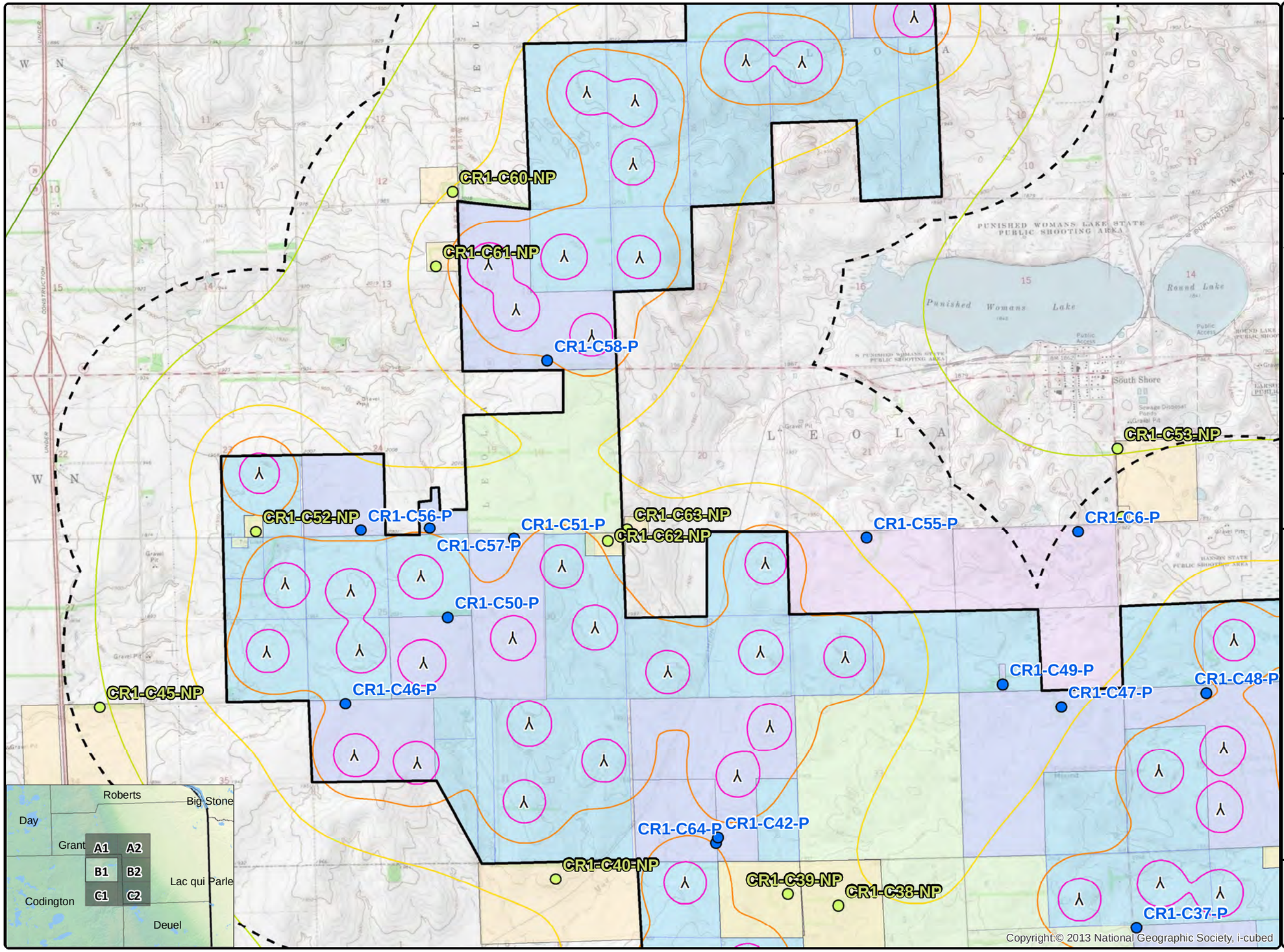
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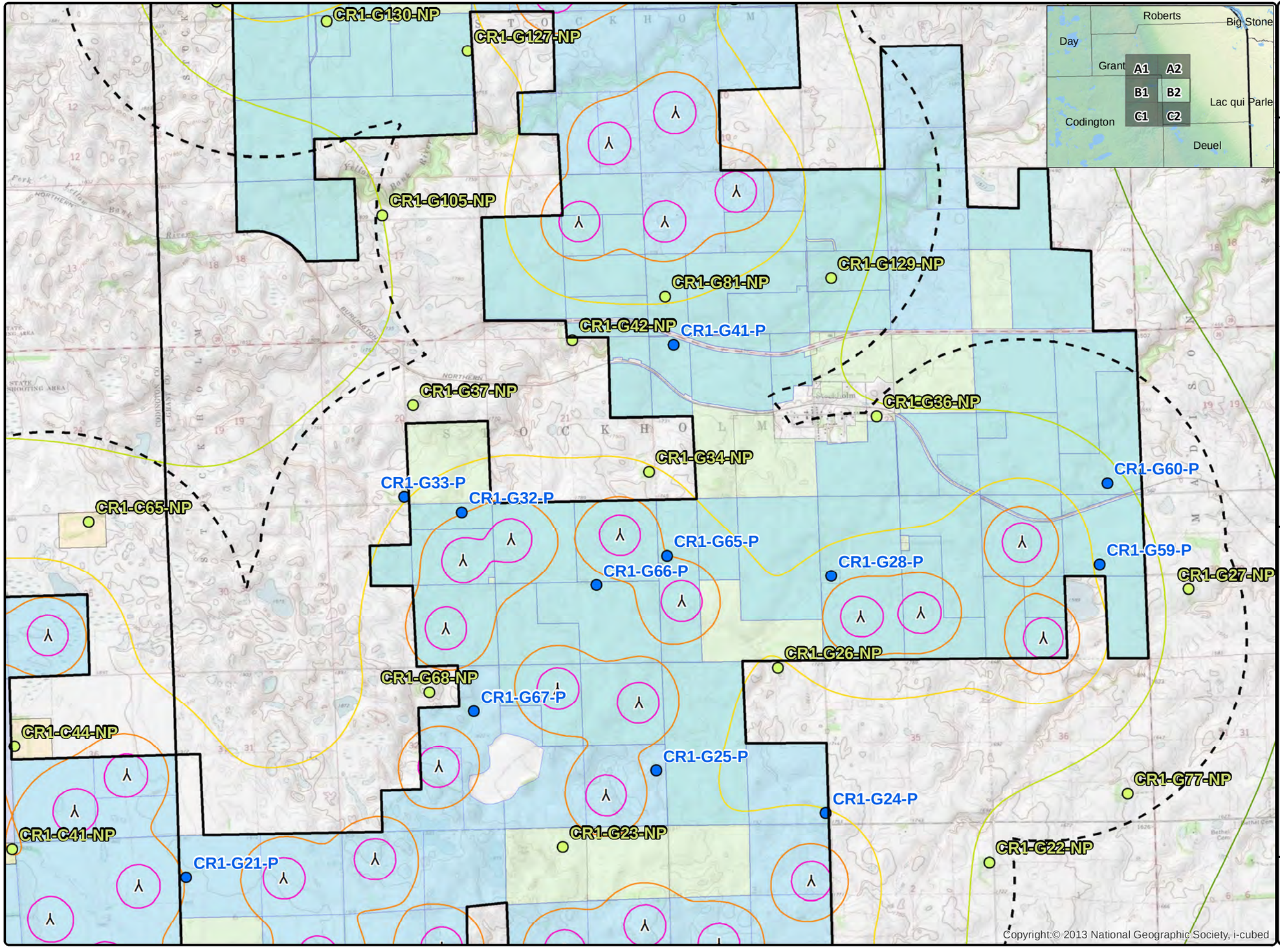
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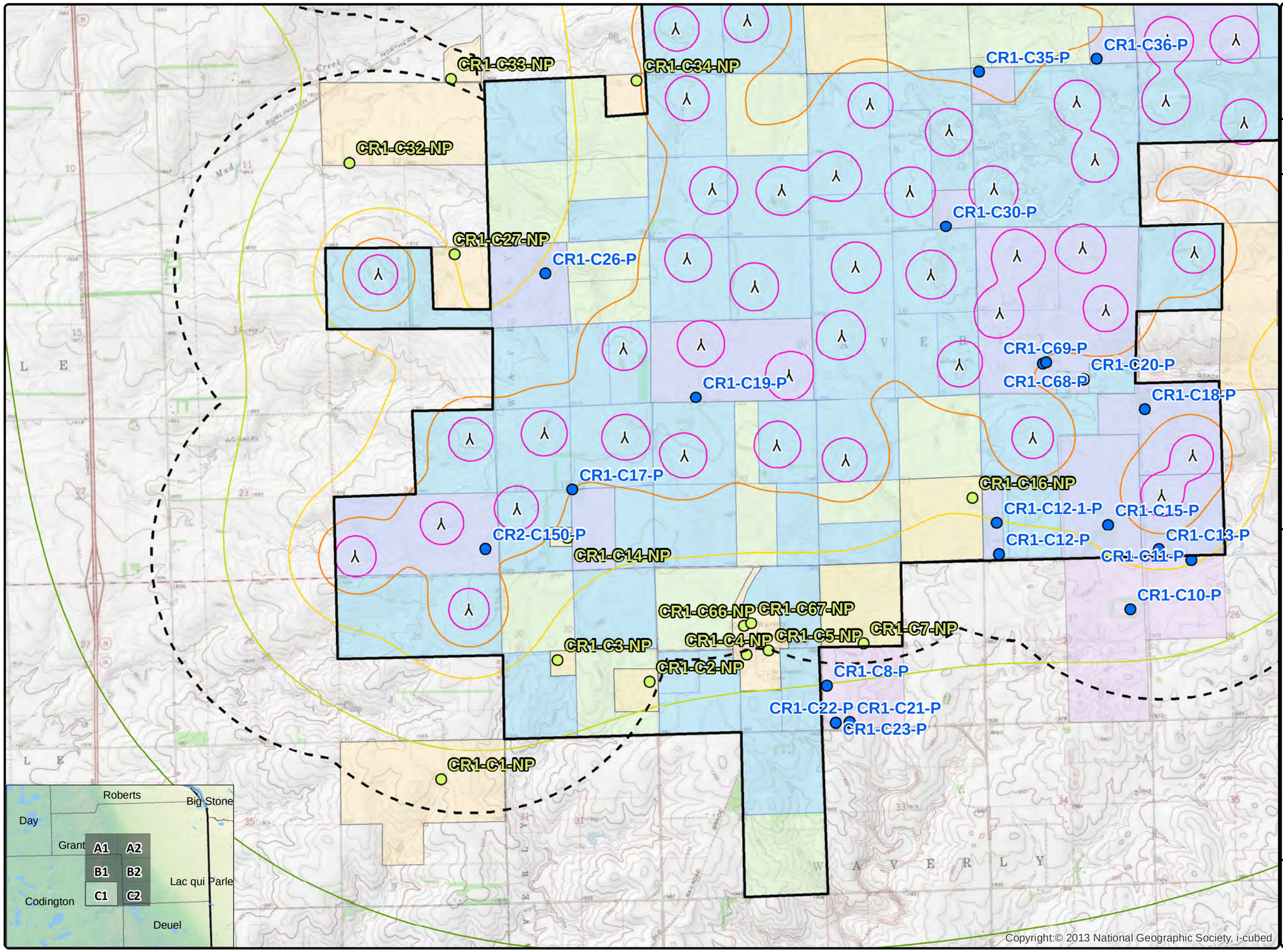
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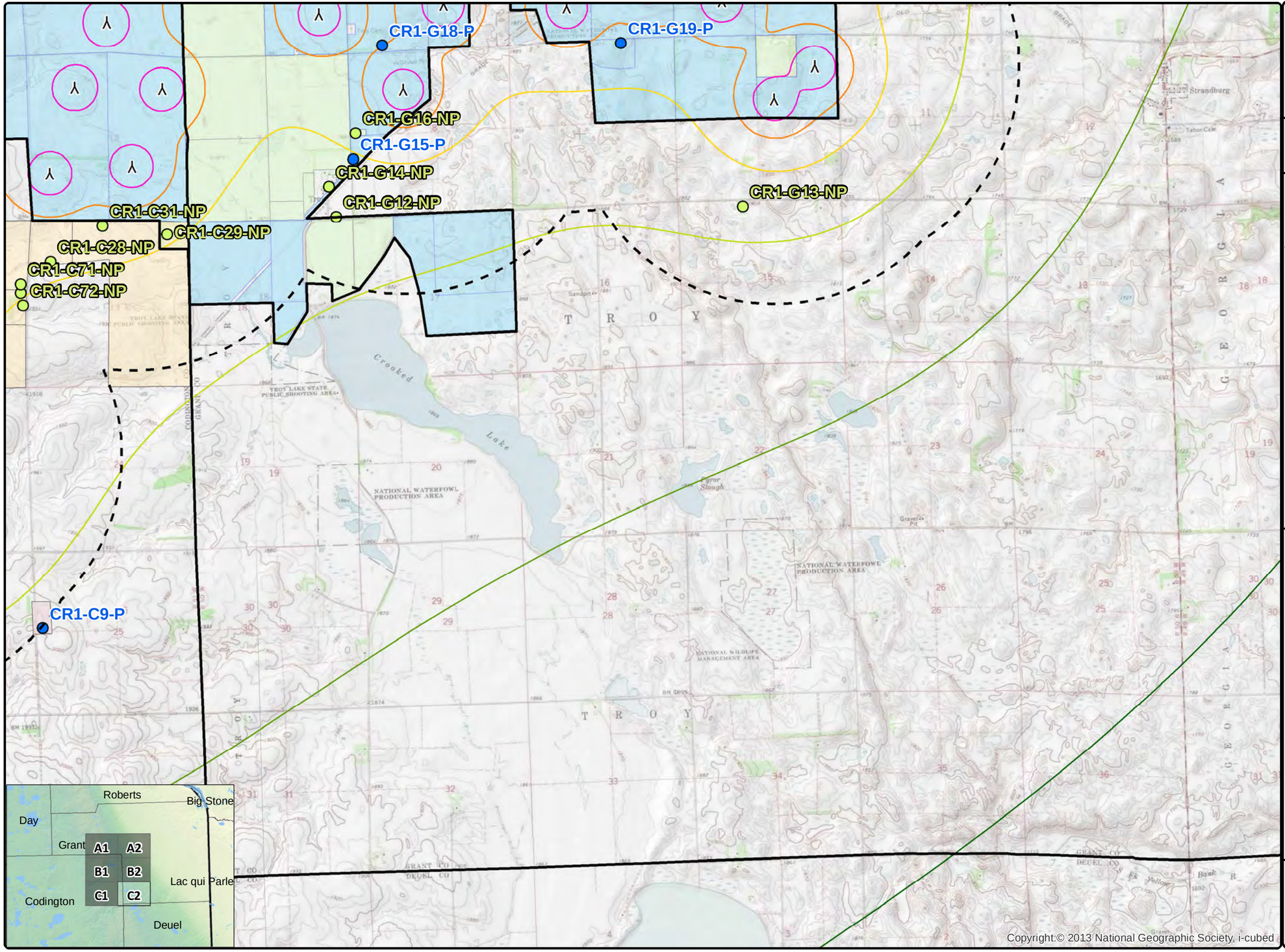
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Final Report
Crowned Ridge Wind Farm
Shadow Flicker Study
Codington and Grant Counties, SD

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January 22,

2019

Author: Jay Haley, P.E., Partner

TABLE OF CONTENTS

1. INTRODUCTION 2
2. BACKGROUND 2
3. STUDY METHODOLOGY 3
4. RESULTS OF ANALYSIS 6
5. CONCLUSIONS 9
APPENDIX A: CROWNED RIDGE WIND ENERGY PROJECT SITE OVERVIEW MAP 10
APPENDIX B: WIND TURBINE COORDINATES 12
APPENDIX C: TABLE OF SHADOW FLICKER RESULTS 17
APPENDIX D: STANDARD RESOLUTION SHADOW FLICKER MAPS 26

LIST OF TABLES

Table 1: Huron, SD monthly sunshine probabilities 5
Table 2: Codington County occupied structures realistic shadow flicker distribution. 7
Table 3: Grant County occupied structures realistic shadow flicker distribution. 8
Table 4: Summary of shadow flicker predictions. 8

Report Update

EAPC bears no responsibility to update this report for any changes occurring subsequent to the final issuance of this report.

Revision History

Revision No.	Revision Purpose	Date	Revised By
0	Original	1/22/2019	J. Haley

Executive Summary

EAPC was hired to provide estimates of the potential shadow flicker impacts for a proposed wind turbine layout in Codington and Grant Counties of the Crowned Ridge wind farm project in northeastern South Dakota. The scope of this report includes all proposed turbines included in the Crowned Ridge project that will be permitted separately through the South Dakota Public Utilities Commission. Locations of area occupied structures and a wind turbine layout using a mixture of wind turbines manufactured by General Electric (GE) were provided to EAPC by Crowned Ridge Wind, LLC. A computer model was built combining digital elevation data with the information supplied by Crowned Ridge Wind, LLC to generate shadow flicker models for the site. The resulting models were then used to perform shadow flicker calculations for the 150 turbines. Based on the calculations, site-wide realistic shadow flicker maps were produced to predict the shadow flicker at nearby residences within the Crowned Ridge Project area.

The model is based on a number of conservative assumptions. No credit was taken for the blocking effects of trees or buildings. The receptors were omni-directional rather than modeling specific facades of buildings, and the study assumes 100% turbine availability.

The scope of this study includes the shadow flicker impacts of the Crowned Ridge wind farm on the two counties it is located within, Codington and Grant. The shadow flicker ordinances of both counties limit the maximum number of shadow flicker to 30 hours per year at occupied structures.

For the shadow study in Codington County, the 67 occupied structures (33 participating and 34 non-participating) were represented in the model by omni-directional shadow receptors that simulate a 1 m x 1 m window at 1 m above ground level.

For the shadow study in Grant County, 58 occupied structures (17 participating and 41 non-participating) were represented in the model by omni-directional shadow receptors that simulate a 1 m x 1 m window at 1 m above ground level.

For the Crowned Ridge turbine array provided, no occupied structures experienced more than 29 hours and 50 minutes of shadow flickering per year based on realistic assumptions regarding operational time and sunshine probability, therefore, the Crowned Ridge wind farm is in compliance with the shadow flicker limitations set forth in both Codington County's Section 5.22.03 paragraph 13 of Ordinance #68, and Section 1211.04 paragraph 14 of Grant County's Ordinance 2016-01C, which is 30 hours per year.

1. INTRODUCTION

EAPC was hired to conduct shadow flicker studies for the regional development of the Crowned Ridge wind farm project located in Codington and Grant Counties in northeastern South Dakota. The regional development's layout consists of 137 GE 2.3 MW wind turbines with a hub height of 90 meters (including 20 alternate turbine locations) and 13 GE 2.3 MW wind turbines with a hub height of 80 meters for a total of 150 wind turbines. The locations of the proposed wind turbines were supplied by Crowned Ridge Wind, LLC.

From the database of occupied structures and coordinates supplied by Crowned Ridge Wind, LLC, 67 occupied structures (33 participating and 34 non-participating) in Codington County and 58 occupied structures (17 participating and 41 non-participating) in Grant County were found to be within 2 kilometers of a wind turbine and were included in the shadow models. Shadow flicker does not extend beyond a distance of approximately 1,700 meters from the wind turbine base.

The area of interest for this report is located in Codington and Grant Counties near the town of Watertown in northeastern South Dakota. The surrounding terrain has a change in elevation across the project site ranging from 475 to 621 meters (1,558 to 2,037 feet) at the wind turbine base. The region's vegetation is comprised primarily of prairie grass and agricultural land. The project overview map can be found in Appendix A.

2. BACKGROUND

Shadow flicker from wind turbines occurs when rotating wind turbine blades move between the sun and the observer. Shadow flicker is generally experienced in areas near wind turbines where the distance between the observer and wind turbine blade is short enough that sunlight has not been significantly diffused by the atmosphere. When the blades rotate, this shadow creates a pulsating effect, known as shadow flicker. If the blade's shadow is passing over the window of a building, it will have the effect of increasing and decreasing the light intensity in the room at a low frequency in the range of 0.4 to 0.78 Hz, hence the term "flicker." In this case, with a maximum rotational speed of 15.6 rpm for the GE 2.3-116, the frequency would be 0.78 Hz. This flickering effect can also be experienced outdoors, but the effect is typically less intense, and becomes less intense when farther from the wind turbine causing the flicker.

This flickering effect is most noticeable within approximately 1,000 meters of the turbine, and becomes more and more diffused as the distance increases. Beyond 1,700 meters, the shadow flicker effects are indistinguishable. There are no uniform standards defining what distance from the turbine is regarded as an acceptable limit beyond which the shadow flicker is considered to be insignificant. The same applies to the number of hours of flickering that is deemed to be acceptable. For this study, in the interest of being conservative, any occupied structure within 2,000 meters of a wind turbine was included in the analysis.

Shadow flicker is typically greatest in the winter months when the angle of the sun is lower and casts longer shadows. The effect is also more pronounced around sunrise and sunset when the sun is near the horizon and the shadows are longer. A number of factors influence the amount of shadow flicker on the shadow receptors.

One consideration is the environment around the shadow receptor. Obstacles such as terrain, trees or buildings between the wind turbine and the receptor can significantly reduce or eliminate shadow flicker effects. Deciduous trees may block the shadow flickering effect to some degree, depending on the tree density, species present and time of year. Deciduous trees can lead to a reduction of shadow flicker during the summer when the trees are bearing leaves. However, during the winter months, these trees are without their leaves and their impact on shadow flicker is not as significant. Coniferous trees tend to provide mitigation from shadow flicker year round. For this study, no credit was taken for any potential shading effects from any type of trees or other obstacles that would reduce the number of shadow flickering hours at the structures which will make the shadow flicker prediction more conservative (higher than in reality).

Another consideration is the time of day when shadow flicker occurs. For example, it may be more acceptable for private homes to experience the shadow flickering during daytime hours when family members may be at work or school. Likewise, a commercial property would not be significantly affected if all the shadow flicker impact occurred before or after business hours.

The climate also needs be considered when assessing shadow flicker. In areas with a significant amount of overcast weather, there would be less shadow flicker, as there are no shadows if the sun is blocked by clouds. Also, if the wind is not blowing, the turbines would not be operational and therefore not creating shadow flickering.

3. *STUDY METHODOLOGY*

This shadow flicker analysis was performed utilizing windPRO, which has the ability to calculate detailed shadow flicker maps across an entire area of interest or at site-specific locations using shadow receptors.

Shadow maps which indicate where the shadows will be cast and for how long, are generated using windPRO, calculating the shadow flicker in varying user-defined resolutions. Standard resolution was used for this study and represents shadow flicker being calculated every three minutes of every day over the period of an entire year over a grid with a 20 m by 20 m resolution.

In addition to generating a shadow flicker map, the amount of shadow flicker that may occur at a specific point can be calculated more precisely by placing a shadow receptor at the location of interest and essentially “recording” the shadow flicker that occurs as the relative sunrise to sunset motion of the sun is simulated throughout an entire year.

The point-specific shadow flicker calculation is run at a higher resolution as compared to the shadow flicker map calculation to utilize the highest precision available within windPRO. Shadow flicker at each shadow receptor location is calculated every minute of every day for an entire year. Shadow receptors can be configured to represent an omni-directional window of a specific size at a specific point (greenhouse mode) or a window facing a single direction of a specific size at a specific point (single direction mode). The shadow receptors used in this analysis were configured as greenhouse-mode receptors representing a 1 m x 1 m window located 1 m above ground level. This represents more of a "worst-case" scenario and thus will produce more conservative results since it assumes that all windows are always in direct line of sight with the turbines and the sun.

As a part of the calculation method, windPRO must determine whether or not a turbine will be visible at the receptor locations and not blocked by local topography or obstacles. It does this by performing a preliminary Zones of Visual Influence (ZVI) calculation, utilizing 10 m grid spacing. If a particular turbine is not visible within the 10 m x 10 m area that the shadow receptor is contained within, then that turbine is not included in the shadow flicker calculation for that receptor.

The inputs for the windPRO shadow flicker calculation include the following:

- Turbine Coordinates
- Turbine Specifications
- Shadow Receptor Coordinates
- Monthly Sunshine Probabilities
- Joint Wind Speed and Direction Frequency Distribution
- USGS Digital Elevation Model (DEM) (height contour data)

A description of each input variable and how they affect the shadow flicker calculation are included below.

Turbine Coordinates: The location of a wind turbine in relation to a shadow receptor is one of the most important factors in determining shadow flicker impacts. A line-of-site is required for shadow flicker to occur. The intensity of the shadow flicker is dependent upon the distance from the wind turbine and weather conditions. The table of wind turbine coordinates can be found in Appendix B.

Turbine Specifications: A wind turbine's total height and rotor diameter will be included in the windPRO shadow flicker model. The taller the wind turbine, the more likely shadow flicker could have an impact on local shadow receptors as the ability to clear obstacles (such as hills or trees) is greater, although in this analysis, no credit is taken for any such blockage from trees. The larger the rotor diameter is, the wider the area where shadows will be cast. Also included with the turbine specifications are the cut-in and cut-out wind speeds within which the wind turbine is operational. If the wind speed is below the cut-in

threshold or above the cut-out threshold, the turbine rotor will not be spinning and thus shadow flicker will not occur.

Shadow Receptor Coordinates: As with the wind turbine coordinates, the elevation, distance and orientation of a shadow receptor in relation to the wind turbines and the sun are the main factors in determining the impact of shadow flicker. EAPC was provided with coordinates for all participating and non-participating occupied structures found to be located within 2 kilometers of the 150 proposed wind turbine locations.

Monthly Sunshine Probabilities: windPRO calculates sunrise and sunset times to determine the total annual hours of daylight for the modeled area. To further refine the shadow flicker calculations, the monthly probability of sunshine is included to account for cloud cover. The greater the probability of cloud cover, the less of an impact from shadow flicker. The monthly sunshine probabilities for many of the larger cities across the United States are available from the National Climatic Data Center (NCDC). For this study, 18 years' worth of monthly sunshine probability data were retrieved for Huron, SD, which was the closest, most representative station, to create the long-term representative monthly sunshine probabilities. The long-term representative monthly average sunshine probabilities are presented below in Table 1.

Table 1: Huron, SD monthly sunshine probabilities

Huron, SD Monthly Sunshine Probabilities (1965-1983)												
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sunshine %	0.62	0.62	0.62	0.59	0.66	0.69	0.76	0.74	0.69	0.59	0.51	0.51
retrieved from: http:// http://www1.ncdc.noaa.gov/pub/data/ccd-data/pctpos15.dat												

Joint Wind Speed and Direction Frequency Distribution: A set of long-term corrected wind distributions was provided by Crowned Ridge Wind, LLC to represent the annual wind speed and direction distribution for the project site. This data was used to estimate the probable number of operational hours for the wind turbines from each of the 12 wind direction sectors. During operation, the wind turbine rotors will always be assumed to face into the wind and automatically orient themselves as the wind direction changes. Shadow flicker can only occur when the blades are turning and the wind turbine rotor is between the sun and the receptor. Shadow flicker is most significant when the rotor is facing the sun.

USGS Digital Elevation Model (DEM) (height contour data): For this study, 3 m resolution USGS National Elevation Database (NED) DEM's were used to construct 10-foot interval height contour lines for the windPRO shadow flicker model. The height contour information is important to the shadow flicker calculation since it allows the model to place the wind turbines and the shadow receptors at the correct elevations. The height contour lines also allow the model to include the topography of the site when calculating the zones of visual influence surrounding the wind turbine and shadow receptor locations.

Wind Turbines from Adjacent Projects: The Crowned Ridge II project is adjacent to the Crowned Ridge project. Because shadow flicker impacts are cumulative, there will be impacts from the Crowned Ridge II project that will be additive to the impacts from the Crowned Ridge project. The Crowned Ridge II wind turbine array was included in the model to capture the full shadow flicker impacts on the receptors, which are included in the tabular results; however, the shadow flicker iso-line maps only show the shadow flicker from the Crowned Ridge array.

The actual calculation of potential shadow flicker at a given shadow receptor is carried out by simulating the environment near the wind turbines and the shadow receptors. The position of the sun relative to the turbine rotor disk and the resulting shadow is calculated in time steps of one minute throughout an entire year. If the shadow of the rotor disk (which in the calculation is assumed solid) at any time casts a shadow on a receptor window, then this step will be registered as one minute of shadow flicker. The calculation also requires that the sun must be at least 3.0° above the horizon in order to register shadow flicker. When the sun angle is less than 3.0°, the shadow quickly becomes too diffuse to be distinguishable since the amount of atmosphere that the light must pass through is 15 times greater than when the sun is directly overhead.

The sun's path with respect to each wind turbine location is calculated by the software to determine the paths of cast shadows for every minute of every day over a full year. The turbine runtime and direction are calculated from the site's long-term wind speed and direction distribution. Finally, the effects of cloud cover are calculated using long-term reference data (monthly sunshine probability) to arrive at the projected annual flicker time at each receptor.

4. *Results of Analysis*

The term "realistic" as used in this report means that turbine operational hours and direction as well as local sunshine probabilities have been factored in, but no blocking or shading effects due to trees or structures have been accounted for. This means that the realistic estimates are still inherently conservative values. Also, the realistic shadow flicker hours predicted by windPRO assumes an availability factor of 100% which is very unlikely to be the case. Actual availability factors will likely be in the range of 95-98%, however, with a conservative approach to estimating shadow flicker totals, the realistic estimates are not discounted accordingly.

<u>Crowned Ridge Codington County Turbines</u>

For Codington County, a total of 67 (33 participating and 34 non-participating) occupied structures within 2 kilometers of a wind turbine were analyzed and standard resolution realistic shadow flicker maps were generated for the turbine array.

The 67 shadow receptors were then modeled as greenhouse-mode receptors and the estimated shadow flicker was calculated for the array. No shadow receptors are expected

to experience more than 28 hours and 42 minutes of shadow flicker per year. Therefore, the Crowned Ridge wind farm would be in compliance with Section 5.22.03 paragraph 13 of Ordinance #68. Of the 67 receptors, the number that registered no shadow flicker hours was 13 (19.4%).

The maximum modeled expected shadow flicker at a participating receptor is 28 hours and 42 minutes and the maximum modeled expected shadow flicker at a non-participating receptor is 28 hours and 20 minutes. Table 2 contains the realistic shadow flicker distribution of the 67 occupied residences.

Table 2: Codington County occupied structures realistic shadow flicker distribution.

Realistic Shadow Flicker (hrs/year)	Number of Non-Participating Occupied Structures	Number of Participating Occupied Structures
0	12	1
0 to 5	5	3
5 to 10	10	6
10 to 15	2	6
15 to 20	1	5
20 to 25	1	6
25 to 30	3	6
30+	0	0

Crowned Ridge Grant County Turbines

For Grant County, 58 (17 participating and 41 non-participating) occupied structures within 2 kilometers of a wind turbine were found and analyzed. Standard resolution realistic shadow flicker maps were generated for the turbine array.

The 58 shadow receptors were then modeled as greenhouse-mode receptors and the estimated shadow flicker was calculated for the array. No occupied structures are expected to experience more than 29 hours and 50 minutes of shadow flicker per year. Therefore, the Crowned Ridge wind farm would be in compliance with Section 1211.04 paragraph 14 of Grant County's Ordinance 2016-01C. Of the 58 occupied structures, the number that registered no shadow flicker hours was 19 (32.7%).

The maximum modeled expected shadow flicker at a participating receptor is 29 hours and 50 minutes and the maximum modeled expected shadow flicker at a non-participating receptor is 25 hours and 18 minutes. Table 3 contains the realistic shadow flicker distribution of the 58 occupied structures.

Table 3: Grant County occupied structures realistic shadow flicker distribution.

Realistic Shadow Flicker (hrs/year)	Number of Non-Participating Occupied Structures	Number of Participating Occupied Structures
0	15	4
0 to 5	10	1
5 to 10	7	2
10 to 15	4	3
15 to 20	3	3
20 to 25	1	2
25 to 30	1	2
30+	0	0

Crowned Ridge Turbines Summary

For the Crowned Ridge Project, no occupied structures are expected to experience more than 29 hours and 50 minutes of shadow flicker per year, for both counties. The summary of results is shown in table 4 below. The full table of results from the realistic shadow flicker study can be found in Appendix C. Table C-1 lists the results sorted by receptor number and Table C-2 lists the results sorted by shadow flicker hours from highest to lowest., The Crowned Ridge II wind turbine array was included in the model to capture the full shadow flicker impacts on the receptors, which are included in the tabular results; however, the shadow flicker iso-line maps only show the shadow flicker from the Crowned Ridge array. The maps showing the shadow flicker impact iso-lines for the Crowned Ridge wind farm are in Appendix D.

Table 4: Summary of shadow flicker predictions.

County	Feature	Shadow Limit (hr/yr)	Maximum Predicted (hr/yr)
Codington	Participating Occupied Structures	30	28:42
	Non-Participating Occupied Structures	30	28:20
Grant	Participating Occupied Structures	30	29:50
	Non-Participating Occupied Structures	30	25:18

5. CONCLUSIONS

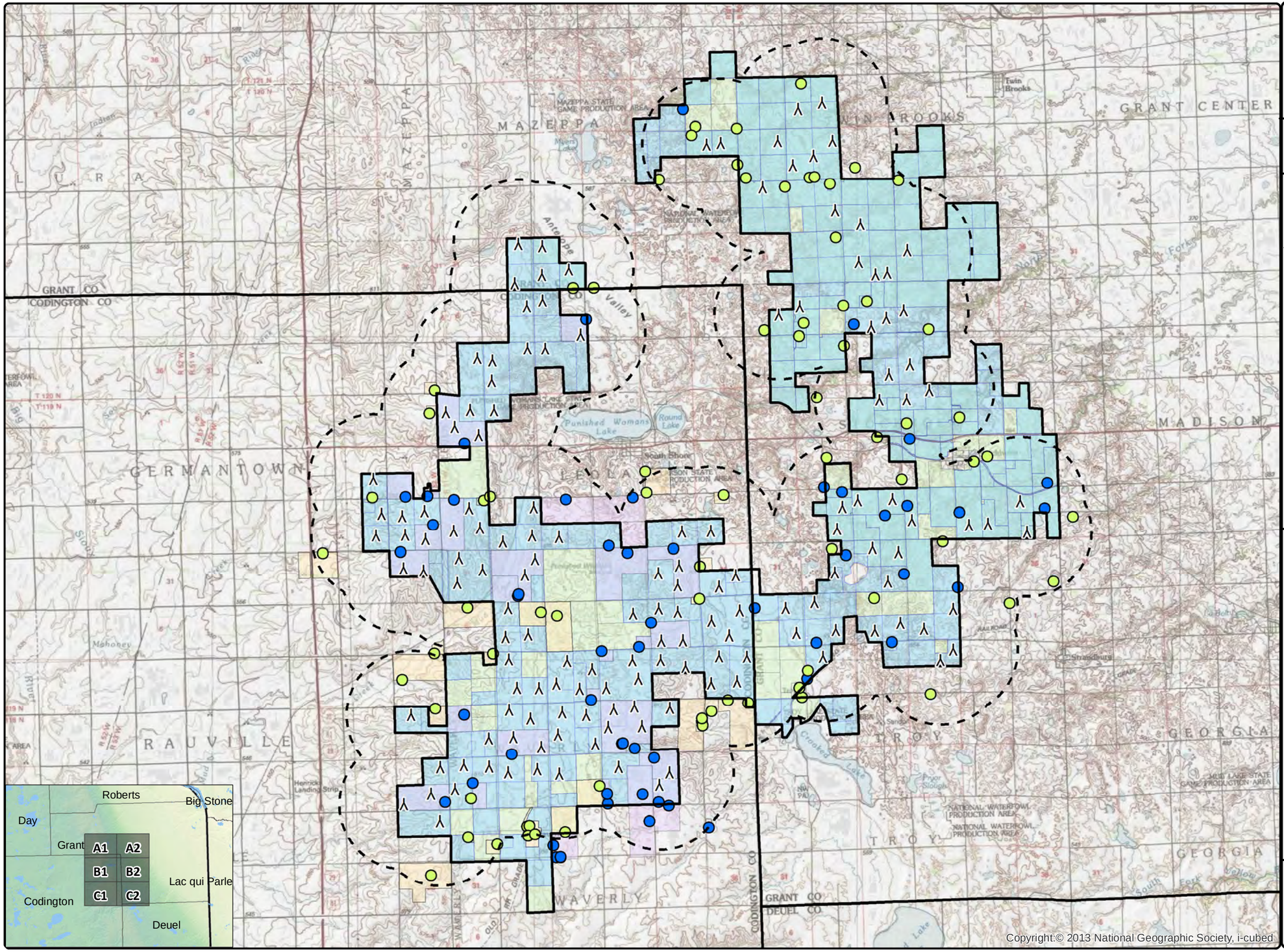
The shadow flicker impact on the receptors was calculated with reductions due to turbine operational direction and sunshine probabilities included. For both counties, no occupied structures are expected to experience more than 29 hours and 50 minutes of shadow flicker per year.

This shadow flicker analysis is based on a number of conservative assumptions including:

- No credit was taken for the blocking effects of trees or buildings.
- The receptors were omni-directional rather than modeling specific facades of buildings.
- Study assumes 100% turbine availability
- Study assumes all turbine locations, including alternates, are built and operating

The overall effect of using these conservative assumptions indicate that realistically, the number of hours of shadow flicker that would be observed will be less than those predicted by this study.

APPENDIX A: CROWNED RIDGE WIND ENERGY PROJECT SITE OVERVIEW MAP



EAPC WIND ENERGY

www.eapc.net | 701.775.3000

Crowned Ridge Wind Farm
Project Overview Map

Client

SWCA Environmental Consultants

Project Description

Wind turbine layout with land parcels within the project footprint and existing occupied strucures and occupied Codington County land parcels within 2 km of a wind turbine.

Location: Watertown, SD

Project #: 20174430

Issue Dates

#	Description	Date
1	Original	2019.01.15

Drawn By: AS | *Checked By: JH*

Legend

- Crowned Ridge Turbines
- 2 km Turbine Buffer
- County Lines
- CR1 Project Boundary
- Non-Participants
- Participants
- Participating Codington Parcels
- Non-Part. Codington Parcels
- Participating Land Parcels
- Non-Participating Land Parcels

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APPENDIX B: WIND TURBINE COORDINATES

Crowned Ridge Wind Farm
GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14

WTG	Turbine Type	Easting (m)	Northing (m)	Base Elev. AMSL (m)	Sound Profile
CRI-1	GE2.3 116RD 90HH r2.madE	659,443	5,003,083	610.2	LNTE
CRI-2	GE2.3 116RD 90HH r2.madE	660,185	5,003,010	598.1	LNTE
CRI-3	GE2.3 116RD 90HH r2.madE	661,008	5,002,288	584.2	LNTE
CRI-4	GE2.3 116RD 90HH r2.madE	660,173	5,002,120	602.4	LNTE
CRI-5	GE2.3 116RD 90HH r2.madE	659,337	5,001,862	609.9	LNTE
CRI-6	GE2.3 116RD 90HH r2.madE	660,193	5,001,329	610.4	LNTE
CRI-7	GE2.3 116RD 90HH r2.madE	659,705	5,001,146	618.0	LNTE
CRI-8	GE2.3 116RD 90HH r2.madE	661,380	5,000,282	588.3	LNTE
CRI-9	GE2.3 116RD 90HH r2.madE	659,731	4,999,855	613.3	LNTE
CRI-10	GE2.3 116RD 90HH r2.madE	660,280	4,999,837	615.0	LNTE
CRI-11	GE2.3 116RD 90HH r2.madE	658,170	4,999,546	611.0	LNTE
CRI-12	GE2.3 116RD 90HH r2.madE	658,644	4,999,460	615.0	LNTE
CRI-13	GE2.3 116RD 90HH r2.madE	658,622	4,998,843	613.3	LNTE
CRI-14	GE2.3 116RD 90HH r2.madE	657,947	4,997,935	618.3	LNTE
CRI-15	GE2.3 116RD 90HH r2.madE	658,688	4,997,924	618.9	LNTE
CRI-16	GE2.3 116RD 90HH r2.madE	657,203	4,997,856	611.9	LNTE
CRI-17	GE2.3 116RD 90HH r2.madE	657,476	4,997,410	611.1	LNTE
CRI-18	GE2.3 116RD 90HH r2.madE	658,217	4,997,154	618.0	LNTE
CRI-19	GE2.3 116RD 90HH r2.madE	654,954	4,995,804	601.1	LNTE
CRI-20	GE2.3 116RD 90HH r2.madE	659,920	4,994,924	594.4	LNTE
CRI-21	GE2.3 116RD 90HH r2.madE	657,925	4,994,896	617.1	LNTE
CRI-22	GE2.3 116RD 90HH r2.madE	656,543	4,994,796	616.5	LNTE
CRI-23	GE2.3 116RD 90HH r2.madE	655,208	4,994,717	594.5	LNTE
CRI-24	GE2.3 116RD 90HH r2.madE	655,852	4,994,652	609.0	LNTE
CRI-25	GE2.3 116RD 90HH r2.madE	658,251	4,994,286	606.0	LNTE
CRI-26	GE2.3 116RD 90HH r2.madE	665,405	4,994,191	578.3	LNTE
CRI-27	GE2.3 116RD 90HH r2.madE	657,442	4,994,187	621.0	LNTE
CRI-28	GE2.3 116RD 90HH r2.madE	664,517	4,994,168	579.0	LNTE
CRI-29	GE2.3 116RD 90HH r2.madE	655,940	4,994,069	606.9	LNTE
CRI-30	GE2.3 116RD 90HH r2.madE	659,871	4,994,052	593.6	LNTE
CRI-31	GE2.3 116RD 90HH r2.madE	655,030	4,994,051	603.0	LNTE
CRI-32	GE2.3 116RD 90HH r2.madE	660,704	4,993,998	606.0	LNTE
CRI-33	GE2.3 116RD 90HH r2.madE	656,566	4,993,941	618.0	LNTE
CRI-34	GE2.3 116RD 90HH r2.madE	658,966	4,993,856	599.6	LNTE
CRI-35	GE2.3 116RD 90HH r2.madE	657,602	4,993,347	607.5	LNTE
CRI-36	GE2.3 116RD 90HH r2.madE	659,966	4,993,319	594.0	LNTE
CRI-37	GE2.3 116RD 90HH r2.madE	664,419	4,993,110	587.2	LNTE
CRI-38	GE2.3 116RD 90HH r2.madE	658,338	4,992,981	600.5	LNTE
CRI-39	GE2.3 116RD 90HH r2.madE	656,507	4,992,958	609.0	LNTE
CRI-40	GE2.3 116RD 90HH r2.madE	655,889	4,993,035	603.0	LNTE
CRI-41	GE2.3 116RD 90HH r2.madE	663,782	4,992,883	597.2	LNTE

Crowned Ridge Wind Farm
GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
continued

WTG	Turbine Type	Easting (m)	Northing (m)	Base Elev. AMSL (m)	Sound Profile
CRI-43	GE2.3 116RD 90HH r2.madE	666,181	4,992,815	577.8	LNTE
CRI-44	GE2.3 116RD 90HH r2.madE	665,665	4,992,460	576.0	LNTE
CRI-46	GE2.3 116RD 90HH r2.madE	664,387	4,992,505	591.0	LNTE
CRI-48	GE2.3 116RD 90HH r2.madE	663,794	4,991,782	587.5	LNTE
CRI-49	GE2.3 116RD 90HH r2.madE	664,385	4,991,685	581.6	LNTE
CRI-50	GE2.3 116RD 90HH r2.madE	662,999	4,991,622	612.0	LNTE
CRI-51	GE2.3 116RD 90HH r2.madE	666,299	4,991,723	575.3	LNTE
CRI-52	GE2.3 116RD 90HH r2.madE	665,426	4,991,398	575.6	LNTE
CRI-53	GE2.3 116RD 90HH r2.madE	659,750	4,990,981	598.7	LNTE
CRI-54	GE2.3 116RD 90HH r2.madE	665,979	4,990,946	573.7	LNTE
CRI-55	GE2.3 116RD 90HH r2.madE	659,045	4,990,899	597.0	LNTE
CRI-56	GE2.3 116RD 90HH r2.madE	664,548	4,990,794	591.9	LNTE
CRI-57	GE2.3 116RD 90HH r2.madE	663,874	4,990,787	600.1	LNTE
CRI-58	GE2.3 116RD 90HH r2.madE	665,663	4,990,303	585.0	LNTE
CRI-59	GE2.3 116RD 90HH r2.madE	666,523	4,990,291	573.0	LNTE
CRI-60	GE2.3 116RD 90HH r2.madE	659,155	4,990,208	593.9	LNTE
CRI-61	GE2.3 116RD 90HH r2.madE	662,982	4,990,178	612.0	LNTE
CRI-62	GE2.3 116RD 90HH r2.madE	660,954	4,990,155	600.8	LNTE
CRI-63	GE2.3 116RD 90HH r2.madE	664,627	4,989,977	588.7	LNTE
CRI-64	GE2.3 116RD 90HH r2.madE	663,858	4,990,188	604.5	LNTE
CRI-65	GE2.3 116RD 90HH r2.madE	661,732	4,989,898	609.0	LNTE
CRI-66	GE2.3 116RD 90HH r2.madE	663,165	4,989,613	614.9	LNTE
CRI-67	GE2.3 116RD 90HH r2.madE	666,226	4,989,531	574.8	LNTE
CRI-68	GE2.3 116RD 90HH r2.madE	665,420	4,989,461	585.0	LNTE
CRI-69	GE2.3 116RD 80HH r2.madE	660,621	4,989,453	605.4	LNTE
CRI-70	GE2.3 116RD 90HH r2.madE	662,171	4,989,319	611.0	LNTE
CRI-71	GE2.3 116RD 80HH r2.madE	659,405	4,989,320	607.4	LNTE
CRI-72	GE2.3 116RD 80HH r2.madE	660,087	4,989,309	606.0	LNTE
CRI-73	GE2.3 116RD 90HH r2.madE	661,344	4,989,297	609.8	LNTE
CRI-74	GE2.3 116RD 90HH r2.madE	663,041	4,988,744	615.0	LNTE
CRI-75	GE2.3 116RD 90HH r2.madE	664,137	4,988,702	609.0	LNTE
CRI-76	GE2.3 116RD 90HH r2.madE	662,399	4,988,667	615.0	LNTE
CRI-77	GE2.3 116RD 80HH r2.madE	659,158	4,988,642	612.0	LNTE
CRI-78	GE2.3 116RD 80HH r2.madE	660,811	4,988,558	604.2	LNTE
CRI-79	GE2.3 116RD 90HH r2.madE	656,125	4,988,485	595.0	LNTE
CRI-80	GE2.3 116RD 90HH r2.madE	661,552	4,988,481	608.8	LNTE
CRI-81	GE2.3 116RD 90HH r2.madE	659,825	4,988,365	606.5	LNTE
CRI-82	GE2.3 116RD 90HH r2.madE	663,271	4,988,133	613.0	LNTE
CRI-83	GE2.3 116RD 90HH r2.madE	662,227	4,988,103	606.5	LNTE
CRI-84	GE2.3 116RD 80HH r2.madE	660,677	4,987,880	600.5	LNTE
CRI-85	GE2.3 116RD 90HH r2.madE	659,295	4,987,798	612.0	LNTE

Crowned Ridge Wind Farm
GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
continued

WTG	Turbine Type	Easting (m)	Northing (m)	Base Elev. AMSL (m)	Sound Profile
CRI-86	GE2.3 116RD 90HH r2.madE	658,534	4,987,759	613.3	LNTE
CRI-87	GE2.3 116RD 90HH r2.madE	661,830	4,987,596	609.0	LNTE
CRI-88	GE2.3 116RD 90HH r2.madE	660,157	4,987,492	603.0	LNTE
CRI-89	GE2.3 116RD 80HH r2.madE	657,758	4,986,926	614.9	LNTE
CRI-90	GE2.3 116RD 80HH r2.madE	658,545	4,986,881	612.0	LNTE
CRI-91	GE2.3 116RD 80HH r2.madE	657,023	4,986,868	612.0	LNTE
CRI-92	GE2.3 116RD 80HH r2.madE	660,039	4,986,804	606.9	LNTE
CRI-93	GE2.3 116RD 80HH r2.madE	659,133	4,986,700	608.0	LNTE
CRI-94	GE2.3 116RD 80HH r2.madE	660,716	4,986,660	600.7	LNTE
CRI-95	GE2.3 116RD 90HH r2.madE	657,488	4,986,184	612.0	LNTE
CRI-96	GE2.3 116RD 90HH r2.madE	656,744	4,986,037	609.0	LNTE
CRI-97	GE2.3 116RD 80HH r2.madE	655,899	4,985,715	592.6	LNTE
CRI-98	GE2.3 116RD 90HH r2.madE	657,015	4,985,192	609.0	LNTE
CRI-99	GE2.3 116RD 90HH r2.madE	672,521	4,990,188	556.7	LNTE
CRI-100	GE2.3 116RD 90HH r2.madE	668,885	4,990,286	585.0	LNTE
CRI-101	GE2.3 116RD 90HH r2.madE	672,921	4,990,513	544.6	LNTE
CRI-102	GE2.3 116RD 90HH r2.madE	668,059	4,991,023	580.9	LNTE
CRI-103	GE2.3 116RD 90HH r2.madE	669,279	4,991,115	582.0	LNTE
CRI-104	GE2.3 116RD 90HH r2.madE	672,009	4,991,151	555.0	LNTE
CRI-105	GE2.3 116RD 90HH r2.madE	670,488	4,991,091	571.7	LNTE
CRI-106	GE2.3 116RD 90HH r2.madE	671,278	4,991,335	567.0	LNTE
CRI-107	GE2.3 116RD 90HH r2.madE	667,723	4,991,800	582.0	LNTE
CRI-108	GE2.3 116RD 90HH r2.madE	672,917	4,991,775	541.2	LNTE
CRI-109	GE2.3 116RD 90HH r2.madE	670,897	4,992,616	557.3	LNTE
CRI-111	GE2.3 116RD 90HH r2.madE	671,220	4,993,526	550.6	LNTE
CRI-112	GE2.3 116RD 90HH r2.madE	670,419	4,993,665	561.0	LNTE
CRI-113	GE2.3 116RD 90HH r2.madE	675,201	4,994,165	497.6	LNTE
CRI-114	GE2.3 116RD 90HH r2.madE	669,318	4,994,256	561.8	LNTE
CRI-115	GE2.3 116RD 90HH r2.madE	673,402	4,994,374	516.4	LNTE
CRI-116	GE2.3 116RD 90HH r2.madE	671,642	4,994,527	531.0	LNTE
CRI-117	GE2.3 116RD 90HH r2.madE	669,488	4,994,930	545.6	LNTE
CRI-118	GE2.3 116RD 90HH r2.madE	669,961	4,995,134	540.3	LNTE
CRI-119	GE2.3 116RD 90HH r2.madE	674,992	4,995,107	492.0	LNTE
CRI-120	GE2.3 116RD 90HH r2.madE	671,034	4,995,179	536.2	LNTE
CRI-121	GE2.3 116RD 90HH r2.madE	670,629	4,998,259	531.0	LNTE
CRI-122	GE2.3 116RD 90HH r2.madE	671,475	4,998,261	517.8	LNTE
CRI-123	GE2.3 116RD 90HH r2.madE	672,180	4,998,561	505.0	LNTE
CRI-124	GE2.3 116RD 90HH r2.madE	670,926	4,999,036	523.3	LNTE
CRI-125	GE2.3 116RD 90HH r2.madE	671,580	4,999,340	509.8	LNTE
CRI-126	GE2.3 116RD 90HH r2.madE	670,382	5,000,519	516.0	LNTE
CRI-127	GE2.3 116RD 90HH r2.madE	670,845	5,000,795	507.4	LNTE

Crowned Ridge Wind Farm
GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
continued

WTG	Turbine Type	Easting (m)	Northing (m)	Base Elev. AMSL (m)	Sound Profile
CRI-128	GE2.3 116RD 90HH r2.madE	671,388	5,001,034	498.4	LNTE
CRI-129	GE2.3 116RD 90HH r2.madE	667,516	5,000,900	553.8	LNTE
CRI-130	GE2.3 116RD 90HH r2.madE	668,158	5,001,149	546.0	LNTE
CRI-131	GE2.3 116RD 90HH r2.madE	670,512	5,002,137	504.0	LNTE
CRI-132	GE2.3 116RD 90HH r2.madE	670,875	5,002,186	499.0	LNTE
CRI-133	GE2.3 116RD 90HH r2.madE	669,990	5,002,521	502.6	LNTE
CRI-134	GE2.3 116RD 90HH r2.madE	671,497	5,002,893	483.0	LNTE
CRI-Alt1	GE2.3 116RD 90HH r2.madE	673,995	4,994,412	508.0	LNTE
CRI-Alt2	GE2.3 116RD 90HH r2.madE	669,250	4,992,900	562.3	LNTE
CRI-Alt3	GE2.3 116RD 90HH r2.madE	668,624	4,991,988	581.3	LNTE
CRI-Alt4	GE2.3 116RD 90HH r2.madE	670,047	5,003,703	495.4	LNTE
CRI-Alt7	GE2.3 116RD 90HH r2.madE	669,265	5,004,141	504.3	LNTE
CRI-Alt8	GE2.3 116RD 90HH r2.madE	667,012	5,004,840	525.5	LNTE
CRI-Alt9	GE2.3 116RD 90HH r2.madE	667,945	5,005,534	511.0	LNTE
CRI-Alt11	GE2.3 116RD 90HH r2.madE	668,585	5,005,813	499.5	LNTE
CRI-Alt12	GE2.3 116RD 90HH r2.madE	665,718	5,006,213	532.5	LNTE
CRI-Alt14	GE2.3 116RD 90HH r2.madE	667,485	5,006,268	514.9	LNTE
CRI-Alt15	GE2.3 116RD 90HH r2.madE	669,174	5,006,282	480.8	LNTE
CRI-Alt16	GE2.3 116RD 90HH r2.madE	665,280	5,006,161	540.0	LNTE
CRI-Alt17	GE2.3 116RD 90HH r2.madE	668,112	5,007,271	490.7	LNTE
CRI-Alt18	GE2.3 116RD 90HH r2.madE	668,857	5,007,463	475.0	LNTE
CRI-Alt19	GE2.3 116RD 90HH r2.madE	663,816	4,986,314	613.1	LNTE
CRI-Alt20	GE2.3 116RD 90HH r2.madE	664,124	4,986,705	611.8	LNTE
CRI-Alt22	GE2.3 116RD 90HH r2.madE	662,551	4,986,877	614.6	LNTE
CRI-Alt42	GE2.3 116RD 90HH r2.madE	659,646	4,992,833	585.0	LNTE
CRI-Alt45	GE2.3 116RD 90HH r2.madE	657,553	4,992,576	599.8	LNTE
CRI-Alt47	GE2.3 116RD 90HH r2.madE	659,131	4,991,788	579.0	LNTE

APPENDIX C: TABLE OF SHADOW FLICKER RESULTS

Table C-1: Crowned Ridge Shadow Flicker Tabular Results Sorted by Receptor ID
Realistic case shadow results at existing structures
Results using GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
Codington County

Receptor ID	Participation Status	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Shadow (hrs/year)	Distance to Nearest Turbine (ft)
CR1-C1-NP	Non-P	656,743.00	4,983,525.00	595.9	0:00	5,541
CR1-C2-NP	Non-P	658,791.00	4,984,483.00	601.6	0:00	6,273
CR1-C3-NP	Non-P	657,888.00	4,984,697.00	604.2	4:10	3,294
CR1-C4-NP	Non-P	659,744.00	4,984,749.00	605.9	0:00	5,981
CR1-C5-NP	Non-P	659,958.00	4,984,794.00	605.2	0:00	5,659
CR1-C6-P	Participant	662,989.00	4,995,228.00	599.8	0:00	6,102
CR1-C7-NP	Non-P	660,893.00	4,984,861.00	593.2	0:00	3,022
CR1-C9-P	Participant	665,352.00	4,985,004.00	609.0	18:25	1,621
CR1-C10-P	Participant	663,510.00	4,985,195.00	609.0	12:55	1,762
CR1-C11-P	Participant	664,111.00	4,985,679.00	609.0	12:03	1,614
CR1-C12-P	Participant	662,222.00	4,985,736.00	603.0	18:29	2,201
CR1-C12-1-P	Participant	662,199.00	4,986,047.00	606.0	10:06	2,818
CR1-C13-P	Participant	663,792.00	4,985,785.00	612.0	22:39	1,739
CR1-C14-NP	Non-P	657,982.00	4,985,894.00	609.0	9:59	1,880
CR1-C15-P	Participant	663,291.00	4,986,026.00	615.0	21:43	1,952
CR1-C16-NP	Non-P	661,960.00	4,986,288.00	606.0	7:49	2,736
CR1-C17-P	Participant	658,031.00	4,986,373.00	609.1	26:40	1,886
CR1-C18-P	Participant	663,651.00	4,987,157.00	610.5	23:07	2,146
CR1-C19-P	Participant	659,243.00	4,987,276.00	611.5	21:20	1,722
CR1-C20-P	Participant	663,054.00	4,987,455.00	606.0	16:02	2,336
CR1-C26-P	Participant	657,767.00	4,988,493.00	597.0	7:32	3,484
CR1-C27-NP	Non-P	656,876.00	4,988,683.00	583.0	6:58	2,549
CR1-C28-NP	Non-P	665,429.00	4,988,598.00	590.8	2:43	2,831
CR1-C29-NP	Non-P	666,572.00	4,988,867.00	575.9	6:54	2,457
CR1-C30-P	Participant	661,699.00	4,988,957.00	615.0	23:21	1,614
CR1-C31-NP	Non-P	665,939.00	4,988,950.00	585.4	0:00	2,126
CR1-C32-NP	Non-P	655,843.00	4,989,581.00	568.6	0:00	3,714
CR1-C33-NP	Non-P	656,839.00	4,990,404.00	569.8	0:00	6,719
CR1-C34-NP	Non-P	658,661.00	4,990,389.00	589.1	26:03	1,726
CR1-C35-P	Participant	662,025.00	4,990,475.00	609.0	11:47	2,123
CR1-C36-P	Participant	663,181.00	4,990,600.00	615.0	25:52	1,532
CR1-C37-P	Participant	663,563.00	4,991,342.00	605.1	27:44	1,631
CR1-C38-NP	Non-P	660,639.00	4,991,557.00	597.0	6:04	3,474
CR1-C39-NP	Non-P	660,144.00	4,991,670.00	588.0	6:55	2,605
CR1-C40-NP	Non-P	657,865.00	4,991,818.00	583.8	6:42	2,690
CR1-C41-NP	Non-P	665,053.00	4,992,084.00	576.1	20:43	2,359
CR1-C42-P	Participant	659,458.00	4,992,229.00	580.0	11:54	1,801
CR1-C44-NP	Non-P	665,076.00	4,993,095.00	578.2	28:20	2,159
CR1-C45-NP	Non-P	653,390.00	4,993,503.00	573.0	1:41	5,673

Table C-1: Crowned Ridge Shadow Flicker Tabular Results Sorted by Receptor ID
Realistic case shadow results at existing structures
Results using GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
Codington County
continued

Receptor ID	Participation Status	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Shadow (hrs/year)	Distance to Nearest Turbine (ft)
CR1-C46-P	Participant	655,802.00	4,993,540.00	609.7	25:38	1,680
CR1-C47-P	Participant	662,825.00	4,993,508.00	613.8	5:00	3,750
CR1-C48-P	Participant	664,247.00	4,993,646.00	588.0	3:46	1,923
CR1-C49-P	Participant	662,250.00	4,993,731.00	609.0	1:12	5,148
CR1-C50-P	Participant	656,806.00	4,994,388.00	621.0	28:30	1,591
CR1-C51-P	Participant	657,455.00	4,995,160.00	621.0	24:39	1,768
CR1-C52-NP	Non-P	654,924.00	4,995,231.00	603.0	6:46	1,883
CR1-C53-NP	Non-P	663,376.00	4,996,043.00	578.6	0:00	7,201
CR1-C54-NP	Non-P	663,421.00	4,995,376.00	583.4	0:00	5,351
CR1-C55-P	Participant	660,914.00	4,995,169.00	607.9	2:51	3,360
CR1-C56-P	Participant	655,953.00	4,995,244.00	606.0	28:42	1,972
CR1-C57-P	Participant	656,628.00	4,995,266.00	615.0	10:23	1,568
CR1-C58-P	Participant	657,781.00	4,996,906.00	615.0	15:49	1,647
CR1-C59-P	Participant	661,548.00	5,000,754.00	584.1	7:36	1,644
CR1-C60-NP	Non-P	656,855.00	4,998,565.00	613.5	3:29	2,592
CR1-C61-NP	Non-P	656,690.00	4,997,831.00	612.0	27:42	1,686
CR1-C62-NP	Non-P	658,375.00	4,995,138.00	615.0	18:05	1,676
CR1-C63-NP	Non-P	658,566.00	4,995,254.00	612.6	10:42	2,408
CR1-C64-P	Participant	659,436.00	4,992,174.00	581.0	19:47	1,614
CR1-C65-NP	Non-P	665,805.00	4,995,305.00	579.0	1:29	3,884
CR1-C66-NP	Non-P	659,718.00	4,985,032.00	606.0	0:00	5,800
CR1-C67-NP	Non-P	659,789.00	4,985,057.00	606.0	0:00	5,791
CR1-C68-P	Participant	662,652.00	4,987,606.00	609.0	8:10	2,146
CR1-C69-P	Participant	662,685.00	4,987,619.00	609.0	7:45	2,185
CR1-C70-NP	Non-P	665,135.00	4,988,293.00	595.7	12:05	3,540
CR1-C71-NP	Non-P	665,137.00	4,988,378.00	594.6	7:28	3,448
CR1-C72-NP	Non-P	665,158.00	4,988,170.00	595.2	7:38	3,776
CR2-C150-P	Participant	657,178.00	4,985,788.00	612.0	9:58	1,640

Table C-1: Crowned Ridge Shadow Flicker Tabular Results Sorted by Receptor ID
Realistic case shadow results at existing structures
Results using GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
Grant County
continued

Receptor ID	Participation Status	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Shadow (hrs/year)	Distance to Nearest Turbine (ft)
CR1-G12-NP	Non-P	668,229.00	4,989,039.00	575.0	0:00	4,623
CR1-G13-NP	Non-P	672,216.00	4,989,142.00	558.0	0:00	3,576
CR1-G14-NP	Non-P	668,156.00	4,989,332.00	574.1	0:00	3,940
CR1-G15-P	Participant	668,396.00	4,989,607.00	576.0	0:00	2,746
CR1-G16-NP	Non-P	668,419.00	4,989,861.00	576.0	0:00	2,070
CR1-G18-P	Participant	668,678.00	4,990,722.00	585.0	22:28	1,585
CR1-G19-P	Participant	671,018.00	4,990,744.00	570.0	5:42	2,077
CR1-G21-P	Participant	666,766.00	4,991,807.00	577.1	28:59	1,555
CR1-G22-NP	Non-P	674,670.00	4,991,955.00	527.6	0:00	5,781
CR1-G23-NP	Non-P	670,471.00	4,992,104.00	560.1	5:16	2,185
CR1-G24-P	Participant	673,058.00	4,992,440.00	539.4	0:00	2,231
CR1-G25-P	Participant	671,391.00	4,992,858.00	549.0	14:36	1,804
CR1-G26-NP	Non-P	672,589.00	4,993,869.00	531.0	8:15	3,140
CR1-G27-NP	Non-P	676,630.00	4,994,642.00	480.8	2:54	4,944
CR1-G28-P	Participant	673,113.00	4,994,772.00	514.1	22:47	1,614
CR1-G32-P	Participant	669,477.00	4,995,401.00	546.0	19:55	1,545
CR1-G33-P	Participant	668,911.00	4,995,550.00	548.7	4:00	2,779
CR1-G34-NP	Non-P	671,320.00	4,995,798.00	531.0	1:28	2,238
CR1-G36-NP	Non-P	673,559.00	4,996,344.00	498.1	0:00	6,211
CR1-G37-NP	Non-P	668,998.00	4,996,452.00	549.0	0:00	5,246
CR1-G38-NP	Non-P	673,972.00	4,996,493.00	494.5	0:00	5,646
CR1-G41-P	Participant	671,563.00	4,997,050.00	497.7	0:00	3,983
CR1-G42-NP	Non-P	670,566.00	4,997,097.00	518.9	0:00	3,819
CR1-G43-NP	Non-P	661,141.00	5,001,721.00	584.2	18:19	1,909
CR1-G44-NP	Non-P	661,781.00	5,001,732.00	583.7	2:49	3,123
CR1-G59-P	Participant	675,755.00	4,994,888.00	488.3	12:40	2,605
CR1-G60-P	Participant	675,830.00	4,995,687.00	477.0	5:42	3,343
CR1-G65-P	Participant	671,496.00	4,994,973.00	537.0	29:50	1,539
CR1-G66-P	Participant	670,802.00	4,994,681.00	539.8	16:39	1,801
CR1-G67-P	Participant	669,597.00	4,993,440.00	555.8	12:03	2,106
CR1-G68-NP	Non-P	669,159.00	4,993,632.00	564.7	2:09	2,113
CR1-G77-NP	Non-P	676,031.00	4,992,629.00	503.1	0:00	5,728
CR1-G81-NP	Non-P	671,478.00	4,997,523.00	508.7	0:00	2,421
CR1-G105-NP	Non-P	668,696.00	4,998,325.00	549.0	0:00	6,345
CR1-G108-NP	Non-P	669,516.00	5,001,186.00	522.2	11:37	3,586
CR1-G109-NP	Non-P	667,064.00	5,000,425.00	566.4	0:59	2,152
CR1-G110-NP	Non-P	671,218.00	5,005,064.00	456.4	0:00	5,889
CR1-G113-NP	Non-P	666,228.00	5,005,549.00	537.0	7:15	2,746

Table C-1: Crowned Ridge Shadow Flicker Tabular Results Sorted by Receptor ID
Realistic case shadow results at principle structures
Results using GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
Grant County
continued

Receptor ID	Participation Status	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Shadow (hrs/year)	Distance to Nearest Turbine (ft)
CR1-G114-NP	Non-P	666,214.00	5,006,667.00	520.8	23:18	2,205
CR1-G115-NP	Non-P	664,933.00	5,006,731.00	544.6	7:58	2,188
CR1-G117-NP	Non-P	663,801.00	5,005,084.00	581.3	0:00	6,004
CR1-G124-P	Participant	669,843.00	5,000,605.00	525.0	19:21	1,791
CR1-G125-NP	Non-P	668,289.00	5,000,643.00	543.0	15:48	1,716
CR1-G126-NP	Non-P	672,157.00	5,000,446.00	484.3	3:21	3,176
CR1-G127-NP	Non-P	669,534.00	4,999,939.00	533.9	2:23	3,369
CR1-G128-NP	Non-P	670,242.00	5,001,314.00	513.0	14:58	2,612
CR1-G129-NP	Non-P	673,111.00	4,997,703.00	477.8	2:27	4,153
CR1-G130-NP	Non-P	668,147.00	5,000,233.00	549.0	0:00	3,005
CR1-G131-NP	Non-P	668,466.00	5,005,145.00	505.1	1:31	2,133
CR1-G132-NP	Non-P	669,098.00	5,004,948.00	501.0	7:38	2,703
CR1-G133-NP	Non-P	669,881.00	5,005,460.00	478.8	3:26	3,556
CR1-G135-NP	Non-P	668,616.00	5,005,161.00	504.2	8:10	2,142
CR1-G136-NP	Non-P	667,706.00	5,004,861.00	522.0	10:34	2,277
CR1-G137-NP	Non-P	666,501.00	5,005,136.00	529.5	18:36	1,939
CR1-G138-NP	Non-P	664,809.00	5,006,456.00	549.0	25:18	1,824
CR1-G139-NP	Non-P	668,199.00	5,008,062.00	475.9	8:05	2,612
CR1-G140-P	Participant	664,546.00	5,007,269.00	551.1	0:00	4,360
CR1-G149-NP	Non-P	669,284.00	5,003,283.00	503.2	12:39	2,815

Table C-2: Crowned Ridge Shadow Flicker Tabular Results Sorted by Real Case Shadow Flicker Hours/Year
Realistic case shadow results at existing structures
Results using GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
Codington County

Receptor ID	Participation Status	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Shadow (hrs/year)	Distance to Nearest Turbine (ft)
CR1-C44-NP	Non-P	665,076.00	4,993,095.00	578.2	28:20	2,159
CR1-C61-NP	Non-P	656,690.00	4,997,831.00	612.0	27:42	1,686
CR1-C34-NP	Non-P	658,661.00	4,990,389.00	589.1	26:03	1,726
CR1-C41-NP	Non-P	665,053.00	4,992,084.00	576.1	20:43	2,359
CR1-C62-NP	Non-P	658,375.00	4,995,138.00	615.0	18:05	1,676
CR1-C70-NP	Non-P	665,135.00	4,988,293.00	595.7	12:05	3,540
CR1-C63-NP	Non-P	658,566.00	4,995,254.00	612.6	10:42	2,408
CR1-C14-NP	Non-P	657,982.00	4,985,894.00	609.0	9:59	1,880
CR1-C16-NP	Non-P	661,960.00	4,986,288.00	606.0	7:49	2,736
CR1-C72-NP	Non-P	665,158.00	4,988,170.00	595.2	7:38	3,776
CR1-C71-NP	Non-P	665,137.00	4,988,378.00	594.6	7:28	3,448
CR1-C27-NP	Non-P	656,876.00	4,988,683.00	583.0	6:58	2,549
CR1-C39-NP	Non-P	660,144.00	4,991,670.00	588.0	6:55	2,605
CR1-C29-NP	Non-P	666,572.00	4,988,867.00	575.9	6:54	2,457
CR1-C52-NP	Non-P	654,924.00	4,995,231.00	603.0	6:46	1,883
CR1-C40-NP	Non-P	657,865.00	4,991,818.00	583.8	6:42	2,690
CR1-C38-NP	Non-P	660,639.00	4,991,557.00	597.0	6:04	3,474
CR1-C3-NP	Non-P	657,888.00	4,984,697.00	604.2	4:10	3,294
CR1-C60-NP	Non-P	656,855.00	4,998,565.00	613.5	3:29	2,592
CR1-C28-NP	Non-P	665,429.00	4,988,598.00	590.8	2:43	2,831
CR1-C45-NP	Non-P	653,390.00	4,993,503.00	573.0	1:41	5,673
CR1-C65-NP	Non-P	665,805.00	4,995,305.00	579.0	1:29	3,884
CR1-C1-NP	Non-P	656,743.00	4,983,525.00	595.9	0:00	5,541
CR1-C2-NP	Non-P	658,791.00	4,984,483.00	601.6	0:00	6,273
CR1-C31-NP	Non-P	665,939.00	4,988,950.00	585.4	0:00	2,126
CR1-C32-NP	Non-P	655,843.00	4,989,581.00	568.6	0:00	3,714
CR1-C33-NP	Non-P	656,839.00	4,990,404.00	569.8	0:00	6,719
CR1-C4-NP	Non-P	659,744.00	4,984,749.00	605.9	0:00	5,981
CR1-C54-NP	Non-P	663,421.00	4,995,376.00	583.4	0:00	5,351
CR1-C5-NP	Non-P	659,958.00	4,984,794.00	605.2	0:00	5,659
CR1-C66-NP	Non-P	659,718.00	4,985,032.00	606.0	0:00	5,800
CR1-C67-NP	Non-P	659,789.00	4,985,057.00	606.0	0:00	5,791
CR1-C7-NP	Non-P	660,893.00	4,984,861.00	593.2	0:00	3,022
CR1-C53-NP	Non-P	663,376.00	4,996,043.00	578.6	0:00	7,201
CR1-C56-P	Participant	655,953.00	4,995,244.00	606.0	28:42	1,972
CR1-C50-P	Participant	656,806.00	4,994,388.00	621.0	28:30	1,591
CR1-C37-P	Participant	663,563.00	4,991,342.00	605.1	27:44	1,631
CR1-C17-P	Participant	658,031.00	4,986,373.00	609.1	26:40	1,886
CR1-C36-P	Participant	663,181.00	4,990,600.00	615.0	25:52	1,532

Table C-2: Crowned Ridge Shadow Flicker Tabular Results Sorted by Real Case Shadow Flicker Hours/Year
Realistic case shadow results at existing structures
Results using GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
Codington County
continued

Receptor ID	Participation Status	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Shadow (hrs/year)	Distance to Nearest Turbine (ft)
CR1-C46-P	Participant	655,802.00	4,993,540.00	609.7	25:38	25:38
CR1-C51-P	Participant	657,455.00	4,995,160.00	621.0	24:39	24:39
CR1-C30-P	Participant	661,699.00	4,988,957.00	615.0	23:21	23:21
CR1-C18-P	Participant	663,651.00	4,987,157.00	610.5	23:06	23:07
CR1-C13-P	Participant	663,792.00	4,985,785.00	612.0	22:38	22:39
CR1-C15-P	Participant	663,291.00	4,986,026.00	615.0	21:42	21:43
CR1-C19-P	Participant	659,243.00	4,987,276.00	611.5	21:20	21:20
CR1-C64-P	Participant	659,436.00	4,992,174.00	581.0	19:47	19:47
CR1-C12-P	Participant	662,222.00	4,985,736.00	603.0	18:29	18:29
CR1-C9-P	Participant	665,352.00	4,985,004.00	609.0	18:24	18:25
CR1-C20-P	Participant	663,054.00	4,987,455.00	606.0	16:01	16:02
CR1-C58-P	Participant	657,781.00	4,996,906.00	615.0	15:49	15:49
CR1-C10-P	Participant	663,510.00	4,985,195.00	609.0	12:55	12:55
CR1-C11-P	Participant	664,111.00	4,985,679.00	609.0	12:03	12:03
CR1-C42-P	Participant	659,458.00	4,992,229.00	580.0	11:54	11:54
CR1-C35-P	Participant	662,025.00	4,990,475.00	609.0	11:46	11:47
CR1-C57-P	Participant	656,628.00	4,995,266.00	615.0	10:23	10:23
CR1-C12-1-P	Participant	662,199.00	4,986,047.00	606.0	10:06	10:06
CR2-C150-P	Participant	657,178.00	4,985,788.00	612.0	9:58	9:58
CR1-C68-P	Participant	662,652.00	4,987,606.00	609.0	8:10	8:10
CR1-C69-P	Participant	662,685.00	4,987,619.00	609.0	7:44	7:45
CR1-C59-P	Participant	661,548.00	5,000,754.00	584.1	7:36	7:36
CR1-C26-P	Participant	657,767.00	4,988,493.00	597.0	7:32	7:32
CR1-C47-P	Participant	662,825.00	4,993,508.00	613.8	5:00	5:00
CR1-C48-P	Participant	664,247.00	4,993,646.00	588.0	3:46	3:46
CR1-C55-P	Participant	660,914.00	4,995,169.00	607.9	2:51	2:51
CR1-C49-P	Participant	662,250.00	4,993,731.00	609.0	1:12	1:12
CR1-C6-P	Participant	662,989.00	4,995,228.00	599.8	0:00	0:00

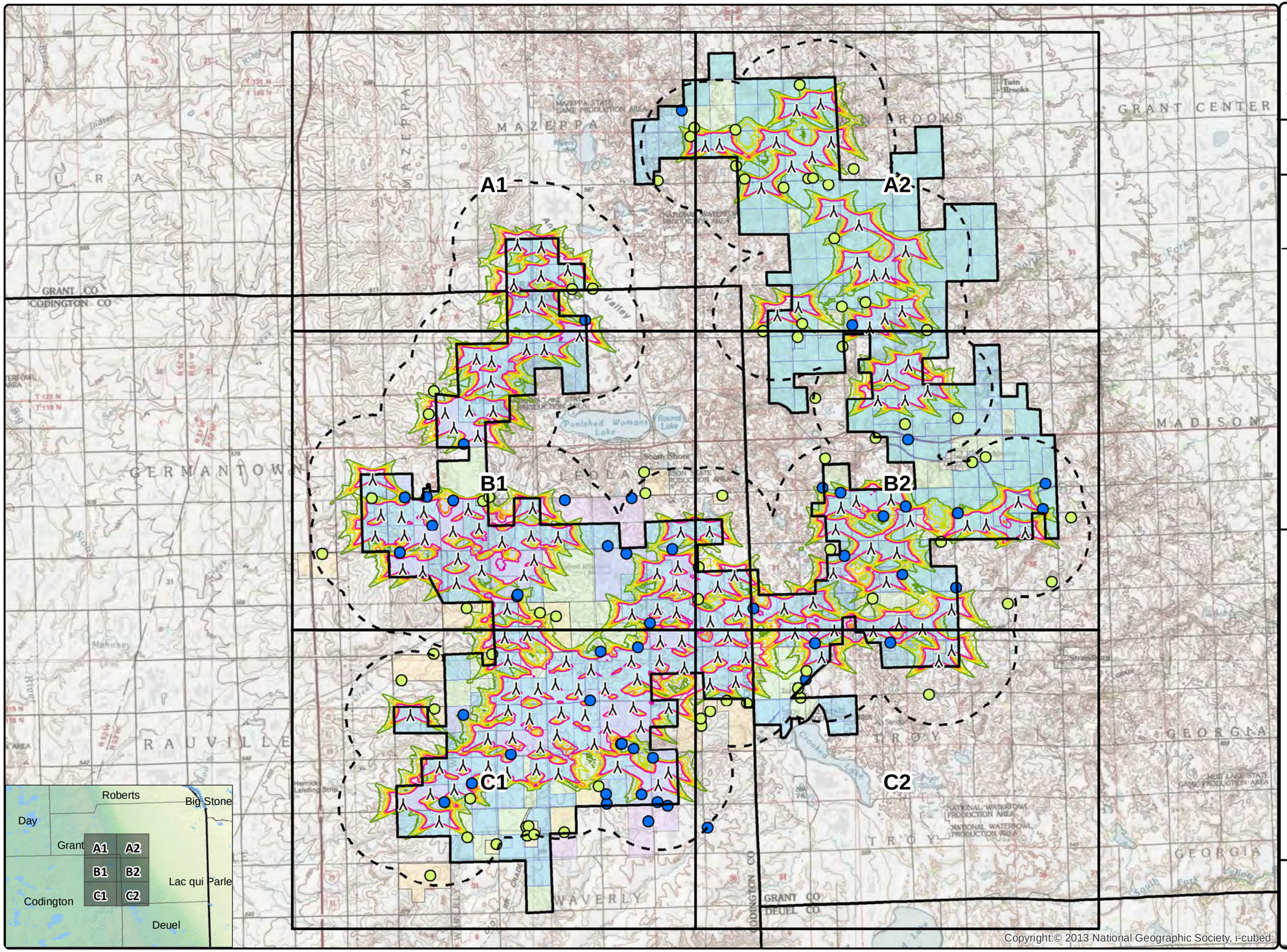
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UTM NAD83 Zone 14
Grant County
continued

Receptor ID	Participation Status	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Shadow (hrs/year)	Distance to Nearest Turbine (ft)
CR1-G138-NP	Non-P	664,809.00	5,006,456.00	549.0	25:18	1,824
CR1-G114-NP	Non-P	666,214.00	5,006,667.00	520.8	23:18	2,205
CR1-G137-NP	Non-P	666,501.00	5,005,136.00	529.5	18:36	1,939
CR1-G43-NP	Non-P	661,141.00	5,001,721.00	584.2	18:19	1,909
CR1-G125-NP	Non-P	668,289.00	5,000,643.00	543.0	15:48	1,716
CR1-G128-NP	Non-P	670,242.00	5,001,314.00	513.0	14:58	2,612
CR1-G149-NP	Non-P	669,284.00	5,003,283.00	503.2	12:39	2,815
CR1-G108-NP	Non-P	669,516.00	5,001,186.00	522.2	11:37	3,586
CR1-G136-NP	Non-P	667,706.00	5,004,861.00	522.0	10:34	2,277
CR1-G26-NP	Non-P	672,589.00	4,993,869.00	531.0	8:15	3,140
CR1-G135-NP	Non-P	668,616.00	5,005,161.00	504.2	8:10	2,142
CR1-G139-NP	Non-P	668,199.00	5,008,062.00	475.9	8:05	2,612
CR1-G115-NP	Non-P	664,933.00	5,006,731.00	544.6	7:58	2,188
CR1-G132-NP	Non-P	669,098.00	5,004,948.00	501.0	7:38	2,703
CR1-G113-NP	Non-P	666,228.00	5,005,549.00	537.0	7:15	2,746
CR1-G23-NP	Non-P	670,471.00	4,992,104.00	560.1	5:16	2,185
CR1-G133-NP	Non-P	669,881.00	5,005,460.00	478.8	3:26	3,556
CR1-G126-NP	Non-P	672,157.00	5,000,446.00	484.3	3:21	3,176
CR1-G27-NP	Non-P	676,630.00	4,994,642.00	480.8	2:54	4,944
CR1-G44-NP	Non-P	661,781.00	5,001,732.00	583.7	2:49	3,123
CR1-G129-NP	Non-P	673,111.00	4,997,703.00	477.8	2:27	4,153
CR1-G127-NP	Non-P	669,534.00	4,999,939.00	533.9	2:23	3,369
CR1-G68-NP	Non-P	669,159.00	4,993,632.00	564.7	2:09	2,113
CR1-G131-NP	Non-P	668,466.00	5,005,145.00	505.1	1:31	2,133
CR1-G34-NP	Non-P	671,320.00	4,995,798.00	531.0	1:28	2,238
CR1-G109-NP	Non-P	667,064.00	5,000,425.00	566.4	0:59	2,152
CR1-G12-NP	Non-P	668,229.00	4,989,039.00	575.0	0:00	4,623
CR1-G16-NP	Non-P	668,419.00	4,989,861.00	576.0	0:00	2,070
CR1-G14-NP	Non-P	668,156.00	4,989,332.00	574.1	0:00	3,940
CR1-G22-NP	Non-P	674,670.00	4,991,955.00	527.6	0:00	5,781
CR1-G13-NP	Non-P	672,216.00	4,989,142.00	558.0	0:00	3,576
CR1-G77-NP	Non-P	676,031.00	4,992,629.00	503.1	0:00	5,728
CR1-G38-NP	Non-P	673,972.00	4,996,493.00	494.5	0:00	5,646
CR1-G37-NP	Non-P	668,998.00	4,996,452.00	549.0	0:00	5,246
CR1-G42-NP	Non-P	670,566.00	4,997,097.00	518.9	0:00	3,819
CR1-G81-NP	Non-P	671,478.00	4,997,523.00	508.7	0:00	2,421
CR1-G36-NP	Non-P	673,559.00	4,996,344.00	498.1	0:00	6,211
CR1-G105-NP	Non-P	668,696.00	4,998,325.00	549.0	0:00	6,345

Table C-2: Crowned Ridge Shadow Flicker Tabular Results Sorted by Real Case Shadow Flicker Hours/Year
Realistic case shadow results at principle structures
Results using GE 2.3-116-90 m HH, GE 2.3-116-80 m HH WTG's
UTM NAD83 Zone 14
Grant County
continued

Receptor ID	Participation Status	Easting (m)	Northing (m)	Elevation AMSL (m)	Real Case Shadow (hrs/year)	Distance to Nearest Turbine (ft)
CR1-G110-NP	Non-P	671,218.00	5,005,064.00	456.4	0:00	5,889
CR1-G117-NP	Non-P	663,801.00	5,005,084.00	581.3	0:00	6,004
CR1-G130-NP	Non-P	668,147.00	5,000,233.00	549.0	0:00	3,005
CR1-G65-P	Participant	671,496.00	4,994,973.00	537.0	29:50	1,539
CR1-G21-P	Participant	666,766.00	4,991,807.00	577.1	28:59	1,555
CR1-G28-P	Participant	673,113.00	4,994,772.00	514.1	22:47	1,614
CR1-G18-P	Participant	668,678.00	4,990,722.00	585.0	22:28	1,585
CR1-G32-P	Participant	669,477.00	4,995,401.00	546.0	19:55	1,545
CR1-G124-P	Participant	669,843.00	5,000,605.00	525.0	19:21	1,791
CR1-G66-P	Participant	670,802.00	4,994,681.00	539.8	16:39	1,801
CR1-G25-P	Participant	671,391.00	4,992,858.00	549.0	14:36	1,804
CR1-G59-P	Participant	675,755.00	4,994,888.00	488.3	12:40	2,605
CR1-G67-P	Participant	669,597.00	4,993,440.00	555.8	12:03	2,106
CR1-G19-P	Participant	671,018.00	4,990,744.00	570.0	5:42	2,077
CR1-G60-P	Participant	675,830.00	4,995,687.00	477.0	5:42	3,343
CR1-G33-P	Participant	668,911.00	4,995,550.00	548.7	4:00	2,779
CR1-G15-P	Participant	668,396.00	4,989,607.00	576.0	0:00	2,746
CR1-G24-P	Participant	673,058.00	4,992,440.00	539.4	0:00	2,231
CR1-G41-P	Participant	671,563.00	4,997,050.00	497.7	0:00	3,983
CR1-G140-P	Participant	664,546.00	5,007,269.00	551.1	0:00	4,360

APPENDIX D: STANDARD RESOLUTION SHADOW FLICKER MAPS



0 0.75 1.5 3 Mile

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Crowned Ridge Wind Farm
Shadow Flicker Iso-Lines
Overview Map

Client

SWCA Environmental Consultants

Project Description

Wind turbine layout with occupied structures within 2 km.

Predicted shadow flicker levels at existing residences.

Location: Watertown, SD
Project #: 20174430

Issue Dates

#	Description	Date
1	Original	2019.01.15

Drawn By: AS *Checked By: JH*

Legend

- Crowned Ridge Turbines
- 2 km Turbine Buffer
- County Lines
- CR1 Project Boundary
- Non-Participants
- Participants

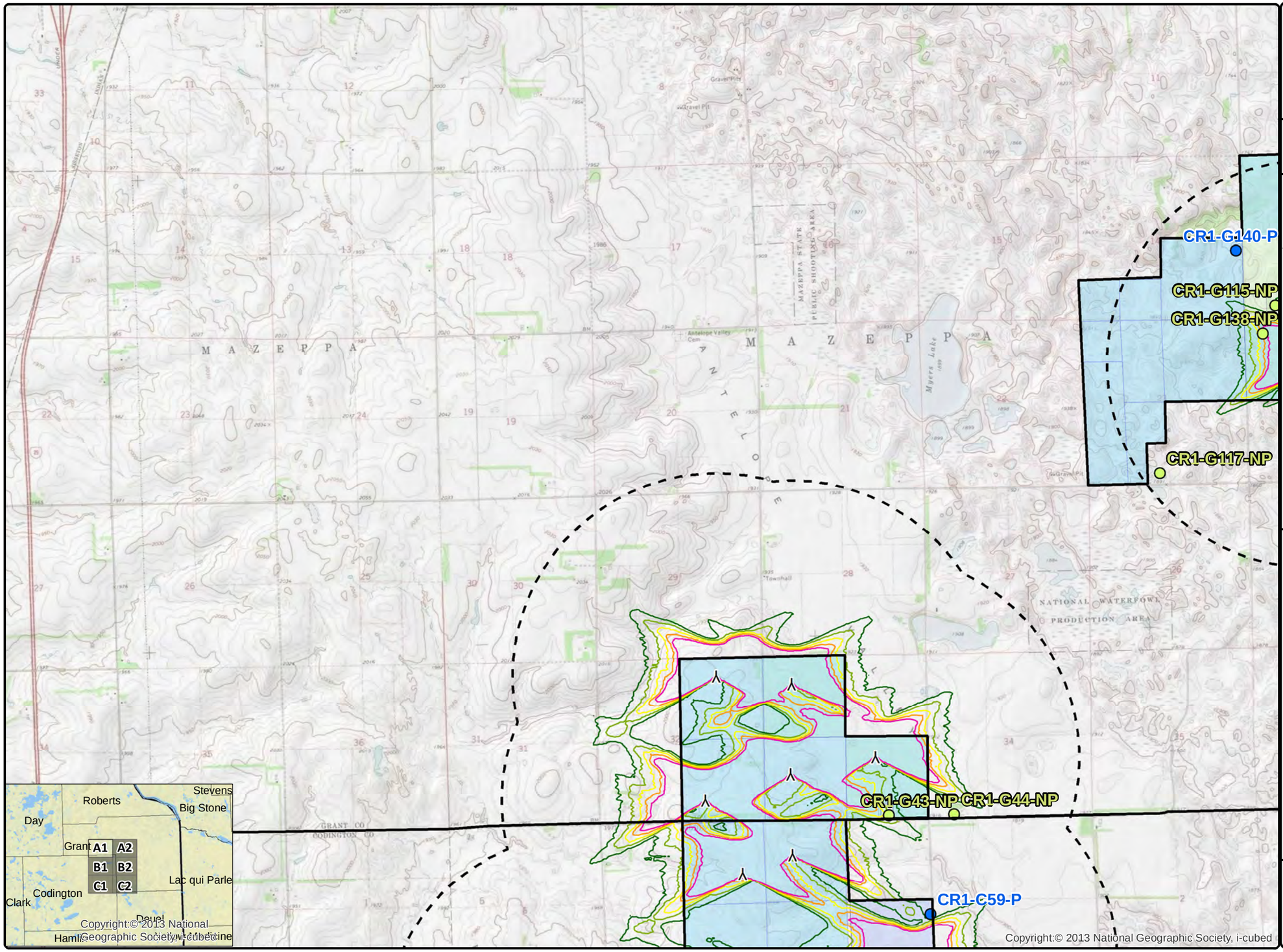
Shadow Flicker (hr/yr)

- 10
- 15
- 20
- 25
- 30
- Participating Codington Parcels
- Non-Part. Codington Parcels
- Participating Land Parcels
- Non-Participating Land Parcels

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0 0.25 0.5 1 Mile

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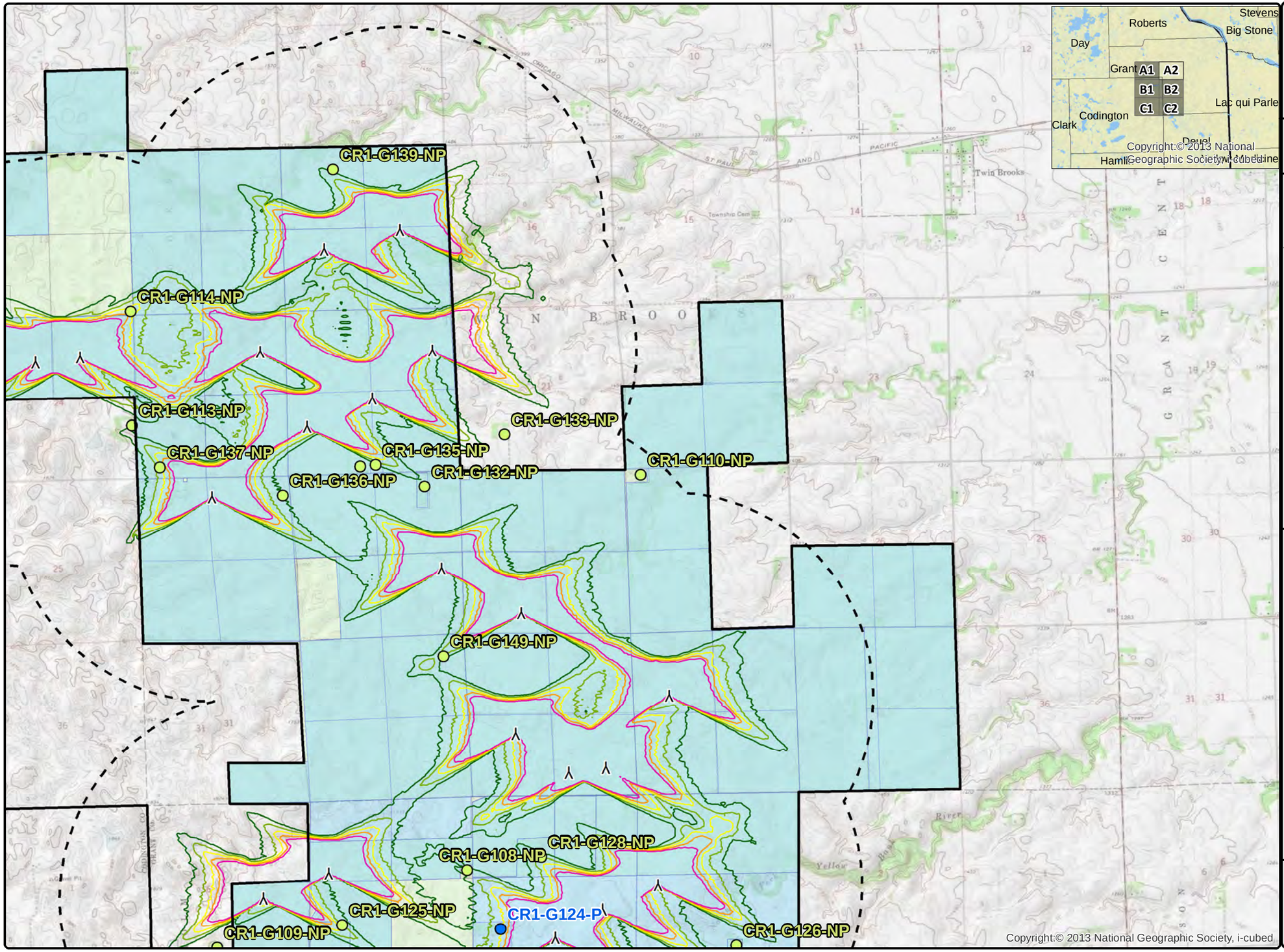
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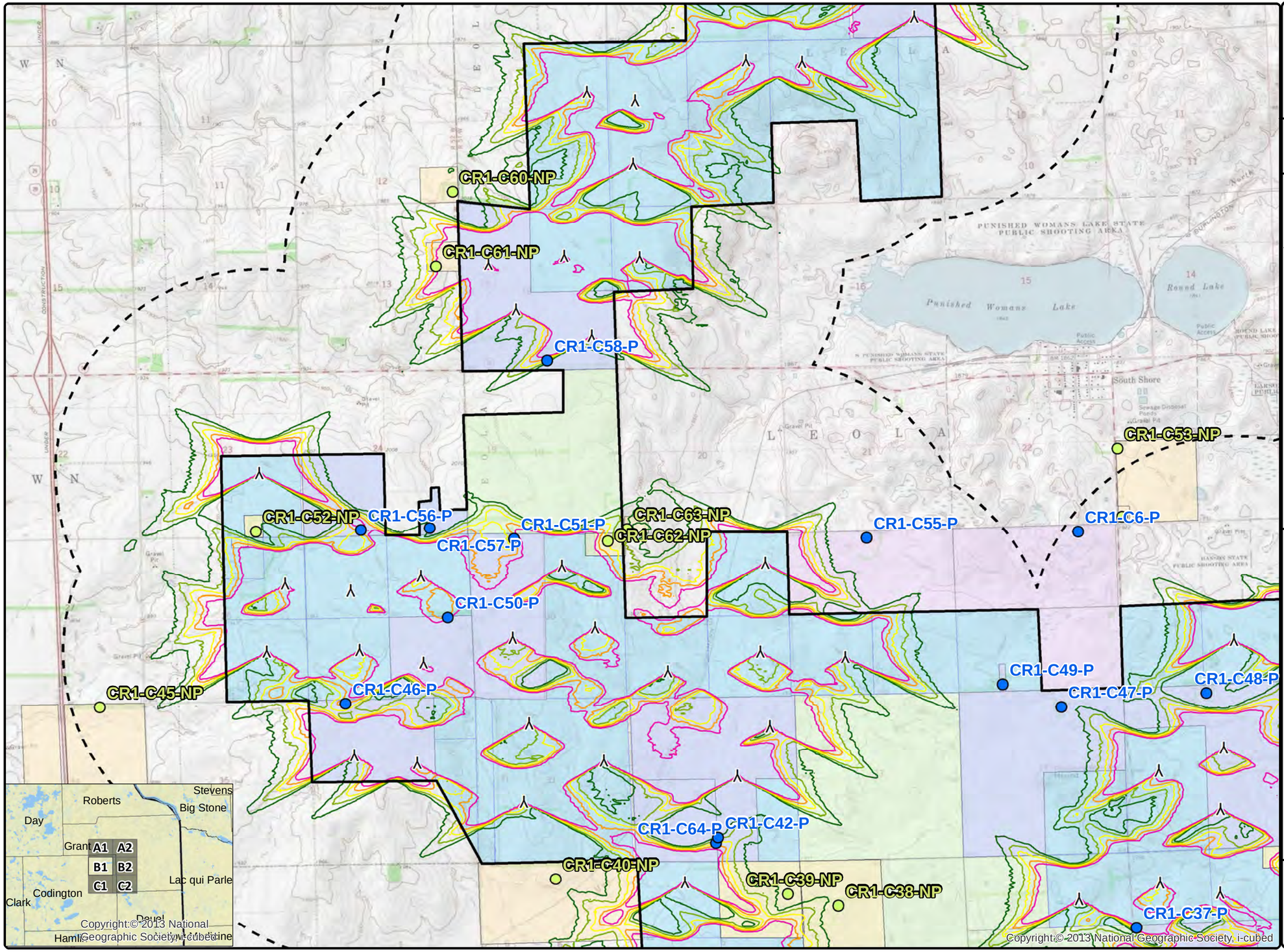
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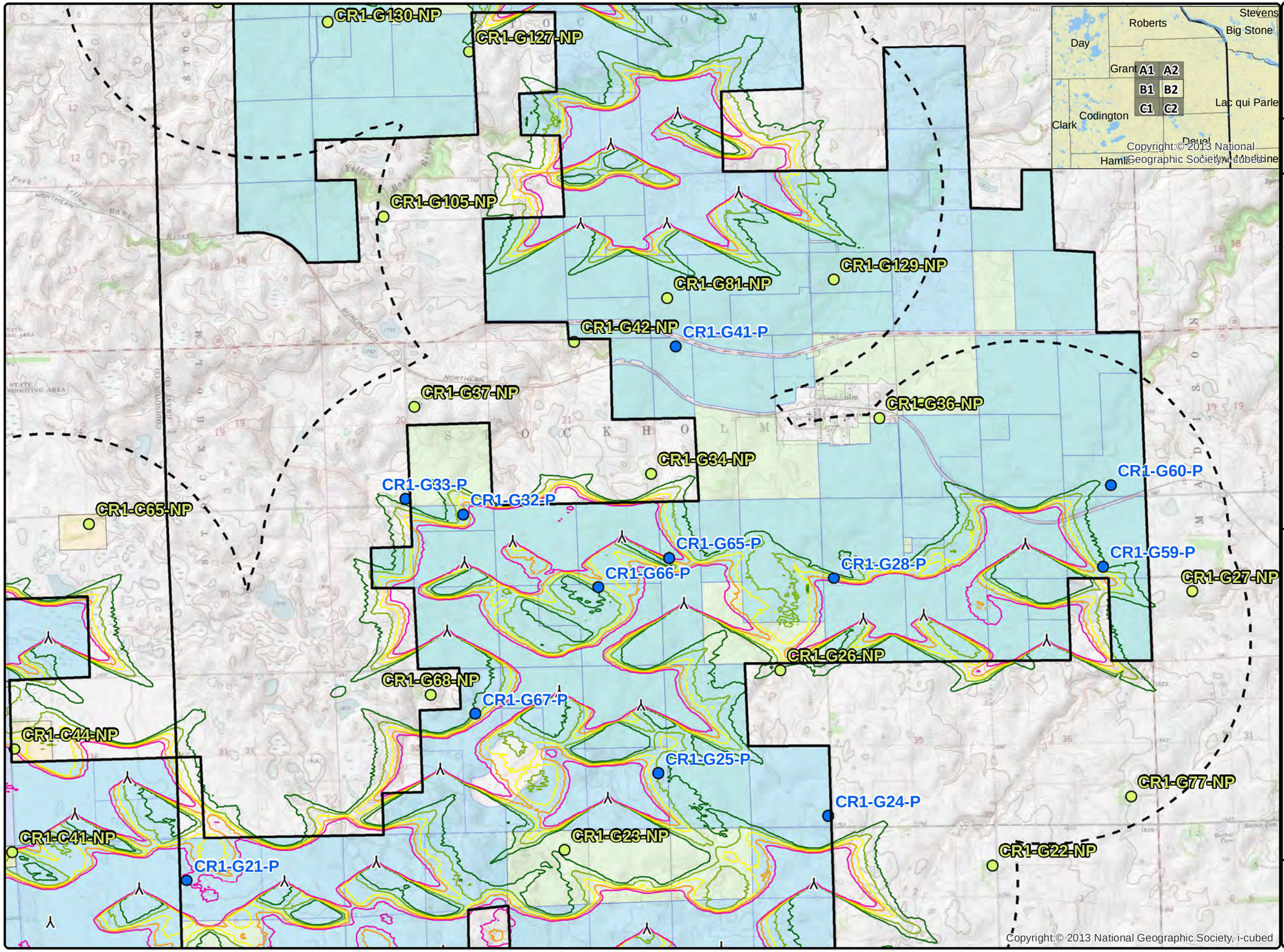
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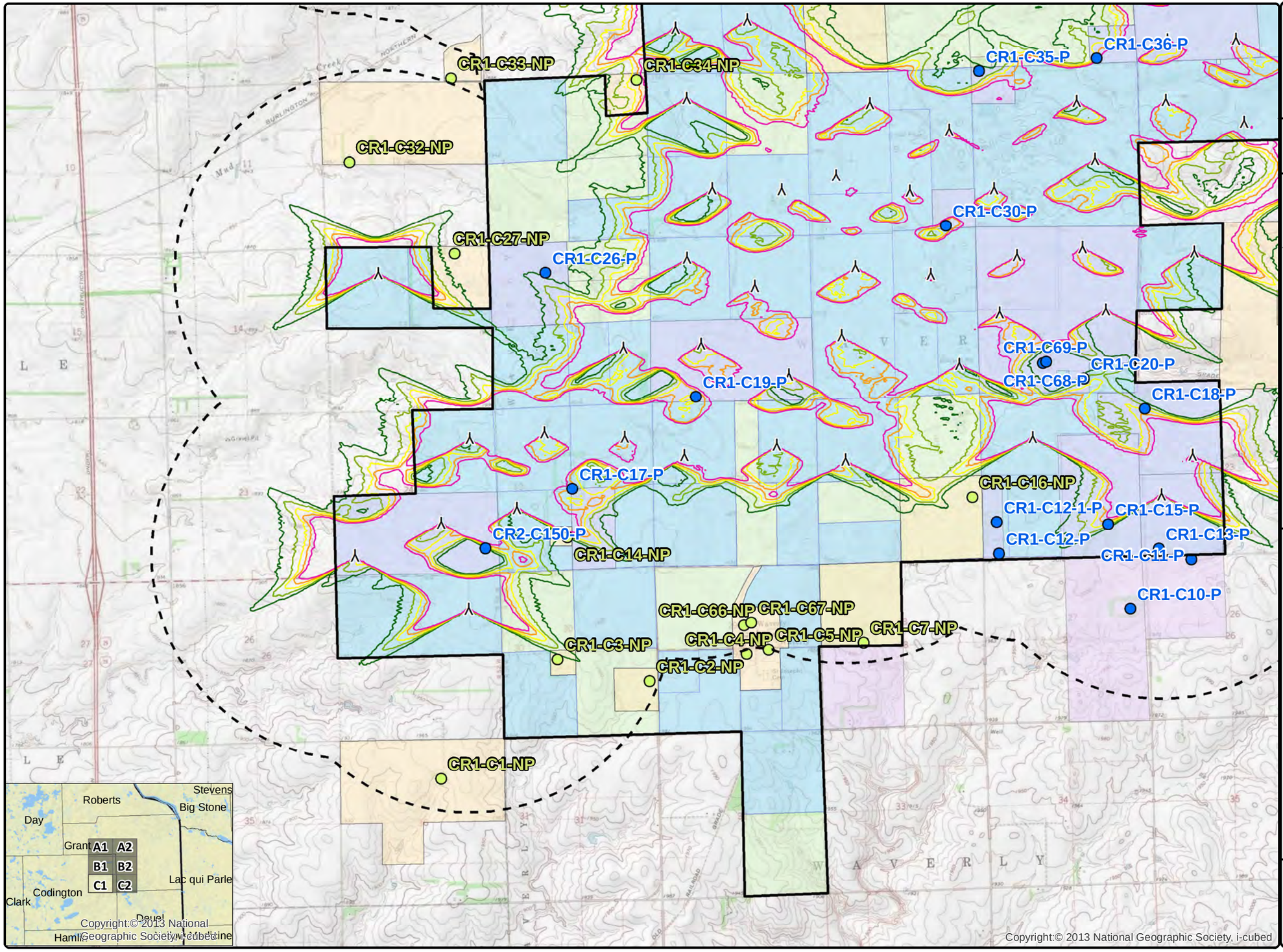
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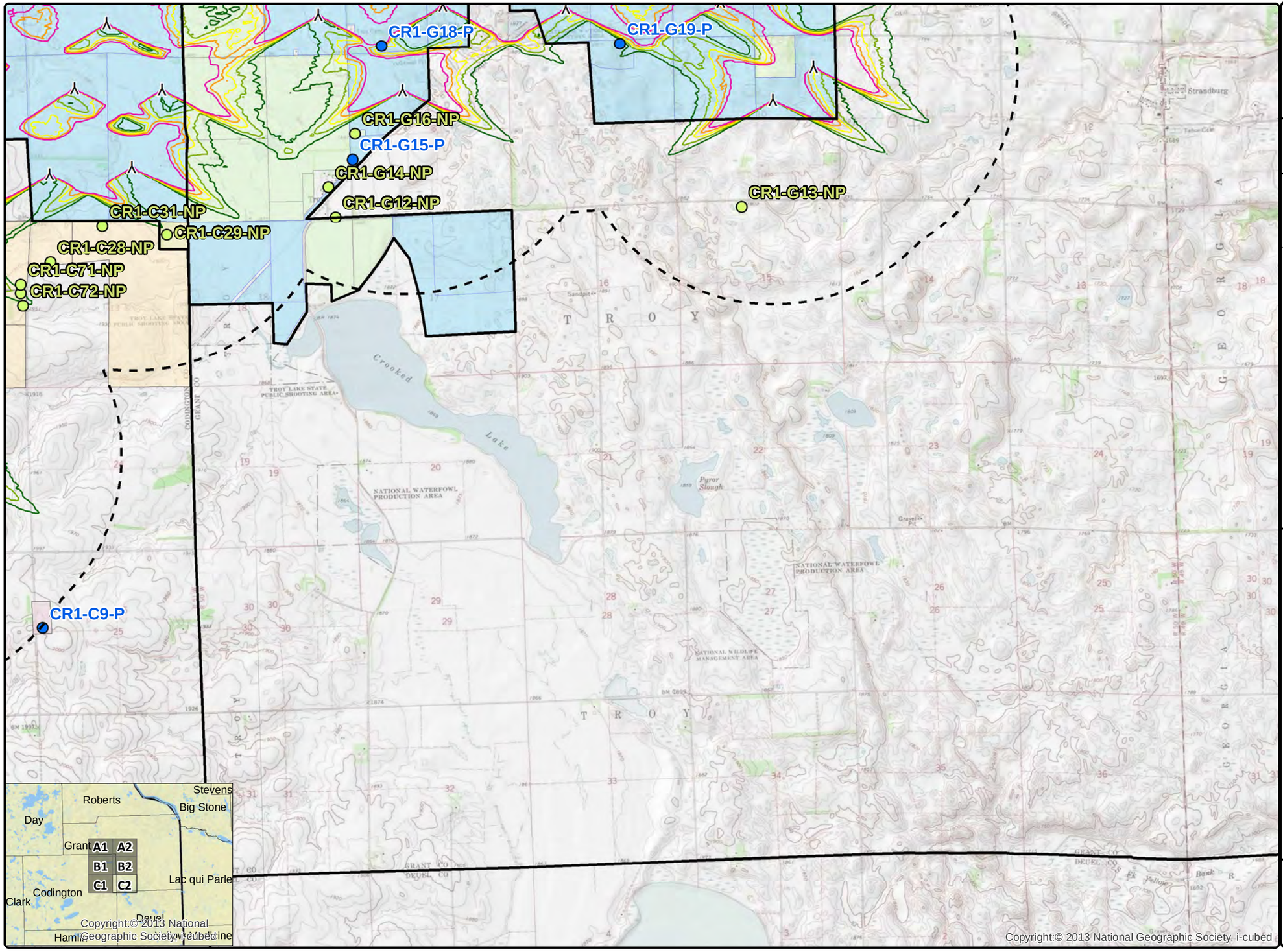
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0 0.25 0.5 1 Mile

EAPC WIND ENERGY

www.eapc.net | 701.775.3000

Crowned Ridge Wind Farm
Shadow Flicker Iso-Lines

Client

SWCA Environmental Consultants

Project Description

Wind turbine layout with occupied structures within 2 km.

Predicted shadow flicker levels at existing residences.

Location: Watertown, SD
Project #: 20174430

Issue Dates

#	Description	Date
1	Original	2019.01.15

Drawn By: AS *Checked By: JH*

Legend

- Crowned Ridge Turbines
- 2 km Turbine Buffer
- County Lines
- CR1 Project Boundary
- Non-Participants
- Participants

Shadow Flicker (hr/yr)

- 10
- 15
- 20
- 25
- 30
- Participating Codington Parcels
- Non-Part. Codington Parcels
- Participating Land Parcels
- Non-Participating Land Parcels

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Codington County
Planning Commission / Board of Adjustment
1910 West Kemp Avenue
Watertown, SD 57201-3048

Email: codington.county@sdstate.edu
Website: codington.org

Phone: (605) 882-6300
Fax: (605) 882-6302

July 20, 2018

Crowned Ridge, LLC and Crowned Ridge II, LLC
700 Universe Blvd.
Juno Beach, FL 33408

To whom it may concern

This letter is written to formally inform you that on July 16, 2018 the Codington County Board of Adjustment (Board) approved your request for a conditional use permit to operate a Wind Energy System on property described in your application within Germantown, Leola, Waverly, Kranzburg, and Rauville Townships.

The Conditional Use permit will allow you to operate a wind energy system with up to 164 wind towers and other structures/uses in the manner presented in your application and at the meeting. The Board approved the Conditional Use Permit based upon the staff report, testimony at the meeting and in the application, findings read at the meeting, and conditions to be agreed upon in a letter of assurance. The official findings of fact will be filed at the zoning office upon review and signature of the Chairperson of the Board. Please contact this office if you would like a copy of the findings of fact for your records. As noted, the Board approved your permit subject to you signing a letter of assurance with the following conditions:

1) Effective Date and Transferability:
   a. Upon issuance of permit by South Dakota Public Utilities Commission.
   b. This permit shall expire if either no construction as described in the application has commenced within three (3) years of issuance by the County Board of Adjustment; or if a State Permit from the South Dakota Public Utility Commission has not been issued within two (2) years of issuance by the County Board of Adjustment; or any within three (3) years of the final decision regarding any appeal to circuit court relating to the issuance of the permit.
   c. The applicant may apply for an extension of this permit if the requirements of 1.b above cannot be met.
   d. The Conditional Use permit is transferable. Subsequent owners/operators shall agree to the same conditions described herein.

2) General Requirements:
   a. There shall be no discharge of industrial processed water on the site

b. Storage of petroleum products in quantities exceeding one hundred (100) gallons at one (1) locality in one (1) tank or series of tanks must be in elevated tanks; such tanks larger than eleven hundred (1,100) gallons must have a secondary containment system where it is deemed necessary by the Board of Adjustment.
c. Grantor shall provide the zoning office with an updated local contact information of plant supervisor with authority to implement dust control and other necessary enforcement of the conditions of this permit.

3) Obligation to Meet Requirements:

a. Applicant agrees to meet requirements of Section 5.22 of the Codington County Ordinance in reference to remaining obligations including but not limited to: submittal of Soil Erosion and Sediment Control Plans, Haul Road Agreements, Decommissioning Plan, Final site location of towers, building permit application, meeting applicable federal and state requirement as required by Section 5.22
b. Applicant acknowledges the ability of the Board of Adjustment to require some form of financial assurance to cover the anticipated costs of decommissioning the WES Facility on or before July 16, 2023.

4) Violation and Penalties:

a. Violations of requirements of the ordinance relating to the operations of a specific tower will result in enforcement/penalties in reference to the specific tower found to be in violation, and will be enforced in the manner as described in Section 4.b below.
b. Violation of the terms of this conditional use permit will be determined by the Codington County Zoning Officer.
   (1) The first violation substantiated by the Zoning Officer of this conditional use permit may result in a notification letter stating the violation and a prescribed period of time to remove the violation. A second violation occurring within one calendar year of the previous violation may result in a review of the validity of the conditional use permit and potential revocation of said permit. A third violation within one calendar year of the initial violation may result in revocation of the conditional use permit and cessation of all feeder operations within forty-five days (45) of notice of revocation.
   (2) The applicant may make appeal from the decision of the Zoning Officer or other agent of the Codington County Board of Adjustment to the Codington County Board of Adjustment. The applicant shall file with the Zoning Officer a notice of appeal specifying the grounds thereof. The Zoning Officer shall forthwith transmit to the Board of Adjustment all papers constituting the record upon which the action appealed from was taken. Such appeal shall be taken within thirty (30) days. Appeals from the Board of Adjustment shall be taken to Circuit Court.
   (3) Failure to comply with the decision of the Zoning Officer or other agent of the Codington County Board of Adjustment may be deemed a separate violation.

I have attached the Letter of Assurance to this letter for your signature. Please note, two letters of assurance have been attached to be signed on behalf of the separate entities (Crowned Ridge, LLC and Crowned Ridge II, LLC.) These letters of assurance will be filed with this letter and the original application at the Zoning Office. If you would like a copy of the letter of assurance after signature from the Chairperson of the Board, please contact this office. Further, if you have any other questions you may reach me at 882-6300 between the hours of 9:00 a.m. and 11:00 a.m. on Mondays, Wednesdays, and Fridays.

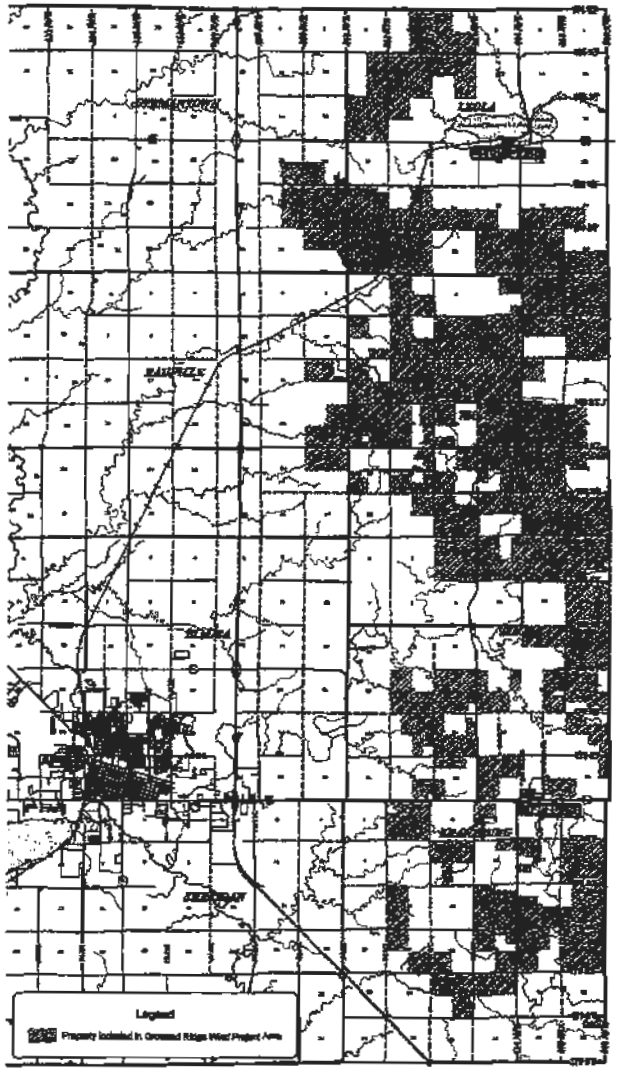
Sincerely,

Luke Muller /bg

Luke Muller
Codington County Zoning Officer

Exhibit "A"

Crowned Ridge, LLC and Crowned Ridge II, LLC:
Wind Energy System Orientation Map



Prepared by: Luke Muller
Codington County Zoning Officer
1910 West Kemp Avenue
Watertown, SD 57201

Letter of Assurance

A Conditional Use Permit under Codington County Zoning Ordinance 3.04.02.21., "Wind Energy Systems" has been granted by the Codington County Board of Adjustment to Crowned Ridge Wind, LLC to operate a Wind Energy System with up to 164 Wind Towers and other ancillary structures/uses described in the application.

Property location: As displayed in Exhibit "A" attached and hereby incorporated by reference.

Conditions to be placed upon the conditional use permit issued to Crowned Ridge Wind, LLC by the Codington County Board of Adjustment on July 16, 2018:

1) Effective Date and Transferability:
   a. Upon issuance of permit by South Dakota Public Utilities Commission.
   b. This permit shall expire if either no construction as described in the application has commenced within three (3) years of issuance by the County Board of Adjustment; or if a State Permit from the South Dakota Public Utility Commission has not been issued within two (2) years of issuance by the County Board of Adjustment; or any within three (3) years of the final decision regarding any appeal to circuit court relating to the issuance of the permit.
   c. The applicant may apply for an extension of this permit if the requirements of 1.b above cannot be met.
   d. The Conditional Use permit is transferable. Subsequent owners/operators shall agree to the same conditions described herein.

2) General Requirements:
   a. There shall be no discharge of industrial processed water on the site
   b. Storage of petroleum products in quantities exceeding one hundred (100) gallons at one (1) locality in one (1) tank or series of tanks must be in elevated tanks; such tanks larger than eleven hundred (1,100) gallons must have a secondary containment system where it is deemed necessary by the Board of Adjustment.
   c. Grantor shall provide the zoning office with an updated local contact information of plant supervisor with authority to implement dust control and other necessary enforcement of the conditions of this permit.

3) Obligation to Meet Requirements:

   a. Applicant agrees to meet requirements of Section 5.22 of the Codington

4) Violation and Penalties:

a. Violations of requirements of the ordinance relating to the operations of a specific tower will result in enforcement/penalties in reference to the specific tower found to be in violation, and will be enforced in the manner as described in Section 4.b below.

b. Violation of the terms of this conditional use permit will be determined by the Codington County Zoning Officer.

(1) The first violation substantiated by the Zoning Officer of this conditional use permit may result in a notification letter stating the violation and a prescribed period of time to remove the violation. A second violation occurring within one calendar year of the previous violation may result in a review of the validity of the conditional use permit and potential revocation of said permit. A third violation within one calendar year of the initial violation may result in revocation of the conditional use permit and cessation of all operations within forty-five days (45) of notice of revocation.

(2) The applicant may make appeal from the decision of the Zoning Officer or other agent of the Codington County Board of Adjustment to the Codington County Board of Adjustment. The applicant shall file with the Zoning Officer a notice of appeal specifying the grounds thereof. The Zoning Officer shall forthwith transmit to the Board of Adjustment all papers constituting the record upon which the action appealed from was taken. Such appeal shall be taken within thirty (30) days. Appeals from the Board of Adjustment shall be taken to Circuit Court.

(3) Failure to comply with the decision of the Zoning Officer or other agent of the Codington County Board of Adjustment may be deemed a separate violation.

IN WITNESS WHEREOF, Codington County and the Grantor(s) have executed this Conditional Use Permit Letter of Assurance.

Crowned Ridge Wind, LLC (Grantor)
by (Name): John Di Donato
its (Title): Vice President

Date

Robert Fox
Chairperson
Codington County Board of Adjustment

11-19-18
Date

STATE OF Florida
SS:
COUNTY OF Palm Beach

This instrument was acknowledged before me on 15 September 2018 by

STATE OF SOUTH DAKOTA
SS:
COUNTY OF CODINGTON

This instrument was acknowledged before me on 11-19, 2018 by Robert Fox, representing Codington County as the Chairman of the Codington County Board of Adjustment.

IN WITNESS WHEREOF, I hereunto set my hand and official seal

Becky L. Goens Notary Public
My Commission Expires: 5-17-22

BECKY L. GOENS
NOTARY PUBLIC
SOUTH DAKOTA
SEAL SEAL

Prepared by: Luke Muller
Codington County Zoning Officer
1910 West Kemp Avenue
Watertown, SD 57201

Letter of Assurance

A Conditional Use Permit under Codington County Zoning Ordinance 3.04.02.21., "Wind Energy Systems" has been granted by the Codington County Board of Adjustment to Crowned Ridge Wind II, LLC to operate a Wind Energy System with up to 164 Wind Towers and other ancillary structures/uses described in the application.

Property location: As displayed in Exhibit "A" attached and hereby incorporated by reference.

Conditions to be placed upon the conditional use permit issued to Crowned Ridge Wind II, LLC by the Codington County Board of Adjustment on July 16, 2018:

1) Effective Date and Transferability:
   a. Upon issuance of permit by South Dakota Public Utilities Commission.
   b. This permit shall expire if either no construction as described in the application has commenced within three (3) years of issuance by the County Board of Adjustment; or if a State Permit from the South Dakota Public Utility Commission has not been issued within two (2) years of issuance by the County Board of Adjustment; or any within three (3) years of the final decision regarding any appeal to circuit court relating to the issuance of the permit.
   c. The applicant may apply for an extension of this permit if the requirements of 1.b above cannot be met.
   d. The Conditional Use permit is transferable. Subsequent owners/operators shall agree to the same conditions described herein.

2) General Requirements:
   a. There shall be no discharge of industrial processed water on the site
   b. Storage of petroleum products in quantities exceeding one hundred (100) gallons at one (1) locality in one (1) tank or series of tanks must be in elevated tanks; such tanks larger than eleven hundred (1,100) gallons must have a secondary containment system where it is deemed necessary by the Board of Adjustment.
   c. Grantor shall provide the zoning office with an updated local contact information of plant supervisor with authority to implement dust control and other necessary enforcement of the conditions of this permit.

3) Obligation to Meet Requirements:

   a. Applicant agrees to meet requirements of Section 5.22 of the Codington

4) Violation and Penalties:

a. Violations of requirements of the ordinance relating to the operations of a specific tower will result in enforcement/penalties in reference to the specific tower found to be in violation, and will be enforced in the manner as described in Section 4.b below.

b. Violation of the terms of this conditional use permit will be determined by the Codington County Zoning Officer.

(1) The first violation substantiated by the Zoning Officer of this conditional use permit may result in a notification letter stating the violation and a prescribed period of time to remove the violation. A second violation occurring within one calendar year of the previous violation may result in a review of the validity of the conditional use permit and potential revocation of said permit. A third violation within one calendar year of the initial violation may result in revocation of the conditional use permit and cessation of all operations within forty-five days (45) of notice of revocation.

(2) The applicant may make appeal from the decision of the Zoning Officer or other agent of the Codington County Board of Adjustment to the Codington County Board of Adjustment. The applicant shall file with the Zoning Officer a notice of appeal specifying the grounds thereof. The Zoning Officer shall forthwith transmit to the Board of Adjustment all papers constituting the record upon which the action appealed from was taken. Such appeal shall be taken within thirty (30) days. Appeals from the Board of Adjustment shall be taken to Circuit Court.

(3) Failure to comply with the decision of the Zoning Officer or other agent of the Codington County Board of Adjustment may be deemed a separate violation.

IN WITNESS WHEREOF, Codington County and the Grantor(s) have executed this Conditional Use Permit Letter of Assurance.

Crowned Ridge Wind II, LLC (Grantor)
by (Name): John Di Donato
its (Title): Vice President

Date

Chairperson
Codington County Board of Adjustment

11-19-18
Date

STATE OF Florida
SS:
COUNTY OF Palm Beach

000478

This instrument was acknowledged before me on 25 September 2018 by [illegible] on behalf of Crowned Ridge Wind II, LLC (Grantor).

STATE OF SOUTH DAKOTA
SS:
COUNTY OF CODINGTON

This instrument was acknowledged before me on 11-19, 2018 by Robert Fox, representing Codington County as the Chairman of the Codington County Board of Adjustment.

IN WITNESS WHEREOF, I hereunto set my hand and official seal.

Becky L. Goens Notary Public
My Commission Expires: 5-17-22

BECKY L. GOENS
NOTARY PUBLIC
SOUTH DAKOTA
SEAL SEAL

Letter of Assurance

A Conditional Use Permit under Grant County Zoning Ordinance 11.01.03.22., "Wind Energy Systems" has been granted by the Grant County Board of Adjustment to Crowned Ridge, LLC to operate a Wind Energy System with up to 32 Wind Towers and other ancillary structures/uses described in the application.

Property location: As displayed in Exhibit "A" attached and hereby incorporated by reference.

Conditions to be placed upon the conditional use permit issued to Crowned Ridge, LLC by the Grant County Board of Adjustment on December 17, 2018:

1) Effective Date and Transferability:
   a. Upon issuance of permit by South Dakota Public Utilities Commission.
   b. This permit shall expire on December 17, 2020 if no substantial construction as described in the application has been completed; or if a State Permit from the South Dakota Public Utility Commission has not been issued; or within two (2) years of the final decision regarding any appeal to circuit court relating to the issuance of the permit.
   c. The applicant may apply for an extension of this permit if the requirements of 1.b above cannot be met.
   d. The Conditional Use permit is transferable. Subsequent owners/operators shall agree to the same conditions described herein.

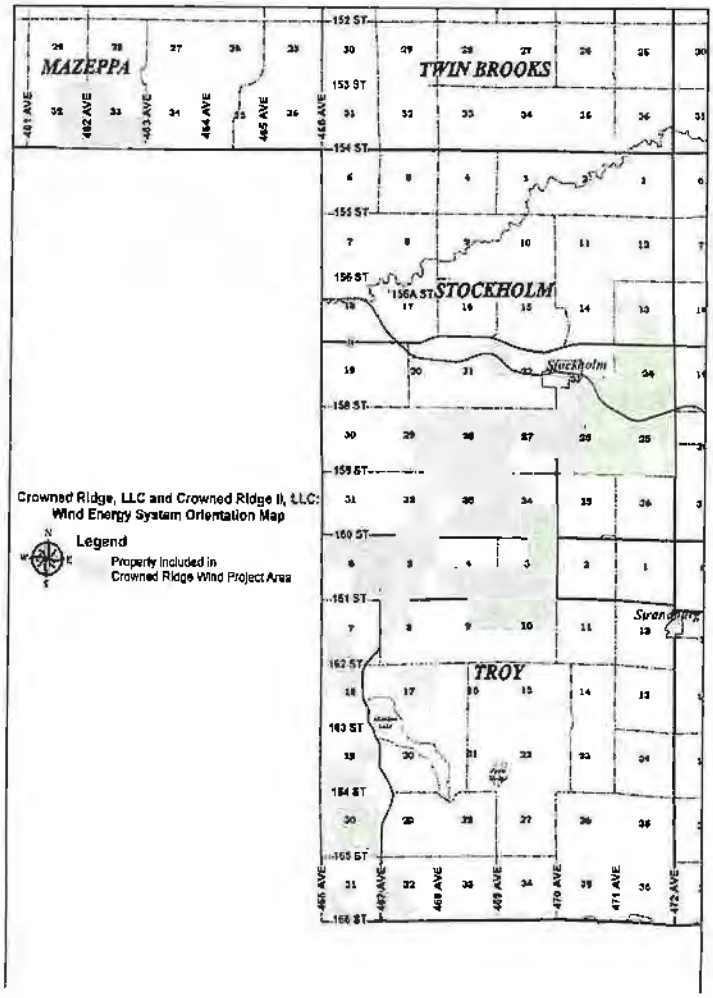
2) General Requirements:
   a. There shall be no discharge of industrial processed water on the site
   b. Storage of petroleum products in quantities exceeding one hundred (100) gallons at one (1) locality in one (1) tank or series of tanks must be in elevated tanks; such tanks larger than eleven hundred (1,100) gallons must have a secondary containment system where it is deemed necessary by the Board of Adjustment.
   c. Grantor shall provide the zoning office with an updated local contact information of plant supervisor with authority to implement dust control and other necessary enforcement of the conditions of this permit.

3) Obligation to Meet Requirements:
   a. Applicant agrees to construct all WES towers with a setback distance equal to or greater than exhibited in the application.
   b. Applicant agrees that the construction and operation of all WES towers will comply with noise and shadow flicker thresholds exhibited in the application's noise and shadow flicker analysis
   c. Applicant further agrees to meet requirements of Section 1211 of the Grant County Ordinance in a manner consistent with its application in reference to remaining obligations including but not limited to: submittal of Soil Erosion and Sediment Control Plans, Haul Road Agreements, Decommissioning Plan, Final

closure.

4) Violation and Penalties:
   a. Violations of requirements of the ordinance relating to the operations of a specific tower will result in enforcement/penalties in reference to the specific tower found to be in violation, and will be enforced in the manner as described in Section 4.b below.
   b. Violation of the terms of this conditional use permit will be determined by the Grant County Zoning Officer.
      (1) The first violation substantiated by the Zoning Officer of this conditional use permit may result in a notification letter stating the violation and a prescribed period of time to remove the violation. A second violation occurring within one calendar year of the previous violation may result in a review of the validity of the conditional use permit and potential revocation of said permit. A third violation within one calendar year of the initial violation may result in revocation of the conditional use permit and/or cessation of the specific tower within forty-five days (45) of notice of revocation.
      (2) The applicant may make appeal from the decision of the Zoning Officer or other agent of the Grant County Board of Adjustment to the Grant County Board of Adjustment. The applicant shall file with the Zoning Officer a notice of appeal specifying the grounds thereof. The Zoning Officer shall forthwith transmit to the Board of Adjustment all papers constituting the record upon which the action appealed from was taken. Such appeal shall be taken within thirty (30) days. Appeals from the Board of Adjustment shall be taken to Circuit Court.
      (3) Failure to comply with the decision of the Zoning Officer or other agent of the Grant County Board of Adjustment may be deemed a separate violation.

5. Exhibit A



Chairperson
Grant County Board of Adjustment

Date

STATE OF Florida
SS:
COUNTY OF Palm Beach

This instrument was acknowledged before me on January 11, 2019 by John Di Donato, on behalf of Crowned Ridge, LLC (Grantor/Applicant).

IN WITNESS WHEREOF, I hereunto set my hand and official seal.

Notary Public
My Commission Expires:

Kim L. Otto
Notary Public - State of Florida
My Commission # GG 939840
Expires March 28, 2020

STATE OF SOUTH DAKOTA
SS:
COUNTY OF GRANT

This instrument was acknowledged before me on _____, 201_ by Nancy Johnson, representing Grant County as the Chair of the Grant County Board of Adjustment.

IN WITNESS WHEREOF, I hereunto set my hand and official seal.

Notary Public
My Commission Expires:

LBNL-6362E

ERNEST ORLANDO LAWRENCE
BERKELEY NATIONAL LABORATORY

A Spatial Hedonic Analysis of the Effects of Wind Energy Facilities on Surrounding Property Values in the United States

**Ben Hoen, Jason P. Brown, Thomas Jackson,
Ryan Wiser, Mark Thayer and Peter Cappers**

**Environmental Energy
Technologies Division**

August 2013

Download from http://emp.lbl.gov/sites/all/files/lbnl-6362e.pdf

This work was supported by the Office of Energy Efficiency and Renewable Energy (Wind and Water Power Technologies Office) of the U.S. Department of Energy under Contract No. DE-AC02-05CH1123.

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LBNL-6362E

A Spatial Hedonic Analysis of the Effects of Wind Energy Facilities on Surrounding Property Values in the United States

Prepared for the

Office of Energy Efficiency and Renewable Energy
Wind and Water Power Technologies Office
U.S. Department of Energy

Principal Authors:

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San Diego State University
5500 Campanile Dr., San Diego, CA 92182-4485

August 2013

This work was supported by the Office of Energy Efficiency and Renewable Energy (Wind and Water Power Technologies Office) of the U.S. Department of Energy under Contract No. DE-AC02-05CH1123.

[†] Corresponding author: Phone: 845-758-1896; Email: bhoen@lbl.gov; Mailing address: 20 Sawmill Road, Milan NY 12571.

000485

Acknowledgements

This work was supported by the Office of Energy Efficiency and Renewable Energy (Wind and Water Power Technologies Office) of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231. For funding and supporting this work, we especially thank Patrick Gilman, Cash Fitzpatrick, and Mark Higgins (U.S. DOE). For providing the data that were central to the analysis contained herein, we thank Cameron Rogers (Fiserv) and Joshua Tretter (CoreLogic Inc.), both of whom were highly supportive and extremely patient throughout the complicated data-aquistion process. Finally, we would like to thank the many external reviewers for providing valuable comments on an earlier draft version of the report. Of course, any remaining errors or omissions are our own.

000486

Abstract

Previous research on the effects of wind energy facilities on surrounding home values has been limited by small samples of relevant home-sale data and the inability to account adequately for confounding home-value factors and spatial dependence in the data. This study helps fill those gaps. We collected data from more than 50,000 home sales among 27 counties in nine states. These homes were within 10 miles of 67 different wind facilities, and 1,198 sales were within 1 mile of a turbine—many more than previous studies have collected. The data span the periods well before announcement of the wind facilities to well after their construction. We use OLS and spatial-process difference-in-difference hedonic models to estimate the home-value impacts of the wind facilities; these models control for value factors existing before the wind facilities' announcements, the spatial dependence of unobserved factors effecting home values, and value changes over time. A set of robustness models adds confidence to our results. Regardless of model specification, we find no statistical evidence that home values near turbines were affected in the post-construction or post-announcement/pre-construction periods. Previous research on potentially analogous disamenities (e.g., high-voltage transmission lines, roads) suggests that the property-value effect of wind turbines is likely to be small, on average, if it is present at all, potentially helping to explain why no evidence of an effect was found in the present research.

Table of Contents

1. Introduction 1
2. Previous Literature 2
3. Methodology 7
   - 3.1. Basic Approach and Models 8
   - 3.2. Spatial Dependence 12
   - 3.3. Robustness Tests 14
     - 3.3.1. Outliers and Influential Cases 15
     - 3.3.2. Interacting Sale Year at the County Level 15
     - 3.3.3. Using Only the Most Recent Sales 15
     - 3.3.4. Using Homes between 5 and 10 Miles as Reference Category 16
     - 3.3.5. Using Transactions Occurring More than 2 Years before Announcement as Reference Category 16
4. Data 17
   - 4.1. Wind Turbine Locations 17
   - 4.2. Real Estate Transactions 17
   - 4.3. Home and Site Characteristics 18
   - 4.4. Census Information 19
   - 4.5. Distances to Turbine 19
   - 4.6. Wind Facility Development Periods 19
   - 4.7. Data Summary 20
   - 4.8. Comparison of Means 23
5. Results 25
   - 5.1. Estimation Results for Base Models 25
     - 5.1.1. Control Variables 26
     - 5.1.2. Variables of Interest 28
     - 5.1.3. Impact of Wind Turbines 32
   - 5.2. Robustness Tests 34
6. Conclusion 37
7. References 39
8. Appendix – Full Results 44

000488

Tables

Table 1: Interactions between Wind Facility Development Periods and Distances – ½ Mile 12

Table 2: Interactions between Wind Facility Development Periods and Distances - 1 Mile.....12

Table 3: Summary Statistics 21

Table 4: Summary of Transactions by County 22

Table 5: Frequency Crosstab of Wind Turbine Distance and Development Period Bins.....22

Table 6: Wind Facility Summary.....23

Table 7: Dependent and Independent Variable Means 25

Table 8: Levels and Significance for County- and State-Interacted Controlling Variables.....28

Table 9: Results of Interacted Variables of Interest: *fdp* and *tdis*.....31

Table 10: "Net" Difference-in-Difference Impacts of Turbines.....34

Table 11: Robustness Half-Mile Model Results.....36

Figures

Figure 1: Map of Transactions, States, and Counties.....21

1. Introduction

In 2012, approximately 13 gigawatts (GW) of wind turbines were installed in the United States, bringing total U.S. installed wind capacity to approximately 60 GW from more than 45,000 turbines (AWEA, 2013). Despite uncertainty about future extensions of the federal production tax credit, U.S. wind capacity is expected by some to continue growing by approximately 5–6 GW annually owing to state renewable energy standards and areas where wind can compete with natural gas on economics alone (Bloomberg, 2013); this translates into approximately 2,750 turbines per year.[1] Much of that development is expected to occur in relatively populated areas (e.g., New York, New England, the Mid-Atlantic and upper Midwest) (Bloomberg, 2013).

In part because of the expected wind development in more-populous areas, empirical investigations into related community concerns are required. One concern is that the values of properties near wind developments may be reduced; after all, it has been demonstrated that in some situations market perceptions about an area's disamenities (and amenities)[2] are capitalized into home prices (e.g., Boyle and Kiel, 2001; Jackson, 2001; Simons and Saginor, 2006). The published research about wind energy and property values has largely coalesced around a finding that homes sold after nearby wind turbines have been constructed do not experience statistically significant property value impacts. Additional research is required, however, especially for homes located within about a half mile of turbines, where impacts would be expected to be the largest. Data and studies are limited for these proximate homes in part because setback requirements generally result in wind facilities being sited in areas with relatively few houses, limiting available sales transactions that might be analyzed.

This study helps fill the research gap by collecting and analyzing data from 27 counties across nine U.S. states, related to 67 different wind facilities. Specifically, using the collected data, the study constructs a pooled model that investigates average effects near the turbines across the sample while controlling for the local effects of many potentially correlated independent variables. Property-value effect estimates are derived from two types of models: (1) an ordinary

[1] Assuming 2-MW turbines, the 2012 U.S. average (AWEA, 2013), and 5.5 GW of annual capacity growth.
[2] Disamenities and amenities are defined respectively as disadvantages (e.g., a nearby noxious industrial site) and advantages (e.g., a nearby park) of a location.

least squares (OLS) model, which is standard for this type of disamenity research (see, e.g., discussion in Jackson, 2003; Sirmans et al., 2005), and (2) a spatial-process model, which accounts for spatial dependence. Each type of model is used to construct a difference-in-difference (DD) specification—which simultaneously controls for preexisting amenities or disamenities in areas where turbines were sited and changes in the community after the wind facilities' construction was announced—to estimate effects near wind facilities after the turbines were announced and, later, after the turbines were constructed.[3]

The remainder of the report is structured as follows. Section 2 reviews the current literature. Section 3 details our methodology. Section 4 describes the study data. Section 5 presents the results, and Section 6 provides a discussion and concluding remarks.

2. Previous Literature

Although the topic is relatively new, the peer-reviewed literature investigating impacts to home values near wind facilities is growing. To date, results largely have coalesced around a common set of non-significant findings generated from home sales after the turbines became operational. Previous Lawrence Berkeley National Laboratory (LBNL) work in this area (Hoen et al., 2009, 2011) found no statistical evidence of adverse property-value effects due to views of and proximity to wind turbines after the turbines were constructed (i.e., post-construction or PC). Other peer-reviewed and/or academic studies also found no evidence of PC effects despite using a variety of techniques and residential transaction datasets. These include homes surrounding wind facilities in Cornwall, United Kingdom (Sims and Dent, 2007; Sims et al., 2008); multiple wind facilities in McLean County, Illinois (Hinman, 2010); near the Maple Ridge Wind Facility in New York (Heintzelman and Tuttle, 2011); and, near multiple facilities in Lee County, Illinois (Carter, 2011). Analogously, a 2012 Canadian case found a lack of evidence near a wind facility in Ontario to warrant the lowering of surrounding assessments (Kenney v MPAC, 2012). In contrast, one recent study did find impacts to land prices near a facility in North Rhine-Westphalia, Germany (Sunak and Madlener, 2012). Taken together, these results imply that the

[3] Throughout this report, the terms "announced/announcement" and "constructed/construction" represent the dates on which the proposed wind facility (or facilities) entered the public domain and the dates on which facility construction began, respectively. Home transactions can either be pre-announcement (PA), post-announcement/pre-construction (PAPC), or post-construction (PC).

PC effects of wind turbines on surrounding home values, if they exist, are often too small for detection or sporadic (i.e., a small percentage overall), or appearing in some communities for some types of properties but not others.

In the post-announcement, pre-construction period (i.e., PAPC), however, recent analysis has found more evidence of potential property value effects: by theorizing the possible existence of, but not finding, an effect (Laposa and Mueller, 2010; Sunak and Madlener, 2012); potentially finding an effect (Heintzelman and Tuttle, 2011)[4]; and, consistently finding what the author terms an "anticipation stigma" effect (Hinman, 2010). The studies that found PAPC property-value effects appear to align with earlier studies that suggested lower community support for proposed wind facilities before construction—potentially indicating a risk-averse (i.e., fear of the unknown) stance by community members—but increased support after facilities began operation (Gipe, 1995; Palmer, 1997; Devine-Wright, 2005; Wolsink, 2007; Bond, 2008, 2010). Similarly, researchers have found that survey respondents who live closer to turbines support the turbines more than respondents who live farther away (Braunholtz and MORI Scotland, 2003; Baxter et al., 2013), which could also indicate more risk-adverse / fear of the unknown effects (these among those who live farther away). Analogously, a recent case in Canada, although dismissed, highlighted the fears that nearby residents have for a planned facility (Wiggins v. WPD Canada Corporation, 2013)

Some studies have examined property-value conditions existing before wind facilities were announced (i.e., pre-announcement or PA). This is important for exploring correlations between wind facility siting and pre-existing home values from an environmental justice perspective and also for measuring PAPC and PC effects more accurately. Hoen et al. (2009, 2011) and Sims and Dent (2007) found evidence of depressed values for homes that sold before a wind facility's announcement and were located near the facility's eventual location, but they did not adjust their PC estimates for this finding. Hinman (2010) went further, finding value reductions of 12%–20% for homes near turbines in Illinois, which sold prior to the facilities' announcements; then using these findings to deflate their PC home-value-effect estimates.

[4] Heintzelman and Tuttle do not appear convinced that the effect they found is related to the PAPC period, yet the two counties in which they found an effect (Clinton and Franklin Counties, NY) had transaction data produced almost entirely in the PAPC period.

Some research has linked wind-related property-value effects with the effects of better-studied disamenities (Hoen et al., 2009). The broader disamenity literature (e.g., Boyle and Kiel, 2001; Jackson, 2001; Simons and Saginor, 2006) suggests that, although property-value effects might occur near wind facilities as they have near other disamenities, those effects (if they do exist) are likely to be relatively small, are unlikely to persist some distance from a facility, and might fade over time as home buyers who are more accepting of the condition move into the area (Tiebout, 1956).

For example, a review of the literature investigating effects near high-voltage transmission lines (a largely visual disturbance, as turbines may be for many surrounding homes) found the following: property-value reductions of 0%–15%; effects that fade with distance, often only affecting properties crossed by or immediately adjacent to a line or tower; effects that can increase property values when the right-of-way is considered an amenity; and effects that fade with time as the condition becomes more accepted (Kroll and Priestley, 1992). While potentially much more objectionable to residential communities than turbines, a review of the literature on landfills (which present odor, traffic, and groundwater-contamination issues) indicates effects that vary by landfill size (Ready, 2010). Large-volume operations (accepting more than 500 tons per day) reduce adjacent property values by 13.7% on average, fading to 5.9% one mile from the landfill. Lower-volume operations reduce adjacent property values by 2.7% on average, fading to 1.3% one mile away, with 20%–26% of lower-volume landfills not having any statistically significant impact. A study of 1,600 toxic industrial plant openings found adverse impacts of 1.5% within a half mile, which disappeared if the plants closed (Currie et al., 2012). Finally, a review of the literature on road noise (which might be analogous to turbine noise) shows property-value reductions of 0% –11% (median 4%) for houses adjacent to a busy road that experience a 10-dBA noise increase, compared with houses on a quiet street (Bateman et al., 2001).

It is not clear where wind turbines might fit into these ranges of impacts, but it seems unlikely that they would be considered as severe a disamenity as a large-volume landfill, which present odor, traffic, and groundwater-contamination issues. Low-volume landfills, with an effect near 3%, might be a better comparison, because they have an industrial (i.e., non-natural) quality, similar to turbines, but are less likely to have clear health effects. If sound is the primary

concern, a 4% effect (corresponding to road noise) could be applied to turbines, which might correspond to a 10-dBA increase for houses within a half mile of a turbine (see e.g., Hubbard and Shepherd, 1991). Finally, as with transmission lines, if houses are in sight but not within sound distance of turbines, there may be no property-value effects unless those homes are immediately adjacent to the turbines. In summary, assuming these potentially analogous disamenity effects can be entirely transferred, turbine impacts might be 0%–14%, but more likely might coalesce closer to 3%–4%.

Of course, wind turbines have certain positive qualities that landfills, transmission lines, and roads do not always have, such as mitigating greenhouse gas emissions. no air or water pollution, no use of water during the generation of energy, and no generation of solid or hazardous waste that requires permanent storage/disposal (IPCC, 2011). Moreover, wind facilities can, and often do, provide economic benefits to local communities (Lantz and Tegen, 2009; Slattery et al., 2011; Brown et al., 2012; Loomis et al., 2012), which might not be the case for all other disamenities. Similarly, wind facilities can have direct positive effects on local government budgets through property tax or other similar payments (Loomis and Aldeman, 2011), which might, for example, improve school quality and thus increase nearby home values (e.g., Haurin and Brasington, 1996; Kane et al., 2006). These potential positive qualities might mitigate potential negative wind effects somewhat or even entirely. Therefore for the purposes of this research we will assume 3-4% is a maximum possible effect.

The potentially small average property-value effect of wind turbines, possibly reduced further by wind's positive traits, might help explain why effects have not been discovered consistently in previous research. To discover effects with small margins of error, large amounts of data are needed. However, previous datasets of homes very near turbines have been small. Hoen et al. (2009, 2011) used 125 PC transactions within a mile of the turbines, while others used far fewer PC transactions within a mile: Heintzelman and Tuttle (2012) ($n \sim 35$); Hinman (2010) ($n \sim 11$), Carter (2011) ($n \sim 41$), and Sunak and Madlener (2012) ($n \sim 51$). Although these numbers of observations are adequate to examine large impacts (e.g., over 10%), they are less likely to reveal small effects with any reasonable degree of statistical significance. Using results from Hoen et al. (2009) and the confidence intervals for the various fixed-effect variables in that study, estimates for the numbers of transactions needed to find effects of various sizes were obtained.

Approximately 50 cases are needed to find an effect of 10% and larger, 100 cases for 7.5%, 200 cases for 5%, 350 cases for 4%, 700 cases for 3%, and approximately 1,000 cases for a 2.5% effect.[5] Therefore, in order to detect an effect in the range of 3%–4%, a dataset of approximately 350–700 cases within a mile of the turbines will be required to detect it statistically, a number that to-date has not been amassed by any of the previous studies.

As discussed above, in addition to being relatively small on average, impacts are likely to decay with distance. As such, an appropriate empirical approach must be able to reveal spatially diminishing effects. Some researchers have used continuous variables to capture these effects, such as linear distance (Hoen et al., 2009; Sims et al., 2008) and inverse distance (Heintzelman and Tuttle, 2012; Sunak and Madlener, 2012), but doing so forces the model to estimate effects at the mean distance. In some cases, those means can be far from the area of expected impact. For example, Heintzelman and Tuttle (2012) estimated an inverse distance effect using a mean distance of more than 10 miles from the turbines, while Sunak and Madlener (2012) used a mean distance of approximately 1.9 miles. Using this approach weakens the ability of the model to quantify real effects near the turbines, where they are likely to be stronger. More importantly, this method encourages researchers to extrapolate their findings to the ends of the distance curve, near the turbines, despite having few data at those distances to support these extrapolations. This was the case for Heintzelman and Tuttle (2012), who had fewer than 10 cases within a half mile in the two counties where effects were found and only a handful that sold in those counties after the turbines were built, yet they extrapolated their findings to a quarter mile and even a tenth of a mile, where they had very few (if any) cases. Similarly, Sunak and Madlener (2012) had only six PC sales within a half mile and 51 within 1 mile, yet they extrapolated their findings to these distance bands.

One way to avoid using a single continuous function to estimate effects at all distances is to use a spline model, which breaks the distances into continuous groups (Hoen et al., 2011), but this method still imposes structure on the data by forcing the ends of each spline to tie together. A second and more transparent method is to use fixed-effect variables for discrete distances, which imposes little structure on the data (Hoen et al., 2009; Hinman, 2010; Carter, 2011; Hoen et al.,

[5] This analysis is available upon request from the authors.

2011). Although this latter method has been used in a number of studies, because of a paucity of data, the resulting models are often ineffective at detecting what might be relatively small effects very close to the turbines. As such, when using this method (or any other, in fact) it is important that the underlying dataset is large enough to estimate the anticipated magnitude of the effect sizes.

Finally, one rarely investigated aspect of potential wind-turbine effects is the possibly idiosyncratic nature of spatially averaged transaction data used in the hedonic analyses. Sunak and Madlener (2012) used a geographically weighted regression (GWR), which estimates different regressions for small clusters of data and then allows the investigation of the distribution of effects across all of the clusters. Although GWR can be effective for understanding the range of impacts across the study area, it is not as effective for determining an average effect or for testing the statistical significance of the range of estimates. Results from studies that use GWR methods are also sometimes counter-intuitive.[6] As is discussed in more detail in the methodology section, a potentially better approach is to estimate a spatial-process model that is flexible enough to simultaneously control for spatial heterogeneity and spatial dependence, while also estimating an average effect across fixed discrete effects.

In summary, building on the existing literature, further research is needed on property-value effects in particularly close proximity to wind turbines. Specifically, research is needed that uses a large set of data near the turbines, accounts for home values before the announcement of the facility (as well as after announcement but before construction), accounts for potential spatial dependence in unobserved factors effecting home values, and uses a fixed-effect distance model that is able to accurately estimate effects near turbines.

3. Methodology

The present study seeks to respond to the identified research needs noted above, with this section describing our methodological framework for estimating the effects of wind turbines on the value of nearby homes in the United States.

[6] For example, Sunak and Madlener (2012) find larger effects related to the turbines in a city that is farther from the turbines than they find in a town which is closer. Additionally, they find stronger effects in the center of a third town than they do on the outskirts of that town, which do not seem related to the location of the turbines.

3.1. Basic Approach and Models

Our methods are designed to help answer the following questions:

1. Did homes that sold prior to the wind facilities' announcement (PA)—and located within a short distance (e.g., within a half mile) from where the turbines were eventually located—sell at lower prices than homes located farther away?
2. Did homes that sold after the wind facilities' announcement but before construction (PAPC)—and located within a short distance (e.g., within a half mile)—sell at lower prices than homes located farther away?
3. Did homes that sold after the wind facilities' construction (PC)—and located within a short distance (e.g., within a half mile)—sell at lower prices than homes located farther away?
4. For question 3 above, if no statistically identifiable effects are found, what is the likely maximum effect possible given the margins of error around the estimates?

To answer these questions, the hedonic pricing model (Rosen, 1974; Freeman, 1979) is used in this paper, as it has been in other disamenity research (Boyle and Kiel, 2001; Jackson, 2001; Simons and Saginor, 2006). The value of this approach is that is allows one to disentangle and control for the potentially competing influences of home, site, neighborhood, and market characteristics on property values, and to uniquely determine how home values near announced or operating facilities are affected.[7] To test for these effects, two pairs of "base" models are estimated, which are then coupled with a set of "robustness" models to test and bound the estimated effects. One pair is estimated using a standard OLS model, and the other is estimated using a spatial-process model. The models in each pair are different in that one focuses on all homes within 1 mile of an existing turbine (*one-mile* models), which allows the maximum number of data for the fixed effect to be used, while the other focuses on homes within a half mile (*half-mile* models), where effects are more likely to appear but fewer data are available. We assume that, if effects exist near turbines, they are larger for the *half-mile* models than the *one-mile* models.

[7] See Jackson (2003) for a further discussion of the Hedonic Pricing Model and other analysis methods.

As is common in the literature (Malpezzi, 2003; Sirmans et al., 2005), a semi-log functional form of the hedonic pricing model is used for all models, where the dependent variable is the natural log of sales price. The OLS *half-mile* model form is as follows:

$$\ln(SP_i) = \alpha + \sum_a \beta_1(T_i \bullet S_i) + \beta_2(W_i) + \sum_b \beta_3(X_i \bullet C_i) + \beta_4(D_i \bullet P_i) + \varepsilon_i \quad (1)$$

where

SP_i represents the sale price for transaction *i*,

α is the constant (intercept) across the full sample,

T_i is a vector of time-period dummy variables (e.g., sale year and if the sale occurred in winter) in which transaction *i* occurred,

S_i is the state in which transaction *i* occurred,

W_i is the census tract in which transaction *i* occurred,

X_i is a vector of home, site, and neighborhood characteristics for transaction *i* (e.g., square feet, age, acres, bathrooms, condition, percent of block group vacant and owned, median age of block group),[8]

C_i is the county in which transaction *i* occurred,

D_i is a vector of four fixed-effect variables indicating the distance (to the nearest turbine) bin (i.e., group) in which transaction *i* is located (e.g., within a half mile, between a half and 1 mile, between 1 and 3 miles, and between 3 and 10 miles),

P_i is a vector of three fixed-effect variables indicating the wind project development period in which transaction *i* occurred (e.g., PA, PAPC, PC),

$B_{1\text{-}3}$ is a vector of estimates for the controlling variables,

B_4 is a vector of 12 parameter estimates of the distance-development period interacted variables of interest,

ε_i is a random disturbance term for transaction *i*.

This pooled construction uses all property transactions in the entire dataset. In so doing, it takes advantage of the large dataset in order to estimate an average set of turbine-related effects across all study areas, while simultaneously allowing for the estimation of controlling characteristics at

[8] A "block group" is a US Census Bureau geographic delineation that contains a population between 600 to 3000 persons.

the local level, where they are likely to vary substantially across the study areas.[9] Specifically, the interaction of county-level fixed effects (C_i) with the vector of home, site, and neighborhood characteristics (X_i) allows different slopes for each of these independent variables to be estimated for each county. Similarly, interacting the state fixed-effect variables (S_i) with the sale year and sale winter fixed effects variables (T_i) (i.e., if the sale occurred in either Q1 or Q4) allows the estimation of the respective inflation/deflation and seasonal adjustments for each state in the dataset.[10] Finally, to control for the potentially unique collection of neighborhood characteristics that exist at the micro-level, census tract fixed effects are estimated.[11] Because a pooled model is used that relies upon the full dataset, smaller effect sizes for wind turbines will be detectable. At the same time, however, this approach does not allow one to distinguish possible wind turbine effects that may be larger in some communities than in others.

As discussed earlier, effects might predate the announcement of the wind facility and thus must be controlled for. Additionally, the area surrounding the wind facility might have changed over time simultaneously with the arrival of the turbines, which could affect home values. For example, if a nearby factory closed at the same time a wind facility was constructed, the influence of that factor on all homes in the general area would ideally be controlled for when estimating wind turbine effect sizes.

To control for both of these issues simultaneously, we use a difference-in-difference (*DD)* specification (see e.g., Hinman, 2010; Zabel and Guignet, 2012) derived from the interaction of

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[9] The dataset does not include "participating" landowners, those that have turbines situated on their land, but does include "neighboring" landowners, those adjacent to or nearby the turbines. One reviewer notes that the estimated average effects also include any effects from payments "neighboring" landowners might receive that might transfer with the home. Based on previous conversations with developers (see Hoen et al, 2009), we expect that the frequency of these arrangements is low, as is the right to transfer the payments to the new homeowner. Nonetheless, our results should be interpreted as "net" of any influence whatever "neighboring" landowner arrangements might have.

[10] Unlike the vector of home, site, and neighborhood characteristics, sale price inflation/deflation and seasonal changes were not expected tovary substantially across various counties in the same states in our sample and therefore the interaction was made at the state level. This assumption was tested as part of the robustness tests though, where they are interacted at the county level and found to not affect the results.

[11] In part because of the rural nature of many of the study areas included in the research sample, these census tracts are large enough to contain sales that are located close to the turbines as well as those farther away, thereby ensuring that they do not unduly absorb effects that might be related to the turbines. Moreover each tract contains sales from throughout the study periods, both before and after the wind facilities' announcement and construction, further ensuring they are not biasing the variables of interest.

the spatial (D_i) and temporal (P_i) terms. These terms produce a vector of 11 parameter estimates (β_4) as shown in Table 1 for the *half-mile* models and in Table 2 for the *one-mile* models. The omitted (or reference) group in both models is the set of homes that sold prior to the wind facilities' announcement and which were located more than 3 miles away from where the turbines were eventually located (A3). It is assumed that this reference category is likely not affected by the imminent arrival of the turbines, although this assumption is tested in the robustness tests.

Using the *half-mile* models, to test whether the homes located near the turbines that sold in the PA period were uniquely affected (*research question 1*), we examine A0, from which the null hypothesis is A0=0. To test if the homes located near the turbines that sold in the PAPC period were uniquely affected (*research question 2*), we first determine the difference in their values as compared to those farther away (B0-B3), while also accounting for any pre-announcement (i.e., pre-existing) difference (A0-A3) and any change in the local market over the development period (B3-A3). Because all covariates are determined in relation to the omitted category (A3), the null hypothesis collapses B0-A0-B3=0. Finally, in order to determine if homes near the turbines that sold in the PC period were uniquely affected (*research question 3*), we test if C0-A0-C3=0. Each of these *DD* tests are estimated using a linear combination of variables that produces the "net effect" and a measure of the standard error and corresponding confidence intervals of the effect, which enables the estimation of the maximum (and minimum) likely impacts for each research question. We use 90% confidence intervals both to determine significance and to estimate maximum likely effects (*research question 4*).

Following the same logic as above, the corresponding hypothesis tests for the *one-mile* models are as follows: *PA*, A1=0; *PAPC*, B1-A1-B3=0; and, *PC*, C1-A1-C3=0.

Table 1: Interactions between Wind Facility Development Periods and Distances – ½ Mile

Wind Facility Development Periods	Distances to Nearest Turbine			
	Within 1/2 Mile	Between 1/2 and 1 Mile	Between 1 and 3 Miles	Outside of 3 Miles
Prior to Announcement	A0	A1	A2	A3 (Omitted)
After Announcement but Prior to Construction	B0	B1	B2	B3
Post Construction	C0	C1	C2	C3

Table 2: Interactions between Wind Facility Development Periods and Distances - 1 Mile

Wind Facility Development Periods	Distances to Nearest Turbine		
	Within 1 Mile	Between 1 and 3 Miles	Outside of 3 Miles
Prior to Announcement	A1	A2	A3 (Omitted)
After Announcement but Prior to Construction	B1	B2	B3
Post Construction	C1	C2	C3

3.2. Spatial Dependence

As discussed briefly above, a common feature of the data used in hedonic models is the spatially dense nature of the real estate transactions. While this spatial density can provide unique insights into local real estate markets, one concern that is often raised is the impact of potentially omitted variables given that this is impossible to measure all of the local characteristics that affect housing prices. As a result, spatial dependence in a hedonic model is likely because houses located closer to each other typically have similar unobservable attributes. Any correlation between these unobserved factors and the explanatory variables used in the model (e.g., distance to turbines) is a source of omitted-variable bias in the OLS models. A common approach used in

the hedonic literature to correct this potential bias is to include local fixed effects (Hoen et al., 2009, 2011; Zabel and Guignet, 2012), which is our approach as described in formula (1).

In addition to including local fixed effects, spatial econometric methods can be used to help further mitigate the potential impact of spatially omitted variables by modeling spatial dependence directly. When spatial dependence is present and appropriately modeled, more accurate (i.e., less biased) estimates of the factors influencing housing values can be obtained. These methods have been used in a number of previous hedonic price studies; examples include the price impacts of wildfire risk (Donovan et al., 2007), residential community associations (Rogers, 2006), air quality (Anselin and Lozano-Gracia, 2009), and spatial fragmentation of land use (Kuethe, 2012). To this point, however, these methods have not been applied to studies of the impact of wind turbines on property values.

Moran's I is the standard statistic used to test for spatial dependence in OLS residuals of the hedonic equation. If the Moran's I is statistically significant (as it is in our models – see Section 5.1.2), the assumption of spatial independence is rejected. To account for this, in spatial-process models, spatial dependence is routinely modeled as an additional covariate in the form of a spatially lagged dependent variable *Wy*, or in the error structure $\mu = \lambda W\mu + \varepsilon$, where ε is an identically and independently distributed disturbance term (Anselin, 1988). Neighboring criterion determines the structure of the spatial weights matrix *W*, which is frequently based on contiguity, distance criterion, or *k*-nearest neighbors (Anselin, 2002). The weights in the spatial-weights matrix are typically row standardized so that the elements of each row sum to one.

The spatial-process model, known as the SARAR model (Kelejian and Prucha, 1998)[12], allows for both forms of spatial dependence, both as an autoregressive process in the lag-dependent and in the error structure, as shown by:

$$\begin{aligned} y &= \rho Wy + X\beta + \mu, \\ \mu &= \lambda W\mu + \varepsilon. \end{aligned} \qquad (2)$$

[12] SARAR refers to a "spatial-autoregressive model with spatial autoregressive residuals".

Equation (2) is often estimated by a multi-step procedure using generalized moments and instrumental variables (Arraiz et al., 2009), which is our approach. The model allows for the innovation term ε in the disturbance process to be heteroskedastic of an unknown form (Kelejian and Prucha, 2010). If either λ or ρ are not significant, the model reduces to the respective spatial lag or spatial error model (SEM). In our case, as is discussed later, the spatial process model reduces to the SEM, therefore both *half-mile* and *one-mile* SEMs are estimated, and, as with the OLS models discussed above, a similar set of *DD* "net effects" are estimated for the PA, PAPC, and PC periods. One requirement of the spatial model is that the x/y coordinates be unique across the dataset. However, the full set of data (as described below) contains, in some cases, multiple sales for the same property, which consequently would have non-unique x/y coordinates.[13] Therefore, for the spatial models, only the most recent sale is used. An OLS model using this limited dataset is also estimated as a robustness test.

In total, four "base" models are estimated: an OLS *one-mile* model, a SEM *one-mile* model, an OLS *half-mile* model, and a SEM *half-mile* model. In addition, a series of robustness models are estimated as described next.

3.3. Robustness Tests

To test the stability of and potentially bound the results from the four base models, a series of robustness tests are conducted that explore: the effect that outliers and influential cases have on the results; a micro-inflation/deflation adjustment by interacting the sale-year fixed effects with the county fixed effects rather than state fixed effects; the use of only the most recent sale of homes in the dataset to compare results to the SEM models that use the same dataset; the application of a more conservative reference category by using transactions between 5 and 10 miles (as opposed to between 3 and 10 miles) as the reference; and a more conservative

[13] The most recent sale weights the transactions to those occurring after announcement and construction, that are more recent in time. One reviewer wondered if the frequency of sales was affected near the turbines, which is also outside the scope of the study, though this "sales volume" was investigated in Hoen et al. (2009), where no evidence of such an effect was discovered. Another correctly noted that the most recent assessment is less accurate for older sales, because it might overestimate some characteristics of the home (e.g., sfla, baths) that might have changed (i.e., increased) over time. This would tend to bias those characteristics' coefficients downward. Regardless, it is assumed that this occurrence is not correlated with proximity to turbines and therefore would not bias the variables of interest.

reference category by using transactions more than 2 years PA (as opposed to simply PA) as the reference category. Each of these tests is discussed in detail below.

3.3.1. Outliers and Influential Cases

Most datasets contain a subset of observations with particularly high or low values for the dependent variables, which might bias estimates in unpredictable ways. In our robustness test, we assume that observations with sales prices above or below the 99% and 1% percentile are potentially problematic outliers. Similarly, individual sales transactions and the values of the corresponding independent variables might exhibit undue influence on the regression coefficients. In our analysis, we therefore estimate a set of Cook's Distance statistics (Cook, 1977; Cook and Weisberg, 1982) on the base OLS *half-mile* model and assume any cases with an absolute value of this statistic greater than one to be potentially problematic influential cases. To examine the influence of these cases on our results, we estimate a model with both the outlying sales prices and Cook's influential cases removed.

3.3.2. Interacting Sale Year at the County Level

It is conceivable that housing inflation and deflation varied dramatically in different parts of the same state. In the base models, we interact sale year with the state to account for inflation and deflation of sales prices, but a potentially more-accurate adjustment might be warranted. To explore this, a model with the interaction of sale year and county, instead of state, is estimated.

3.3.3. Using Only the Most Recent Sales

The dataset for the base OLS models includes not only the most recent sale of particular homes, but also, if available, the sale prior to that. Some of these earlier sales occurred many years prior to the most recent sale. The home and site characteristics (square feet, acres, condition, etc.) used in the models are populated via assessment data for the home. For some of these data, only the most recent assessment information is available (rather than the assessment from the time of sale), and therefore older sales might be more prone to error as their characteristics might have

changed since the sale.[14] Additionally, the SEMs require that all x/y coordinates entered into the model are unique; therefore, for those models only the most recent sale is used. Excluding older sales therefore potentially reduces measurement error, and also enables a more-direct comparison of effects between the base OLS model and SEM results.

3.3.4. Using Homes between 5 and 10 Miles as Reference Category

The base models use the collection of homes between 3 and 10 miles from the wind facility (that sold before the announcement of the facility) as the reference category in which wind facility effects are not expected. However, it is conceivable that wind turbine effects extend farther than 3 miles. If homes outside of 3 miles are affected by the presence of the turbines, then effects estimated for the target group (e.g., those inside of 1 mile) will be biased downward (i.e., smaller) in the base models. To test this possibility and ensure that the results are not biased, the group of homes located between 5 and 10 miles is used as a reference category as a robustness test.

3.3.5. Using Transactions Occurring More than 2 Years before Announcement as Reference Category

The base models use the collection of homes that sold before the wind facilities were announced (and were between 3 and 10 miles from the facilities) as the reference category, but, as discussed in Hoen et al. (2009, 2011), the announcement date of a facility, when news about a facility enters the public domain, might be after that project was known in private. For example, wind facility developers may begin talking to landowners some time before a facility is announced, and these landowners could share that news with neighbors. In addition, the developer might erect an anemometer to collect wind-speed data well before the facility is formally "announced," which might provide concrete evidence that a facility may soon to be announced. In either case, this news might enter the local real estate market and affect home prices before the formal facility announcement date. To explore this possibility, and to ensure that the reference category

[14] As discussed in more detail in the Section 4, approximately 60% of all the data obtained for this study (that obtained from CoreLogic) used the most recent assessment to populate the home and site characteristics for all transactions of a given property.

is unbiased, a model is estimated that uses transactions occurring more than 2 years before the wind facilities were announced (and between 3 and 10 miles) as the reference category.

Combined, this diverse set of robustness tests allows many assumptions used for the base models to be tested, potentially allowing greater confidence in the final results.

4. Data

The data used for the analysis are comprised of four types: wind turbine location data, real estate transaction data, home and site characteristic data, and census data. From those, two additional sets of data are calculated: distance to turbine and wind facility development period. Each data type is discussed below. Where appropriate, variable names are shown in *italics*.

4.1. Wind Turbine Locations

Location data (i.e., x/y coordinates) for installed wind turbines were obtained via an iterative process starting with Federal Aviation Administration obstacle data, which were then linked to specific wind facilities by Ventyx[15] and matched with facility-level data maintained by LBNL. Ultimately, data were collected on the location of almost all wind turbines installed in the U.S. through 2011 ($n \sim 40{,}000$), with information about each facility's announcement, construction, and operation dates as well as turbine nameplate capacity, hub height, rotor diameter, and facility size.

4.2. Real Estate Transactions

Real estate transaction data were collected through two sources, each of which supplied the home's sale price (*sp*), sale date (*sd*), x/y coordinates, and address including zip code. From those, the following variables were calculated: natural log of sale price (*lsp*), sale year (*sy*), if the sale occurred in winter (*swinter*) (i.e., in Q1 or Q4).

The first source of real estate transaction data was CoreLogic's extensive dataset of U.S. residential real estate information.[16] Using the x/y coordinates of wind turbines, CoreLogic

[15] See the EV Energy Map, which is part of the Velocity Suite of products at www.ventyx.com.
[16] See www.corelogic.com.

selected all arms-length single-family residential transactions between 1996 and 2011 within 10 miles of a turbine in any U.S. counties where they maintained data (not including New York – see below) on parcels smaller than 15 acres.[17] The full set of counties for which data were collected were then winnowed to 26 by requiring at least 250 transactions in each county, to ensure a reasonably robust estimation of the controlling characteristics (which, as discussed above, are interacted with county-level fixed effects), and by requiring at least one PC transaction within a half mile of a turbine in each county (because this study's focus is on homes that are located in close proximity to turbines).

The second source of data was the New York Office of Real Property Tax Service (NYORPTS),[18] which supplied a set of arms-length single-family residential transactions between 2001 and 2012 within 10 miles of existing turbines in any New York county in which wind development had occurred prior to 2012. As before, only parcels smaller than 15 acres were included, as were a minimum of 250 transactions and at least one PC transaction within a half mile of a turbine for each New York county. Both CoreLogic and NYORPTS provided the most recent home sale and, if available, the prior sale.

4.3. Home and Site Characteristics

A set of home and site characteristic data was also collected from both data suppliers: 1000s of square feet of living area (*sfla1000*), number of acres of the parcel (*acres*), year the home was built (or last renovated, whichever is more recent) (*yrbuilt*), and the number of full and half bathrooms (*baths*).[19] Additional variables were calculated from the other variables as well: log of 1,000s of square feet (*lsfla1000*),[20] the number of acres less than 1 (*lt1acre)*,[21] age at the time of sale (*age*), and age squared (*agesqr*).[22]

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[17] The 15 acre screen was used because of a desire to exclude from the sample any transaction of property that might be hosting a wind turbine, and therefore directly benefitting from the turbine's presence (which might then increase property values). To help ensure that the screen was effective, all parcels within a mile of a turbine were also visually inspected using satellite and ortho imagery via a geographic information system.

[18] See www.orps.state.ny.us

[19] *Baths* was calculated in the following manner: full bathrooms + (half bathrooms x 0.5). Some counties did not have *baths* data available, so for them *baths* was not used as an independent variable.

[20] The distribution of *sfla1000* is skewed, which could bias OLS estimates, thus *lsfla1000* is used instead, which is more normally distributed. Regression results, though, were robust when *sfla1000* was used instead.

Regardless of when the sale occurred, CoreLogic supplied the related home and site characteristics as of the most recent assessment, while NYORPTS supplied the assessment data as of the year of sale.[23]

4.4. Census Information

Each of the homes in the data was matched (based on the x/y coordinates) to the underlying census block group and tract via ArcGIS. Using the year 2000 block group census data, each transaction was appended with neighborhood characteristics including the median age of the residents (*medage*), the total number of housing units (*units*), the number vacant (*vacant*) homes, and the number of owned (*owned*) homes. From these, the percentages of the total number of housing units in the block group that were vacant and owned were calculated, i.e., *pctvacant* and *pctowned*.

4.5. Distances to Turbine

Using the x/y coordinates of both the homes and the turbines, a Euclidian distance (in miles) was calculated for each home to the nearest wind turbine (*tdis*), regardless of when the sale occurred (e.g., even if a transaction occurred prior to the wind facility's installation).[24] These were then broken into four mutually exclusive distance bins (i.e., groups) for the base *half-mile* models: inside a half mile, between a half and 1 mile, between 1 and 3 miles, and between 3 and 10 miles. They were broken into three mutually exclusive bins for the base *one-mile* models: inside 1 mile, between 1 and 3 miles, and between 3 and 10 miles.

4.6. Wind Facility Development Periods

After identifying the nearest wind turbine for each home, a match could be made to Ventyx' dataset of facility-development announcement and construction dates. These facility-development dates in combination with the dates of each sale of the homes determined in which

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[21] This variable allows the separate estimations of the 1st acre and any additional acres over the 1st.
[22] *Age* and *agesqr* together account for the fact that, as homes age, their values usually decrease, but further increases in age might bestow countervailing positive "antique" effects.
[23] See footnote 13.
[24] Before the distances were calculated, each home inside of 1 mile was visually inspected using satellite and ortho imagery, with x/y coordinates corrected, if necessary, so that those coordinates were on the roof of the home.

of the three facility-development periods (*fdp*) the transaction occurred: *pre-announcement* (PA), *post-announcement-pre-construction* (PAPC), or *post-construction* (PC).

4.7. Data Summary

After cleaning to remove missing or erroneous data, a final dataset of 51,276 transactions was prepared for analysis.[25] As shown in the map of the study area (Figure 1), the data are arrayed across nine states and 27 counties (see Table 4), and surround 67 different wind facilities.

Table 3 contains a summary of those data. The average unadjusted sales price for the sample is $122,475. Other average house characteristics include the following: 1,600 square feet of living space; house age of 48 years[26]; land parcel size of 0.90 acres; 1.6 bathrooms; in a block group in which 74% of housing units are owned, 9% are vacant, and the median resident age is 38 years; located 4.96 miles from the nearest turbine; and sold at the tail end of the PA period.

The data are arrayed across the temporal and distance bins as would be expected, with smaller numbers of sales nearer the turbines, as shown in Table 5. Of the full set of sales, 1,198 occurred within 1 mile of a then-current or future turbine location, and 376 of these occurred post construction; 331 sales occurred within a half mile, 104 of which were post construction. Given these totals, the models should be able to discern a post construction effect larger than ~3.5% within a mile and larger than ~7.5% within a half mile (see discussion in Section 2). These effects are at the top end of the expected range of effects based on other disamenities (high-voltage power lines, roads, landfills, etc.).

[25] Cleaning involved the removal of all data that did not have certain core characteristics (sale date, sale price, *sfla*, *yrbuilt*, *acres*, *median age*, etc.) fully populated as well as the removal of any sales that had seemingly miscoded data (e.g., having a *sfla* that was greater than *acres*, having a *yrbuilt* more than 1 year after the sale, having less than one *bath*) or that did not conform to the rest of the data (e.g., had *acres* or *sfla* that were either larger or smaller, respectively, than 99% or 1% of the data). OLS models were rerun with those "nonconforming" data included with no substantive change in the results in comparison to the screened data presented in the report.

[26] Age could be as low as -1(for a new home) for homes that were sold before construction was completed.

Figure 1: Map of Transactions, States, and Counties

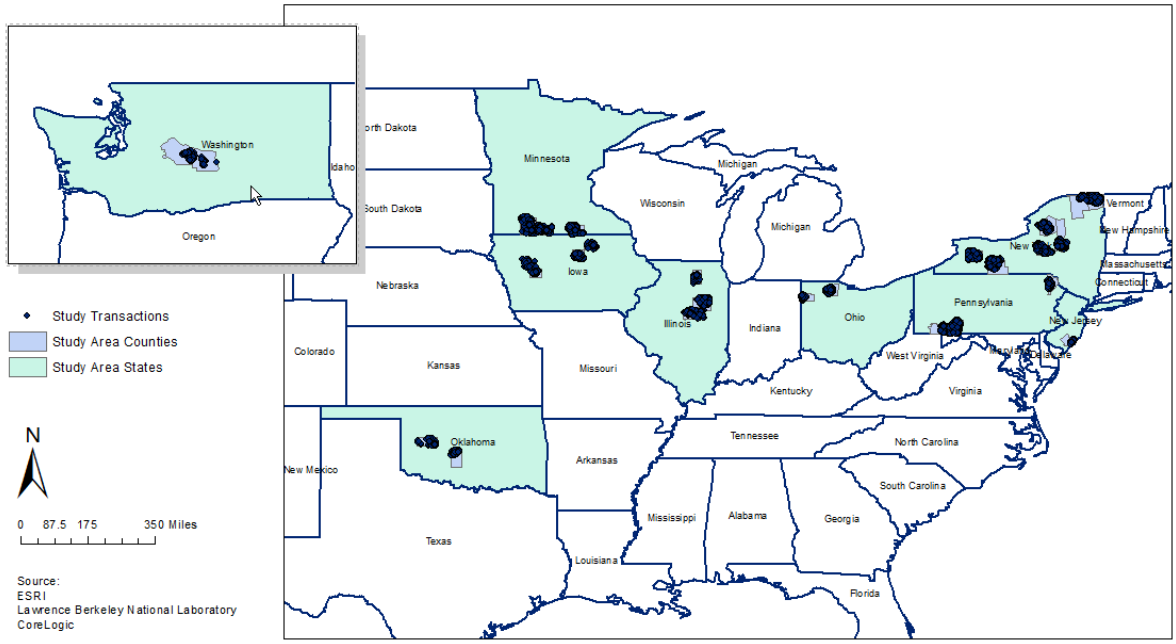


Table 3: Summary Statistics

Variable	Description	Mean	Std. Dev.	Min	Max
sp	sale price in dollars	$ 122,475	$ 80,367	$ 9,750	$ 690,000
lsp	natural log of sale price	11.52	0.65	9.19	13.44
sd	sale date	1/18/2005	1,403 days	1/1/1996	9/30/2011
sy	sale year	2005	3.84	1996	2011
sfla1000	living area in 1000s of square feet	1.60	0.57	0.60	4.50
lsfla1000	natural log of sfla1000	0.41	0.34	-0.50	1.50
acres	number of acres in parcel	0.90	1.79	0.03	14.95
acreslt1*	acres less than 1	-0.58	0.34	-0.97	0.00
age	age of home at time of sale	48	37	-1	297
agesq	age squared	3689	4925	0	88209
baths**	number of bathrooms	1.60	0.64	1.00	5.50
pctowner	fraction of house units in block group that are owned (as of 2000)	0.74	0.17	0.63	0.98
pctvacant	fraction of house units in block group that are vacant (as of 2000)	0.09	0.10	0.00	0.38
med_age	median age of residents in block group (as of 2000)	38	6	20	63
tdis	distance to nearest turbine (as of December 2011) in miles	4.96	2.19	0.09	10.00
fdp***	facility development period of nearest turbine at time of sale	1.94	0.87	1.00	3.00
Note: The number of cases for the full dataset is 51,276					
** acreslt1 is calculated as follows: acres (if less than 1) * - 1*					
*** Some counties did not have bathrooms populated; for those, these variables are entered into the regression as 0.*					
**** fdp periods are: 1, pre-announcement,; 2, post-announcement-pre-construction; and, 3, post-construction.*					

Table 4: Summary of Transactions by County

County	State	<1/2 mile	1/2-1 mile	1-3 miles	3-10 miles	Total
Carroll	IA	12	56	331	666	1,065
Floyd	IA	3	2	402	119	526
Franklin	IA	8	1	9	322	340
Sac	IA	6	77	78	485	646
DeKalb	IL	4	8	44	605	661
Livingston	IL	16	6	237	1,883	2,142
McLean	IL	18	88	380	4,359	4,845
Cottonwood	MN	3	10	126	1,012	1,151
Freeborn	MN	17	16	117	2,521	2,671
Jackson	MN	19	28	36	149	232
Martin	MN	7	25	332	2,480	2,844
Atlantic	NJ	34	96	1,532	6,211	7,873
Paulding	OH	15	58	115	309	497
Wood	OH	5	31	563	4,844	5,443
Custer	OK	45	24	1,834	349	2,252
Grady	OK	1	6	97	874	978
Fayette	PA	1	2	10	284	297
Somerset	PA	23	100	1,037	2,144	3,304
Wayne	PA	4	29	378	739	1,150
Kittitas	WA	2	6	61	349	418
Clinton	NY	4	6	49	1,419	1,478
Franklin	NY	16	41	75	149	281
Herkimer	NY	3	17	354	1,874	2,248
Lewis	NY	5	6	93	732	836
Madison	NY	5	26	239	3,053	3,323
Steuben	NY	5	52	140	1,932	2,129
Wyoming	NY	50	50	250	1,296	1,646
Total		331	867	8,919	41,159	51,276

Table 5: Frequency Crosstab of Wind Turbine Distance and Development Period Bins

	<1/2 mile	1/2-1 mile	1-3 miles	3-10 miles	total
PA	143	383	3,892	16,615	21,033
PAPC	84	212	1,845	9,995	12,136
PC	104	272	3,182	14,549	18,107
total	331	867	8,919	41,159	51,276

As shown in Table 6, the home sales occurred around wind facilities that range from a single-turbine project to projects of 150 turbines, with turbines of 290–476 feet (averaging almost 400 feet) in total height from base to tip of blade and with an average nameplate capacity of 1,637 kW. The average facility was announced in 2004 and constructed in 2007, but some were announced as early as 1998 and others were constructed as late as 2011.

Table 6: Wind Facility Summary

	mean	min	25th percentile	median	75th percentile	max
turbine rotor diameter (feet)	262	154	253	253	269	328
turbine hub height (feet)	256	197	256	262	262	328
turbine total height (feet)	388	290	387	389	397	476
turbine capacity (kW)	1637	660	1500	1500	1800	2500
facility announcement year	2004	1998	2002	2003	2005	2010
facility construction year	2007	2000	2004	2006	2010	2011
number of turbines in facility	48	1	5	35	84	150
nameplate capacity of facility (MW)	79	1.5	7.5	53	137	300

Note: The data correspond to 67 wind facilities located in the study areas. Mean values are rounded to integers

4.8. Comparison of Means

To provide additional context for the analysis discussed in the next section, we further summarize the data here using four key variables across the sets of development period (*fdp*) and distance bins (*tdis*) used in the *one-mile* models.[27] The variables are the dependent variable log of sale price *(lsp)* and three independent variables: *lsfla100*, *acres*, and *age*. These summaries are provided in Table 7; each sub-table gives the mean values of the variables across the three *fdp* bins and three *tdis* bins, and the corresponding figures plot those values.

The top set of results are focused on the log of the sales price, and show that, based purely on price and not controlling for differences in homes, homes located within 1 mile of turbines had lower sale prices than homes farther away; this is true across all of the three development periods. Moreover, the results also show that, over the three periods, the closer homes appreciated to a somewhat lesser degree than homes located farther from the turbines. As a result, focusing only on the post-construction period, these results might suggest that home prices near turbines are

[27] Summaries for the *half-mile* models reveal a similar relationship, so only the *one-mile* model summaries are shown here.

adversely impacted by the turbines. After all, the logarithmic values for the homes within a mile of the turbines (11.39) and those outside of a three miles (11.72) translate into an approximately 40% difference, in comparison to an 21% difference before the wind facilities were announced (11.16 vs. 11.35).[28] Focusing on the change in average values between the pre-announcement and post-construction periods might also suggest an adverse effect due to the turbines, because homes inside of 1 mile appreciated more slowly (11.16 to 11.39, or 25%) than those outside of 3 miles (11.35 to 11.72, or 45%). Both conclusions of adverse turbine effects, however, disregard other important differences between the homes, which vary over the periods and distances. Similarly, comparing the values of the PA inside 1 mile homes (11.16) and the PC outside of 3 miles homes (11.72), which translates into a difference of 75%, and which is the basis for comparison in the regressions discussed below, but also ignores any differences in the underlying characteristics.

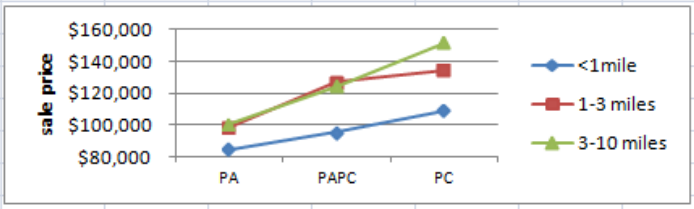
The remainder of Table 7, for example, indicates that, although the homes that sold within 1 mile are lower in value, they are also generally (in all but the PA period) smaller, on larger parcels of land, and older. These differences in home size and age across the periods and distances might explain the differences in price, while the differences in the size of the parcel, which add value, further amplifying the differences in price. Without controlling for these possible impacts, one cannot reliably estimate the impact of wind turbines on sales prices.

In summary, focusing solely on trends in home price (or price per square foot) alone, and for only the PC period, as might be done in a simpler analysis, might incorrectly suggest that wind turbines are affecting price when other aspects of the markets, and other home and sites characteristic differences, could be driving the observed price differences. This is precisely why researchers generally prefer the hedonic model approach to control for such effects, and the results from our hedonic OLS and spatial modeling detailed in the next section account for these and many other possible influencing factors.

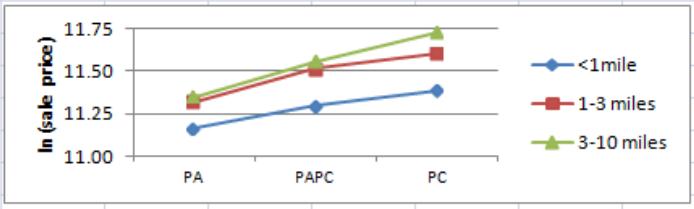
[28] Percentage differences are calculated as follows: exp(11.72-11.39)-1=0.40 and exp(11.35-11.16)-1=0.21.

Table 7: Dependent and Independent Variable Means

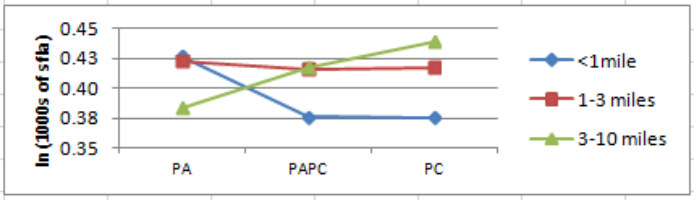
Sale Price			
	<1mile	1-3 miles	3-10 miles
PA	$ 84,830	$ 98,676	$100,485
PAPC	$ 95,223	$127,054	$124,532
PC	$109,133	$134,647	$151,559



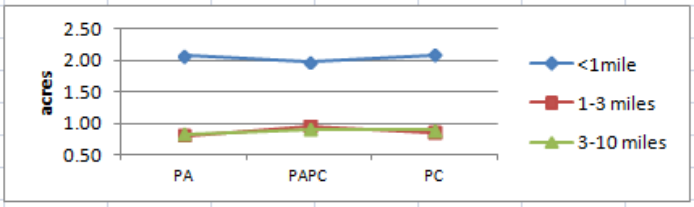
Log of Sale Price			
	<1mile	1-3 miles	3-10 miles
PA	11.16	11.32	11.35
PAPC	11.30	11.52	11.56
PC	11.39	11.61	11.72



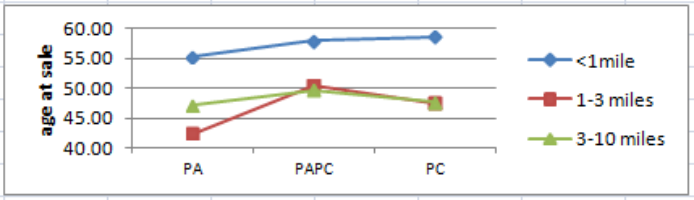
Log of Square Feet (in 1000s)			
	<1mile	1-3 miles	3-10 miles
PA	0.43	0.42	0.38
PAPC	0.38	0.42	0.42
PC	0.38	0.42	0.44



Number of Acres			
	<1mile	1-3 miles	3-10 miles
PA	2.08	0.80	0.83
PAPC	1.98	0.94	0.90
PC	2.09	0.84	0.89



Age at the Time of Sale			
	<1mile	1-3 miles	3-10 miles
PA	55.32	42.34	47.19
PAPC	58.01	50.34	49.73
PC	58.63	47.39	47.73



5. Results

This section contains analysis results and discussion for the four base models, as well as the results from the robustness models.

5.1. Estimation Results for Base Models

000514

Estimation results for the "base" models are shown in Table 8 and Table 9.[29] In general, given the diverse nature of the data, the models perform adequately, with adjusted R^2 values ranging from 0.63 to 0.67 (bottom of Table 9).

5.1.1. Control Variables

The controlling home, site, and block group variables, which are interacted at the county level, are summarized in Table 8. Table 8 focuses on only one of the base models, the *one-mile* OLS model, but full results from all models are shown in the Appendix. [30] To concisely summarize results for all of the 27 counties, the table contains the percentage of all 27 counties for which each controlling variable has statistically significant (at or below the 10% level) coefficients for the *one-mile* OLS model. For those controlling variables that are found to be statistically significant, the table further contains mean values, standard deviations, and minimum and maximum levels.

Many of the county-interacted controlling variables (e.g., *lsfla1000, lt1acre, age, agesqr, baths,* and *swinter*) are consistently (in more than two thirds of the counties) statistically significant (with a *p*-value < 0.10) and have appropriately sized mean values. The seemingly spurious minimum and maximum values among some of the county-level controlling variables (e.g., *lt1acre* minimum of -0.069) likely arise when these variables in particular counties are highly correlated with other variables, such as square feet (*lsfla1000*), and also when sample size is limited.[31] The other variables (*acres* and the three block group level census variables: *pctvacant, pctowner,* and *med_age*) are statistically significant in 33-59% of the counties. Only one variable's mean value—the percent of housing units vacant in the block group as of the 2000 census (*pctvacant*)—was counterintuitive. In that instance, a positive coefficient was estimated, when in fact, one would expect that increasing the percent of vacant housing would lower prices;

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[29] The OLS models are estimated using the areg procedure in Stata with robust (White's corrected) standard errors (White, 1980). The spatial error models are estimated using the *gstslshet* routine in the sphet package in R, which also allows for robust standard errors to be estimated. See: http://cran.r-project.org/web/packages/sphet/sphet.pdf

[30] The controlling variables' coefficients were similar across the base models, so only the *one-mile* results are summarized here.

[31] The possible adverse effects of these collinearities were fully explored both via the removal of the variables and by examining VIF statistics. The VOI results are robust to controlling variable removal and have relatively low (< 5) VIF statistics.

this counter-intuitive effect may be due to collinearity with one or more of the other variables, or possible measurement errors.[32]

The sale year variables, which are interacted with the state, are also summarized in Table 8, with the percentages indicating the number of states in which the coefficients are statistically significant. The inclusion of these sale year variables in the regressions control for inflation and deflation across the various states over the study period. The coefficients represent a comparison to the omitted year, which is 2011. All sale year state-level coefficients are statistically significant in at least 50% of the states in all years except 2010, and they are significant in two thirds of the states in all except 3 years. The mean values of all years are appropriately signed, showing a monotonically ordered peak in values in 2007, with lower values in the prior and following years. The minimum and maximum values are similarly signed (negative) through 2003 and from 2007 through 2010 (positive), and are both positive and negative in years 2003 through 2006, indicating the differences in inflation/deflation in those years across the various states. This reinforces the appropriateness of interacting the sale years at the state level. Finally, although not shown, the model also contains 250 fixed effects for the census tract delineations, of which approximately 50% were statistically significant.

[32] The removal of this, as well as the other block group census variables, however, did not substantively influence the results of the VOI.

Table 8: Levels and Significance for County- and State-Interacted Controlling Variables[33]

Variable	% of Counties/States Having Significant (p -value <0.10) Coefficients	Statistics for Significant Variables			
		Mean	St Dev	Min	Max
lsfla1000	100%	0.604	0.153	0.332	0.979
acres	48%	0.025	0.035	-0.032	0.091
lt1acre	85%	0.280	0.170	-0.069	0.667
age	81%	-0.006	0.008	-0.021	0.010
agesqr	74%	-0.006	0.063	-0.113	0.108
*baths**	85%	0.156	0.088	0.083	0.366
pctvacant	48%	1.295	3.120	-2.485	9.018
pctowner	33%	0.605	0.811	-0.091	2.676
med_age	59%	-0.016	0.132	-0.508	0.066
swinter	78%	-0.034	0.012	-0.053	-0.020
sy1996	100%	-0.481	0.187	-0.820	-0.267
sy1997	100%	-0.448	0.213	-0.791	-0.242
sy1998	100%	-0.404	0.172	-0.723	-0.156
sy1999	100%	-0.359	0.169	-0.679	-0.156
sy2000	88%	-0.298	0.189	-0.565	-0.088
sy2001	88%	-0.286	0.141	-0.438	-0.080
sy2002	67%	-0.261	0.074	-0.330	-0.128
sy2003	67%	-0.218	0.069	-0.326	-0.119
sy2004	75%	-0.084	0.133	-0.208	0.087
sy2005	67%	0.082	0.148	-0.111	0.278
sy2006	67%	0.128	0.158	-0.066	0.340
sy2007	67%	0.196	0.057	0.143	0.297
sy2008	56%	0.160	0.051	0.084	0.218
sy2009	50%	0.138	0.065	0.071	0.219
sy2010	33%	0.172	0.063	0.105	0.231

** % of counties significant is reported only for counties that had the baths variable populated (17 out of 27 counties)*

5.1.2. Variables of Interest

The variables of interest, the interactions between the *fdp* and *tdis* bins, are shown in Table 9 for the four base models. The reference (i.e., omitted) case for these variables are homes that sold prior to the wind facilities' announcement (PA) and are located between 3 and 10 miles from the

[33] Controlling variable statistics are provided for only the *one-mile* OLS model but did not differ substantially for other models. All variables are interacted with counties, except for sale year (sy), which is interacted with the state.

wind turbines' eventual locations. In relation to that group of transactions, three of the eight interactions in the *one-mile* models and four of the 11 interactions in the *half-mile* models produce coefficients that are statistically significant (at the 10% level).

Across all four base models none of the PA coefficients show statistically significant differences between the reference category (outside of 3 miles) and the group of transactions within a mile for the *one-mile* models (OLS: -1.7%, *p*-value 0.48; SEM: -0.02%, *p*-value 0.94)[34] or within a half- or between one-half and one-mile for the *half-mile* models (OLS inside a half mile: 0.01%, *p*-value 0.97; between a half and 1 mile: -2.3%, *p*-value 0.38; SEM inside a half mile: 5.3%, *p*-value 0.24; between a half and 1 mile: -1.8%, *p*-value 0.60). Further, none of the coefficients are significant, and all are relatively small (which partially explains their non-significance). Given these results, we find an absence of evidence of a PA effect for homes close to the turbines (*research question 1*). These results can be contrasted with the differences in prices between within-1-mile homes and outside-of-3-miles homes as summarized in Section 4.8 when no differences in the homes, the local market, the neighborhood, etc. are accounted for. The approximately 75% difference in price (alone) in the pre-announcement period 1-mile homes, as compared to the PC 3-mile homes, discussed in Section 4.8, is largely explained by differences in the controlling characteristics, which is why the pre-announcement distance coefficients shown here are not statistically significant.

Turning to the PAPC and PC periods, the results also indicate statistically insignificant differences in average home values, all else being equal, between the reference group of transactions (sold in the PA period) and those similarly located more than 3 miles from the turbines but sold in the PAPC or PC periods. Those differences are estimated to be between -0.8% and -0.5%.

The results presented above, and in Table 8, include both OLS and spatial models. Prior to estimating the spatial models, the Moran's I was calculated using the residuals of an OLS model that uses the same explanatory variables as the spatial models and the same dataset (only the most recent transactions). The Moran's I statistic (0.133) was highly significant (*p*-value 0.00),

[34] p-values are not shown in the table can but can be derived from the standard errors, which are shown.

which allows us to reject the hypothesis that the residuals are spatially independent. Therefore, there was justification in estimating the spatial models. However, after estimation, we determined that only the spatial error process was significant. As a result, we estimated spatial error models (SEMs) for the final specification. The spatial autoregressive coefficient, lambda (bottom of Table 9), which is an indication of spatial autocorrelation in the residuals, is sizable and statistically significant in both SEMs (0.26, *p*-value 0.00). The SEM models' variable-of-interest coefficients are quite similar to those of the OLS models. In most cases, the coefficients are the same sign, approximately the same level, and often similarly insignificant, indicating that although spatial dependence is present it does not substantively bias the variables of interest. The one material difference is the coefficient size and significance for homes outside of 3 miles in the PAPC and PC periods, 3.3% (*p*-value 0.000) and 3.1% (*p*-value 0.008), indicating there are important changes to home values over the periods that must be accounted for in the later DD models in order to isolate the potential impacts that occur due to the presence of wind turbines.

Table 9: Results of Interacted Variables of Interest: *fdp* and *tdis*

		one-mile	*one-mile*	*half-mile*	*half-mile*
		OLS	SEM	OLS	SEM
fdp	tdis	β (se)	β (se)	β (se)	β (se)
PA	< 1 mile	-0.017	0.002		
		(0.024)	*(0.031)*		
PA	1-2 miles	-0.015	0.008		
		(0.011)	*(0.016)*		
PA	> 3 miles	Omitted	Omitted		
		n/a	*n/a*		
PAPC	< 1 mile	-0.035	-0.038		
		(0.029)	*(0.033)*		
PAPC	1-2 miles	-0.001	-0.033.		
		(0.014)	*(0.018)*		
PAPC	> 3 miles	-0.006	-0.033***		
		(0.008)	*(0.01)*		
PC	< 1 mile	0.019	-0.022		
		(0.026)	*(0.032)*		
PC	1-2 miles	0.044***	-0.001		
		(0.014)	*(0.019)*		
PC	> 3 miles	-0.005	-0.031**		
		(0.010)	*(0.012)*		
PA	< 1/2 mile			0.001	0.053
				(0.039)	*(0.045)*
PA	1/2 - 1 mile			-0.023	-0.018
				(0.027)	*(0.035)*
PA	1-2 miles			-0.015	0.008
				(0.011)	*(0.016)*
PA	> 3 miles			Omitted	Omitted
				n/a	*n/a*
PAPC	< 1/2 mile			-0.028	-0.065
				(0.049)	*(0.056)*
PAPC	1/2 - 1 mile			-0.038	-0.027
				(0.033)	*(0.036)*
PAPC	1-2 miles			-0.001	-0.034.
				(0.014)	*(0.017)*
PAPC	> 3 miles			-0.006	-0.033***
				(0.008)	*(0.009)*
PC	< 1/2 mile			-0.016	-0.036
				(0.041)	*(0.046)*
PC	1/2 - 1 mile			0.032	-0.016
				(0.031)	*(0.035)*
PC	1-2 miles			0.044***	-0.001
				(0.014)	*(0.018)*
PC	> 3 miles			-0.005	-0.031**
				(0.010)	*(0.012)*
lambda			0.247 ***		0.247 ***
			(0.008)		*(0.008)*
*Note: p-values: < 0.1 *, < 0.05 **, <0.01 ***.*					
n		51,276	38,407	51,276	38,407
adj R-sqr		0.67	0.64	0.67	0.64

000520

5.1.3. Impact of Wind Turbines

As discussed above, there are important differences in property values between development periods for the reference group of homes (those located outside of 3 miles) that must be accounted for. Further, although they are not significant, differences between the reference category and those transactions inside of 1 mile in the PA period still must be accounted for if accurate measurements of PAPC or PC wind turbine effects are to be estimated. The DD specification accounts for both of these critical effects.

Table 10 shows the results of the DD tests across the four models, based on the results for the variables of interest presented in Table 9.[35] For example, to determine the net difference for homes that sold inside of a half mile (drawing from the *half-mile* OLS model) in the PAPC period, we use the following formula: PAPC half-mile coefficient (-0.028) less the PAPC 3-mile coefficient (-0.006) less the PA half-mile coefficient (0.001), which equals -0.024 (without rounding), which equates to 2.3% difference,[36] and is not statistically significant.

None of the DD effects in either the OLS or SEM specifications are statistically significant in the PAPC or PC periods, indicating that we do not observe a statistically significant impact of wind turbines on property values. Some small differences are apparent in the calculated coefficients, with those for PAPC being generally more negative/less positive than their PC counterparts, perhaps suggestive of a small announcement effect that declines once a facility is constructed. Further, the inside-a-half-mile coefficients are more negative/less positive than their between-a-half-and-1-mile counterparts, perhaps suggestive of a small property value impact very close to turbines.[37] However, in all cases, the sizes of these differences are smaller than the margins of error in the model (i.e., 90% confidence interval) and thus are not statistically significant. Therefore, based on these results, we do not find evidence supporting either of our two core hypotheses (*research questions 2 and 3*). In other words, there is no statistical evidence that homes in either the PAPC or PC periods that sold near turbines (i.e., within a mile or even a half

[35] All DD estimates for the OLS models were calculated using the post-estimation "lincom" test in Stata, which uses the stored results' variance/covariance matrix to test if a linear combination of coefficients is different from 0. For the SEM models, a similar test was performed in R.

[36] All differences in coefficients are converted to percentages in the table as follows: exp(coef)-1.

[37] Although not discussed in the text, this trend continues with homes between 1 and 2 miles being less negative/more positive than homes closer to the turbines (e.g., those within 1 mile).

mile) did so for less than similar homes that sold between 3 and 10 away miles in the same period.

Further, using the standard errors from the DD models we can estimate the maximum size an average effect would have to be in our sample for the model to detect it (*research question 4*). For an average effect in the PC period to be found for homes within 1 mile of the existing turbines (therefore using the *one-mile* model results), an effect greater than 4.9%, either positive or negative, would have to be present to be detected by the model.[38] In other words, it is highly unlikely that the true average effect for homes that sold in our sample area within 1 mile of an existing turbine is larger than +/-4.9%. Similarly, it is highly unlikely that the true average effect for homes that sold in our sample area within a half mile of an existing turbine is larger than +/-9.0%.[39] Regardless of these maximum effects, however, as well as the very weak suggestion of a possible small announcement effect and a possible small effect on homes that are very close to turbines, the core results of these models show effect sizes that are not statistically significant from zero, and are considerably smaller than these maximums.[40]

[38] Using the 90% confidence interval (i.e., 10% level of significance) and assuming more than 300 cases, the critical t-value is 1.65. Therefore, using the standard error of 0.030, the 90% confidence intervals for the test will be +/-0.049.

[39] Using the critical t-value of 1.66 for the 100 PC cases within a half mile in our sample and the standard error of 0.054.

[40] It is of note that these maximum effects are slightly larger than those we expected to find, as discussed earlier. This likely indicates that there was more variation in this sample, causing relatively higher standard errors for the same number of cases, than in the sample used for the 2009 study (Hoen et al., 2009, 2011).

Table 10: "Net" Difference-in-Difference Impacts of Turbines

		< 1 Mile	< 1 Mile	< 1/2 Mile	< 1/2 Mile
		OLS	SEM	OLS	SEM
fdp	tdis	b/se	b/se	b/se	b/se
PAPC	< 1 mile	-1.2% ^{NS}	-0.7% ^{NS}		
		(0.033)	*(0.037)*		
PC	< 1 mile	4.2% ^{NS}	0.7% ^{NS}		
		(0.030)	*(0.035)*		
PAPC	< 1/2 mile			-2.3% ^{NS}	-8.1% ^{NS}
				(0.060)	*(0.065)*
PAPC	1/2 - 1 mile			-0.8% ^{NS}	2.5% ^{NS}
				(0.039)	*(0.043)*
PC	< 1/2 mile			-1.2% ^{NS}	-5.6% ^{NS}
				(0.054)	*(0.057)*
PC	1/2 - 1 mile			6.3% ^{NS}	3.4% ^{NS}
				(0.036)	*(0.042)*
*Note: p-values: > 10% ^{NS}, < 10% *, < 5% **, <1 % ******					

5.2. Robustness Tests

Table 11 summarizes the results from the robustness tests. For simplicity, only the DD coefficients are shown and only for the *half-mile* OLS models.[41] The first two columns show the base OLS and SEM *half-mile* DD results (also presented earlier, in Table 9), and the remaining columns show the results from the robustness models as follows: exclusion of outliers and influential cases from the dataset (*outlier*); using sale year/county interactions instead of sale year/state (*sycounty*); using only the most recent sales instead of the most recent and prior sales (*recent*); using homes between 5 and 10 miles as the reference category, instead of homes between 3 and 10 miles (*outside5*); and using transactions occurring more than 2 years before announcement as the reference category instead of using transactions simply *before* announcement (*prior*).

[41] Results were also estimated for the *one-mile* OLS models for each of the robustness tests and are available upon request: the results do not substantively differ from what is presented here for the *half-mile* models. Because of the similarities in the results between the OLS and SEM "base" models, robustness tests on the SEM models were not prepared as we assumed that differences between the two models for the robustness tests would be minimal as well.

000523

The robustness results have patterns similar to the base model results: none of the coefficients are statistically different from zero; all coefficients (albeit non-significant) are lower in the PAPC period than the PC period; and, all coefficients (albeit non-significant) are lower (i.e., less negative/more positive) within a half mile than outside a half mile.[42] In sum, regardless of dataset or specification, there is no change in the basic conclusions drawn from the base model results: there is no evidence that homes near operating or announced wind turbines are impacted in a statistically significant fashion. Therefore, if effects do exist, either the average impacts are relatively small (within the margin of error in the models) and/or sporadic (impacting only a small subset of homes). Moreover, these results seem to corroborate what might be predicted given the other, potentially analogous disamenity literature that was reviewed earlier, which might be read to suggest that any property value effect of wind turbines might coalesce at a maximum of 3%–4%, on average. Of course, we cannot offer that corroboration directly because, although the size of the coefficients in the models presented here are reasonably consistent with effects of that magnitude, none of our models offer results that are statistically different from zero.

[42] This trend also continues outside of 1 mile, with those coefficients being less negative/more positive than those within 1 mile.

Table 11: Robustness Half-Mile Model Results

				Robustness OLS Models				
		Base OLS	Base SEM	outlier	sycounty	recent	outside5	prior
fdp	tdis	β (se)	β (se)	β (se)	β (se)	β (se)	β (se)	β (se)
PAPC	< 1/2 mile	-2.3% ^{NS}	-8.1% ^{NS}	-4.7% ^{NS}	-4.2% ^{NS}	-5.6% ^{NS}	-1.7% ^{NS}	0.1% ^{NS}
		(0.060)	*(0.065)*	*(0.056)*	*(0.060)*	*(0.066)*	*(0.060)*	*(0.062)*
PAPC	1/2 - 1 mile	-0.8% ^{NS}	2.5% ^{NS}	-1.7% ^{NS}	-2.5% ^{NS}	2.3% ^{NS}	-0.2% ^{NS}	0.4% ^{NS}
		(0.039)	*(0.043)*	*(0.036)*	*(0.039)*	*(0.043)*	*(0.039)*	*(0.044)*
PC	< 1/2 mile	-1.2% ^{NS}	-5.6% ^{NS}	-0.5% ^{NS}	-1.8% ^{NS}	-4.3% ^{NS}	-0.3% ^{NS}	1.3% ^{NS}
		(0.054)	*(0.057)*	*(0.047)*	*(0.054)*	*(0.056)*	*(0.054)*	*(0.056)*
PC	1/2 - 1 mile	6.3% ^{NS}	3.4% ^{NS}	6.2% ^{NS}	3.8% ^{NS}	4.1% ^{NS}	7.1% ^{NS}	7.5% ^{NS}
		(0.036)	*(0.041)*	*(0.033)*	*(0.036)*	*(0.042)*	*(0.036)*	*(0.041)*
Note: p-values: > 0.1 ^{NS}*, < 0.1 *, <0.5 **, <0.01 ******								
	n	51,276	38,407	50,106	51,276	38,407	51,276	51,276
	adj R-sqr	0.67	0.64	0.66	0.67	0.66	0.67	0.67

6. Conclusion

Wind energy facilities are expected to continue to be developed in the United States. Some of this growth is expected to occur in more-populated regions, raising concerns about the effects of wind development on home values in surrounding communities.

Previous published and academic research on this topic has tended to indicate that wind facilities, after they have been constructed, produce little or no effect on home values. At the same time, some evidence has emerged indicating potential home-value effects occurring after a wind facility has been announced but before construction. These previous studies, however, have been limited by their relatively small sample sizes, particularly in relation to the important population of homes located very close to wind turbines, and have sometimes treated the variable for distance to wind turbines in a problematic fashion. Analogous studies of other disamenities—including high-voltage transmission lines, landfills, and noisy roads—suggest that if reductions in property values near turbines were to occur, they would likely be no more than 3%–4%, on average, but to discover such small effects near turbines, much larger amounts of data are needed than have been used in previous studies. Moreover, previous studies have not accounted adequately for potentially confounding home-value factors, such as those affecting home values before wind facilities were announced, nor have they adequately controlled for spatial dependence in the data, i.e., how the values and characteristics of homes located near one another influence the value of those homes (independent of the presence of wind turbines).

This study helps fill those gaps by collecting a very large data sample and analyzing it with methods that account for confounding factors and spatial dependence. We collected data from more than 50,000 home sales among 27 counties in nine states. These homes were within 10 miles of 67 different then-current or existing wind facilities, with 1,198 sales that were within 1 mile of a turbine (331 of which were within a half mile)—many more than were collected by previous research efforts. The data span the periods well before announcement of the wind facilities to well after their construction. We use OLS and spatial-process difference-in-difference hedonic models to estimate the home-value impacts of the wind facilities; these models control for value factors existing prior to the wind facilities' announcements, the spatial dependence of home values, and value changes over time. We also employ a series of robustness

models, which provide greater confidence in our results by testing the effects of data outliers and influential cases, heterogeneous inflation/deflation across regions, older sales data for multi-sale homes, the distance from turbines for homes in our reference case, and the amount of time before wind-facility announcement for homes in our reference case.

Across all model specifications, we find no statistical evidence that home prices near wind turbines were affected in either the post-construction or post-announcement/pre-construction periods. Therefore, if effects do exist, either the average impacts are relatively small (within the margin of error in the models) and/or sporadic (impacting only a small subset of homes). Related, our sample size and analytical methods enabled us to bracket the size of effects that would be detected, if those effects were present at all. Based on our results, we find that it is *highly unlikely* that the actual average effect for homes that sold in our sample area within 1 mile of an existing turbine is larger than +/-4.9%. In other words, the average value of these homes could be as much as 4.9% higher than it would have been without the presence of wind turbines, as much as 4.9% lower, the same (i.e., zero effect), or anywhere in between. Similarly, it is highly unlikely that the average actual effect for homes that sold in our sample area within a half mile of an existing turbine is larger than +/-9.0%. In other words, the average value of these homes could be as much as 9% higher than it would have been without the presence of wind turbines, as much as 9% lower, the same (i.e., zero effect), or anywhere in between.

Regardless of these potential maximum effects, the core results of our analysis consistently show no sizable statistically significant impact of wind turbines on nearby property values. The maximum impact suggested by potentially analogous disamenities (high-voltage transmission lines, landfills, roads etc.) of 3%-4% is at the far end of what the models presented in this study would have been able to discern, potentially helping to explain why no statistically significant effect was found. If effects of this size are to be discovered in future research, even larger samples of data may be required. For those interested in estimating such effects on a more micro (or local) scale, such as appraisers, these possible data requirements may be especially daunting, though it is also true that the inclusion of additional market, neighborhood, and individual property characteristics in these more-local assessments may sometimes improve model fidelity.

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8. Appendix – Full Results

	OneMile OLS		HalfMile OLS		OneMile SEM		HalfMile SEM	
Variables	**coef**	**se**	**coef**	**se**	**coef**	**se**	**coef**	**se**
Intercept	11.332***	(0.058)	11.330***	(0.058)	11.292***	(0.090)	11.292***	(0.090)
fdp3tdis3_11	-0.017	(0.024)			0.002	(0.031)		
fdp3tdis3_12	-0.015	(0.011)			0.008	(0.016)		
fdp3tdis3_21	-0.035	(0.029)			-0.038	(0.033)		
fdp3tdis3_22	-0.001	(0.014)			-0.033*	(0.017)		
fdp3tdis3_23	-0.006	(0.008)			-0.033***	(0.009)		
fdp3tdis3_31	0.019	(0.026)			-0.022	(0.031)		
fdp3tdis3_32	0.044***	(0.014)			-0.001	(0.018)		
fdp3tdis3_33	-0.005	(0.010)			-0.031***	(0.012)		
fdp3tdis4_10			0.001	(0.039)			0.053	(0.045)
fdp3tdis4_11			-0.023	(0.027)			-0.018	(0.035)
fdp3tdis4_12			-0.015	(0.011)			0.008	(0.016)
fdp3tdis4_20			-0.028	(0.049)			-0.065	(0.056)
fdp3tdis4_21			-0.038	(0.033)			-0.027	(0.036)
fdp3tdis4_22			-0.001	(0.014)			-0.034*	(0.017)
fdp3tdis4_23			-0.006	(0.008)			-0.033***	(0.009)
fdp3tdis4_30			-0.016	(0.041)			-0.036	(0.046)
fdp3tdis4_31			0.032	(0.031)			-0.016	(0.035)
fdp3tdis4_32			0.044***	(0.014)			-0.001	(0.018)
fdp3tdis4_33			-0.005	(0.010)			-0.031***	(0.012)
lsfla1000_ia_car	0.750***	(0.042)	0.749***	(0.042)	0.723***	(0.045)	0.722***	(0.045)
lsfla1000_ia_flo	0.899***	(0.054)	0.900***	(0.054)	0.879***	(0.060)	0.88***	(0.060)
lsfla1000_ia_fra	0.980***	(0.077)	0.980***	(0.077)	0.932***	(0.083)	0.934***	(0.083)
lsfla1000_ia_sac	0.683***	(0.061)	0.683***	(0.061)	0.633***	(0.065)	0.633***	(0.064)
lsfla1000_il_dek	0.442***	(0.037)	0.441***	(0.037)	0.382***	(0.040)	0.38***	(0.040)
lsfla1000_il_liv	0.641***	(0.030)	0.641***	(0.030)	0.643***	(0.046)	0.643***	(0.046)
lsfla1000_il_mcl	0.512***	(0.019)	0.512***	(0.019)	0.428***	(0.029)	0.428***	(0.029)
lsfla1000_mn_cot	0.800***	(0.052)	0.800***	(0.052)	0.787***	(0.077)	0.787***	(0.077)
lsfla1000_mn_fre	0.594***	(0.028)	0.595***	(0.028)	0.539***	(0.031)	0.539***	(0.031)
lsfla1000_mn_jac	0.587***	(0.101)	0.587***	(0.101)	0.551***	(0.102)	0.55***	(0.102)
lsfla1000_mn_mar	0.643***	(0.025)	0.643***	(0.025)	0.603***	(0.029)	0.603***	(0.029)
lsfla1000_nj_atl	0.421***	(0.012)	0.421***	(0.012)	0.389***	(0.014)	0.389***	(0.014)
lsfla1000_ny_cli	0.635***	(0.044)	0.635***	(0.044)	0.606***	(0.045)	0.606***	(0.045)
lsfla1000_ny_fra	0.373***	(0.092)	0.375***	(0.092)	0.433***	(0.094)	0.436***	(0.094)
lsfla1000_ny_her	0.520***	(0.034)	0.520***	(0.034)	0.559***	(0.035)	0.559***	(0.035)
lsfla1000_ny_lew	0.556***	(0.054)	0.556***	(0.054)	0.518***	(0.057)	0.518***	(0.057)
lsfla1000_ny_mad	0.503***	(0.025)	0.503***	(0.025)	0.502***	(0.025)	0.502***	(0.025)
lsfla1000_ny_ste	0.564***	(0.032)	0.564***	(0.032)	0.534***	(0.034)	0.534***	(0.034)
lsfla1000_ny_wyo	0.589***	(0.034)	0.589***	(0.034)	0.566***	(0.034)	0.566***	(0.034)
lsfla1000_oh_pau	0.625***	(0.080)	0.624***	(0.080)	0.567***	(0.090)	0.565***	(0.090)
lsfla1000_oh_woo	0.529***	(0.030)	0.529***	(0.030)	0.487***	(0.035)	0.487***	(0.035)
lsfla1000_ok_cus	0.838***	(0.037)	0.838***	(0.037)	0.794***	(0.046)	0.793***	(0.046)
lsfla1000_ok_gra	0.750***	(0.063)	0.750***	(0.063)	0.706***	(0.072)	0.706***	(0.072)
lsfla1000_pa_fay	0.332***	(0.111)	0.332***	(0.111)	0.335***	(0.118)	0.334***	(0.118)
lsfla1000_pa_som	0.564***	(0.025)	0.564***	(0.025)	0.548***	(0.031)	0.548***	(0.031)
lsfla1000_pa_way	0.486***	(0.056)	0.486***	(0.056)	0.44***	(0.063)	0.44***	(0.063)
lsfla1000_wa_kit	0.540***	(0.073)	0.540***	(0.073)	0.494***	(0.078)	0.494***	(0.078)

	OneMile OLS		HalfMile OLS		OneMile SEM		HalfMile SEM	
Variables	**coef**	**se**	**coef**	**se**	**coef**	**se**	**coef**	**se**
acres_ia_car	0.033	(0.030)	0.033	(0.030)	0.013	(0.032)	0.013	(0.032)
acres_ia_flo	0.050***	(0.014)	0.050***	(0.014)	0.044***	(0.014)	0.044***	(0.014)
acres_ia_fra	-0.008	(0.022)	-0.008	(0.022)	-0.009	(0.022)	-0.009	(0.022)
acres_ia_sac	0.064***	(0.014)	0.064***	(0.014)	0.054***	(0.015)	0.054***	(0.015)
acres_il_dek	0.068**	(0.027)	0.064**	(0.027)	0.055*	(0.029)	0.048*	(0.029)
acres_il_liv	0.023	(0.014)	0.023	(0.014)	0.014	(0.018)	0.014	(0.018)
acres_il_mcl	0.091***	(0.010)	0.091***	(0.010)	0.092***	(0.011)	0.092***	(0.011)
acres_mn_cot	-0.030***	(0.011)	-0.030***	(0.011)	-0.024*	(0.013)	-0.024*	(0.013)
acres_mn_fre	-0.002	(0.007)	-0.002	(0.007)	0.002	(0.008)	0.002	(0.008)
acres_mn_jac	0.019	(0.016)	0.020	(0.016)	0.03*	(0.016)	0.03*	(0.016)
acres_mn_mar	0.020**	(0.008)	0.020**	(0.008)	0.017*	(0.009)	0.017*	(0.009)
acres_nj_atl	-0.041	(0.031)	-0.041	(0.031)	-0.013	(0.026)	-0.013	(0.026)
acres_ny_cli	0.019***	(0.007)	0.019***	(0.007)	0.022***	(0.007)	0.022***	(0.007)
acres_ny_fra	0.009	(0.010)	0.009	(0.010)	0.014	(0.011)	0.014	(0.011)
acres_ny_her	-0.004	(0.008)	-0.004	(0.008)	0.012	(0.008)	0.012	(0.008)
acres_ny_lew	0.014*	(0.008)	0.014*	(0.008)	0.014	(0.009)	0.014	(0.009)
acres_ny_mad	0.021***	(0.003)	0.021***	(0.003)	0.021***	(0.004)	0.021***	(0.004)
acres_ny_ste	0.009*	(0.005)	0.009*	(0.005)	0.007	(0.005)	0.007	(0.005)
acres_ny_wyo	0.016***	(0.004)	0.016***	(0.004)	0.019***	(0.004)	0.019***	(0.004)
acres_oh_pau	-0.010	(0.020)	-0.010	(0.020)	0.01	(0.024)	0.009	(0.024)
acres_oh_woo	-0.007	(0.010)	-0.007	(0.010)	0.002	(0.010)	0.002	(0.010)
acres_ok_cus	-0.037*	(0.019)	-0.037*	(0.019)	-0.034	(0.022)	-0.034	(0.022)
acres_ok_gra	0.014	(0.010)	0.014	(0.010)	0.019*	(0.011)	0.019*	(0.011)
acres_pa_fay	-0.006	(0.023)	-0.006	(0.023)	0.01	(0.023)	0.01	(0.023)
acres_pa_som	0.003	(0.009)	0.004	(0.009)	0.009	(0.010)	0.009	(0.010)
acres_pa_way	0.017**	(0.007)	0.017**	(0.007)	0.024***	(0.007)	0.024***	(0.007)
acres_wa_kit	0.009	(0.010)	0.009	(0.010)	0.014	(0.011)	0.014	(0.011)
acreslt1_ia_car	0.446***	(0.136)	0.448***	(0.136)	0.559***	(0.144)	0.56***	(0.143)
acreslt1_ia_flo	0.436***	(0.112)	0.435***	(0.112)	0.384***	(0.118)	0.383***	(0.118)
acreslt1_ia_fra	0.670***	(0.124)	0.668***	(0.124)	0.684***	(0.139)	0.68***	(0.139)
acreslt1_ia_sac	0.159	(0.115)	0.160	(0.115)	0.222*	(0.123)	0.221*	(0.123)
acreslt1_il_dek	0.278***	(0.066)	0.285***	(0.066)	0.282***	(0.073)	0.294***	(0.073)
acreslt1_il_liv	0.278***	(0.063)	0.276***	(0.063)	0.383***	(0.088)	0.38***	(0.088)
acreslt1_il_mcl	-0.069***	(0.021)	-0.070***	(0.021)	-0.007	(0.032)	-0.007	(0.032)
acreslt1_mn_cot	0.529***	(0.093)	0.529***	(0.093)	0.466***	(0.120)	0.465***	(0.120)
acreslt1_mn_fre	0.314***	(0.053)	0.314***	(0.053)	0.294***	(0.061)	0.293***	(0.061)
acreslt1_mn_jac	0.250*	(0.144)	0.247*	(0.145)	0.169	(0.146)	0.162	(0.146)
acreslt1_mn_mar	0.452***	(0.062)	0.452***	(0.062)	0.461***	(0.069)	0.462***	(0.069)
acreslt1_nj_atl	0.135***	(0.048)	0.135***	(0.048)	0.044	(0.047)	0.043	(0.047)
acreslt1_ny_cli	0.115***	(0.044)	0.115***	(0.044)	0.108**	(0.047)	0.108**	(0.047)
acreslt1_ny_fra	0.118	(0.100)	0.118	(0.100)	0.113	(0.115)	0.113	(0.115)
acreslt1_ny_her	0.364***	(0.047)	0.364***	(0.047)	0.331***	(0.050)	0.332***	(0.050)
acreslt1_ny_lew	0.119*	(0.061)	0.120**	(0.061)	0.117*	(0.067)	0.117*	(0.067)

	OneMile OLS		HalfMile OLS		OneMile SEM		HalfMile SEM	
Variables	**coef**	**se**	**coef**	**se**	**coef**	**se**	**coef**	**se**
acreslt1_ny_mad	0.017	(0.031)	0.018	(0.031)	0.043	(0.032)	0.043	(0.032)
acreslt1_ny_ste	0.100**	(0.042)	0.100**	(0.042)	0.18***	(0.047)	0.18***	(0.047)
acreslt1_ny_wyo	0.144***	(0.035)	0.144***	(0.035)	0.137***	(0.039)	0.137***	(0.039)
acreslt1_oh_pau	0.426***	(0.087)	0.425***	(0.087)	0.507***	(0.120)	0.507***	(0.120)
acreslt1_oh_woo	0.124***	(0.034)	0.124***	(0.034)	0.114***	(0.041)	0.114***	(0.041)
acreslt1_ok_cus	0.103	(0.070)	0.104	(0.070)	0.091	(0.092)	0.093	(0.092)
acreslt1_ok_gra	-0.038	(0.054)	-0.038	(0.054)	-0.065	(0.066)	-0.065	(0.066)
acreslt1_pa_fay	0.403***	(0.153)	0.403***	(0.153)	0.42**	(0.165)	0.42**	(0.164)
acreslt1_pa_som	0.243***	(0.039)	0.243***	(0.039)	0.223***	(0.047)	0.223***	(0.047)
acreslt1_pa_way	0.138**	(0.062)	0.138**	(0.062)	0.108	(0.077)	0.109	(0.077)
acreslt1_wa_kit	0.335**	(0.134)	0.335**	(0.134)	0.342**	(0.164)	0.342**	(0.164)
age_ia_car	-0.013***	(0.001)	-0.013***	(0.001)	-0.011***	(0.001)	-0.011***	(0.001)
age_ia_flo	-0.013***	(0.002)	-0.013***	(0.002)	-0.013***	(0.002)	-0.013***	(0.002)
age_ia_fra	-0.012***	(0.003)	-0.012***	(0.003)	-0.011***	(0.003)	-0.011***	(0.003)
age_ia_sac	-0.013***	(0.003)	-0.013***	(0.003)	-0.011***	(0.003)	-0.011***	(0.003)
age_il_dek	-0.004***	(0.001)	-0.004***	(0.001)	-0.004***	(0.001)	-0.004***	(0.001)
age_il_liv	-0.001	(0.001)	-0.002	(0.001)	-0.003	(0.002)	-0.003	(0.002)
age_il_mcl	-0.004***	(0.001)	-0.004***	(0.001)	-0.006***	(0.001)	-0.006***	(0.001)
age_mn_cot	-0.021***	(0.003)	-0.021***	(0.003)	-0.013***	(0.005)	-0.013***	(0.005)
age_mn_fre	-0.013***	(0.001)	-0.013***	(0.001)	-0.012***	(0.002)	-0.012***	(0.002)
age_mn_jac	-0.018***	(0.005)	-0.018***	(0.005)	-0.018***	(0.005)	-0.018***	(0.005)
age_mn_mar	-0.010***	(0.001)	-0.010***	(0.001)	-0.009***	(0.002)	-0.009***	(0.002)
age_nj_atl	-0.004***	(0.000)	-0.004***	(0.000)	-0.003***	(0.001)	-0.003***	(0.001)
age_ny_cli	-0.005***	(0.001)	-0.005***	(0.001)	-0.005***	(0.001)	-0.005***	(0.001)
age_ny_fra	-0.004	(0.003)	-0.005	(0.003)	-0.005*	(0.003)	-0.005*	(0.003)
age_ny_her	-0.008***	(0.001)	-0.008***	(0.001)	-0.008***	(0.001)	-0.008***	(0.001)
age_ny_lew	-0.008***	(0.001)	-0.008***	(0.001)	-0.009***	(0.001)	-0.009***	(0.001)
age_ny_mad	-0.006***	(0.001)	-0.006***	(0.001)	-0.006***	(0.001)	-0.006***	(0.001)
age_ny_ste	-0.006***	(0.001)	-0.006***	(0.001)	-0.007***	(0.001)	-0.007***	(0.001)
age_ny_wyo	-0.006***	(0.001)	-0.006***	(0.001)	-0.006***	(0.001)	-0.006***	(0.001)
age_oh_pau	0.003	(0.003)	0.003	(0.003)	0.003	(0.004)	0.003	(0.004)
age_oh_woo	0.008***	(0.001)	0.008***	(0.001)	0.01***	(0.001)	0.01***	(0.001)
age_ok_cus	-0.000	(0.002)	-0.000	(0.002)	0.002	(0.003)	0.002	(0.003)
age_ok_gra	-0.000	(0.002)	-0.000	(0.002)	0.001	(0.002)	0.001	(0.002)
age_pa_fay	0.010**	(0.004)	0.010**	(0.004)	0.01**	(0.005)	0.01**	(0.005)
age_pa_som	-0.006***	(0.001)	-0.006***	(0.001)	-0.008***	(0.001)	-0.008***	(0.001)
age_pa_way	0.006***	(0.002)	0.006***	(0.002)	0.007***	(0.002)	0.007***	(0.002)
age_wa_kit	0.010***	(0.003)	0.010***	(0.003)	0.014***	(0.003)	0.014***	(0.003)
agesq_ia_car	0.034***	(0.011)	0.034***	(0.000)	0.022*	(0.012)	0.022*	(0.012)
agesq_ia_flo	0.040***	(0.016)	0.040**	(0.016)	0.044***	(0.016)	0.044***	(0.016)
agesq_ia_fra	0.025	(0.022)	0.025	(0.022)	0.02	(0.023)	0.021	(0.023)
agesq_ia_sac	0.032	(0.022)	0.032	(0.022)	0.025	(0.023)	0.025	(0.023)
agesq_il_dek	0.008	(0.010)	0.008	(0.010)	0.013	(0.012)	0.013	(0.011)
agesq_il_liv	-0.023**	(0.009)	-0.023**	(0.009)	-0.011	(0.014)	-0.011	(0.014)
agesq_il_mcl	0.005	(0.007)	0.005	(0.007)	0.021*	(0.011)	0.021*	(0.011)
agesq_mn_cot	0.109**	(0.043)	0.109**	(0.043)	0.032	(0.069)	0.033	(0.069)
agesq_mn_fre	0.046***	(0.010)	0.045***	(0.010)	0.044***	(0.012)	0.044***	(0.012)
agesq_mn_jac	0.103***	(0.035)	0.104***	(0.035)	0.1***	(0.034)	0.101***	(0.034)
agesq_mn_mar	0.012	(0.012)	0.012	(0.012)	0.006	(0.014)	0.006	(0.014)

	OneMile OLS		HalfMile OLS		OneMile SEM		HalfMile SEM	
Variables	**coef**	**se**	**coef**	**se**	**coef**	**se**	**coef**	**se**
agesq_nj_atl	0.010***	(0.003)	0.010***	(0.003)	0.003	(0.005)	0.003	(0.005)
agesq_ny_cli	0.011*	(0.006)	0.011*	(0.006)	0.011*	(0.006)	0.011*	(0.006)
agesq_ny_fra	-0.011	(0.022)	-0.011	(0.022)	-0.002	(0.020)	-0.002	(0.020)
agesq_ny_her	0.022***	(0.005)	0.022***	(0.005)	0.022***	(0.006)	0.022***	(0.006)
agesq_ny_lew	0.031***	(0.006)	0.031***	(0.006)	0.032***	(0.007)	0.032***	(0.007)
agesq_ny_mad	0.017***	(0.003)	0.017***	(0.003)	0.023***	(0.003)	0.023***	(0.003)
agesq_ny_ste	0.013**	(0.005)	0.013**	(0.005)	0.018***	(0.005)	0.018***	(0.005)
agesq_ny_wyo	0.016***	(0.005)	0.016***	(0.005)	0.017***	(0.005)	0.017***	(0.005)
agesq_oh_pau	-0.044**	(0.022)	-0.045**	(0.022)	-0.043	(0.028)	-0.043	(0.028)
agesq_oh_woo	-0.074***	(0.007)	-0.074***	(0.007)	-0.091***	(0.009)	-0.091***	(0.009)
agesq_ok_cus	-0.091***	(0.019)	-0.091***	(0.019)	-0.113***	(0.026)	-0.113***	(0.026)
agesq_ok_gra	-0.081***	(0.023)	-0.081***	(0.023)	-0.097***	(0.029)	-0.097***	(0.029)
agesq_pa_fay	-0.112***	(0.032)	-0.112***	(0.032)	-0.105***	(0.034)	-0.106***	(0.034)
agesq_pa_som	0.000	(0.008)	0.002	(0.008)	0.016*	(0.009)	0.016*	(0.009)
agesq_pa_way	-0.000***	(0.012)	-0.052***	(0.012)	-0.053***	(0.014)	-0.053***	(0.014)
agesq_wa_kit	-0.000***	(0.027)	-0.097***	(0.027)	-0.132***	(0.031)	-0.132***	(0.031)
bathsim_ia_sac	-0.050	(0.073)	-0.050	(0.073)	-0.082	(0.077)	-0.081	(0.077)
bathsim_il_dek	-0.005	(0.015)	-0.005	(0.015)	0.001	(0.018)	0.001	(0.018)
bathsim_ny_cli	0.090***	(0.025)	0.090***	(0.025)	0.087***	(0.024)	0.087***	(0.024)
bathsim_ny_fra	0.246***	(0.062)	0.245***	(0.062)	0.213***	(0.064)	0.212***	(0.064)
bathsim_ny_her	0.099***	(0.022)	0.099***	(0.022)	0.079***	(0.022)	0.079***	(0.022)
bathsim_ny_lew	0.168***	(0.030)	0.167***	(0.030)	0.142***	(0.031)	0.142***	(0.031)
bathsim_ny_mad	0.180***	(0.014)	0.180***	(0.014)	0.157***	(0.013)	0.157***	(0.013)
bathsim_ny_ste	0.189***	(0.019)	0.189***	(0.019)	0.166***	(0.020)	0.166***	(0.020)
bathsim_ny_wyo	0.107***	(0.021)	0.107***	(0.021)	0.1***	(0.021)	0.1***	(0.021)
bathsim_oh_pau	0.095*	(0.051)	0.095*	(0.051)	0.149***	(0.057)	0.149***	(0.057)
bathsim_oh_woo	0.094***	(0.017)	0.094***	(0.017)	0.092***	(0.019)	0.092***	(0.019)
bathsim_pa_fay	0.367***	(0.077)	0.367***	(0.077)	0.301***	(0.082)	0.302***	(0.082)
bathsim_pa_way	0.082**	(0.036)	0.082**	(0.036)	0.081**	(0.041)	0.081**	(0.041)
pctvacant_ia_car	-2.515*	(1.467)	-2.521*	(1.468)	-2.011	(1.936)	-2.019	(1.937)
pctvacant_ia_flo	0.903	(1.152)	0.921	(1.152)	1.358	(1.409)	1.339	(1.410)
pctvacant_ia_fra	8.887**	(3.521)	8.928**	(3.518)	-2.596	(1.703)	-2.6	(1.703)
pctvacant_ia_sac	0.672	(0.527)	0.673	(0.527)	1.267***	(0.377)	1.266***	(0.377)
pctvacant_il_dek	0.052	(0.639)	0.062	(0.638)	0.037	(0.964)	0.069	(0.961)
pctvacant_il_liv	-0.475	(0.474)	-0.476	(0.474)	-0.699	(0.872)	-0.701	(0.872)
pctvacant_il_mcl	-0.365	(0.397)	-0.366	(0.397)	0.445	(0.670)	0.442	(0.670)
pctvacant_mn_cot	1.072*	(0.592)	1.072*	(0.592)	0.272	(1.039)	0.273	(1.039)
pctvacant_mn_fre	-1.782**	(0.703)	-1.787**	(0.703)	-1.372	(0.965)	-1.384	(0.965)
pctvacant_mn_jac	-1.345	(0.883)	-1.318	(0.884)	-1.285	(1.084)	-1.313	(1.084)
pctvacant_mn_mar	2.178***	(0.502)	2.175***	(0.502)	1.53**	(0.622)	1.528**	(0.622)
pctvacant_nj_atl	-0.054	(0.062)	-0.054	(0.062)	0.096	(0.085)	0.095	(0.085)
pctvacant_ny_cli	0.709***	(0.224)	0.709***	(0.224)	0.842***	(0.251)	0.841***	(0.251)
pctvacant_ny_fra	6.173***	(2.110)	6.104***	(2.113)	0.519	(0.710)	0.499	(0.709)
pctvacant_ny_her	-1.226***	(0.247)	-1.226***	(0.247)	-1.347***	(0.288)	-1.347***	(0.288)
pctvacant_ny_lew	-0.125	(0.127)	-0.125	(0.127)	-0.266*	(0.159)	-0.266*	(0.159)
pctvacant_ny_mad	0.750***	(0.196)	0.752***	(0.196)	0.767***	(0.246)	0.765***	(0.246)
pctvacant_ny_ste	0.280	(0.190)	0.281	(0.190)	0.039	(0.242)	0.04	(0.242)
pctvacant_ny_wyo	0.179*	(0.101)	0.178*	(0.101)	0.225*	(0.119)	0.224*	(0.119)
pctvacant_oh_pau	-1.473	(1.498)	-1.473	(1.499)	-1.341	(1.951)	-1.256	(1.952)

	OneMile OLS		HalfMile OLS		OneMile SEM		HalfMile SEM	
Variables	**coef**	**se**	**coef**	**se**	**coef**	**se**	**coef**	**se**
pctvacant_oh_woo	-0.565	(0.400)	-0.565	(0.400)	-0.304	(0.563)	-0.306	(0.563)
pctvacant_ok_cus	-0.127	(0.358)	-0.140	(0.359)	-0.167	(0.521)	-0.189	(0.521)
pctvacant_ok_gra	1.413*	(0.777)	1.414*	(0.777)	0.537	(1.045)	0.536	(1.045)
pctvacant_pa_fay	0.227	(0.596)	0.229	(0.596)	0.232	(0.807)	0.235	(0.807)
pctvacant_pa_som	0.517***	(0.098)	0.516***	(0.098)	0.562***	(0.138)	0.562***	(0.138)
pctvacant_pa_way	0.445***	(0.156)	0.444***	(0.156)	0.446**	(0.175)	0.446**	(0.175)
pctvacant_wa_kit	-0.076	(0.546)	-0.075	(0.546)	-0.377	(0.282)	-0.377	(0.281)
pctowner_ia_car	-0.225	(0.244)	-0.225	(0.244)	-0.156	(0.324)	-0.156	(0.324)
pctowner_ia_flo	0.579**	(0.238)	0.578**	(0.238)	0.75***	(0.290)	0.75***	(0.290)
pctowner_ia_fra	0.207	(0.310)	0.206	(0.310)	0.172	(0.393)	0.169	(0.393)
pctowner_ia_sac	0.274	(0.585)	0.261	(0.586)	-0.34	(0.545)	-0.345	(0.545)
pctowner_il_dek	0.075	(0.088)	0.073	(0.087)	0.032	(0.123)	0.028	(0.123)
pctowner_il_liv	0.176	(0.140)	0.176	(0.140)	0.265	(0.200)	0.264	(0.200)
pctowner_il_mcl	0.389***	(0.051)	0.388***	(0.051)	0.331***	(0.101)	0.331***	(0.101)
pctowner_mn_cot	0.375***	(0.138)	0.375***	(0.138)	0.609**	(0.254)	0.609**	(0.254)
pctowner_mn_fre	-0.119	(0.090)	-0.120	(0.090)	-0.072	(0.124)	-0.073	(0.124)
pctowner_mn_jac	-0.206	(0.474)	-0.205	(0.474)	-0.175	(0.569)	-0.185	(0.570)
pctowner_mn_mar	0.262***	(0.076)	0.262***	(0.076)	0.151	(0.103)	0.151	(0.103)
pctowner_nj_atl	-0.087**	(0.037)	-0.087**	(0.037)	-0.036	(0.052)	-0.037	(0.052)
pctowner_ny_cli	-0.229	(0.171)	-0.229	(0.171)	-0.305	(0.199)	-0.303	(0.199)
pctowner_ny_fra	2.743*	(1.500)	2.693*	(1.505)	-0.315	(1.447)	-0.398	(1.442)
pctowner_ny_her	0.246***	(0.095)	0.246***	(0.095)	0.213*	(0.109)	0.213*	(0.109)
pctowner_ny_lew	-0.034	(0.185)	-0.034	(0.185)	-0.126	(0.219)	-0.126	(0.219)
pctowner_ny_mad	0.750***	(0.075)	0.750***	(0.075)	0.723***	(0.084)	0.723***	(0.084)
pctowner_ny_ste	0.192	(0.128)	0.191	(0.128)	-0.083	(0.162)	-0.084	(0.162)
pctowner_ny_wyo	-0.089	(0.111)	-0.089	(0.111)	-0.109	(0.138)	-0.108	(0.138)
pctowner_oh_pau	-0.187	(0.347)	-0.185	(0.348)	-1.245***	(0.473)	-1.249***	(0.474)
pctowner_oh_woo	0.263***	(0.092)	0.264***	(0.092)	0.274**	(0.136)	0.274**	(0.136)
pctowner_ok_cus	0.068	(0.104)	0.068	(0.104)	-0.041	(0.146)	-0.043	(0.146)
pctowner_ok_gra	0.271*	(0.159)	0.271*	(0.159)	0.253	(0.217)	0.253	(0.217)
pctowner_pa_fay	-0.413	(1.736)	-0.420	(1.736)	-0.15	(2.037)	-0.165	(2.037)
pctowner_pa_som	0.171	(0.114)	0.170	(0.114)	0.098	(0.173)	0.098	(0.173)
pctowner_pa_way	-0.351	(0.441)	-0.348	(0.441)	-0.251	(0.345)	-0.252	(0.345)
pctowner_wa_kit	0.257	(2.139)	0.259	(2.139)	-0.358	(1.889)	-0.361	(1.890)
med_age_ia_car	0.002	(0.002)	0.002	(0.002)	0.003	(0.003)	0.003	(0.003)
med_age_ia_flo	0.003	(0.002)	0.003	(0.002)	0.004	(0.003)	0.004	(0.003)
med_age_ia_fra	0.066***	(0.015)	0.066***	(0.015)	0.014**	(0.006)	0.014**	(0.006)
med_age_ia_sac	0.028**	(0.014)	0.028**	(0.014)	0.012	(0.010)	0.012	(0.010)
med_age_il_dek	-0.001	(0.002)	-0.001	(0.002)	-0.001	(0.003)	-0.001	(0.003)
med_age_il_liv	-0.004	(0.004)	-0.004	(0.004)	-0.005	(0.005)	-0.005	(0.005)
med_age_il_mcl	-0.006***	(0.002)	-0.006***	(0.002)	-0.006**	(0.003)	-0.006**	(0.003)
med_age_mn_cot	0.017***	(0.005)	0.017***	(0.005)	0.018**	(0.008)	0.018**	(0.008)
med_age_mn_fre	0.012***	(0.002)	0.012***	(0.002)	0.013***	(0.002)	0.013***	(0.002)
med_age_mn_jac	0.013	(0.008)	0.013	(0.008)	0.012	(0.010)	0.012	(0.010)
med_age_mn_mar	0.013***	(0.003)	0.013***	(0.003)	0.012***	(0.003)	0.012***	(0.003)
med_age_nj_atl	0.010***	(0.001)	0.010***	(0.001)	0.016***	(0.002)	0.016***	(0.002)
med_age_ny_cli	0.020***	(0.004)	0.020***	(0.004)	0.02***	(0.004)	0.02***	(0.004)
med_age_ny_fra	-0.517***	(0.198)	-0.511***	(0.198)	0.008	(0.040)	0.01	(0.039)
med_age_ny_her	0.007*	(0.003)	0.007*	(0.003)	0.005	(0.003)	0.005	(0.003)

	OneMile OLS		HalfMile OLS		OneMile SEM		HalfMile SEM	
Variables	**coef**	**se**	**coef**	**se**	**coef**	**se**	**coef**	**se**
med_age_ny_lew	0.013***	(0.005)	0.013***	(0.005)	0.008	(0.005)	0.008	(0.005)
med_age_ny_mad	0.004**	(0.002)	0.004**	(0.002)	0.004*	(0.002)	0.004*	(0.002)
med_age_ny_ste	0.012***	(0.003)	0.012***	(0.003)	0.001	(0.004)	0.001	(0.004)
med_age_ny_wyo	0.008	(0.005)	0.007	(0.005)	0.008	(0.006)	0.008	(0.006)
med_age_oh_pau	0.034***	(0.013)	0.034***	(0.013)	0.019	(0.012)	0.019	(0.012)
med_age_oh_woo	-0.004	(0.003)	-0.004	(0.003)	-0.004	(0.004)	-0.004	(0.004)
med_age_ok_cus	0.004	(0.002)	0.004	(0.002)	0.008**	(0.004)	0.008**	(0.004)
med_age_ok_gra	0.011	(0.009)	0.011	(0.009)	0	(0.006)	0	(0.006)
med_age_pa_fay	0.049	(0.073)	0.049	(0.073)	0.052	(0.095)	0.052	(0.095)
med_age_pa_som	0.008***	(0.002)	0.008***	(0.002)	0.012***	(0.004)	0.012***	(0.004)
med_age_pa_way	-0.005	(0.012)	-0.005	(0.012)	0.002	(0.007)	0.002	(0.007)
med_age_wa_kit	-0.015	(0.095)	-0.015	(0.095)	0.025	(0.034)	0.025	(0.034)
swinter_ia	-0.034**	(0.015)	-0.034**	(0.015)	-0.039***	(0.015)	-0.039***	(0.015)
swinter_il	-0.020**	(0.008)	-0.020**	(0.008)	-0.013	(0.012)	-0.013	(0.012)
swinter_mn	-0.053***	(0.009)	-0.053***	(0.009)	-0.057***	(0.011)	-0.057***	(0.011)
swinter_nj	-0.007	(0.006)	-0.007	(0.006)	-0.008	(0.007)	-0.008	(0.007)
swinter_ny	-0.030***	(0.007)	-0.030***	(0.007)	-0.026***	(0.007)	-0.026***	(0.007)
swinter_oh	-0.048***	(0.012)	-0.048***	(0.012)	-0.055***	(0.014)	-0.055***	(0.014)
swinter_ok	-0.039**	(0.015)	-0.039**	(0.015)	-0.024	(0.018)	-0.024	(0.018)
swinter_pa	-0.025*	(0.015)	-0.025*	(0.015)	-0.02	(0.017)	-0.02	(0.017)
swinter_wa	-0.004	(0.046)	-0.004	(0.046)	0.014	(0.051)	0.013	(0.051)
sy_1996_ia	-0.436***	(0.137)	-0.433***	(0.137)	-0.493***	(0.157)	-0.489***	(0.157)
sy_1996_il	-0.267***	(0.037)	-0.267***	(0.037)	-0.344***	(0.061)	-0.344***	(0.061)
sy_1996_mn	-0.521***	(0.058)	-0.521***	(0.059)	-0.585***	(0.065)	-0.585***	(0.065)
sy_1996_nj	-0.820***	(0.022)	-0.820***	(0.022)	-0.717***	(0.038)	-0.717***	(0.038)
sy_1996_oh	-0.298***	(0.042)	-0.298***	(0.042)	-0.43***	(0.053)	-0.43***	(0.053)
sy_1996_ok	-0.444***	(0.073)	-0.444***	(0.073)	-0.846***	(0.079)	-0.846***	(0.079)
sy_1996_pa	-0.584***	(0.060)	-0.584***	(0.060)	-0.604***	(0.067)	-0.604***	(0.067)
sy_1997_il	-0.242***	(0.036)	-0.242***	(0.036)	-0.234***	(0.052)	-0.232***	(0.052)
sy_1997_mn	-0.445***	(0.055)	-0.445***	(0.055)	-0.535***	(0.060)	-0.535***	(0.060)
sy_1997_nj	-0.791***	(0.021)	-0.791***	(0.021)	-0.686***	(0.038)	-0.686***	(0.038)
sy_1997_oh	-0.302***	(0.043)	-0.302***	(0.043)	-0.39***	(0.053)	-0.39***	(0.053)
sy_1997_pa	-0.458***	(0.057)	-0.458***	(0.057)	-0.51***	(0.066)	-0.51***	(0.066)
sy_1998_ia	-0.442***	(0.078)	-0.441***	(0.078)	-0.633***	(0.099)	-0.634***	(0.099)
sy_1998_il	-0.156***	(0.031)	-0.156***	(0.031)	-0.175***	(0.048)	-0.175***	(0.048)
sy_1998_mn	-0.391***	(0.054)	-0.391***	(0.054)	-0.484***	(0.059)	-0.484***	(0.059)
sy_1998_nj	-0.723***	(0.020)	-0.723***	(0.021)	-0.633***	(0.037)	-0.633***	(0.037)
sy_1998_oh	-0.217***	(0.040)	-0.217***	(0.040)	-0.302***	(0.047)	-0.302***	(0.047)
sy_1998_ok	-0.394***	(0.048)	-0.395***	(0.048)	-0.816***	(0.059)	-0.818***	(0.059)
sy_1998_pa	-0.481***	(0.059)	-0.480***	(0.059)	-0.554***	(0.068)	-0.552***	(0.067)
sy_1998_wa	-0.433***	(0.115)	-0.433***	(0.115)	-0.356**	(0.161)	-0.356**	(0.161)
sy_1999_ia	-0.347***	(0.085)	-0.345***	(0.086)	-0.568***	(0.117)	-0.565***	(0.117)
sy_1999_il	-0.155***	(0.031)	-0.156***	(0.031)	-0.215***	(0.046)	-0.214***	(0.046)
sy_1999_mn	-0.302***	(0.055)	-0.303***	(0.055)	-0.367***	(0.059)	-0.368***	(0.059)
sy_1999_nj	-0.679***	(0.020)	-0.679***	(0.020)	-0.583***	(0.036)	-0.583***	(0.036)
sy_1999_oh	-0.161***	(0.040)	-0.161***	(0.040)	-0.243***	(0.047)	-0.243***	(0.047)
sy_1999_ok	-0.347***	(0.044)	-0.348***	(0.044)	-0.743***	(0.050)	-0.743***	(0.050)
sy_1999_pa	-0.452***	(0.058)	-0.452***	(0.058)	-0.515***	(0.066)	-0.515***	(0.066)
sy_1999_wa	-0.432***	(0.114)	-0.432***	(0.114)	-0.454***	(0.166)	-0.453***	(0.165)

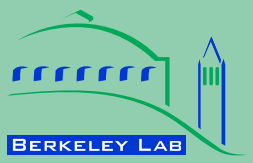
	OneMile OLS		HalfMile OLS		OneMile SEM		HalfMile SEM	
Variables	**coef**	**se**	**coef**	**se**	**coef**	**se**	**coef**	**se**
sy_2000_ia	-0.165	(0.145)	-0.164	(0.146)	-0.246	(0.183)	-0.246	(0.183)
sy_2000_il	-0.088***	(0.031)	-0.088***	(0.031)	-0.172***	(0.045)	-0.171***	(0.045)
sy_2000_mn	-0.148***	(0.051)	-0.149***	(0.051)	-0.224***	(0.053)	-0.224***	(0.053)
sy_2000_nj	-0.565***	(0.020)	-0.565***	(0.020)	-0.461***	(0.036)	-0.462***	(0.036)
sy_2000_oh	-0.098**	(0.041)	-0.098**	(0.041)	-0.161***	(0.047)	-0.16***	(0.047)
sy_2000_ok	-0.330***	(0.050)	-0.331***	(0.050)	-0.748***	(0.059)	-0.749***	(0.059)
sy_2000_pa	-0.394***	(0.057)	-0.395***	(0.057)	-0.478***	(0.067)	-0.478***	(0.067)
sy_2000_wa	-0.463***	(0.115)	-0.463***	(0.115)	-0.403**	(0.160)	-0.402**	(0.160)
sy_2001_ia	-0.334***	(0.065)	-0.332***	(0.065)	-0.435***	(0.066)	-0.433***	(0.066)
sy_2001_il	-0.080**	(0.031)	-0.080***	(0.031)	-0.101**	(0.048)	-0.101**	(0.048)
sy_2001_mn	-0.119**	(0.050)	-0.119**	(0.050)	-0.204***	(0.051)	-0.204***	(0.052)
sy_2001_nj	-0.438***	(0.018)	-0.438***	(0.018)	-0.333***	(0.034)	-0.333***	(0.034)
sy_2001_oh	-0.033	(0.036)	-0.033	(0.036)	-0.078**	(0.040)	-0.078**	(0.040)
sy_2001_ok	-0.250***	(0.041)	-0.251***	(0.041)	-0.648***	(0.044)	-0.648***	(0.044)
sy_2001_pa	-0.402***	(0.055)	-0.402***	(0.055)	-0.446***	(0.063)	-0.447***	(0.063)
sy_2001_wa	-0.378***	(0.122)	-0.378***	(0.122)	-0.275*	(0.163)	-0.275*	(0.163)
sy_2002_ia	-0.130**	(0.059)	-0.128**	(0.059)	-0.264***	(0.064)	-0.261***	(0.064)
sy_2002_il	0.008	(0.030)	0.007	(0.030)	-0.013	(0.043)	-0.013	(0.043)
sy_2002_mn	-0.072	(0.050)	-0.072	(0.050)	-0.138***	(0.051)	-0.139***	(0.051)
sy_2002_nj	-0.330***	(0.019)	-0.330***	(0.019)	-0.195***	(0.035)	-0.195***	(0.035)
sy_2002_ny	-0.307***	(0.020)	-0.307***	(0.020)	-0.342***	(0.020)	-0.342***	(0.020)
sy_2002_oh	-0.022	(0.038)	-0.022	(0.038)	-0.053	(0.042)	-0.053	(0.042)
sy_2002_ok	-0.249***	(0.045)	-0.249***	(0.045)	-0.649***	(0.052)	-0.649***	(0.052)
sy_2002_pa	-0.313***	(0.053)	-0.313***	(0.053)	-0.355***	(0.059)	-0.354***	(0.059)
sy_2002_wa	-0.241**	(0.123)	-0.241**	(0.123)	-0.216	(0.166)	-0.216	(0.166)
sy_2003_ia	-0.195**	(0.081)	-0.194**	(0.081)	-0.311***	(0.085)	-0.314***	(0.084)
sy_2003_il	0.034	(0.030)	0.034	(0.030)	0.021	(0.040)	0.021	(0.040)
sy_2003_mn	0.034	(0.049)	0.034	(0.049)	-0.026	(0.049)	-0.026	(0.049)
sy_2003_nj	-0.119***	(0.017)	-0.119***	(0.017)	0.023	(0.033)	0.023	(0.033)
sy_2003_ny	-0.247***	(0.020)	-0.247***	(0.020)	-0.276***	(0.020)	-0.276***	(0.020)
sy_2003_oh	0.005	(0.036)	0.005	(0.036)	-0.019	(0.039)	-0.019	(0.039)
sy_2003_ok	-0.229***	(0.046)	-0.229***	(0.046)	-0.632***	(0.053)	-0.632***	(0.053)
sy_2003_pa	-0.191***	(0.052)	-0.191***	(0.052)	-0.213***	(0.054)	-0.213***	(0.054)
sy_2003_wa	-0.326***	(0.114)	-0.326***	(0.114)	-0.335**	(0.159)	-0.337**	(0.159)
sy_2004_ia	-0.209***	(0.076)	-0.208***	(0.076)	-0.307***	(0.087)	-0.308***	(0.087)
sy_2004_il	0.087***	(0.029)	0.087***	(0.029)	0.105***	(0.034)	0.105***	(0.034)
sy_2004_mn	0.082*	(0.049)	0.081*	(0.049)	0.036	(0.049)	0.036	(0.049)
sy_2004_ny	-0.179***	(0.019)	-0.179***	(0.019)	-0.2***	(0.020)	-0.2***	(0.020)
sy_2004_oh	0.059	(0.037)	0.059	(0.037)	0.067*	(0.039)	0.067*	(0.039)
sy_2004_ok	-0.143***	(0.041)	-0.143***	(0.041)	-0.511***	(0.044)	-0.511***	(0.044)
sy_2004_pa	-0.146***	(0.052)	-0.146***	(0.052)	-0.145***	(0.053)	-0.145***	(0.053)
sy_2004_wa	-0.144	(0.113)	-0.144	(0.113)	-0.082	(0.152)	-0.081	(0.152)
sy_2005_ia	-0.074**	(0.037)	-0.075**	(0.037)	-0.151***	(0.040)	-0.151***	(0.040)
sy_2005_il	0.125***	(0.027)	0.125***	(0.027)	0.139***	(0.032)	0.138***	(0.032)
sy_2005_mn	0.163***	(0.048)	0.162***	(0.048)	0.12**	(0.048)	0.119**	(0.048)
sy_2005_nj	0.278***	(0.018)	0.278***	(0.018)	0.453***	(0.034)	0.453***	(0.034)
sy_2005_ny	-0.110***	(0.019)	-0.111***	(0.019)	-0.122***	(0.019)	-0.122***	(0.019)
sy_2005_oh	0.112***	(0.036)	0.112***	(0.036)	0.099***	(0.037)	0.098***	(0.037)
sy_2005_ok	-0.018	(0.038)	-0.018	(0.038)	-0.354***	(0.038)	-0.354***	(0.038)

000539

	OneMile OLS		HalfMile OLS		OneMile SEM		HalfMile SEM	
Variables	**coef**	**se**	**coef**	**se**	**coef**	**se**	**coef**	**se**
sy_2005_pa	-0.060	(0.051)	-0.060	(0.051)	-0.058	(0.053)	-0.058	(0.053)
sy_2005_wa	-0.070	(0.111)	-0.070	(0.111)	0.025	(0.153)	0.025	(0.153)
sy_2006_ia	-0.050*	(0.028)	-0.051*	(0.028)	-0.106***	(0.028)	-0.106***	(0.028)
sy_2006_il	0.192***	(0.026)	0.192***	(0.026)	0.215***	(0.030)	0.215***	(0.030)
sy_2006_mn	0.206***	(0.049)	0.206***	(0.049)	0.164***	(0.049)	0.164***	(0.049)
sy_2006_nj	0.340***	(0.017)	0.340***	(0.017)	0.514***	(0.032)	0.514***	(0.032)
sy_2006_ny	-0.066***	(0.019)	-0.066***	(0.019)	-0.073***	(0.019)	-0.073***	(0.019)
sy_2006_oh	0.147***	(0.034)	0.147***	(0.034)	0.144***	(0.035)	0.144***	(0.035)
sy_2006_ok	0.025	(0.039)	0.026	(0.039)	-0.3***	(0.037)	-0.3***	(0.037)
sy_2006_pa	0.008	(0.051)	0.008	(0.051)	-0.001	(0.052)	-0.001	(0.052)
sy_2006_wa	-0.066	(0.131)	-0.066	(0.131)	0.02	(0.160)	0.021	(0.160)
sy_2007_ia	0.013	(0.028)	0.012	(0.028)	-0.019	(0.028)	-0.019	(0.028)
sy_2007_il	0.218***	(0.025)	0.218***	(0.025)	0.251***	(0.028)	0.251***	(0.028)
sy_2007_mn	0.177***	(0.049)	0.177***	(0.049)	0.145***	(0.048)	0.144***	(0.048)
sy_2007_nj	0.297***	(0.017)	0.297***	(0.017)	0.459***	(0.031)	0.459***	(0.031)
sy_2007_ny	-0.020	(0.019)	-0.020	(0.019)	-0.022	(0.019)	-0.022	(0.019)
sy_2007_oh	0.144***	(0.035)	0.143***	(0.035)	0.138***	(0.036)	0.138***	(0.036)
sy_2007_ok	0.149***	(0.037)	0.150***	(0.037)	-0.154***	(0.034)	-0.154***	(0.034)
sy_2007_pa	0.030	(0.051)	0.030	(0.051)	0.067	(0.052)	0.067	(0.052)
sy_2007_wa	0.189*	(0.110)	0.189*	(0.110)	0.209	(0.147)	0.209	(0.147)
sy_2008_ia	0.011	(0.029)	0.010	(0.029)	-0.029	(0.029)	-0.029	(0.029)
sy_2008_il	0.219***	(0.026)	0.218***	(0.026)	0.217***	(0.029)	0.217***	(0.029)
sy_2008_mn	0.149***	(0.050)	0.149***	(0.050)	0.108**	(0.049)	0.108**	(0.049)
sy_2008_nj	0.195***	(0.018)	0.195***	(0.018)	0.35***	(0.032)	0.35***	(0.032)
sy_2008_ny	-0.000	(0.019)	-0.000	(0.019)	-0.008	(0.019)	-0.008	(0.019)
sy_2008_oh	0.084**	(0.036)	0.084**	(0.036)	0.061*	(0.037)	0.061*	(0.037)
sy_2008_ok	0.154***	(0.039)	0.153***	(0.039)	-0.145***	(0.035)	-0.145***	(0.035)
sy_2008_pa	0.044	(0.053)	0.044	(0.053)	0.055	(0.053)	0.056	(0.053)
sy_2008_wa	0.178	(0.117)	0.179	(0.117)	0.326**	(0.148)	0.325**	(0.148)
sy_2009_ia	-0.056	(0.036)	-0.057	(0.036)	-0.102***	(0.036)	-0.102***	(0.036)
sy_2009_il	0.158***	(0.026)	0.158***	(0.026)	0.176***	(0.028)	0.176***	(0.028)
sy_2009_mn	0.104**	(0.051)	0.104**	(0.051)	0.089*	(0.050)	0.089*	(0.050)
sy_2009_nj	0.071***	(0.019)	0.071***	(0.019)	0.238***	(0.032)	0.238***	(0.032)
sy_2009_ny	-0.005	(0.019)	-0.005	(0.019)	-0.013	(0.019)	-0.013	(0.019)
sy_2009_oh	0.036	(0.035)	0.036	(0.035)	0.028	(0.036)	0.028	(0.036)
sy_2009_ok	0.219***	(0.038)	0.219***	(0.038)	-0.102***	(0.034)	-0.101***	(0.034)
sy_2009_pa	0.009	(0.053)	0.010	(0.053)	0.0003	(0.054)	0.0004	(0.054)
sy_2010_ia	0.018	(0.029)	0.017	(0.029)	-0.004	(0.028)	-0.004	(0.028)
sy_2010_il	0.105***	(0.028)	0.105***	(0.028)	0.104***	(0.029)	0.104***	(0.029)
sy_2010_mn	0.181***	(0.050)	0.180***	(0.050)	0.137***	(0.049)	0.137***	(0.049)
sy_2010_nj	0.010	(0.019)	0.010	(0.019)	0.177***	(0.032)	0.178***	(0.032)
sy_2010_ny	0.003	(0.021)	0.003	(0.021)	-0.006	(0.020)	-0.006	(0.020)
sy_2010_oh	-0.017	(0.036)	-0.017	(0.036)	-0.024	(0.036)	-0.024	(0.036)
sy_2010_ok	0.231***	(0.038)	0.231***	(0.038)	-0.074**	(0.033)	-0.074**	(0.033)
sy_2010_pa	0.013	(0.057)	0.013	(0.057)	0.013	(0.057)	0.013	(0.057)
sy_2010_wa	0.207	(0.127)	0.207	(0.127)	0.305*	(0.165)	0.305*	(0.165)
note: *** p<0.01, ** p<0.05, * p<0.1								
N	51,276		51,276		38,407		38,407	
Adjusted R^2	0.66		0.66		0.64		0.64	

000540

LBNL-2829E



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The Impact of Wind Power Projects on Residential Property Values in the United States: A Multi-Site Hedonic Analysis

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Environmental Energy Technologies Division

December 2009

Download from http://eetd.lbl.gov/EA/EMP

The work described in this report was funded by the Office of Energy Efficiency and Renewable Energy (Wind & Hydropower Technologies Program) of the U.S. Department of Energy under Contract No. DE-AC02-05CH1123.

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LBNL-2829E

The Impact of Wind Power Projects on Residential Property Values in the United States: A Multi-Site Hedonic Analysis

Prepared for the

Office of Energy Efficiency and Renewable Energy
Wind & Hydropower Technologies Program
U.S. Department of Energy
Washington, D.C.

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December 2009

The work described in this report was funded by the Office of Energy Efficiency and Renewable Energy (Wind & Hydropower Technologies Program) of the U.S. Department of Energy under Contract No. DE-AC02-05CH1123.

Abstract

With wind energy expanding rapidly in the U.S. and abroad, and with an increasing number of communities considering wind power development nearby, there is an urgent need to empirically investigate common community concerns about wind project development. The concern that property values will be adversely affected by wind energy facilities is commonly put forth by stakeholders. Although this concern is not unreasonable, given property value impacts that have been found near high voltage transmission lines and other electric generation facilities, the impacts of wind energy facilities on residential property values had not previously been investigated thoroughly. The present research collected data on almost 7,500 sales of single-family homes situated within 10 miles of 24 existing wind facilities in nine different U.S. states. The conclusions of the study are drawn from eight different hedonic pricing models, as well as both repeat sales and sales volume models. The various analyses are strongly consistent in that none of the models uncovers conclusive evidence of the existence of any widespread property value impacts that might be present in communities surrounding wind energy facilities. Specifically, neither the view of the wind facilities nor the distance of the home to those facilities is found to have any consistent, measurable, and statistically significant effect on home sales prices. Although the analysis cannot dismiss the possibility that individual homes or small numbers of homes have been or could be negatively impacted, it finds that if these impacts do exist, they are either too small and/or too infrequent to result in any widespread, statistically observable impact.

Table of Contents

List of Tables vi

List of Figures vii

Acknowledgements viii

Executive Summary ix

1. Introduction 1

2. Previous Research 4
   2.1. Hedonic Models and Environmental Disamenities 4
   2.2. Impacts of Wind Projects on Property Values 6

3. Data Overview 10
   3.1. Site Selection 10
   3.2. Data Collection 13
      3.2.1. Tabular Data 13
      3.2.2. GIS Data 15
      3.2.3. Field Data 15
      3.2.4. Field Data Collection 18
   3.3. Data Summary 18

4. Base Hedonic Model 23
   4.1. Dataset 23
   4.2. Model Form 24
   4.3. Analysis of Results 28

5. Alternative Hedonic Models 33
   5.1. View and Distance Stability Models 33
      5.1.1. Dataset and Model Form 34
      5.1.2. Analysis of Results 35
   5.2. Continuous Distance Model 36
      5.2.1. Dataset and Model Form 36
      5.2.2. Analysis of Results 37
   5.3. All Sales Model 37
      5.3.1. Dataset and Model Form 38
      5.3.2. Analysis of Results 39
   5.4. Temporal Aspects Model 42
      5.4.1. Dataset and Model Form 42
      5.4.2. Analysis of Results 44
   5.5. Orientation Model 47
      5.5.1. Dataset and Model Form 47
      5.5.2. Analysis of Results 49
   5.6. Overlap Model 50
      5.6.1. Dataset and Model Form 51
      5.6.2. Analysis of Results 52

6. Repeat Sales Analysis 55
   6.1. Repeat Sales Models and Environmental Disamenities Literature 55

6.2. Dataset 56
6.3. Model Form 57
6.4. Analysis of Results 59

7. Sales Volume Analysis 63
7.1. Dataset 63
7.2. Model Form 65
7.3. Analysis of Results 66

8. Wind Projects and Property Values: Summary of Key Results 69
8.1. Area Stigma 69
8.2. Scenic Vista Stigma 71
8.3. Nuisance Stigma 73

9. Conclusions 75

References 76

Appendix A : Study Area Descriptions 82
A.1 WAOR Study Area: Benton and Walla Walla Counties (Washington), and Umatilla County (Oregon) 84
A.2 TXHC Study Area: Howard County (Texas) 87
A.3 OKCC Study Area: Custer County (Oklahoma) 90
A.4 IABV Study Area: Buena Vista County (Iowa) 93
A.5 ILLC Study Area: Lee County (Illinois) 96
A.6 WIKCDC Study Area: Kewaunee and Door Counties (Wisconsin) 99
A.7 PASC Study Area: Somerset County (Pennsylvania) 102
A.8 PAWC Study Area: Wayne County (Pennsylvania) 105
A.9 NYMCOC Study Area: Madison and Oneida Counties (New York) 108
A.10 NYMC Study Area: Madison County (New York) 111

Appendix B : Methodology for Calculating Distances with GIS 114

Appendix C : Field Data Collection Instrument 117

Appendix D : Vista Ratings with Photos 120

Appendix E : View Ratings with Photos 122

Appendix F : Selecting the Primary ("Base") Hedonic Model 124
F.1 Discussion of Fully Unrestricted Model Form 124
F.2 Analysis of Alterative Model Forms 127
F.3 Selecting a Base Model 131

Appendix G : OLS Assumptions, and Tests for the Base Model 132

Appendix H : Alternative Models: Full Hedonic Regression Results 139

000546

List of Tables

Table 1: Summary of Existing Literature on Impacts of Wind Projects on Property Values..... 9
Table 2: Summary of Study Areas..... 12
Table 3: Definition of VIEW Categories..... 16
Table 4: Definition of VISTA Categories..... 17
Table 5: Summary of Transactions across Study Areas and Development Periods..... 19
Table 6: Summary Statistics: All Sales and Post-Construction Sales..... 21
Table 7: Summary of Variables of Interest: All Sales and Post-Construction Sales..... 22
Table 8: List of Variables of Interest Included in the Base Model..... 25
Table 9: List of Home and Site Characteristics Included in the Base Model..... 27
Table 10: Results from the Base Model..... 32
Table 11: Frequency Crosstab of VIEW and DISTANCE Parameters..... 35
Table 12: Results from Distance and View Stability Models..... 35
Table 13: Results from Continuous Distance Model..... 37
Table 14: Frequency Summary for DISTANCE in All Sales Model..... 39
Table 15: Results from All Sales Model..... 41
Table 16: Results from Equality Test of VIEW Coefficients in the All Sales Model..... 41
Table 17: Results from Equality Test of DISTANCE Coefficients in the All Sales Model..... 42
Table 18: Frequency Crosstab of DISTANCE and PERIOD..... 44
Table 19: Results from Temporal Aspects Model..... 45
Table 20: Results from Equality Test of Temporal Aspects Model Coefficients..... 47
Table 21: Frequency Crosstab of VIEW and ORIENTATION..... 49
Table 22: Percentage Crosstab of VIEW and ORIENTATION..... 49
Table 23: Results from Orientation Model..... 50
Table 24: Definition of OVERLAP Categories..... 51
Table 25: Frequency Crosstab of OVERLAP and VIEW..... 52
Table 26: Results from Overlap Model..... 54
Table 27: List of Variables Included in the Repeat Sales Model..... 57
Table 28: Results from Repeat Sales Model..... 60
Table 29: Sales Volumes by PERIOD and DISTANCE..... 64
Table 30: Equality Test of Sales Volumes between PERIODS..... 67
Table 31: Equality Test of Volumes between DISTANCES using 3-5 Mile Reference..... 67
Table 32: Equality Test of Sales Volumes between DISTANCES using 1-3 Mile Reference..... 67
Table 33: Impact of Wind Projects on Property Values: Summary of Key Results..... 69
Table A - 1: Summary of Study Areas..... 83
Table A - 2: Summarized Results of Restricted and Unrestricted Model Forms..... 128
Table A - 3: Summary of VOI Standard Errors for Restricted and Unrestricted Models..... 130
Table A - 4: Summary of VOI Coefficients for Restricted and Unrestricted Models..... 130
Table A - 5: Summary of Significant VOI Above and Below Zero in Unrestricted Models..... 131
Table A - 6: Full Results for the Distance Stability Model..... 139
Table A - 7: Full Results for the View Stability Model..... 140
Table A - 8: Full Results for the Continuous Distance Model..... 141
Table A - 9: Full Results for the All Sales Model..... 142
Table A - 10: Full Results for the Temporal Aspects Model..... 143
Table A - 11: Full Results for the Orientation Model..... 145
Table A - 12: Full Results for the Overlap Model..... 146

List of Figures

Figure 1: Map of Study Areas and Potential Study Areas 12
Figure 2: Frequency of VISTA Ratings for All and Post-Construction Transactions 20
Figure 3: Frequency of DISTANCE Ratings for Post-Construction Transactions 20
Figure 4: Frequency of VIEW Ratings for Post-Construction Transactions 21
Figure 5: Results from the Base Model for VISTA 29
Figure 6: Results from the Base Model for VIEW 30
Figure 7: Results from the Base Model for DISTANCE 31
Figure 8: Results from the Temporal Aspects Model 46
Figure 9: Repeat Sales Model Results for VIEW 61
Figure 10: Repeat Sales Model Results for DISTANCE 61
Figure 11: Sales Volumes by PERIOD and DISTANCE 65
Figure A - 1: Map of Study Areas 83
Figure A - 2: Map of WAOR Study Area 84
Figure A - 3: Map of TXHC Study Area 87
Figure A - 4: Map of OKCC Study Area 90
Figure A - 5: Map of IABV Study Area 93
Figure A - 6: Map of ILLC Study Area 96
Figure A - 7: Map of WIKCDC Study Area 99
Figure A - 8: Map of PASC Study Area 102
Figure A - 9: Map of PAWC Study Area 105
Figure A - 10: Map of NYMCOC Study Area 108
Figure A - 11: Map of NYMC Study Area 111
Figure A - 12: Field Data Collection Instrument 117
Figure A - 13: Field Data Collection Instrument - Instructions - Page 1 118
Figure A - 14: Field Data Collection Instrument - Instructions - Page 2 119
Figure A - 15: Histogram of Standardized Residuals for Base Model 133
Figure A - 16: Histogram of Mahalanobis Distance Statistics for Base Model 133
Figure A - 17: Histogram of Standardized Residuals for All Sales Model 134
Figure A - 18: Histogram of Mahalanobis Distance Statistics for All Sales Model 134

Acknowledgements

The work described in this report was funded by the Office of Energy Efficiency and Renewable Energy (Wind & Hydropower Technologies Program) of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231. The authors would particularly like to thank Megan McCluer, Patrick Gilman, Jim Ahlgrimm, Michele Desautels, and Steve Lindenberg, all of the U.S. Department of Energy, for their long-term support of this work. For reviewing drafts of this report and/or for providing comments that helped shape the early thinking on this project, the authors thank Mark Bolinger, Galen Barbose, and Larry Dale (Berkeley Lab), Alejandro Moreno (US DOE), Larry Flowers and Eric Lantz (NREL), Peter Dent and Sally Sims (Oxford Brookes University), Sandy Bond (Curtin Business School), Randy Winter, Dave Loomis, and Jennifer Hinman (Illinois State University), Thomas Priestley (CH2M Hill), Barton DeLacy (Cushman & Wakefield), Dave Maturen (Maturen Appraisal), Mike McCann (McCann Appraisal), Tom Hewson (Energy Ventures Analysis), Kimberly Centera (AES), Jeff Peterson (NYSERDA), Charles Kubert (Clean Energy Group), Lisa Linowes (Industrial Wind Action), Chris Taylor (Element Power), Sam Enfield (MAP Royalty, Inc.), and Laurie Jodziewicz (AWEA). Of course, any remaining omissions or inaccuracies are those of the authors.

Executive Summary

Overview

Wind power development in the United States has expanded dramatically in recent years. If that growth is to continue it will require an ever-increasing number of wind power projects to be sited, permitted, and constructed. Most permitting processes in the U.S. require some form of environmental impact assessment as well as public involvement in the siting process. Though public opinion surveys generally show that acceptance towards wind energy is high, a variety of concerns with wind power development are often expressed on the local level during the siting and permitting process. One such concern is the potential impact of wind energy projects on the property values of nearby residences.

Concerns about the possible impact of wind power facilities on residential property values can take many forms, but can be divided into the following non-mutually exclusive categories:

- Area Stigma: A concern that the general area surrounding a wind energy facility will appear more developed, which may adversely affect home values in the local community regardless of whether any individual home has a view of the wind turbines.
- Scenic Vista Stigma: A concern that a home may be devalued because of the view of a wind energy facility, and the potential impact of that view on an otherwise scenic vista.
- Nuisance Stigma: A concern that factors that may occur in close proximity to wind turbines, such as sound and shadow flicker, will have a unique adverse influence on home values.

Although concerns about the possible impact of wind energy facilities on the property values of nearby homes are reasonably well established, the available literature[1] that has sought to quantify the impacts of wind projects on residential property values has a number of shortcomings:

1) Many studies have relied on surveys of homeowners or real estate professionals, rather than trying to quantify real price impacts based on market data;
2) Most studies have relied on simple statistical techniques that have limitations and that can be dramatically influenced by small numbers of sales transactions or survey respondents;
3) Most studies have used small datasets that are concentrated in only one wind project study area, making it difficult to reliably identify impacts that might apply in a variety of areas;
4) Many studies have not reported measurements of the statistical significance of their results, making it difficult to determine if those results are meaningful;
5) Many studies have concentrated on an investigation of the existence of Area Stigma, and have ignored Scenic Vista and/or Nuisance Stigmas;
6) Only a few studies included field visits to homes to determine wind turbine visibility and collect other important information about the home (e.g., the quality of the scenic vista); and
7) Only two studies have been published in peer-reviewed academic journals.

[1] This literature is briefly reviewed in Section 2 of the full report, and includes: Jordal-Jorgensen (1996); Jerabek (2001); Grover (2002); Jerabek (2002); Sterzinger et al. (2003); Beck (2004); Haughton et al. (2004); Khatri (2004); DeLacy (2005); Poletti (2005); Goldman (2006); Hoen (2006); Firestone et al. (2007); Poletti (2007); Sims and Dent (2007); Bond (2008); McCann (2008); Sims et al. (2008); and Kielisch (2009).

This report builds on the previous literature that has investigated the potential impact of wind projects on residential property values by using a hedonic pricing model and by avoiding many of the shortcomings enumerated above. The hedonic pricing model is one of the most prominent and reliable methods for identifying the marginal impacts of different housing and community characteristics on residential property values (see side bar). This approach dates to the seminal work of Rosen (1974) and Freeman (1979), and much of the available literature that has investigated the impacts of potential disamenities on property values has relied on this method.[2]

What Is a Hedonic Pricing Model?

Hedonic pricing models are frequently used by economists and real estate professionals to assess the impacts of house and community characteristics on property values by investigating the sales prices of homes. A house can be thought of as a bundle of characteristics (e.g., number of square feet, number of bathrooms). When a price is agreed upon by a buyer and seller there is an implicit understanding that those characteristics have value. When data from a large number of residential transactions are available, the individual marginal contribution to the sales price of each characteristic for an average home can be estimated with a hedonic regression model. Such a model can statistically estimate, for example, how much an additional bathroom adds to the sale price of an average home. A particularly useful application of the hedonic model is to value non-market goods – goods that do not have transparent and observable market prices. For this reason, the hedonic model is often used to derive value estimates of amenities such as wetlands or lake views, and disamenities such as proximity to and/or views of high-voltage transmission lines, roads, cell phone towers, and landfills. It should be emphasized that the hedonic model is not typically designed to appraise properties (i.e., to establish an estimate of the market value of a home at a specified point in time), as would be done with an automated valuation model. Instead, the typical goal of a hedonic model is to estimate the marginal contribution of individual house or community characteristics to sales prices.

To seed the hedonic model with appropriate market data, this analysis collects information on a large quantity of residential home sales (i.e., transactions) (n = 7,459) from ten communities surrounding 24 existing wind power facilities spread across multiple parts of the U.S. (e.g., nine states). Homes included in this sample are located from 800 ft to over five miles from the nearest wind energy facility, and were sold at any point from before wind facility announcement to over four years after the construction of the nearby wind project. Each of the homes that sold was visited to determine the degree to which the wind facility was likely to have been visible at the time of sale and to collect other essential data.

To assess the potential impacts of all three of the property value stigmas described earlier, a base hedonic model is applied as well as seven alternative hedonic models each designed to investigate the reliability of the results and to explore other aspects of the data (see Table ES - 1 below). In addition, a repeat sales model is analyzed, and an investigation of possible impacts on sales volumes is

[2] Many of these studies are summarized in the following reviews: Kroll and Priestley (1992); McCann (1999); Bateman et al. (2001); Boyle and Kiel (2001); Jackson (2001); Simons and Saginor (2006); and Leonard et al. (2008). For further discussion of the hedonic model and its application to the quantification of environmental stigmas see Jackson (2005) and Simons (2006a).

conducted. Though some limitations to the analysis approach and available data are acknowledged, the resulting product is the most comprehensive and data-rich analysis to date in the U.S. or abroad on the impacts of wind projects on nearby property values.

Analysis Findings

Table ES - 1 describes the ten resulting statistical models that are employed to investigate the effects of wind facilities on residential sales prices, and the specific stigmas that those models investigate. Though all models test some combination of the three possible stigmas, they do so in different ways. For instance, the Base Model asks the question, "All else being equal, do homes near wind facilities sell for prices different than for homes located farther away?", while the All Sales Model asks, "All else being equal, do homes near wind facilities that sell after the construction of the wind facility sell for prices different from similar homes that sold before the announcement and construction of the facility?" Each model is therefore designed to not only test for the reliability of the overall results, but also to explore the myriad of potential effects from a variety of perspectives. Table ES-2 summarizes the results from these models.

Table ES - 1: Description of Statistical Models

Statistical Model	Description
Base Hedonic Model	Using only "post-construction" transactions (those that occurred after the wind facility was built), this model investigates all three stigmas in a straightforward manner
Alternative Hedonic Models	
View Stability	Using only post-construction transactions, this model investigates whether the Scenic Vista Stigma results from the Base Model are independent of the Nuisance and Area Stigma results
Distance Stability	Using only post-construction transactions, this model investigates whether the Nuisance and Area Stigma results from the Base Model are independent of the Scenic Vista Stigma results
Continuous Distance	Using only post-construction transactions, this model investigates Area and Nuisance Stigmas by applying a continuous distance parameter as opposed to the categorical variables for distance used in the previous models
All Sales	Using all transactions, this model investigates whether the results for the three stigmas change if transactions that occurred before the announcement and construction of the wind facility are included in the sample
Temporal Aspects	Using all transactions, this model further investigates Area and Nuisance Stigmas and how they change for homes that sold more than two years pre-announcement through the period more than four years post-construction
Orientation	Using only post-construction transactions, this model investigates the degree to which a home's orientation to the view of wind turbines affects sales prices
Overlap	Using only post-construction transactions, this model investigates the degree to which the overlap between the view of a wind facility and a home's primary scenic vista affects sales prices
Repeat Sales Model	Using paired transactions of homes that sold once pre-announcement and again post-construction, this model investigates the three stigmas, using as a reference transactions of homes located outside of five miles of the nearest wind turbine and that have no view of the turbines
Sales Volume Model	Using both pre-announcement and post-construction transactions, this model investigates whether the rate of home sales (not the price of those sales) is affected by the presence of nearby wind facilities

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Table ES-2: Impact of Wind Projects on Property Values: Summary of Key Results

Statistical Model	Is there statistical evidence of: Area Stigma?	Scenic Vista Stigma?	Nuisance Stigma?	Section Reference
Base Model	No	No	No	*Section 4*
View Stability	Not tested	No	Not tested	*Section 5.1*
Distance Stability	No	Not tested	No	*Section 5.1*
Continuous Distance	No	No	No	*Section 5.2*
All Sales	No	No	Limited	*Section 5.3*
Temporal Aspects	No	No	No	*Section 5.4*
Orientation	No	No	No	*Section 5.5*
Overlap	No	Limited	No	*Section 5.6*
Repeat Sales	No	Limited	No	*Section 6*
Sales Volume	No	Not tested	No	*Section 7*

"No"……. *No statistical evidence of a negative impact*
"Yes"……. *Strong statistical evidence of a negative impact*
"Limited"……. *Limited and inconsistent statistical evidence of a negative impact*
"Not tested"……. *This model did not test for this stigma*

Base Model Results

The Base Model serves as the primary model and allows all three stigmas to be explored. In sum, this model finds no persuasive evidence of any of the three potential stigmas: neither the view of the wind facilities nor the distance of the home to those facilities is found to have any consistent, measurable, and statistically significant effect on home sales prices.

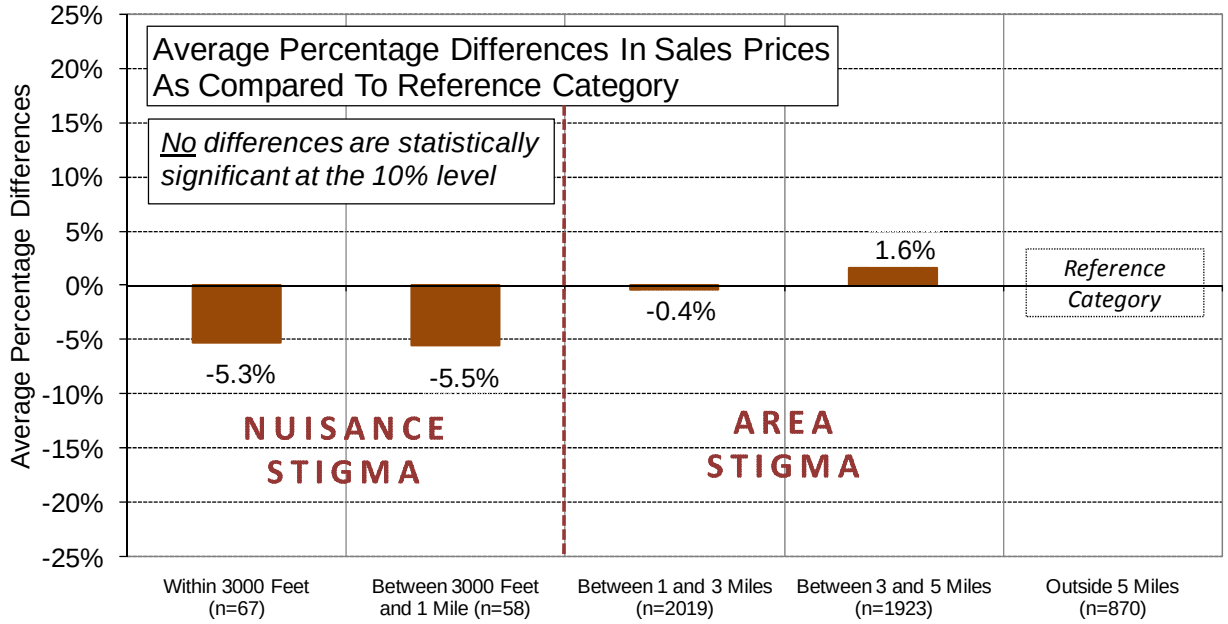
- Area Stigma: To investigate Area Stigma, the model tests whether the sales prices of homes situated anywhere outside of one mile and inside of five miles of the nearest wind facility are measurably different from the sales price of those homes located outside of five miles. No statistically significant differences in sales prices between these homes are found (see Figure ES-1).
- Scenic Vista Stigma: For Scenic Vista Stigma, the model is first used to investigate whether the sales prices of homes with varying scenic vistas - absent the presence of the wind facility - are measurably different. The model results show dramatic and statistically significant differences in this instance (see Figure ES-2); not surprisingly, home buyers and sellers consider the scenic vista of a home when establishing the appropriate sales price. Nonetheless, when the model tests for whether homes with minor, moderate, substantial, or extreme views of wind turbines have measurably different sales prices, no statistically significant differences are apparent (see Figure ES-3).
- Nuisance Stigma: Finally, for Nuisance Stigma, the model is used to test whether the sales prices of homes situated inside of one mile of the nearest wind energy facility are measurably different from those homes located outside of five miles. Although sample size is somewhat limited in this case,[3] the model again finds no persuasive statistical evidence that wind

[3] 125 homes were located inside of one mile of the nearest wind facility and sold post-construction.

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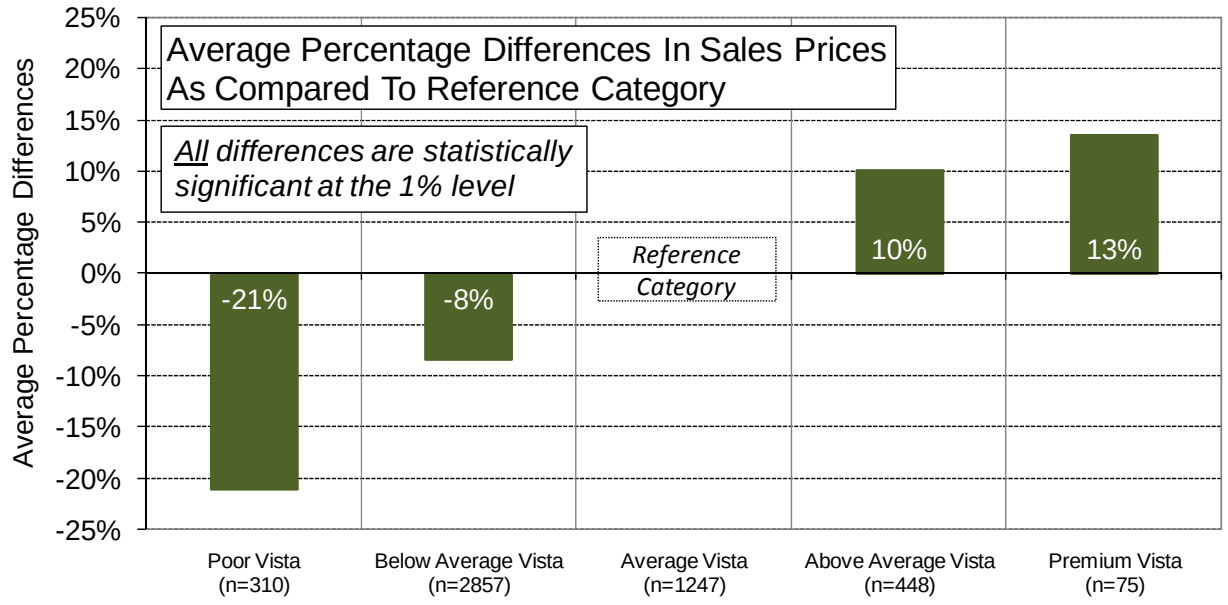
facilities measurably and broadly impact residential sales prices (see Figure ES-1 and later results).

Figure ES-1: Base Model Results: Area and Nuisance Stigma



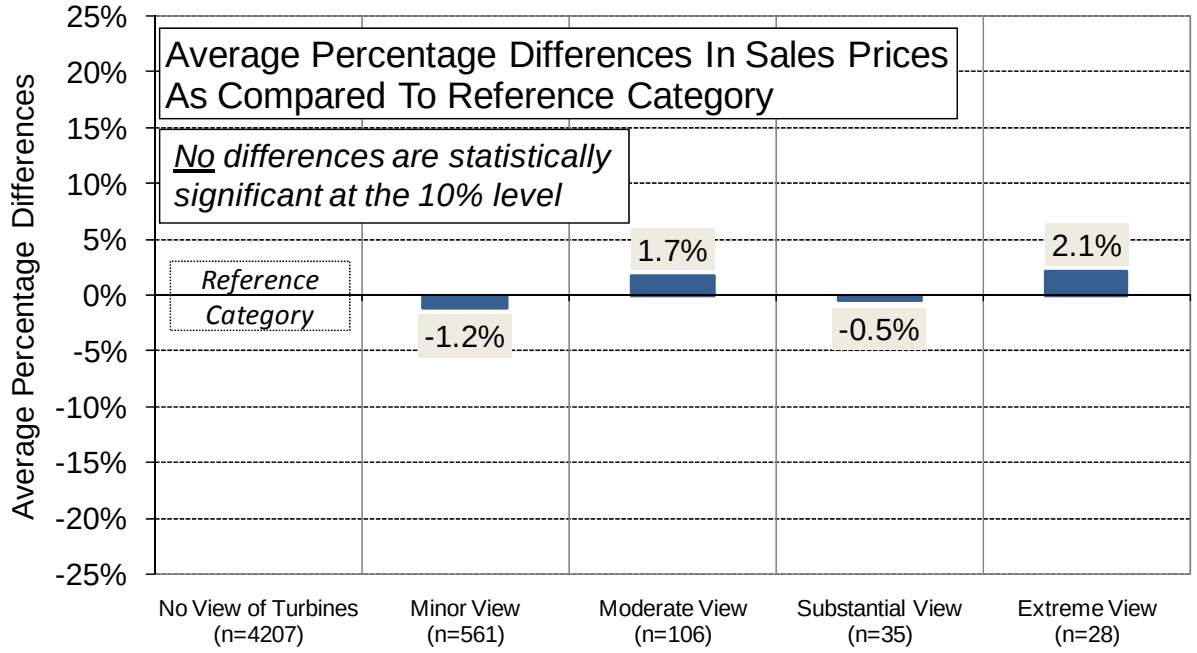
The reference category consists of transactions for homes situated more than five miles from the nearest turbine, and that occured after construction began on the wind facility

Figure ES-2: Base Model Results: Scenic Vista



The reference category consists of transactions for homes with an Average Vista, and that occured after construction began on the wind facility

Figure ES-3: Base Model Results: Scenic Vista Stigma



The reference category consists of transactions for homes without a view of the turbines, and that occured after construction began on the wind facility

The seven alternative hedonic models and the additional analysis contained in the Repeat Sales and Sales Volume Models (see Table ES-2) provide a fuller picture of the three stigmas and the robustness of the Base Model results.

Area Stigma: Other Model Results

Concentrating first on Area Stigma, the results from all of the models are similar: there is no statistical evidence of a widespread Area Stigma among the homes in this sample. Homes in the study areas analyzed here do not appear to be measurably stigmatized by the arrival of a wind facility, regardless of when those homes sold in the wind project development process and regardless of whether the homes are located one mile or five miles away from the nearest facility.

In the All Sales Model, for example, after adjusting for inflation,[4] homes that sold after wind facility construction and that had no view of the turbines are found to have transacted for higher prices - not lower - than those homes that sold prior to wind facility construction. Moreover, in the Temporal Aspects Model, homes that sold more than two years prior to the announcement of the wind facility and that were located more than five miles from where the turbines were eventually located are found to have transacted for lower prices - not higher - than homes situated closer to the turbines and that sold at any time after the announcement and construction of the wind facility (see Figure ES - 4). Further, in the Repeat Sales Model, homes located near the wind facilities that transacted more than once were found to have appreciated between those sales by an amount that was no different from that experienced by homes located in an area

[4] All sales prices in all models are adjusted for inflation, but because this model (and the Temporal Aspects Model) deals with time explicitly, it is mentioned specifically here.

many miles away from the wind facilities. Finally, as shown in Table ES-2, none of the other models identified evidence of a broadly negative and statistically significant Area Stigma.

Scenic Vista Stigma: Other Model Results

With respect to Scenic Vista Stigma, the seven alternative hedonic models and the additional analysis contained in the Repeat Sales Model find little consistent evidence of a broadly negative and statistically significant impact. Although there are 730 residential transactions in the sample that involve homes that had views of a wind facility at the time of sale, 160 of which had relatively significant views (i.e., a rating higher than Minor), none of the various models finds strong statistical evidence that the view of a nearby wind facility impacts sales prices in a significant and consistent manner.

When concentrating only on the view of the wind facilities from a home (and not testing for Area and Nuisance Stigmas simultaneously), for example, the results from the View Stability Model are very similar to those derived from the Base Model, with no evidence of a Scenic Vista Stigma. Similarly, the All Sales Model finds that homes that sold after wind facility construction and that had a view of the facility transacted for prices that are statistically indistinguishable from those homes that sold at any time prior to wind facility construction. The Orientation Model, meanwhile, fails to detect any difference between the sales prices of homes that had either a front, back, or side orientation to the view of the wind facility. As shown in Table ES-2, the Continuous Distance and Temporal Aspects models also do not uncover any evidence of a broadly negative and statistically significant Scenic Vista Stigma.

In the Repeat Sales Model, some limited evidence is found that a Scenic Vista Stigma may exist, but those effects are weak, fairly small, somewhat counter-intuitive, and are at odds with the results of other models. This finding is likely driven by the small number of sales pairs that are located within one mile of the wind turbines and that experience a dramatic view of those turbines. Finally, in the Overlap Model, where the degree to which a view of the wind facility overlaps the primary scenic vista from the home is accounted for, no statistically significant differences in sales prices are detected between homes with somewhat or strongly overlapping views when compared to those homes with wind turbine views that did not overlap the primary scenic vista. Though this model produces some weak evidence of a Scenic Vista Stigma among homes with Minor views of wind facilities, the same model finds that the sales prices of those homes with views that barely overlap the primary scenic vista are positively impacted by the presence of the wind facility. When these two results are combined, the overall impact is negligible, again demonstrating no persuasive evidence of a Scenic Vista Stigma.

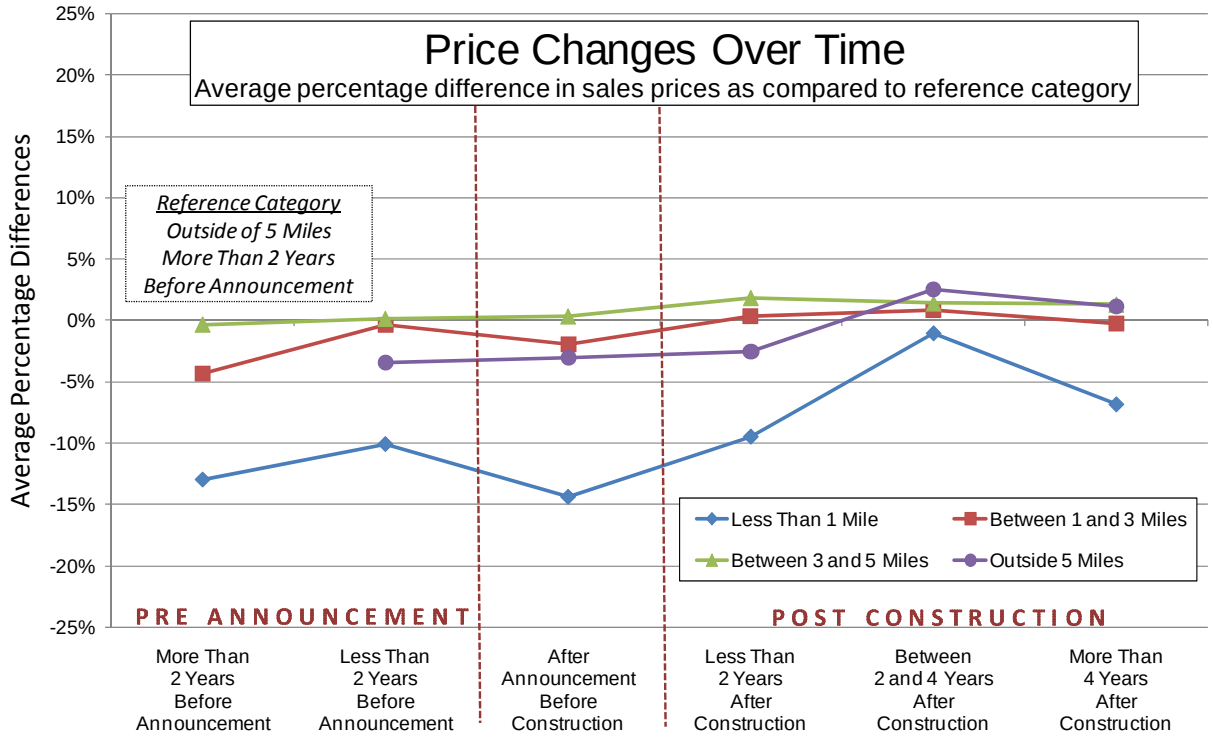
Nuisance Stigma: Other Model Results

Results for Nuisance Stigma from the seven alternative hedonic models and the additional analysis contained in the Repeat Sales and Sales Volume Models support the Base Model results. Taken together, these models present a consistent set of results: homes in this sample that are within a mile of the nearest wind facility, where various nuisance effects have been posited, have not been broadly and measurably affected by the presence of those wind facilities. These results imply that Nuisance Stigma effects are either not present in this sample, or are too small and/or infrequent to be statistically distinguished.

In the Distance Stability Model, for example, when concentrating only on the distance from homes to the nearest wind turbine (and not testing for Scenic Vista Stigma simultaneously), the results are very similar to those derived from the Base Model, with no statistical evidence of a Nuisance Stigma. These results are corroborated by the Continuous Distance, Orientation, Overlap, and Repeat Sales Models, none of which find a statistically significant relationship between distance and either sales prices or appreciation rates. Relatedly, the Sales Volume analysis finds no evidence that homes located within one mile of the nearest wind turbine are sold any more or less frequently than homes located farther away from the wind facilities.

In the All Sales Model, a weakly significant difference is found between the sales prices of homes located between 3000 feet and one mile of the nearest wind facility and the homes that sold before the announcement of the wind facility. This effect, however, is largely explained by the results of the Temporal Aspects Model, shown in Figure ES - 4. The Temporal Aspects Model finds that homes located within one mile of where the wind turbines would eventually be located sold for depressed prices well before the wind facility was even announced or constructed. In all time periods following the commencement of wind facility construction, however, inflation-adjusted sales prices increased - not decreased - relative to pre-announcement levels, demonstrating no statistical evidence of a Nuisance Stigma. The results from the All Sales Model (and, for that matter, the negative, albeit statistically insignificant coefficients inside of one mile in the Base Model, see Figure ES-1) are therefore an indication of sales price levels that preceded wind facility announcement construction, and that are not sustained after construction.

Figure ES - 4: Temporal Aspects Model Results: Area and Nuisance Stigma



The reference category consists of transactions of homes situated more than five miles from where the nearest turbine would eventually be located and that occurred more than two years before announcement of the facility

Conclusions and Further Research Needs

Though each of the analysis techniques used in this report has strengths and weaknesses, the results as a whole are strongly consistent in that none of the models uncovers conclusive evidence of the presence of any of the three property value stigmas that might be present in communities surrounding wind power facilities. Therefore, based on the data sample and analysis presented here, no evidence is found that home prices surrounding wind facilities are consistently, measurably, and significantly affected by either the view of wind facilities or the distance of the home to those facilities. Although the analysis cannot dismiss the possibility that individual homes or small numbers of homes have been or could be negatively impacted, it finds that if these impacts do exist, they are either too small and/or too infrequent to result in any widespread, statistically observable impact. Moreover, to the degree that homes and wind facilities in this sample are similar to homes and facilities in other areas of the United States, the results presented here are expected to be transferable to other areas.

This work builds on the existing literature in a number of respects, but there remain a number of areas for further research. The primary goal of subsequent research should be to concentrate on those homes located closest to wind facilities, where the data sample herein was the most limited. Additional research of the nature reported in this paper could be pursued, but with a greater number of transactions, especially for homes particularly close to wind facilities. A more detailed analysis of sales volume impacts may also be fruitful, as would an assessment of the potential impact of wind facilities on the length of time homes are on the market in advance of an eventual sale. Finally, it would be useful to conduct a survey of those homeowners living close to existing wind facilities, and especially those residents who have bought and sold homes in proximity to wind facilities after facility construction, to assess their opinions on the impacts of wind project development on their home purchase and sales decisions.

1. Introduction

Wind power development has expanded dramatically in recent years (GWEC, 2009). Although the percent of electricity supplied to the U.S. and globally from wind power projects installed through 2008 remains relatively low (1.9% and 1.5%, respectively) (Wiser and Bolinger, 2009), there are expectations that those percentages will rise and that wind energy could contribute a significant percentage of future electricity supply (GWEC, 2008; Wiser and Hand, 2010). Most recently, President Obama, in his 2009 State of the Union address, called for a doubling of renewable energy in three years (by 2012), and in 2008 the U.S. Department of Energy produced a report that analyzed the feasibility of meeting 20% of U.S. electricity demand with wind energy by 2030 (US DOE, 2008).

To meet these goals, a significant amount of wind project development activity would be required. The average size of wind power projects built in the U.S. in 2007 and 2008 was approximately 100 MW (Wiser and Bolinger, 2009) and the total amount of capacity required to reach 20% wind electricity is roughly 300,000 MW (US DOE, 2008). Therefore, to achieve 20% wind electricity by 2030, a total of 3,000 wind facilities may need to be sited and permitted. Most permitting processes in the U.S. require some form of environmental impact assessment, and some form of public involvement in the siting process. Though surveys show that public acceptance is high in general for wind energy (e.g., Wolsink, 2000; Firestone and Kempton, 2006), a variety of concerns are often expressed on the local level that can impact the length and outcome of the siting and permitting process. These concerns range from the potential impacts of wind projects on wildlife habitat and mortality, radar and communications systems, ground transportation and historic and cultural resources, to aesthetic and property value concerns as well as potential nuisance and health impacts. As a result, a variety of siting and permitting guidelines (AWEA, 2008) and impact assessments (NAS, 2007) have been completed.

Surveys of local communities considering wind facilities have consistently ranked adverse impacts on aesthetics and property values in the top tier of concerns (e.g., BBC R&C, 2005; Firestone and Kempton, 2006). Developers of wind energy echo this assessment: they ranked aesthetics and property values as two of the top concerns (first and third respectively) for individuals or communities opposed to wind power development (Paul, 2006). Local residents have even brought suit against a developer over property values (Dale Rankin v. FPL, 2008), and some developers have responded to these concerns by offering "neighbor agreements" that compensate nearby homeowners for the potential impacts of wind projects.

The two concerns of aesthetics and property values are intrinsically linked. It is well established that a home's value will be increased if a high-quality scenic vista is enjoyed from the property (e.g., Seiler et al., 2001). Alternatively, it is reasonable to assume that if a home's scenic vista overlaps with a view of a disamenity, the home might be devalued, as has been found for high-voltage transmission lines (HVTL) (Kroll and Priestley, 1992; Des-Rosiers, 2002). Whether a view of wind turbines similarly impacts home values is a key topic of debate in local siting decisions. Aesthetics alone, however, is not the only pathway through which wind projects might impact residential property values. Distance to the nearest wind turbine, for example, might also have an impact if various nuisance effects are prominent, such as turbine noise,

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shadow flicker,[5] health or safety concerns, or other impacts, real or perceived. In this way, property values near wind turbines might be impacted in the same way as homes near roads might be devalued (Bateman et al., 2001). Additionally, there is evidence that proximity to a disamenity, even if that disamenity is not visible and is not so close as to have obvious nuisance effects, may still decrease a home's sales price, as has been found to be the case for landfills (Thayer et al., 1992).

Taken together, these general concerns about the possible impacts of wind projects on residential property values can be loosely categorized into three potential stigmas:

- Area Stigma: A concern that the general area surrounding a wind energy facility will appear more developed, which may adversely affect home values in the local community regardless of whether any individual home has a view of the wind turbines.
- Scenic Vista Stigma: A concern that a home may be devalued because of the view of a wind energy facility, and the potential impact of that view on an otherwise scenic vista.
- Nuisance Stigma: A concern that factors that may occur in close proximity to wind turbines, such as sound and shadow flicker, will have a unique adverse influence on home values.

These three potential stigmas are not mutually exclusive and could, in theory, be present in part or in combination for any single home. Consequently, all three potential impacts must be considered when analyzing the effects of wind facilities on residential sales prices.

Although concerns about the potential impact of wind projects on residential property values are often mentioned in siting cases, the state of the existing literature on this topic leaves much to be desired. To some extent, the growing body of research investigating this topic has come to opposing conclusions. The most recent and comprehensive of these studies have often concluded that no widespread impacts of wind projects on residential property values are apparent (Hoen, 2006; Sims and Dent, 2007; Sims et al., 2008). At the same time, pre-construction surveys of both homeowners and real estate experts have sometimes found an expectation of negative impacts (e.g. Haughton et al., 2004), and post-construction appraisals have sometimes come to similar conclusions (McCann, 2008; Kielisch, 2009). Given the state of the literature, it is not uncommon for local siting and permitting processes to involve contradicting testimony from experts, as occurred in 2004 when the Public Service Commission of Wisconsin heard opposing conclusions from two studies conducted by experienced home valuation experts (Poletti, 2005; Zarem, 2005).

This report contains the most comprehensive and data-rich analysis to date on the potential impacts of wind projects on nearby residential sales prices. Data from 7,459 residential transactions were collected from the surrounding communities of 24 individual wind projects in nine states and 14 counties in the United States.[6] Because of the large sample size, the diversity of wind projects included in the analysis, and the depth of information collected, a number of different analyses were possible. Specifically, this report relies heavily on a hedonic regression

[5] Shadow flicker occurs when the sun shines through the wind turbine blades when at a low angle to the horizon and shadows are cast on a window or interior wall of a residence (NAS, 2007).

[6] The majority of the analysis only includes homes that sold after wind facility construction began, totaling 4,937 transactions.

model[7] and uses various forms of that model to investigate potential effects and to confirm the robustness of the resulting findings. To further investigate the robustness of the results, a repeat sales model[8] and a sales volume model[9] are also utilized. In sum, this work builds and improves on the previous literature, and provides an in-depth assessment of the question of whether residential property values in the United States have been affected, in a statistically measurable way, by views of and proximity to wind power facilities.

The remainder of this report is structured as follows. The next section discusses the hedonic model in general, its application to environmental disamenities research, and some potentially analogous results drawn from these studies. This is followed by a summary of the existing literature that has investigated the effects of wind energy on residential property values. The report then turns to the data used in the analysis, a discussion of the primary (or "base") hedonic model, and an analysis of the results from that statistical model. Following that, a set of alternative hedonic models are estimated, as well as a repeat sales model and sales volume model, to test for the robustness of the "base" model results and to explore other aspects of the data. Taking into account the full set of results presented earlier, the report then discusses the three stigmas that may lead to wind projects impacting residential property values, and summarizes how the analysis informs the existence and magnitude of these potential effects. The report ends with a brief conclusion, and a discussion of future research possibilities. A number of appendices follow the conclusion, and contain detailed information on each wind project study area, the data collection instrument and qualitative rating systems used in the field research, the investigation of the best "base" model, the hedonic model assumptions and related tests, and full results from all of the additional statistical models estimated in the report.

[7] The hedonic regression model, which was briefly described in a sidebar in the Executive Summary, is described in detail in Section 2.1.

[8] A repeat sales model uses, as its dataset, only those homes that have sold more than once. By comparing annual appreciation rates of homes that sold once before facility announcement, and again after construction, it can be tested, in an alternative fashion, if home values are affected by the distance to or view of nearby wind turbines.

[9] Sales volume can be defined as the percentage of homes that fit a certain criteria (e.g. single family, on less than 25 acres, zoned residential, assessed for more than $10,000) that actually did sell. By comparing sales volumes at various distances to wind facilities, before and after the facility was built, a further robustness test is possible.

2. Previous Research

Hedonic pricing models are frequently used to assess the marginal impacts of house and community characteristics on sales prices and by extension on property values in general. Because the hedonic model is the primary statistical method used in this report, this section begins by describing the model in more detail and providing some relevant examples of its use. The section then reviews the existing literature on the effects of wind energy facilities on surrounding property values, highlights the shortcomings of that literature, and outlines how the present research addresses those shortcomings.

2.1. Hedonic Models and Environmental Disamenities

A house can be thought of as a bundle of characteristics (e.g., number of square feet, number of bathrooms, number of fireplaces, and amount of acreage). When a price is agreed upon between a buyer and seller there is an implicit understanding that those characteristics have value. When data from a number of sales transactions are available, the individual marginal contribution to the sales price of each characteristic can be estimated with a hedonic regression model (Rosen, 1974; Freeman, 1979). This relationship takes the basic form:

Sales price = *f* (house structural characteristics, other factors)

where "house structural characteristics" might include, but are not limited to, the number of square feet of living area, bathrooms, and fireplaces, the presence of central AC and the condition of the home, and "other factors" might include, but are not limited to, home site characteristics (e.g., number of acres), neighborhood characteristics (e.g., school district), market conditions at the time of sale (e.g., prevailing mortgage interest rates), and surrounding environmental conditions (e.g., proximity to a disamenity or amenity).

The relationship between the sales price of homes and the house characteristics and other factors can take various forms. The most common functional form is the semi-log construction where the dependent variable is the natural log of the inflation adjusted sales price, and the independent variables are unadjusted (not transformed) home characteristics and other factors. The usefulness of this form of hedonic model is well established (Malpezzi, 2003; Sirmans et al., 2005b; Simons and Saginor, 2006) assuming that certain threshold assumptions are met.[10] The model is used commonly by academics, real estate assessors, appraisers, and realtors when large datasets are available on past residential sales transactions, and when estimates of the marginal impact of certain house characteristics and other factors on sales prices are desired.[11]

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[10] These assumptions, which are discussed in greater detail in Section 4.2 and Appendix G, include absence of outliers and/or influencers, presence of homoskedastic variances, absence of spatial and temporal autocorrelation, and absence of collinearity between the variables of interest and other independent variables.

[11] It should be emphasized that a hedonic model is not designed to appraise properties (i.e., to establish an estimate of the market value of a home at a specified point in time), as would be done with an automated valuation model (AVM). Rather, hedonic models are designed to estimate the marginal contribution of individual house or community characteristics to sales prices, which requires hedonic models to rely upon large data sets with a sizable number of explanatory variables. Appraisal models, on the other hand, are generally based on small, localized data sets (i.e., "comps") and a limited number of explanatory variables that pertain to nearby properties. Due to their higher level of accuracy through the use of significantly more information (e.g., diverse spatial, temporal, and

000562

A particularly useful application of the hedonic regression model is to value non-market goods – goods that do not have transparent and observable market prices. For this reason, the hedonic model is often used to derive value estimates of amenities such as wetlands (e.g., Mahan et al., 2000) or lake views (e.g., Seiler et al., 2001), and disamenities, such as proximity to and/or views of high-voltage transmission lines (HVTLs) (e.g. Des-Rosiers, 2002), fossil fuel power plants (Davis, 2008), roads (e.g. Bateman et al., 2001), cell phone towers (e.g. Bond and Wang, 2007), and landfills (e.g., Thayer et al., 1992; Ready and Abdalla, 2005).

There are a number of useful reviews that describe the application of hedonic models in these circumstances (Kroll and Priestley, 1992; Farber, 1998; McCann, 1999; Bateman et al., 2001; Boyle and Kiel, 2001; Jackson, 2001; Ready and Abdalla, 2005; Simons and Saginor, 2006; Simons, 2006b; Leonard et al., 2008).[12] The large number of studies covered in these reviews demonstrate that hedonic models are regularly used to investigate the interplay between home values and distance to potential disamenities, teasing out if and how sales prices are adversely affected depending on the distance of a typical home from a disamenity. For example, Carroll et al. (1996) use a hedonic model to estimate a devaluation of 16% for homes "close to" a chemical plant, with a 6.5% increase in sales price per mile away out to 2.5 miles, at which point effects fade entirely. Dale et al. (1999) find a maximum effect of -4% near a lead smelter, with sales prices increasing 2% for each mile away out to two miles, where effects again fade. Ready and Abdalla (2005) find maximum effects near landfills of -12.4%, which fade entirely outside 2,400 feet, and maximum effects near confined animal feeding operations of -6.4%, which fade entirely outside of 1,600 feet. Meanwhile, studies of other energy infrastructure, such as HVTLs, find maximum effects of -5.7% for homes adjacent to a HVTL tower, and an increase in prices of 0.018% per foot away from the tower out to 300 feet (Hamilton and Schwann, 1995), and maximum effects of -14% for homes within 50 feet of a HVTL, but no effect for similar homes at 150 feet (Des-Rosiers, 2002). Further, for fossil fuel power plants, Davis (2008) finds average adverse effects of between 3 and 5% inside of two miles but that those effects fade entirely outside of that distance range.

In addition to investigating how sales prices change with distance to a disamenity, hedonic models have been used to investigate how prices have changed over time. For instance, sales prices have sometimes been found to rebound after the removal of a disamenity, such as a lead smelter (Dale et al., 1999), or to fade over time, as with HVTLs (Kroll and Priestley, 1992) or spent fuel storage facilities (Clark and Allison, 1999). Finally, hedonic models have been used to estimate how views of a disamenity affect sales prices. Des-Rosiers (2002), for example, finds that homes adjacent to a power line and facing a HVTL tower sell for as much as 20% less than similar homes that are not facing a HVTL tower.

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characteristic information) and rigorous methodology, hedonic models can also be used as appraisal models. Automated valuation models cannot, however, be reliably used to measure marginal effects because they do not employ sufficient information to do so, and, more importantly, AVMs do not hold controlling characteristics constant, which could bias any resulting estimates of marginal effects.

[12] For further discussion of the hedonic model and its application to the quantification of environmental stigmas in comparison to other methods see Jackson (2005).

It is unclear how well the existing hedonic literature on other disamenities applies to wind turbines, but there are likely some similarities. For instance, in general, the existing literature seems to suggest that concerns about lasting health effects provide the largest diminution in sales prices, followed by concerns for one's enjoyment of the property, such as auditory and visual nuisances, and that all effects tend to fade with distance to the disamenity - as the perturbation becomes less annoying. This might indicate that property value effects from wind turbines are likely to be the most pronounced quite close to them, but fade quickly as their auditory and visual impacts fade. The existing hedonic literature also, in general, finds that effects fade with time as self-selecting buyers without prejudice towards the disamenity move into the area, or as the real or perceived risks of the disamenity are lessoned (Jackson, 2001). This implies that any stigmas related to wind turbines might also fade over time as local communities come to accept their presence.

2.2. Impacts of Wind Projects on Property Values

Turning to the literature that has investigated the potential property value effects from wind facilities directly, it deserves note that few studies have been academically peer-reviewed and published; in some cases, the work has been performed for a party on one side or the other of the permitting process (e.g., the wind developer or an opposition group). Nonetheless, at a minimum, a brief review of this existing literature will set the stage for and motivate the later discussion of the methods and results of the present work. The literature described below is summarized in Table 1. To frame this discussion, where possible, the three potential stigmas discussed earlier are used:

- Area Stigma: A concern that the general area surrounding a wind energy facility will appear more developed, which may adversely affect home values in the local community regardless of whether any individual home has a view of the wind turbines.
- Scenic Vista Stigma: A concern that a home may be devalued because of the view of a wind energy facility, and the potential impact of that view on an otherwise scenic vista.
- Nuisance Stigma: A concern that factors that may occur in close proximity to wind turbines, such as sound and shadow flicker, will have a unique adverse influence on home values.

In one of the most recent studies, Sims et al. (2008) used a hedonic model to investigate Scenic Vista Stigma using 199 residential transactions within ¼ of a mile of the 16-turbine Bears Down wind facility in Cornwall, UK. They found both large positive and smaller negative significant relationships between views of the turbines and sales prices depending on whether the view is seen from the front or rear of the home, respectively, but found no relationship between the number of wind turbines visible and sales prices. Previously, Sims and Dent (2007) used a hedonic model to investigate Nuisance and Scenic Vista Stigma with 919 transactions for homes within five miles of two wind facilities in the UK, finding only limited evidence of a relationship between proximity to and views of turbines and sales prices, which local real estate experts attributed to other causes. Hoen (2006) investigated Scenic Vista Stigma using a hedonic model to analyze 280 residential transactions occurring near a wind facility in Madison County, NY, and found no evidence that views of turbines significantly affects prices. Jordal-Jorgensen (1996) investigated Nuisance Stigma in Denmark, and found an adverse effect for homes located "close" to the turbines, but no statistical significance was reported.[13]

[13] A copy of this report could not be obtained and therefore its findings are reported based on other citations.

000564

Using different statistical methods, Poletti (2005; 2007) used a *t*-Test to investigate Nuisance and Area Stigma by comparing the mean sales prices of 187 and 256 homes in Illinois and Wisconsin, respectively, located near wind facilities (target group) to those further away (control group).[14, 15] He split these target and control groups into respective smaller and more-homogenous sub-groups, such as large and small tracts, with and without homes, finding no statistical evidence that homes near the wind facilities sold for different prices than those farther away. Sterzinger et al. (2003) analyzed roughly 24,000 residential transactions, which were divided between those within five miles of a wind facility and those outside of five miles in an effort to assess Area Stigma. They compared residential appreciation rates over time, and found no apparent difference between those homes within and outside of five miles from a wind facility, but the statistical significance of this comparison was not reported.

Other authors have used smaller samples of residential transactions and a variety of simple statistical techniques, without reporting statistical significance, and have found a lack of evidence of effects from Nuisance Stigma (Jerabek, 2001; Jerabek, 2002; Beck, 2004) and Area Stigma (DeLacy, 2005; Goldman, 2006). These results, however, are somewhat contrary to what one appraiser has found. In his investigation of Nuisance Stigma around a wind facility in Lee County, IL, McCann (2008) found that two homes nearby a wind facility had lengthy selling periods that, he believes, also adversely affected transaction prices. Additionally, Kielisch (2009) investigated Nuisance Stigma by comparing twelve transactions of undeveloped land near two wind facilities in Wisconsin (Blue Sky Green Field and Forward) to undeveloped land transactions farther away. He found that land tracts near the wind facilities sold for dramatically lower prices ($/acre) than the comparable group, but the statistical significance of the comparison was not reported.

In addition to these revealed preference studies, a number of stated preference surveys (e.g., contingent valuation) and general opinion surveys have investigated the existence of potential effects.[16] A survey of local residents, conducted after the wind facilities were erected, found no evidence of Area Stigma (Goldman, 2006), while another found limited evidence of these stigmas (Bond, 2008).[17] Similarly, some surveys of real estate experts conducted after facility

[14] A *t*-Test is used to compare two sample means by discerning if one is significantly different from the other.

[15] The 2007 study used the data contained in the 2005 study in combination with new data consisting of transactions that occurred in the interim period.

[16] Contingent valuation is a survey based technique to value non-market goods (e.g., an environmental disamenity) that asks respondents what their "willingness to pay" (or "willingness to accept") is to have, for instance, a disamenity removed from (or to have it remain in) their neighborhood. This technique is distinct from a general opinion survey, which might ask whether respondents believe property values have been impacted by an environmental disamenity and, if so, "by how much." Although there are important distinctions between the two techniques, with the contingent valuation method often preferred by economic practitioners, for simplicity no distinction is made here between these two approaches. Finally, another subset of the survey literature focuses on public acceptance (i.e., opinion). Though these public acceptance surveys sometimes cover possible impacts on property values, those impacts are not quantified in economic terms. As a result, public acceptance survey results are not reported here.

[17] Bond (2008) asked respondents to declare if the wind facility, which is located roughly 7 miles away, would effect what they would be willing to pay for their house and 75% said either they would pay the same or more for their house, while the remainder would pay less. When those latter respondents were asked to estimate the percentage difference in value, their estimates averaged roughly 5%.

construction have found no evidence of Area or Nuisance Stigmas (Grover, 2002; Goldman, 2006). These results, however, are contrary to the expectations for Area, Scenic Vista, and Nuisance Stigma effects predicted by local residents (Haughton et al., 2004; Firestone et al., 2007) and real estate experts (Haughton et al., 2004; Khatri, 2004; Kielisch, 2009) prior to construction found elsewhere.[18] The difference between predicted and actual effects might be attributable, at least in part, to the fear of the unknown. For instance, Wolsink (1989) found that public attitudes toward wind power, on average, are at their lowest for local residents during the wind project planning stage, but return almost to pre-announcement levels after the facilities are built. This result is echoed by Exeter-Enterprises-Ltd. (1993) and Palmer (1997), whose post-construction surveys found higher approval than those conducted pre-construction. Others, however, have found that perceptions do not always improve, attributing the lack of improvement to the perceived "success" or lack therefore of the project, with strong disapproval forming if turbines sit idle (Thayer and Freeman, 1987) or are perceived as a waste of taxpayer dollars (Devine-Wright, 2004).

When this literature is looked at as a whole, it appears as if wind projects have been predicted to negatively impact residential property values when pre-construction surveys are conducted, but that sizable, widespread, and statistically significant negative impacts have largely failed to materialize post-construction when actual transaction data become available for analysis. The studies that have investigated Area Stigma with market data have failed to uncover any pervasive effect. Of the studies focused on Scenic Vista and Nuisance Stigmas, only one is known to have found statistically significant adverse effects, yet the authors contend that those effects are likely driven by variables omitted from their analysis (Sims and Dent, 2007). Other studies that have relied on market data have sometimes found the possibility of negative effects, but the statistical significance of those results have rarely been reported.

Despite these findings, the existing literature leaves much to be desired. First, many studies have relied on surveys of homeowners or real estate professionals, rather than trying to quantify real price impacts based on market data. Second, a number of studies conducted rather simplified analyses of the underlying data, potentially not controlling for the many drivers of residential sales prices. Third, many of the studies have relied upon a very limited number of residential sales transactions, and therefore may not have had an adequate sample to statistically discern any property value effects, even if effects did exist. Fourth, and perhaps as a result, many of the studies did not conduct, or at least have not published, the statistical significance of their results. Fifth, when analyzed, there has been some emphasis on Area Stigma, and none of the studies have investigated all three possible stigmas simultaneously. Sixth, only a few of the studies (Hoen, 2006; Sims and Dent, 2007; Sims et al., 2008; Kielisch, 2009) conducted field visits to the homes to assess the quality of the scenic vista from the home, and the degree to which the wind facility might impact that scenic vista. Finally, with two exceptions (Sims and Dent, 2007; Sims et al., 2008), none of the studies have been academically peer-reviewed and published.

[18] It should be noted that the samples used by both Khatri and Kielisch contained a subset of respondents who did have some familiarity with valuing homes near wind facilities.

Table 1: Summary of Existing Literature on Impacts of Wind Projects on Property Values

Document Type Author(s)	Year	Number of Transactions or Respondents	Before or After Wind Facility Construction Commenced	Area Stigma	Scenic Vista Stigma	Nuisance Stigma
Homeowner Survey						
Haughton et al.	2004	501	Before	- *	- *	
Goldman	2006	50	After	**none**		
Firestone et al.	2007	504	Before	- *	- *	
Bond	2008	~300	After		- ?	- ?
Expert Survey						
Grover	2002	13	After	**none**		**none**
Haughton et al.	2004	45	Before	- *	- *	
Khatri	2004	405	Before‡	- ?		- ?
Goldman	2006	50	After	**none**		**none**
Kielisch	2009	57	Before‡			- ?
Transaction Analysis - Simple Statistics						
Jerabek	2001	25	After			**none**
Jerabek	2002	7	After			**none**
Sterzinger et al.	2003	24,000	After	**none**		
Beck	2004	2	After			**none**
Poletti	2005	187	After	**none**		**none**
DeLacy	2005	21	Before†	**none**		
Goldman	2006	4	After	**none**		
Poletti	2007	256	After	**none**		**none**
McCann	2008	2	After			- ?
Kielisch	2009	103	After			- ?
Transaction Analysis - Hedonic Model						
Jordal-Jorgensen	1996	?	After			- ?
Hoen	2006	280	After		**none**	
Sims & Dent	2007	919	After			- *
Sims et al.	2008	199	After		-/+ *	

" none " indicates the majority of the respondents do not believe properties have been affected (for surveys) or that no effect was detected at 10% significance level (for transaction analysis)

"- ?" *indicates a negative effect without statistical significance provided*

"- *" *indicates statistically significant negative effect at 10% significance level*

"-/+ *" *indicates positive and negative statistically significant effects at 10% significance level*

† *Sales were collected after facility announcement but before construction*

‡ *Some respondents had experience with valuations near facilities while others did not*

3. Data Overview

The methods applied in the present work are intended to overcome many of the limitations of the existing literature. First, a large amount of data is collected from residential transactions within 10 miles of 24 different wind projects in the U.S., allowing for a robust statistical analysis across a pooled dataset that includes a diverse group of wind project sites. Second, all three potential stigmas are investigated by exploring the potential impact of wind projects on home values based both on the distance to and view of the projects from the homes. Third, field visits are made to every home in the sample, allowing for a solid assessment of the scenic vista enjoyed by each home and the degree to which the wind facility can be seen from the home, and to collect other value-influencing data from the field (e.g., if the home is situated on a cul-de-sac). Finally, a number of hedonic regression models are applied to the resulting dataset, as are repeat sales and sales volume analyses, in order to assess the robustness of the results.

Testing for the three potential stigmas requires a significant sample of residential transactions within close proximity to existing wind facilities. Unfortunately for the study, most wind power projects are not located near densely populated areas. As a result, finding a single wind project site with enough transaction data to rigorously analyze was not possible. Instead, the approach was to collect data from multiple wind project sites, with the resulting data then pooled together to allow for robust statistical analyses.[19] The remainder of this section describes the site selection process that is used, and provides a brief overview of both the selected study areas and the data that were collected from these areas. Also provided is a description of how scenic vista, views of turbines, and distances from turbines were quantified for use in the hedonic analysis, and a summary of the field data collection effort. The section ends with a brief summary of the resulting dataset.

3.1. Site Selection

For the purpose of this study, an ideal wind project area would:

1) Have a large number of residential transactions both before and, more importantly, after wind facility construction, and especially in close proximity (e.g., within 2 miles) of the facility;
2) Have comprehensive data on home characteristics, sales prices, and locations that are readily available in electronic form; and
3) Be reasonably representative of the types of wind power projects being installed in the United States.

To identify appropriate sites that met these criteria, and that also provided a diversity of locations, the authors obtained from Energy Velocity, LLC a set of Geographic Information System (GIS) coordinates representing 241 wind projects in the U.S. that each had a total nameplate capacity greater than 0.6 megawatts (MW) and had gone online before 2006.[20] Also provided were facility capacity, number of turbines, and announcement, construction, and operational dates. These data were cross-checked with a similar dataset provided by the American Wind Energy Association (AWEA), which also included some turbine hub-height information.

[19] A thorough discussion of this "pooled" approach is contained in Section 4.2 and in Appendix F.

[20] Energy Velocity, LLC was owned at the time by Global Energy Decisions, which was later purchased by Ventyx. The dataset is available as Velocity Suite 2008 from Ventyx.

By using a variety of different GIS sorting techniques involving nearby towns with populations greater than, for example, 2,500 people, using census tract population densities, and having discussions with wind energy stakeholders, a prospective list of 56 possible study areas was generated, which were then ranked using two scales: "highly desirable" to "least desirable," and "feasible" to "potentially unfeasible."[21] Then, through an iterative process that combined calls to county officials to discuss the number of residential transactions and data availability, with investigations using mapping software to find the location of individual wind turbines, and, in some cases, preliminary visits, a list of 17 prospective study areas were chosen as both "highly desirable" and "feasible." Ultimately, three of these proved to be "unfeasible" because of data availability issues and four "undesirable" because the study area was considered not representative. This effort ultimately resulted in a final set of ten study areas that encompass a total of 24 distinct wind facilities (see Figure 1 and Table 2).[22] A full description of each study area is provided in Appendix A.

[21] "Desirability" was a combination of a number of factors: the wind facility having more than one turbine; the study area having greater than 350 sales within 5 miles and within 10 years, 250 of which transacted following construction of the facility; having some transaction data old enough to pre-date facility announcement; having data on the core home and site characteristics (e.g., square feet, acres); and, where possible, having a concentration of sales within 1 mile of the facility. "Feasibility" was also a combination of factors: having home characteristic and sales data in electronic form; having GIS shapefiles of the parcel locations; and being granted ready access to this information.

[22] The "unfeasible" study areas were Cerro Gordo County, IA, Bennington County, VT, and Atlantic County, NJ. Cerro Gordo County, IA contained multiple wind projects totaling 140 MW. Although the data at this site were available in electronic form, the county only agreed to share data in paper form, which would have created an enormous data entry burden. Because another site in the sample was considered similar to the Cerro Gordo site (IABV), Cerro Gordo County was dropped from the prospective sites. Bennington County, VT contained the 11 turbine Searsburg Wind Project (6 MW) but had no electronic records. Atlantic County, NJ contained the five turbine Jersey Atlantic Wind Farm (7.5 MW), but had data in paper records only and the county was unresponsive to inquiries regarding the study. The "undesirable" study areas were Plymouth County, MA, Wood County, OH, Cascade County, MT, and Riverside County, CA. Although the data in Plymouth County, MA were more than adequate, this small, on-land, yet coastal Hull Wind facility (2 turbines, 2.5 MW) was not considered to be particularly representative of wind development across the US. Wood County's four turbine Bowling Green facility (7 MW) met the appropriate data requirements, but ultimately it was decided that this facility was too small and remote to be representative. Cascade County's six turbine Horseshoe Bend Wind Park (9 MW) did not have enough transactions to justify study. Riverside, CA, where roughly 2500 turbines are located, had less-than-desired home characteristic data, had transactions that came more than 10 years after large scale development began, and despite having homes that were within 1 mile of the turbines, those homes typically had limited views because of high subdivision walls.

Figure 1: Map of Study Areas and Potential Study Areas

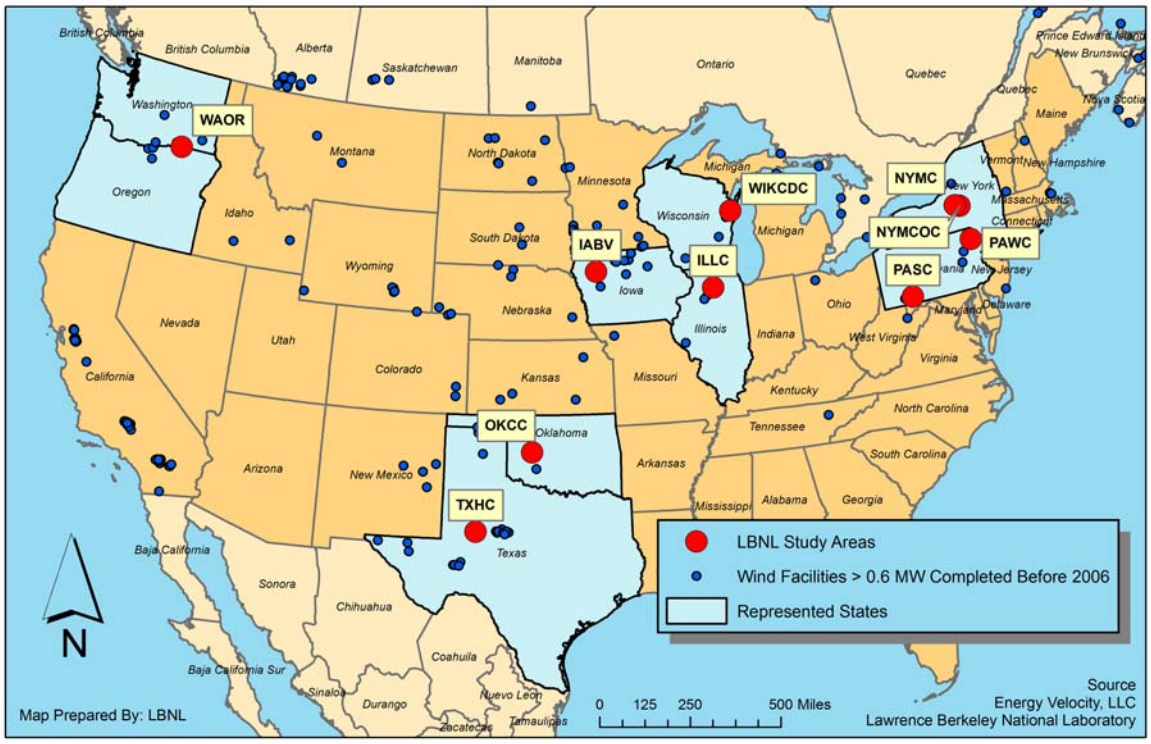


Table 2: Summary of Study Areas

Study Area Code	Study Area Counties, States	Facility Names	Number of Turbines	Number of MW	Max Hub Height (meters)	Max Hub Height (feet)
WAOR	Benton and Walla Walla Counties, WA and Umatilla County, OR	Vansycle Ridge, Stateline, Nine Canyon I & II, Combine Hills	582	429	60	197
TXHC	Howard County, TX	Big Spring I & II	46	34	80	262
OKCC	Custer County, OK	Weatherford I & II	98	147	80	262
IABV	Buena Vista County, IA	Storm Lake I & II, Waverly, Intrepid I & II	381	370	65	213
ILLC	Lee County, IL	Mendota Hills, GSG Wind	103	130	78	256
WIKCDC	Kewaunee and Door Counties, WI	Red River, Lincoln	31	20	65	213
PASC	Somerset County, PA	Green Mountain, Somerset, Meyersdale	34	49	80	262
PAWC	Wayne County, PA	Waymart	43	65	65	213
NYMCOC	Madison and Oneida Counties, NY	Madison	7	12	67	220
NYMC	Madison County, NY	Fenner	20	30	66	218
		TOTAL	**1345**	**1286**		

These 10 study areas and 24 projects are located in nine separate states, and include projects in the Pacific Northwest, upper Midwest, the Northeast, and the South Central region. The wind projects included in the sample total 1,286 MW, or roughly 13% of total U.S. wind power capacity installed at the time (the end of 2005). Turbine hub heights in the sample range from a

minimum of 164 feet (50 meters) in the Washington/Oregon (WAOR) study area, to a maximum of 262 (80 meters) (TXHC, OKCC and PASC), with nine of the ten study areas having hub heights of at least 213 feet (65 meters). The sites include a diverse variety of land types, including combinations of ridgeline (WAOR, PASC, and PAWC), rolling hills (ILLC, WIKCDC, NYMCOC, and NYMC), mesa (TXHC), and windswept plains (OKCC, IABV).[23]

3.2. Data Collection

In general, for each study area, residential transaction data in as close proximity to the wind turbines as possible was sought, from both before and after wind facility construction. To balance the cost and quantity of data collection in each study area with the desire to cover as many study areas as possible, the research effort sought to collect data on 400 to 1,250 transactions in each study area.[24] In some instances, this meant including all residential transactions within ten miles of the wind turbines. In others, only transactions within five miles were included. In some extreme instances, when the number of transactions inside of five miles far exceeded the 1,250 limit, all transactions in close proximity to the wind turbines (e.g., inside three miles) were included in combination with a random sample of transactions outside of that distance band (e.g., between three and five miles).[25] The data selection processes for each Study Area are contained in Appendix A.

Three primary sets of data are used in the analysis: tabular data, GIS data, and field data, each of which is discussed below. Following that, this subsection highlights the two qualitative variables that are essential to this analysis and that therefore require special attention, scenic vista and views of turbines, and then discusses the field data collection process.

3.2.1. Tabular Data

Berkeley Lab obtained tabular transaction data from participating counties[26] containing 7,459 "valid" [27] transactions of single family residential homes, on less than 25 acres,[28] which were

[23] Some areas, such as PASC, had both a ridgeline and rolling hills on which wind facilities were located.

[24] This range was chosen to ensure that a minimum of data were present in each study area to allow for a robust analysis, and yet not too much so as to make data collection (e.g., the visiting of each home) inordinately time and resource consuming in any individual study area.

[25] An alternative method would have been to collect data on every sale that occurred. Although in most cases this would be preferred, in ours it would not have added one additional transaction within close proximity or with dramatic views of wind turbine, the focus of the study. Rather, it would have added an overwhelming majority of transactions of homes without views and at distances outside of three miles from the turbines, all of which would have come at considerably cost and, more importantly, would not likely have influenced the results significantly while perhaps necessitating a reduction in the total number of study areas that could be included in the sample.

[26] In some cases, the county officials, themselves, extracted data from their database, and in some cases a company engaged to manage a county's data provided the necessary information. In either case the provider is referred to as "county." Detailed descriptions of the providers are presented in Appendix A.

[27] Validity was determined by each individual county data provider. A sale that is considered "valid" for county purposes would normally meet the minimum requirements of being arm's length; being a transfer of all rights and warrants associated with the real estate; containing an insignificant amount of personal property so as not to affect the price; demonstrating that neither party in the sale acting under duress or coercion; not being the result of a liquidation of assets or any other auction, a mortgage foreclosure, a tax sale, or a quit claim; and being appropriate for use in calculating the sales price to assessed value ratios that are reported to the state. Due to the formal requirements associated with this calculation, "validity" is often defined by a state's Department of Revenue, as shown, for example, here: http://www.orps.state.ny.us/assessor/manuals/vol6/rfv/index.htm. In addition, though the

sold for a price of more than $10,000,[29] which occurred after January 1, 1996,[30] and which had fully populated "core" home characteristics. These core characteristics are: number of square feet of the living area (not including finished basement), acres of land, bathrooms, and fireplaces, the year the home was built,[31] if the home had exterior wallsthatwere stone, a central air conditioning unit, and/or a finished basement, and the exterior condition of the home. The 7,459 residential transactions in the sample consist of 6,194 homes (a number of the homes in the sample sold more than once in the selected study period). Because each transaction had a corresponding set of the core home characteristic data, they could all be pooled into a single model. In addition to the home characteristic data, each county provided, at a minimum, the home's physical address and sales price. The counties often also provided data on homes in the study area that did not sell in the study period.[32] Finally, market-specific quarterly housing inflation indexes were obtained from Freddie Mac, which allowed nominal sales prices to be adjusted to 1996 dollars.[33]

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sample originally contained 7,498 sales, 34 homes sold twice in a 6 month period and, after discussions with local officials, these transactions were considered likely to have been "invalid" despite the county coding them to the contrary. Additionally, five transactions produced standardized residuals that were more than six standard deviations away from the mean, indicating that these sales were abnormal and likely not valid. Both of these sets of transactions, totaling 39, were removed from the final dataset. Of the 39 sales, 32 sold following construction, 10 were concentrated in IABV and nine in TXHC with the others spread between seven of the remaining eight study areas. One of the homes was inside of one mile from the turbines at the time of sale, and two had views of the turbines (both of which were MINOR). The home that was located within one mile was surrounded by a number of other homes – at similar distances from the turbines - that transacted both before and after the wind facilities were built and were included in the sample. A more thorough discussion of the screening techniques used to ensure the appropriateness of the final data set are presented in detail in Appendix G under "Outliers/Influencers." Finally, it should be noted that the authors are aware of four instances in the study areas when homes were sold to wind developers. In two cases the developer did not resell the home; in the other two, the developer resold the home at a lower price than which it was purchased. But, because the sales were to a related party, these transactions were not considered "valid' and are therefore not included here. One might, however, reasonably expect that the property values of these homes were impacted by the presence of the wind turbines.

[28] Single family residences on more than 25 acres were considered to be likely candidates for alternative uses, such as agricultural and recreational, which could have an influence on sales price that was outside of the capabilities of the model to estimate. Because all records were for parcels that contained a residence, the model did not contain any "land-only" transactions. Further, none of the transactions provided for this research were for parcels on which a turbine was located.

[29] A sales price of $10,000 was considered the absolute minimum amount an improved parcel (one containing a residential structure) would sell for in any of the study areas and study periods. This provided an additional screen over and above the "valid" screen that the counties performed.

[30] This provided a maximum of 12 years of data. Some counties did not have accessible data back to 1996 but in all cases these countries had data on transactions that occurred before the wind facilities were erected.

[31] "Year Built" was used to construct a variable for the age of the home at the time of the sale.

[32] These data were used to calculate the "Sales Volume" percentages referred to in Section 7.

[33] Freddie Mac Conventional Mortgage Home Price Index: municipal statistical area (MSA) series data are available from the following site: http://www.freddiemac.com/finance/cmhpi/. Because most of the study areas do not fall within the MSAs, a collection of local experts was relied upon, including real estate agents, assessors, and appraisers, to decide which MSA most-closely matched that of the local market. In all cases the experts had consensus as to the best MSA to use. In one case (NYMCOC) the sample was split between two MSAs. These indexes are adjusted quarterly, and span the entire sample period. Therefore, during the housing boom, insofar as a boom occurred in the sample areas, the indexes increased in value. Subsequently when the market began falling, the index retracted.

3.2.2. GIS Data

GIS data on parcel location and shape were also required, and were obtained from the counties. The counties also often provided GIS layers for roads, water courses, water bodies, wind turbines (in some cases), house locations, and school district and township/town/village delineations. GIS data on census tract and school district delineations were obtained from the U.S. Census Bureau, if not provided by the county.[34] GIS data were obtained on water courses, water bodies, land elevations, and satellite imagery, as was necessary, from the U.S. Department of Agriculture.[35] Combined, these data allowed each home to be identified in the field, the construction of a GIS layer of wind turbine locations for each facility, and the calculation of the distance from each home to the nearest wind turbine.[36] Determining the distance from each home to the nearest wind turbine was a somewhat involved process, and is discussed in detail in Appendix B. Suffice it to say that each transaction had a unique distance ("DISTANCE")[37] that was determined as the distance between the home and nearest wind turbine at the time of sale, and that these distances are grouped into five categories: inside of 3000 feet (0.57 miles), between 3000 feet and one mile, between one and three miles, between three and five miles, and outside of five miles.[38] Finally, the GIS data were used to discern if the home was situated on a cul-de-sac and had water frontage, both of which were corroborated in the field.

3.2.3. Field Data

Additional data had to be collected through field visits to all homes in the sample. Two qualitative measures in particular – for scenic vista and for view of the wind turbines – are worth discussing in detail because each is essential to the analysis and each required some amount of professional judgment in its creation.

The impact or severity of the view of wind turbines ("VIEW") [39] may be related to some combination of the number of turbines that are visible, the amount of each turbine that is visible (e.g., just the tips of the blades or all of the blades and the tower), the distance to the nearest turbines, the direction that the turbines are arrayed in relation to the viewer (e.g., parallel or perpendicular), the contrast of the turbines to their background, and the degree to which the turbine arrays are harmoniously placed into the landscape (Gipe, 2002). Recent efforts have made some progress in developing quantitative measures of the aesthetic impacts of wind turbines (Torres-Sibillea et al., 2009),[40] but, at the time this project began, few measures had

[34] These data were sourced from the U.S. Census Bureau's Cartographic Boundary Files Webpage: http://www.census.gov/geo/www/cob/bdy_files.html.

[35] These data were sourced from the USDA Geospatial Data Gateway: http://datagateway.nrcs.usda.gov/GatewayHome.html.

[36] Although in some cases the county provided a GIS layer containing wind turbine points, often this was not available. A description of the turbine mapping process is provided in Appendix B.

[37] Distance measures are collectively and individually referred to as "DISTANCE" from this point forward.

[38] The minimum distance of "inside 3000 feet" was chosen because it was the closest cutoff that still provided an ample supply of data for analysis.

[39] View of turbines ratings are collectively and individually referred to as "VIEW" from this point forward.

[40] In addition to these possible field techniques, previous studies have attempted to use GIS to estimate wind turbine visibility using "line-of-sight" algorithms. For example, Hoen (2006) used these algorithms after adding ground cover to the underlying elevation layer. He found that the GIS method differed substantially from the data collected in the field. Seemingly, small inaccuracies in the underlying elevation model, errors in the software's algorithm, and the existence of ground cover not fully accounted for in the GIS, substantially biased GIS-based assessments of

been developed, and what had been developed was difficult to apply in the field (e.g., Bishop, 2002). As a result, the authors opted to develop an ordered qualitative VIEW rating system that consisted of placing the view of turbines into one of five possible categories: NO VIEW, MINOR, MODERATE, SUBSTANTIAL, and EXTREME. These ratings were developed to encompass considerations of distance, number of turbines visible, and viewing angle into one ordered categorical scale, and each rating is defined in Table 3:[41]

Table 3: Definition of VIEW Categories

NO VIEW	The turbines are not visible at all from this home.
MINOR VIEW	The turbines are visible, but the scope (viewing angle) is narrow, there are many obstructions, or the distance between the home and the facility is large.
MODERATE VIEW	The turbines are visible, but the scope is either narrow or medium, there might be some obstructions, and the distance between the home and the facility is most likely a few miles.
SUBSTANTIAL VIEW	The turbines are dramatically visible from the home. The turbines are likely visible in a wide scope and most likely the distance between the home and the facility is short.
EXTREME VIEW	This rating is reserved for sites that are unmistakably dominated by the presence of the wind facility. The turbines are dramatically visible from the home and there is a looming quality to their placement. The turbines are often visible in a wide scope or the distance to the facility is very small.

Photographic examples of each of the categories are contained in Appendix E.

visibility. This was corroborated elsewhere by Maloy and Dean (2001) and Riggs and Dean (2007). As a result of these findings, it was determined that field collection of VIEW data was essential.

[41]In addition to the qualitative rating system that was ultimately used in this study, a variety of quantitative data were collected that might describe the nature of the view of wind turbines, including the total number of turbines visible, the distance of the home to the nearest wind turbine, and the view scope/viewing angle (i.e., the degree to which the turbines spread out in front of the home: narrow, medium, or wide). To explore the validity of the qualitative rating scale two tests were conducted. First, a pre-study survey was conducted by showing 10 different off-site respondents 15 randomly selected photographs from the field representing the various rated VIEW categories. The higher VIEW ratings were oversampled to create a roughly equal distribution among the categories. The respondents rated the views into one of the qualitative categories. The on-site / field collected ratings matched the off-site responses 65% of the time, with 97% of the rankings differing by no more than one category. Ninety-eight percent of the on-site-ranked MINOR VIEWs and 89% of the EXTREME VIEWs were similarly ranked by off-site respondents. The on-site rankings were less than the off-site rankings 97% of the time; it is assumed that this is because on-site ratings took into account a greater portion of the panorama than were captured in the photos, which translated into a lower ranking. Secondly, a post hoc Multinomial Logistic Regression model was created that used the qualitative on-site VIEW ratings as the dependent variable and the quantitative measures of distance to nearest turbine, number of turbines visible, and view scope as the independent variables. This model produced high Pseudo R^2 statistics (Cox and Snell 0.88, Nagelkerke 0.95, and McFadden 0.79) and predicted values that were highly correlated with the actual qualitative rating (Pearson's 0.88). Therefore, both tests corroborated the appropriateness of the simpler qualitative VIEW rankings used herein.

In addition to the qualitative VIEW measurements, a rating for the quality of the scenic vista ("VISTA")[42] from each home, absent the existence of the wind facilities, was also collected in the field. An assessment of the quality of the VISTA from each home was needed because VIEW and VISTA are expected to be correlated; for example, homes with a PREMIUM VISTA are more likely to have a wide viewing angle in which wind turbines might also be seen. Therefore, to accurately measure the impacts of the VIEW of wind turbines on property values a concurrent control for VISTA (independent of any views of turbines) is required. Drawing heavily on the landscape-quality rating system developed by Buhyoff et al. (1994) and to a lesser degree on the systems described by others (Daniel and Boster, 1976; USDA, 1995), an ordered VISTA rating system consisting of five categories was developed: POOR, BELOW AVERAGE, AVERAGE, ABOVE AVERAGE, and PREMIUM, with each rating defined in Table 4:[43]

Table 4: Definition of VISTA Categories

POOR VISTA	These vistas are often dominated by visually discordant man-made alterations (not considering turbines), or are uncomfortable spaces for people, lack interest, or have virtually no recreational potential.
BELOW AVERAGE VISTA	These scenic vistas contain visually discordant man-made alterations (not considering turbines) but are not dominated by them. They are not inviting spaces for people, but are not uncomfortable. They have little interest or mystery and have minor recreational potential.
AVERAGE VISTA	These scenic vistas include interesting views that can be enjoyed often only in a narrow scope. These vistas may contain some visually discordant man-made alterations (not considering turbines), are moderately comfortable spaces for people, have some interest, and have minor recreational potential.
ABOVE AVERAGE VISTA	These scenic vistas include interesting views that often can be enjoyed in a medium to wide scope. They might contain some man-made alterations (not considering turbines), yet still possess significant interest and mystery, are moderately balanced and have some potential for recreation.
PREMIUM VISTA	These scenic vistas would include "picture postcard" views that can be enjoyed in a wide scope. They are often free or largely free of any discordant man made alterations (not considering turbines), possess significant interest, memorable qualities, and mystery and are well balanced and likely have a high potential for recreation.

Photographic examples of each of the categories are contained in Appendix D.

[42] Scenic vista ratings are individually and collectively referred to as "VISTA" from this point forward.

[43] The appropriateness of these rankings were tested in two ways. First, a set of 34 pictures taken on-site and representing various categories of VISTA were shown to 10 off-site respondents who were asked to rank them using the same categories, and then explain why they rated them as such. Although the off-site ratings matched the on-site ratings only 51% of the time, 94% of on- and off-site rankings differed by no more than one category, with 17% of the off-site rankings below the on-site and 26% ranked above. The descriptions of why the rankings where chosen by the off-site respondents illuminated the fact that off-site ratings did not take into account a number of aspects that were not adequately captured in the photos, but that were apparent in the field. This finding was borne out by a second test that had five individuals visit seven homes in the field to rank their scenic vistas. When all respondents were on-site, they similarly ranked the vista 72% of the time, with a rankingthat differed by no more than one category occurring one hundred percent of the time.

In addition to the VIEW and VISTA ratings, it was assumed that the orientation of the home to the view of turbines (e.g., front, back, or side) ("ORIENTATION"), and the degree to which the view of the turbines overlapped the primary scenic vista (e.g., not at all, barely, somewhat or strongly) ("OVERLAP"), might influence residential property values. As such, information on ORIENTATION and OVERLAP were also collected in the field.

3.2.4. Field Data Collection

Field data collection was conducted on a house-by-house basis. Each of the 6,194 homes was visited by the same individual to remove bias among field ratings. Data collection was conducted in the fall of 2006, and the spring, summer, and fall of 2007 and 2008. Each house was photographed and, when appropriate, so too were views of turbines and the prominent scenic vista.[44] Data on VIEW were collected only for those homes that sold after at least one wind power facility had been erected in the study area. When multiple wind facilities, with different construction dates, were visible from a home, field ratings for VIEW were made by taking into account which turbines had been erected at the time of sale. Additionally, if the season at the time of sale differed from that of data collection and, for example, if leaves were off the trees for one but on for the other, an effort was made to modulate the VIEW rating accordingly if necessary.[45]

Both VIEW and VISTA field ratings were arrived at through a Q-Sort method (Pitt and Zube, 1979), which is used to distinguish relatively similar rankings. For views of turbines, the rater first determined if the ranking was MINOR or EXTREME. If neither of these two rankings was appropriate, then only a choice between MODERATE and SUBSTANTIAL was required. Similarly, for VISTA rankings, first POOR and PREMIUM were distinguished from the others; if neither applied then BELOW AVERAGE or ABOVE AVERAGE could be selected. If neither of those were appropriate the VISTA, by default, was considered AVERAGE. In all cases, if wind turbines were visible from the home, the VISTA rankings were made as if those turbines did not exist.

3.3. Data Summary

The final dataset consists of 7,459 valid and screened residential transactions occurring between January 2, 1996 and June 30, 2007. Those transactions are arrayed across time and the ten wind project study areas as shown in Table 5. The sample of valid residential transactions ranges from 412 in Lee County, Illinois (ILLC) to 1,311 in Howard County, Texas (TXHC).[46] Of the total 7,459 transactions, 4,937 occurred after construction commenced on the relevant wind facilities. More specifically, 23% of the transactions (n=1,755) took place before any wind facility was announced and 10% occurred after announcement but before construction commenced (n=767),

[44] In many cases the prominent VISTA was homogenous across groups of home, for instance urban homes on the same road. In those cases a picture of the VISTA of one home was applied to all of the homes. All pictures were taken with a Canon EOS Rebel XTi Single Lens Reflex Camera with a 18-55mm lens. VIEW and VISTA pictures were taken with the lens set to 18mm, with the camera at head height, and with the center of the camera pointed at the center of the prominent VISTA or VIEW. Examples of the various VISTA and VIEW categories are contained in Appendices D and E respectively.

[45] This "modulation" occurred only for trees in the foreground, where, for instance, a single tree could obscure the view of turbines; this would not be the case for trees nearer the horizon.

[46] See description of "valid" in footnote 27 on page 13.

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with the rest of the transactions occurring after construction commenced (66%, *n*=4,937).[47] Of that latter group, 17% (*n*=824, 11% of total) sold in the first year following the commencement of construction, 16% in the second year (*n*=811, 11% of total), and the remainder (67%) sold more than two years after construction commenced (*n*=3,302, 44% of total).

Table 5: Summary of Transactions across Study Areas and Development Periods

	Pre Announcement	Post Announcement Pre Construction	1st Year After Construction	2nd Year After Construction	2+ Years After Construction	Total
Benton/Walla Walla, WA & Umatilla, OR (WAOR)	226	45	76	59	384	**790**
Howard, TX (TXHC)	169	71	113	131	827	**1311**
Custer, OK (OKCC)	484	153	193	187	96	**1113**
Buena Vista, IA (IABV)	152	65	80	70	455	**822**
Lee, IL (ILLC)	115	84	62	71	80	**412**
Kewaunee/Door, WI (WIKCDC)	44	41	68	62	595	**810**
Somerset, PA (PASC)	175	28	46	60	185	**494**
Wayne, PA (PAWC)	223	106	64	71	87	**551**
Madison/Oneida, NY (MYMCOC)	108	9	48	30	268	**463**
Madison, NY (NYMC)	59	165	74	70	325	**693**
TOTAL	**1755**	**767**	**824**	**811**	**3302**	**7459**

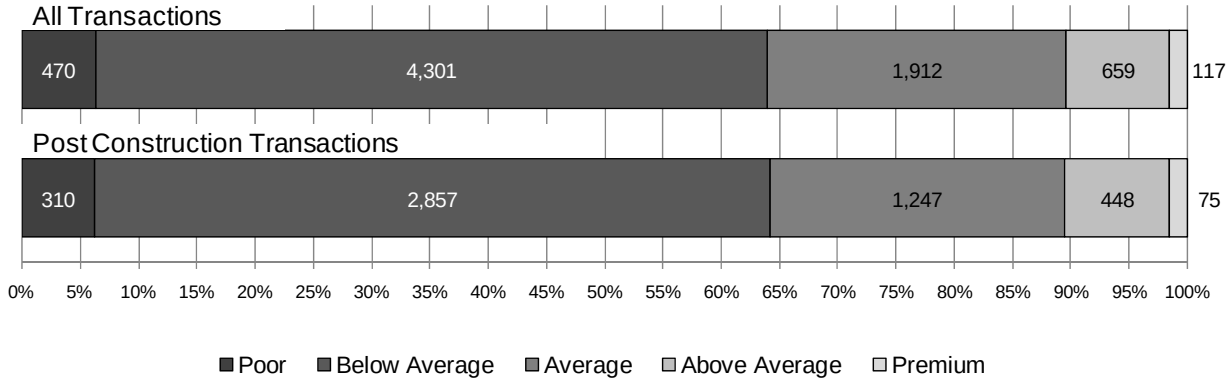
A basic summary of the resulting dataset, including the many independent variables used in the hedonic models described later, is contained in Table 6 and Table 7. These tables present summary information for the full dataset (7,459 transactions) as well as the post-construction subset of that dataset (4,937 transactions); the latter is provided because much of the analysis that follows focuses on those homes that sold after wind facility construction. The mean nominal residential transaction price in the sample is $102,968, or $79,114 in 1996 dollars. The average house in the sample can be described as follows: it is 46 years old, has 1,620 square feet of finished living area above ground, is situated on 1.13 acres, has 1.74 bathrooms, and has a

[47] The announcement date (as well as construction and online dates) was provided by Energy Velocity with the GIS files as described in footnote 20 on page 10. The date corresponds to the first time the facility appears in the public record, which was often the permit application date. This constitutes the first well established date when the existing wind facility would have been likely known by the public, and therefore is appropriate to use for this analysis, but there remain a number of areas for potential bias in this date. First, the permit application date might be preceded by news reports of the impending application; alternatively, if the public record was not published online (that Energy Velocity used to establish their date), the "announcement" date – as used here - could, in fact, follow the permit application date. To address this, when possible, the authors had discussions with the developer of the facility. In most cases, the Energy Velocity dates were found to be accurate, and when they were not they were adjusted to reflect the dates provided by the developer. A second potential source of bias is the possibility that a different project was proposed but never built, but that influenced the residential market in the study area prior to the "announcement" date. Although this is likely rarer, we are aware of at least a few projects that fit that description in the study areas. A final source of bias might revolve around the likelihood that awareness of a project could occur even before the facility is formally announced. For example, a community member might know that a wind facility is being considered because they had been approached by the wind development company well ahead of a public announcement. In turn, they might have had private discussions regarding the facility with other members of the community. Taken together, it is appropriate to assume that there is some bias in the "announcement" date, and that awareness of the project might precede the date used in this analysis. How this bias might affect the results in this report is addressed further in Section 5.3 and footnote 74 on page 38.

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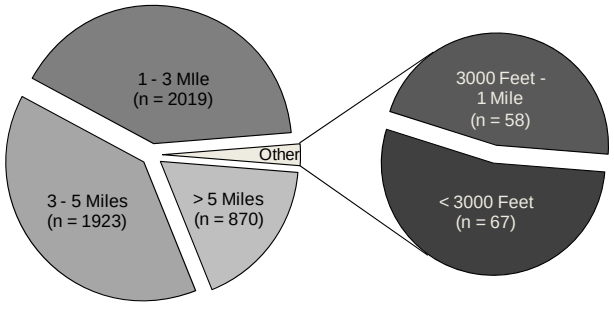
slightly better than average condition.[48] Within the full sample, 6% and 58% of homes had a poor or below average VISTA rating, respectively; 26% of homes received an average rating on this scale, with 9% above average and 2% experiencing premium vistas (see Figure 2).

Figure 2: Frequency of VISTA Ratings for All and Post-Construction Transactions



With respect to the variables of interest, among the post-construction subset of 4,937 transactions, the frequency of the DISTANCE categories is found to follow geometry with the smallest numbers of transactions occurring near the wind turbines and ever increasing numbers further away (see Figure 3). 67 transactions (1%) are situated inside of 3,000 feet (< 0.57 Miles), 58 (1%) are between 3,000 feet and one mile (0.57-1 mile), 2,019 (41%) occur outside of one mile but inside of three miles (1-3 miles), 1,923 (39%) occur between three and five miles (3-5 miles), and 870 (18%) occur outside of five miles (>5 miles).[49] In this same post-construction group, a total of 730 homes that sold (15%) have a view of the wind turbines (see Figure 4). A large majority of those homes have MINOR view ratings (n = 561, 11% of total), with 2% having MODERATE ratings (n=106) and the remaining transactions roughly split between SUBSTANTIAL and EXTREME ratings (n=35, 0.6%, and n=28, 0.5%, respectively). A full description of the variables of interest and how they are arrayed at the study area level is contained in Appendix A.

Figure 3: Frequency of DISTANCE Ratings for Post-Construction Transactions



[48] The variable for the condition of the home was not uniform across study areas because, in some cases, it took into account construction grade while in others it did not.

[49] These numbers and percentages are skewed slightly from the overall population of transactions because homes outside of three miles were often under-sampled to reduce field data collection burdens. Further, higher numbers of homes fall into each of the categories when the post-announcement-pre-construction transactions are included, as they are in some models. These additional transactions are described below in Table 7 under "All Sales."

Figure 4: Frequency of VIEW Ratings for Post-Construction Transactions

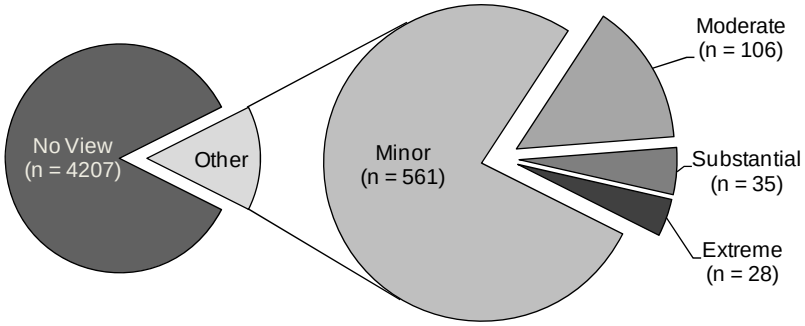


Table 6: Summary Statistics: All Sales and Post-Construction Sales

		All Sales			Post Construction Sales		
Variable Name	**Description**	**Freq. ***	**Mean**	**Std. Dev.**	**Freq. ***	**Mean**	**Std. Dev.**
SalePrice	The unadjusted sale price of the home (in US dollars)	7,459	102,968	64,293	4,937	110,166	69,422
SalePrice96	The sale price of the home adjusted to 1996 US dollars	7,459	79,114	47,257	4,937	80,156	48,906
LN_SalePrice96	The natural log transformation of the sale price of the home adjusted to 1996 US dollars	7,459	11.12	0.58	4,937	11.12	0.60
AgeatSale	The age of the home at the time of sale	7,459	46	37	4,937	47	36
AgeatSale_Sqrd	The age of the home at the time of sale squared	7,459	3,491	5,410	4,937	3,506	5,412
Sqft_1000	The number of square feet of above grade finished living area (in 1000s)	7,459	1.623	0.59	4,937	1.628	0.589
Acres	The number of Acres sold with the residence	7,459	1.13	2.42	4,937	1.10	2.40
Baths	The number of Bathrooms (Full Bath = 1, Half Bath = 0.5)	7,459	1.74	0.69	4,937	1.75	0.70
ExtWalls_Stone	If the home has exterior walls of stone, brick or stucco (Yes = 1, No = 0)	2,287	0.31	0.46	1,486	0.30	0.46
CentralAC	If the home has a Central AC unit (Yes = 1, No = 0)	3,785	0.51	0.50	2,575	0.52	0.50
Fireplace	The number of fireplace openings	2,708	0.39	0.55	1,834	0.40	0.55
Cul_De_Sac	If the home is situated on a cul-de-sac (Yes = 1, No = 0)	990	0.13	0.34	673	0.14	0.34
FinBsmt	If finished basement square feet is greater than 50% times first floor square feet (Yes = 1, No = 0)	1,472	0.20	0.40	992	0.20	0.40
Water_Front	If the home shares a property line with a body of water or river (Yes = 1, No = 0)	107	0.01	0.12	87	0.02	0.13
Cnd_Low	If the condition of the home is Poor (Yes = 1, No = 0)	101	0.01	0.12	69	0.01	0.12
Cnd_BAvg	If the condition of the home is Below Average (Yes = 1, No = 0)	519	0.07	0.25	359	0.07	0.26
Cnd_Avg	If the condition of the home is Average (Yes = 1, No = 0)	4,357	0.58	0.49	2,727	0.55	0.50
Cnd_AAvg	If the condition of the home is Above Average (Yes = 1, No = 0)	2,042	0.27	0.45	1,445	0.29	0.46
Cnd_High	If the condition of the home is High (Yes = 1, No = 0)	440	0.06	0.24	337	0.07	0.25
Vista_Poor	If the Scenic Vista from the home is Poor (Yes = 1, No = 0)	470	0.06	0.24	310	0.06	0.24
Vista_BAvg	If the Scenic Vista from the home is Below Average (Yes = 1, No = 0)	4,301	0.58	0.49	2,857	0.58	0.49
Vista_Avg	If the Scenic Vista from the home is Average (Yes = 1, No = 0)	1,912	0.26	0.44	1,247	0.25	0.44
Vista_AAvg	If the Scenic Vista from the home is Above Average (Yes = 1, No = 0)	659	0.09	0.28	448	0.09	0.29
Vista_Prem	If the Scenic Vista from the home is Premium (Yes = 1, No = 0)	117	0.02	0.12	75	0.02	0.12
SaleYear	The year the home was sold	7,459	2002	2.9	4,937	2004	2.3

** "Freq." applies to the number of cases the parameter's value is not zero*

Table 7: Summary of Variables of Interest: All Sales and Post-Construction Sales

		All Sales			Post Construction Sales		
Variable Name	**Description**	**Freq. ***	**Mean**	**Std. Dev.**	**Freq. ***	**Mean**	**Std. Dev.**
View_None	If the home sold after construction began and had no view of the turbines (Yes = 1, No = 0)	4,207	0.56	0.50	4,207	0.85	0.36
View_Minor	If the home sold after construction began and had a Minor View of the turbines (Yes = 1, No = 0)	561	0.08	0.26	561	0.11	0.32
View_Mod	If the home sold after construction began and had a Moderate View of the turbines (Yes = 1, No = 0)	106	0.01	0.12	106	0.02	0.15
View_Sub	If the home sold after construction began and had a Substantial View of the turbines (Yes = 1, No = 0)	35	-	0.07	35	0.01	0.08
View_Extrm	If the home sold after construction began and had a Extreme View of the turbines (Yes = 1, No = 0)	28	-	0.06	28	0.01	0.08
DISTANCE †	Distance to nearest turbine if the home sold after facility "announcement", otherwise 0	5,705	2.53	2.59	4,895	3.57	1.68
Mile_Less_0.57 †	If the home sold after facility "announcement" and was within 0.57 miles (3000 feet) of the turbines (Yes = 1, No = 0)	80	0.01	0.09	67	0.01	0.12
Mile_0.57to1 †	If the home sold after facility "announcement" and was between 0.57 miles (3000 feet) and 1 mile of the turbines (Yes = 1, No = 0)	65	0.01	0.09	58	0.01	0.11
Mile_1to3 †	If the home sold after facility "announcement" and was between 1 and 3 miles of the turbines (Yes = 1, No = 0)	2,359	0.27	0.44	2,019	0.41	0.49
Mile_3to5 †	If the home sold after facility "announcement" and was between 3 and 5 miles of the turbines (Yes = 1, No = 0)	2,200	0.26	0.44	1,923	0.39	0.49
Mile_Gtr5 †	If the home sold after facility "announcement" and was outside 5 miles of the turbines (Yes = 1, No = 0)	1,000	0.12	0.32	870	0.18	0.38

** "Freq." applies to the number of cases the parameter's value is not zero*

† "All Sales" freq., mean and standard deviation DISTANCE and DISTANCE fixed effects variables (e.g., Mile_1to3) include transactions that occurred after facility "announcement" and before "construction" as well as those that occured post-construction

4. Base Hedonic Model

This section uses the primary hedonic model ("Base Model") to assess whether residential sales prices are affected, in a statistically measurable way, by views of and proximity to wind power facilities. In so doing, it simultaneously tests for the presence of the three potential property value stigmas associated with wind power facilities: Area, Scenic Vista, and Nuisance. This section begins with a discussion of the dataset that is used and the form of the model that is estimated, and then turns to the results of the analysis. Various alternative hedonic models are discussed and estimated in Section 5, with Sections 6 and 7 providing a discussion of and results from the repeat sales and sales volume models.

4.1. Dataset

The data used for the Base Model were described in Section 3.3. A key threshold question is whether or not to include the residential transactions that pre-date the relevant wind facility. Specifically, though the complete dataset consists of 7,459 residential transactions, a number of these transactions (n = 2,522) occurred before the wind facility was constructed. Should these homes which, at the time of sale, would not have had any view of or distance to the wind facility, be included? Two approaches could be applied to address this issue. First, pre-construction transactions could be included in the hedonic model either as part of the reference category within which no wind-project property value impacts are assumed to exist, or instead by specifically identifying these pre-construction transactions through an indicator variable. Second, and alternatively, pre-construction transactions could simply be excluded from the analysis altogether.

For the purpose of the Base Model, the latter approach is used, therefore relying on only the post-construction subset of 4,937 residential transactions. This approach, as compared to the others, results in somewhat more intuitive findings because all homes have a distance greater than zero and have a possibility of some view of the turbines. More importantly, this approach minimizes the chance of inaccuracies that may otherwise exist due to inflation adjustment concerns or outdated home characteristics information.[50] Nonetheless, to test for the implications of this choice of datasets, alternative hedonic models that use the full dataset were estimated, and are discussed in detail in Sections 5.3 and 5.4.

[50] Home characteristics were obtained as of the last property assessment. The timing of that assessment relative to the timing of the home sale transaction dictates how representative the assessed home characteristics are of the subject home when it was sold. For example, if a home sold early in the study period but subsequently had significant improvements made that are reflected in the current assessment data used in the analysis, the model would assign value to these home characteristics at the time of sale when, in fact, those characteristics were inaccurate. Additionally, the inflation adjustment index used in this analysis to translate home values to real 1996 dollars came from the nearest or more appropriate municipal statistical area (MSA). Many of the wind projects in the analysis are located in relatively rural parts of the country, and the housing market in the nearest metropolitan area could be different than the market surrounding wind projects. Although these areas have – in many instances – recently begun to attract home buyers willing to commute back to the metropolitan areas on which the index is based, the older index adjustments are likely less accurate than the more recent adjustments. Using a subset of the data for the majority of the analyses that removes the older, pre-construction, homes minimizes both of these biases.

4.2. Model Form

A standard semi-log functional form is used for the hedonic models (as was discussed in Section 2.1), where the dependent variable (sales price in inflation-adjusted 1996 dollars) is transformed to its natural log form and the independent variables (e.g., square feet and acres) are not transformed. Using this form to examine the effect that views of, and distance to, wind facilities have on sales prices, the following basic model is estimated:

$$\ln(\mathrm{P}) = \beta_0 + \beta_1 \mathrm{N} + \sum_{\mathrm{s}} \beta_2 \mathrm{S} + \sum_{\mathrm{k}} \beta_3 \mathrm{X} + \sum_{\mathrm{v}} \beta_4 \mathrm{VIEW} + \sum_{\mathrm{d}} \beta_5 \mathrm{DISTANCE} + \varepsilon \qquad (1)$$

where
P represents the inflation-adjusted sales price,
N is the spatially weighted neighbors' predicted sales price,
S is the vector of *s* Study Area fixed effects variables (e.g., WAOR, OKCC, etc.),
X is a vector of *k* home and site characteristics (e.g., acres, square feet, number of bathrooms, condition of the home, age of home, VISTA, etc.),
VIEW is a vector of *v* categorical view of turbine variables (e.g., MINOR, MODERATE, etc.),
DISTANCE is a vector of *d* categorical distance to turbine variables (e.g., less than 3000 feet, between one and three miles, etc.),
β_0 is the constant or intercept across the full sample,
β_1 is a parameter estimate for the spatially weighted neighbor's predicted sales price,
β_2 is a vector of *s* parameter estimates for the study area fixed effects as compared to homes sold in the Washington/Oregon (WAOR) study area,
β_3 is a vector of *k* parameter estimates for the home and site characteristics,
β_4 is a vector of *v* parameter estimates for the VIEW variables as compared to homes sold with no view of the turbines,
β_5 is a vector of *d* parameter estimates for the DISTANCE variables as compared to homes sold situated outside of five miles, and
ε is a random disturbance term.

As such, this model, and all subsequent hedonic models, has four primary groups of parameters: variables of interest, spatial adjustments, study-area fixed effects, and home and site characteristics.

The variables of interest, VIEW and DISTANCE, are the focus of this study, and allow the investigation of the presence of Area, Scenic Vista, and Nuisance Stigmas. These variables were defined in Section 3, and are summarized in Table 8. Both VIEW and DISTANCE appear in the model together because a home's value may be affected in part by the magnitude of the view of the wind turbines, and in part by the distance from the home to those turbines, and both variables appear in the Base Model as ordered categorical values. The coefficients associated with these two vectors of variables (β_4 and β_5) represent the marginal impact of views of, and distances to, wind turbines on sales prices, as compared to a "reference" category of residential transactions, and should be ordered monotonically from low to high.[51] This form of variable was used to

[51] "Reference category" refers to the subset of the sample to which other observations are compared, and is pertinent when using categorical or "fixed effect" variables.

000582

impose the least structure on the underlying data.[52] For the purpose of the Base Model, the reference category for the DISTANCE variables are those transactions of homes that were situated outside of five miles from the nearest wind turbine. The reference category for the VIEW variables are those transactions of homes that did not have a view of the wind facility upon sale. Among the post-construction sample of homes, these reference homes are considered the least likely to be affected by the presence of the wind facilities.[53]

Table 8: List of Variables of Interest Included in the Base Model

Variable Name	Description	Type	Expected Sign
View_None	If the home sold after construction began and had no view of the turbines (Yes = 1, No = 0)	Reference	n/a
View_Minor	If the home sold after construction began and had a Minor View of the turbines (Yes = 1, No = 0)	OC	-
View_Mod	If the home sold after construction began and had a Moderate View of the turbines (Yes = 1, No = 0)	OC	-
View_Sub	If the home sold after construction began and had a Substantial View of the turbines (Yes = 1, No = 0)	OC	-
View_Extrm	If the home sold after construction began and had an Extreme View of the turbines (Yes = 1, No = 0)	OC	-
Mile_Less_0.57	If the home sold after facility "construction" and was within 0.57 miles (3000 feet) of the turbines (Yes = 1, No = 0)	OC	-
Mile_0.57to1	If the home sold after facility "construction" and was between 0.57 miles (3000 feet) and 1 mile of the turbines (Yes = 1, No = 0)	OC	-
Mile_1to3	If the home sold after facility "construction" and was between 1 and 3 miles of the turbines (Yes = 1, No = 0)	OC	-
Mile_3to5	If the home sold after facility "construction" and was between 3 and 5 miles of the turbines (Yes = 1, No = 0)	OC	-
Mile_Gtr5	If the home sold after facility "construction" and was outside 5 miles of the turbines (Yes = 1, No = 0)	Reference	n/a

"OC" Ordered Categorical (1 = yes, 0 = no) values are interpreted in relation to the reference categorical case and are expected to have a monotonic order from low to high.

The three stigmas are investigated though these VIEW and DISTANCE variables. Scenic Vista Stigma is investigated through the VIEW variables. Area and Nuisance Stigmas, on the other hand, are investigated through the DISTANCE variables. To distinguish between Area and

[52] In place of the ordered categorical DISTANCE variables, practitioners often rely on a continuous DISTANCE form (e.g., Sims et al., 2008). Similar to ordered categorical variables, continuous variables have a natural ordering, either ascending or descending, but, unlike categorical variables, these "continuous" values are on a scale. Therefore, given any two of its values X_1 and X_2 and a specific functional form, the ratio "X_1/X_2" and the distance "$X_1 - X_2$" have a fixed meaning. Examples of continuous variables other than DISTANCE that are commonly used include the number of square feet of living area (in 1000s) in a home (SQFT_1000) or the acres in the parcel (ACRES). A continuous functional form of this nature "imposes structure" because practitioners must decide how price is related to the underlying variables through the selection of a specific functional relationship between the two. For instance, in the case of DISTANCE, is there a linear relationship (which would imply a similar marginal difference between two distances both near and far from the turbines), does it decay slowly as distance grows, or does it fade completely at some fixed distance? Because of the lack of literature in this area, no *a priori* expectations for which functional form is the best were established, and therefore unstructured categorical variables are used in the Base Model. Nonetheless, a continuous DISTANCE form is explored in Section 5.2.

[53] It is worth noting that these reference homes are situated in both rural and urban locales and therefore are not uniquely affected by influences from either setting. This further reinforces their worthiness as a reference category.

000583

Nuisance Stigma, it is assumed that Nuisance effects are concentrated within one mile of the nearest wind turbine, while Area effects will be considered for those transactions outside of one mile. Any property value effects discovered outside of one mile and based on the DISTANCE variables are therefore assumed to indicate the presence of Area Stigma, while impacts within a mile may reflect the combination of Nuisance and Area Stigma.

The second set of variables in the Base Model - spatial adjustments - correct for the assumed presence of spatial autocorrelation in the error term (ε). It is well known that the sales price of a home can be systematically influenced by the sales prices of those homes that have sold nearby. Both the seller and the buyer use information from comparable surrounding sales to inform them of the appropriate transaction price, and nearby homes often experience similar amenities and disamenities. This lack of independence of home sale prices could bias hedonic regression results and, to help correct for this bias, a spatially (i.e., distance) weighted neighbors' sales price (N) is included in the model. Empirically, the neighbors' price has been found to be a strong (and sometimes even the strongest) predictor of home values (Leonard and Murdoch, forthcoming), and the coefficient β_1 is expected to be positive, indicating a positive correlation between the neighbors' and subject home's sales price. A more-detailed discussion of the importance of this variable, and how it was created, is contained in Appendix G.

The third group of variables in the Base Model - study area fixed effects - control for study area influences and the differences between them. The vector's parameters β_2 represent the marginal impact of being in any one of the study areas, as compared to a reference category. In this case, the reference category is the Washington/Oregon (WAOR) study area.[54] The estimated coefficients for this group of variables represent the combined effects of school districts, tax rates, crime, and other locational influences across an entire study area. Although this approach greatly simplifies the estimation of the model, because of the myriad of influences captured by these study-area fixed effects variables, interpreting the coefficient can be difficult. In general, though, the coefficients simply represent the mean difference in sales prices between the study areas and the reference study area (WAOR). These coefficients are expected to be strongly influential, indicating significant differences in sales prices across study areas.

The fourth group of variables in the Base Model are the core home and site characteristics (X), and include a range of continuous ("C"),[55] discrete ("D"),[56] binary ("B"),[57] and ordered categorical ("OC") variables. The specific home and site variables included in the Base Model are listed in Table 9 along with the direction of expected influence.[58] Variables included are age

[54] Because there is no intent to focus on the coefficients of the study area fixed effect variables, the reference case is arbitrary. Further, the results for the other variables in the model are completely independent of this choice.

[55] See discussion in footnote 52 on previous page.

[56] Discrete variables, similar to continuous variables, are ordered and the distance between the values, such as X_1 and X_2, have meaning, but for these variables, there are only a relatively small number of discrete values that the variable can take, for example, the number of bathrooms in a home (BATHROOMS).

[57] Binary variables have only two conditions: "on" or "off" (i.e., "1" or "0" respectively). Examples are whether the home has central air conditioning ("CENTRAL_AC") or if the home is situated on a cul-de-sac ("CUL_DE_SAC"). The coefficients for these variables are interpreted in relation to when the condition is "off."

[58] For those variables with a "+" sign it is expected that as the variable increases in value (or is valued at "1" as would be the case for fixed effects variables) the price of the home will increase, and the converse is true for the variables with a "-" sign. The expected signs of the variables all follow conventional wisdom (as discussed in

of the home, home and lot size, number of bathrooms and fireplaces, the condition of the home, the quality of the scenic vista from the home, if the home has central AC, a stone exterior, and/or a finished basement, and whether the home is located in a cul-de-sac and/or on a water way.[59]

Table 9: List of Home and Site Characteristics Included in the Base Model

Variable Name	Description	Type	Expected Sign
AgeatSale	The age of the home at the time of sale in years	C	-
AgeatSale_Sqrd	The age of the home at the time of sale squared	C	+
Sqft_1000	The number of square feet of above grade finished living area (in 1000s)	C	+
Acres	The number of Acres sold with the residence	C	+
Baths	The number of Bathrooms (Full Bath = 1, Half Bath = 0.5)	D	+
ExtWalls_Stone	If the home has exterior walls of stone, brick or stucco (Yes = 1, No = 0)	B	+
CentralAC	If the home has a Central AC unit (Yes = 1, No = 0)	B	+
Fireplace	The number of fireplace openings	D	+
Cul_De_Sac	If the home is situated on a cul-de-sac (Yes = 1, No = 0)	B	+
FinBsmt	If finished basement sqft > 50% times first floor sqft (Yes = 1, No = 0)	B	+
Water_Front	If the home shares a property line with a body of water or river (Yes = 1, No = 0)	B	+
Cnd_Low	If the condition of the home is Poor (Yes = 1, No = 0)	OC	-
Cnd_BAvg	If the condition of the home is Below Average (Yes = 1, No = 0)	OC	-
Cnd_Avg	If the condition of the home is Average (Yes = 1, No = 0)	Reference	n/a
Cnd_AAvg	If the condition of the home is Above Average (Yes = 1, No = 0)	OC	+
Cnd_High	If the condition of the home is High (Yes = 1, No = 0)	OC	+
Vista_Poor	If the Scenic Vista from the home is Poor (Yes = 1, No = 0)	OC	-
Vista_BAvg	If the Scenic Vista from the home is Below Average (Yes = 1, No = 0)	OC	-
Vista_Avg	If the Scenic Vista from the home is Average (Yes = 1, No = 0)	Reference	n/a
Vista_AAvg	If the Scenic Vista from the home is Above Average (Yes = 1, No = 0)	OC	+
Vista_Prem	If the Scenic Vista from the home is Premium (Yes = 1, No = 0)	OC	+

"C" Continuous, "D" Discrete, and "B" Binary (1 = yes, 0 = no) values are interpreted in relation to "No"

"OC" Ordered Categorical (1 = yes, 0 = no) values are interpreted in relation to the reference categorical case and are expected to have a monotonic order from low to high.

Sirmans et al., 2005a), save AgeatSale and AgeatSale_Sqrd, which are expected to be negative and positive, respectively. The magnitude of the coefficient of AgeatSale is expected to be larger than that of AgeatSale_Sqrd indicating an initial drop in value as a home increases in age, and then an increase in value as the home becomes considerably older and more "historic."

[59] Some characteristics, such as whether the home had a deck, a pool, or is located on a public sewer, are not available consistently across the dataset and therefore are not incorporated into the model. Other characteristics, such as the number of bedrooms, the number of stories, or if the home had a garage, are available but are omitted from the final model because they are highly correlated with characteristics already included in the model and therefore do not add significantly to the model's explanatory power. More importantly, and as discussed in Appendix G, when their inclusion or exclusion are tested, the results are stable with those derived from the Base Model.

It should be emphasized that in the Base Hedonic Model - equation (1) - and in all subsequent models presented in Section 5, all variables of interest, spatial adjustments, and home and site characteristics are pooled, and therefore their estimates represent the average across all study areas. Ideally, one would have enough data to estimate a model at the study area level - a fully unrestricted model - rather than pooled across all areas. This fully unrestricted model form, along with 15 other model forms (with some variables restricted and others not), are discussed in detail in Appendix F. In total, these 16 different models were estimated to explore which model was the most parsimonious (had the fewest parameters), performed the best (e.g., had the highest adjusted R^2 and the lowest Schwarz information criterion[60]), and had the most stable coefficients and standard errors. The basic pooled model described by equation (1) is found to fit that description, and that model is therefore chosen as the Base Model to which others are compared. By making this choice the effort concentrates on identifying the presence of potential property value impacts across all of the study areas in the sample as opposed to any single study area.[61]

Finally, to assure that the model produces the best linear unbiased parameter estimates, the underlying assumptions of Ordinary Least Squares (OLS) regression techniques must be verified:

1) Homoskedastic error term;
2) Absence of temporal serial correlation;
3) Reasonably limited multicollinearity; and
4) Appropriate controls for outliers and influencers.[62]

These assumptions, and the specific approaches that are used to address them, are discussed in detail in Appendix G.

4.3. Analysis of Results

Table 10 (on page 32) presents the results of the Base Model (equation 1).[63] The model performs well, with an adjusted R^2 of 0.77.[64] The spatial adjustment coefficient (β_1) of 0.29 (*p* value 0.00) indicates that a 10% increase in the spatially weighted neighbor's price increases the subject home's value by an average of 2.9%. The study-area fixed effects (β_2) variables are all significant at the one percent level, demonstrating important differences in home valuations

[60] The Schwarz information criterion measures relative parsimony between similar models (Schwarz, 1978).

[61] Because effects might vary between study areas, and the models estimate an average across all study areas, the full range of effects in individual study areas will go undetermined. That notwithstanding, there is no reason to suspect that effects will be completely "washed out." For that to occur, an effect in one study area would have to be positive while in another area it would have to be negative, and there is no reason to suspect that sales prices would increase because of the turbines in one community while decreasing in other communities.

[62] The absence of spatial autocorrelation is often included in the group of assumptions, but because it was discussed above (and in Appendix G), and is addressed directly by the variable (N_i) included in the model, it is not included in this list.

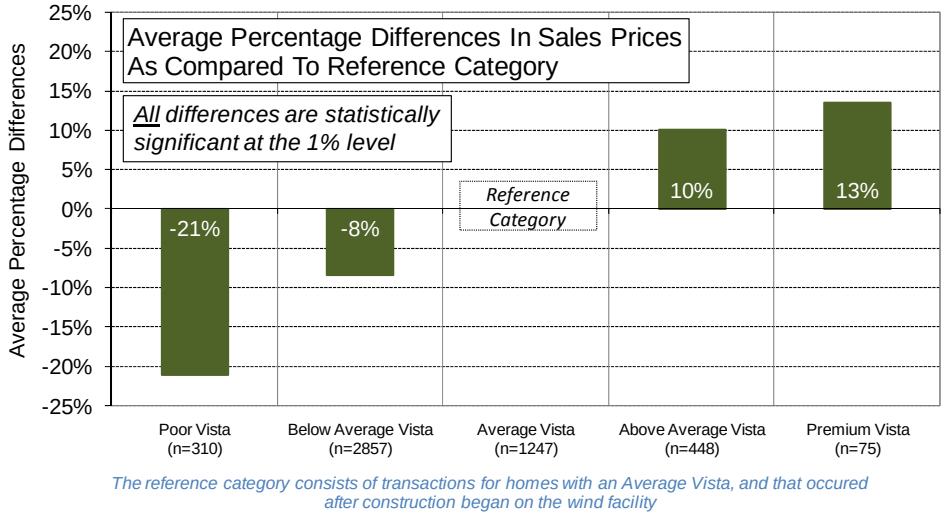
[63] This model and all subsequent models were estimated using the PROC REG procedure of SAS Version 9.2 TS1M0, which produces White's corrected standard errors.

[64] The appropriateness of the R^2 of 0.77 for this research is validated by the extensive hedonic literature that precedes it (see e.g., Kroll and Priestley, 1992; Boyle and Kiel, 2001; Simons, 2006b).

between the reference study area (WAOR) and the other nine study areas.[65] The sign and magnitudes of the home and site characteristics are all appropriate given the *a priori* expectations, and all are statistically significant at the one percent level.[66]

Of particular interest are the coefficient estimates for scenic vista (VISTA) as shown in Figure 5. Homes with a POOR vista rating are found, on average, to sell for 21% less (*p* value 0.00) than homes with an AVERAGE rating, while BELOW AVERAGE homes sell for 8% less (*p* value 0.00). Conversely, homes with an ABOVE AVERAGE vista are found to sell for 10% more (*p* value 0.00) than homes with an AVERAGE vista, while PREMIUM vista homes sell for 13% more than AVERAGE homes (*p* value 0.00). Based on these results, it is evident that home buyers and sellers capitalize the quality of the scenic vista in sales prices.[67]

Figure 5: Results from the Base Model for VISTA



The reference category consists of transactions for homes with an Average Vista, and that occured after construction began on the wind facility

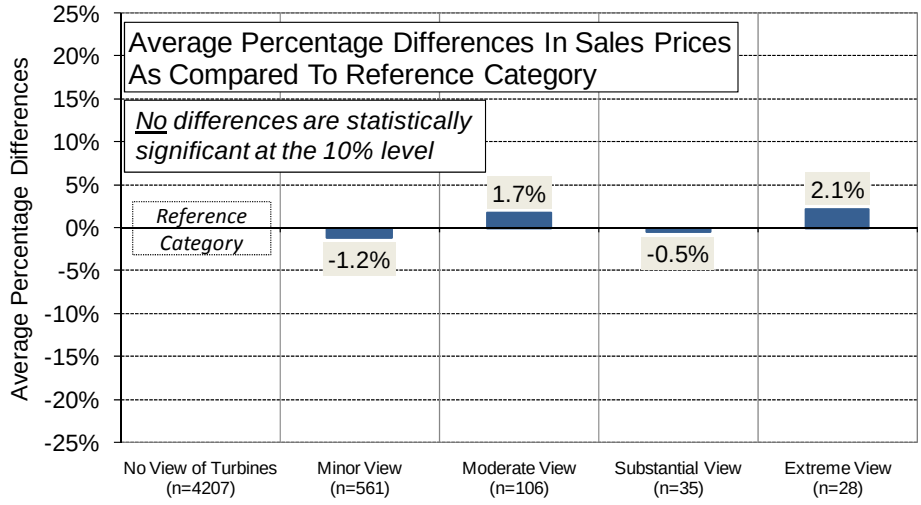
[65] The reference category WAOR study area has the highest mean and median house values in the sample (as shown in Appendix A) so the negative coefficients for all the study area fixed effect variables are appropriate.

[66] To benchmark the results against those of other practitioners the research by Sirmans et al. (2005a; 2005b) was consulted. They conducted a meta-analysis of 64 hedonic studies carried out in multiple locations in the U.S. during multiple time periods, and investigated the coefficients of ten commonly used characteristics, seven of which were included in the model. The similarities between their mean coefficients (i.e., the average across all 64 studies) and those estimated in the present Base Model are striking. The analysis presented here estimates the effect of square feet (in 1000s) on log of sales price at 0.28 and Sirmans et al. provide an estimate of 0.34, while ACRES was similarly estimated (0.02 to 0.03, Base Model and Sirmans et al., respectively). Further, AGEATSALE (age at the time of sale) (-0.006 to -0.009), BATHROOMS (0.09 to 0.09), CENTRALAC (0.09 to 0.08), and FIREPLACE (0.11 to 0.09) all similarly compare. As a group, the Base Model estimates differ from Sirmans et al. estimates in all cases by no more than a third of the Sirmans et al. mean estimate's standard deviation. This, taken with the relatively high adjusted R^2 of the Base Model, demonstrates the appropriateness of the model's specification.

[67] To benchmark these results they are compared to the few studies that have investigated the contribution of inland scenic vistas to sales prices. Benson et al. (2000) find that a mountain vista increases sales price by 8%, while Bourassa et al. (2004) find that wide inland vistas increase sales price by 7.6%. These both compare favorably to the 10% and 14% above average and premium rated VISTA estimates. Comparable studies for below average and poor VISTA were not found and therefore no benchmarking of those coefficients is conducted. Finally, it should again be noted that a home's scenic vista, as discussed in Section 3.2.3, was ranked without taking the presence of the wind turbines into consideration, even if those turbines were visible at the time of home sale.

Despite this finding for scenic vista, however, no statistically significant relationship is found between views of wind turbines and sales prices.[68] The coefficients for the VIEW parameters (β_4) are all relatively small, none are statistically significant, and they are not monotonically ordered (see Figure 6). Homes with EXTREME or SUBSTANTIAL view ratings, for which the Base Model is expected to find the largest differences, sell for, on average, 2.1% more (*p* value 0.80) and 0.5% less (*p* value 0.94) than NO VIEW homes that sold in the same post-construction period. Similarly, homes with MODERATE or MINOR view ratings sell, on average, for 1.7% more (*p* value 0.58) and 1.2% less (*p* value 0.40) than NO VIEW homes, respectively. None of these coefficients are sizable, and none are statistically different from zero. These results indicate that, among this sample at least, a statistically significant relationship between views of wind turbines and residential property values is not evident. In other words, there is an absence of evidence of a Scenic Vista Stigma in the Base Model.

Figure 6: Results from the Base Model for VIEW

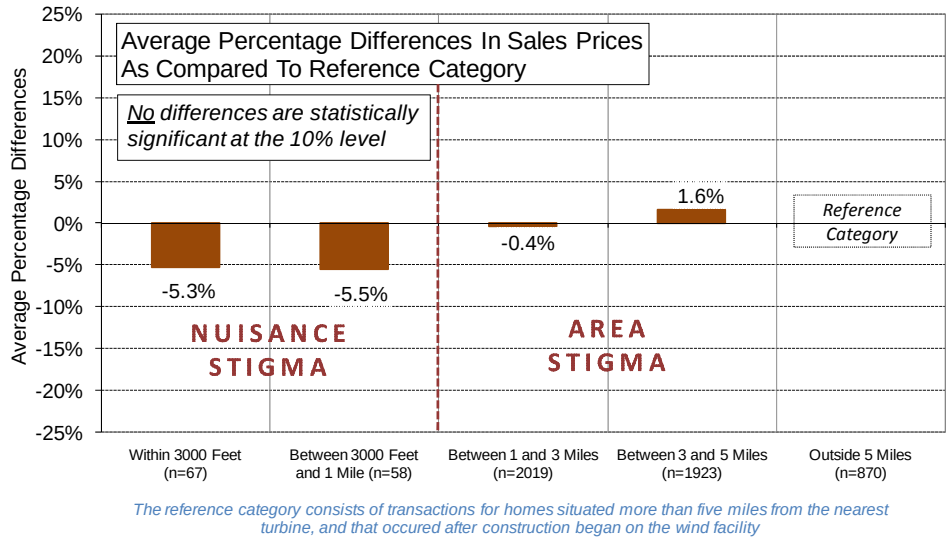


The reference category consists of transactions for homes without a view of the turbines, and that occured after construction began on the wind facility

The coefficients for the DISTANCE parameters (β_5) are also all relatively small and none are statistically significant (see Figure 7). Homes that are situated within 3000 feet (0.57 miles) of the nearest wind turbine, at the time of sale, are found to sell for 5.3% less (*p* value 0.40), on average, than homes outside of 5 miles that sold in the same "post-construction" period. Meanwhile, homes between 3000 feet and 1 mile sold for 5.5% less (*p* value 0.30), on average, than homes more than 5 miles away. Homes that are within 1 to 3 miles of the nearest turbine, as compared to homes outside of 5 miles, sold for essentially the same, on average (coefficient = 0.004, *p* value 0.80), while homes between 3 and 5 miles sold for 1.6% more (*p* value 0.23).

[68] A significance level of 10% is used throughout this report, which corresponds to a *p*-value at or above 0.10. Although this is more liberal than the often used 5% (*p*-value at or above 0.05), it was chosen to give more opportunities for effects that might be fairly weak to be considered significant.

Figure 7: Results from the Base Model for DISTANCE



Looking at these results as a whole, a somewhat monotonic order from low to high is found as homes are situated further away from wind facilities, but all of the coefficients are relatively small and none are statistically different from zero. This suggests that, for homes in the sample at least, there is a lack of statistical evidence that the distance from a home to the nearest wind turbine impacts sales prices, and this is true regardless of the distance band.[69] As such, an absence of evidence of an Area or Nuisance Stigma is found in the Base Model. That notwithstanding, the -5% coefficients for homes that sold within one mile of the nearest wind turbine require further scrutiny. Even though the differences are not found to be statistically significant, they might point to effects that exist but are too small for the model to deem statistically significant due to the relatively small number of homes in the sample within 1 mile of the nearest turbine. Alternatively, these homes may simply have been devalued even before the wind facility was erected, and that devaluation may have carried over into the post construction period (the period investigated by the Base Model). To explore these possibilities, transactions that occurred well before the announcement of the wind facility to well after construction are investigated in the Temporal Aspects Model in the following "Alternative Models" section.

[69] It is worth noting that the number of cases in each of these categories (e.g., n = 67 for homes inside of 3000 feet and n = 58 between 3000 feet and one mile) are small, but are similar to the numbers of cases for other variables in the same model (e.g., LOW CONDITION, n = 69; PREMIUM VISTA, n = 75), the estimates of which were found to be significant above the 1% level.

Table 10: Results from the Base Model

	Coef.	SE	p Value	*n*
Intercept	7.62	0.18	0.00	
Nbr_LN_SalePrice96_hat	0.29	0.02	0.00	4,937
AgeatSale	-0.006	0.0004	0.00	4,937
AgeatSale_Sqrd	0.00002	0.000003	0.00	4,937
Sqft_1000	0.28	0.01	0.00	4,937
Acres	0.02	0.00	0.00	4,937
Baths	0.09	0.01	0.00	4,937
ExtWalls_Stone	0.21	0.02	0.00	1,486
CentralAC	0.09	0.01	0.00	2,575
Fireplace	0.11	0.01	0.00	1,834
FinBsmt	0.08	0.02	0.00	673
Cul_De_Sac	0.10	0.01	0.00	992
Water_Front	0.33	0.04	0.00	87
Cnd_Low	-0.45	0.05	0.00	69
Cnd_BAvg	-0.24	0.02	0.00	350
Cnd_Avg	Omitted	Omitted	Omitted	2,727
Cnd_AAvg	0.14	0.01	0.00	1,445
Cnd_High	0.23	0.02	0.00	337
Vista_Poor	-0.21	0.02	0.00	310
Vista_BAvg	-0.08	0.01	0.00	2,857
Vista_Avg	Omitted	Omitted	Omitted	1,247
Vista_AAvg	0.10	0.02	0.00	448
Vista_Prem	0.13	0.04	0.00	75
WAOR	Omitted	Omitted	Omitted	519
TXHC	-0.75	0.03	0.00	1,071
OKCC	-0.44	0.02	0.00	476
IABV	-0.24	0.02	0.00	605
ILLC	-0.09	0.03	0.00	213
WIKCDC	-0.14	0.02	0.00	725
PASC	-0.31	0.03	0.00	291
PAWC	-0.07	0.03	0.01	222
NYMCOC	-0.20	0.03	0.00	346
NYMC	-0.15	0.02	0.00	469
Post_Con_NoView	Omitted	Omitted	Omitted	4,207
View_Minor	-0.01	0.01	0.40	561
View_Mod	0.02	0.03	0.58	106
View_Sub	-0.01	0.07	0.94	35
View_Extrm	0.02	0.09	0.80	28
Mile_Less_0_57	-0.05	0.06	0.40	67
Mile_0_57to1	-0.05	0.05	0.30	58
Mile_1to3	0.00	0.02	0.80	2,019
Mile_3to5	0.02	0.01	0.23	1,923
Mile_Gtr5	Omitted	Omitted	Omitted	870

"Omitted" = reference category for fixed effects variables
"n" indicates number of cases in category when category = "1"

Model Information

Model Equation Number	**1**
Dependent Variable	**LN_SalePrice96**
Number of Cases	**4937**
Number of Predictors (k)	**37**
F Statistic	**442.8**
Adjusted R Squared	**0.77**

5. Alternative Hedonic Models

The Base Hedonic Model presented in Section 4 found that residential property values have, on average, not been measurably affected by the presence of nearby wind facilities. To test the robustness of this result and to test for other possible impacts from nearby wind projects, the report now turns to a number of other hedonic models. These Alternative Models were created to investigate different approaches to exploring the impact of the variables of interest (#1 and #2, below) and to assess the presence of impacts that are not otherwise fully captured by the Base Model (#3 through #6, below).

1) **View and Distance Stability Models:** Using only post-construction transactions (the same as the Base Model) these models investigate whether the Scenic Vista Stigma (as measured with VIEW) results are independent of the Nuisance and Area Stigma results (as measured by DISTANCE) and vice versa.[70]
2) **Continuous Distance Model:** Using only post-construction transactions, this model investigates Area and Nuisance Stigmas by applying a continuous distance parameter as opposed to the categorical variables for distance used in the previous models.
3) **All Sales Model:** Using all transactions, this model investigates whether the results for the three stigmas change if transactions that occurred before the announcement and construction of the wind facility are included in the sample.
4) **Temporal Aspects Model:** Using all transactions, this model further investigates Area and Nuisance Stigmas and how they change for homes that sold more than two years pre-announcement through the period more than four years post-construction.
5) **Home Orientation Model:** Using only post-construction transactions, this model investigates the degree to which a home's orientation to the view of wind turbines affects sales prices.
6) **View and Vista Overlap Model:** Using only post-construction transactions, this model investigates the degree to which the overlap between the view of a wind facility and a home's primary scenic vista affects sales prices.

Each of these models is described in more depth in the pages that follow. Results are shown for the variables of interest only; full results are contained in Appendix H.

5.1. View and Distance Stability Models

The Base Model (equation 1) presented in Section 4 includes both DISTANCE and VIEW variables because a home's value might be affected in part by the magnitude of the view of a nearby wind facility and in part by the distance from the home to that facility. These two variables may be related, however, in-so-far as homes that are located closer to a wind facility are likely to have a more-dominating view of that facility. To explore the degree to which these two sets of variables are independent of each other (i.e. not collinear) and to further test the robustness of the Base Model results two alternative hedonic models are run, each of which includes only one of the sets of parameters (DISTANCE or VIEW). Coefficients from these models are then compared to the Base Model results.

[70] Recall that the qualitative VIEW variable incorporated the visible distance to the nearest wind facility.

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5.1.1. Dataset and Model Form

The same dataset is used as in the Base Model, focusing again on post-construction transactions (n = 4,937). To investigate DISTANCE effects alone the following model is estimated:

$$\ln(\mathrm{P}) = \beta_0 + \beta_1 \mathrm{N} + \sum_{\mathrm{s}} \beta_2 \mathrm{S} + \sum_{\mathrm{k}} \beta_3 \mathrm{X} + \sum_{\mathrm{d}} \beta_5 \mathrm{DISTANCE} + \varepsilon \quad (2)$$

where
P represents the inflation-adjusted sales price,
N is the spatially weighted neighbors' predicted sales price,
S is the vector of *s* Study Area fixed effects variables (e.g., WAOR, OKCC, etc.),
X is a vector of *k* home and site characteristics (e.g., acres, square feet, number of bathrooms, condition of the home, age of home, VISTA, etc.),
DISTANCE is a vector of *d* categorical distance variables (e.g., less than 3000 feet, between one and three miles, etc.),
β_0 is the constant or intercept across the full sample,
β_1 is a parameter estimate for the spatially weighted neighbor's predicted sales price,
β_2 is a vector of *s* parameter estimates for the study area fixed effects as compared to transactions of homes in the WAOR study area,
β_3 is a vector of *k* parameter estimates for the home and site characteristics,
β_5 is a vector of *d* parameter estimates for the DISTANCE variables as compared to transactions of homes situated outside of five miles, and
ε is a random disturbance term.

The parameters of primary interest are β_5, which represent the marginal differences between home values at various distances from the wind turbines as compared to the reference category of homes outside of five miles. These coefficients can then be compared to the same coefficients estimated from the Base Model.

Alternatively, to investigate the VIEW effects alone, the following model is estimated:

$$\ln(\mathrm{P}) = \beta_0 + \beta_1 \mathrm{N} + \sum_{\mathrm{s}} \beta_2 \mathrm{S} + \sum_{\mathrm{k}} \beta_3 \mathrm{X} + \sum_{\mathrm{v}} \beta_4 \mathrm{VIEW} + \varepsilon \quad (3)$$

where
VIEW is a vector of *v* categorical view variables (e.g., MINOR, MODERATE, etc.),
β_4 is a vector of *v* parameter estimates for the VIEW variables, and
all other components are as defined in equation (2).

The parameters of primary interest in this model are β_4, which represent the marginal differences between home values for homes with varying views of wind turbines at the time of sale as compared to the reference category of homes without a view of those turbines. Again, these coefficients can then be compared to the same coefficients estimated from the Base Model.

Our expectation for both of the models described here is that the results will not be dramatically different from the Base Model, given the distribution of VIEW values across the DISTANCE values, and vice versa, as shown in Table 11. Except for EXTREME view, which is

concentrated inside of 3000 feet, all view ratings are adequately distributed among the distance categories.

Table 11: Frequency Crosstab of VIEW and DISTANCE Parameters

	Inside 3000 Feet	Between 3000 Feet and 1 Mile	Between 1 and 3 Miles	Between 3 and 5 Miles	Outside 5 Miles	Total
No View	6	12	1653	1695	841	**4207**
Minor View	14	24	294	202	27	**561**
Moderate View	8	13	62	21	2	**106**
Substantial View	11	9	10	5	0	**35**
Extreme View	28	0	0	0	0	**28**
TOTAL	**67**	**58**	**2019**	**1923**	**870**	**4937**

5.1.2. Analysis of Results

Summarized results for the variables of interest from the Base Model and the two Alternative Stability Models are presented in Table 12. (For brevity, the full set of results for the models is not shown in Table 12, but is instead included in Appendix H.) The adjusted R^2 for the View and Distance Stability Models is the same as for the Base Model, 0.77. All study area, spatial adjustment, and home and site characteristics are significant at or above the one percent level and are similar in magnitude to the estimates presented earlier for the Base Model.

The DISTANCE and VIEW coefficients, β_5 and β_4, are stable, changing no more than 3%, with most (7 out of 8) not experiencing a change greater than 1%. In all cases, changes to coefficient estimates for the variables of interest are considerably less than the standard errors. Based on these results, there is confidence that the correlation between the VIEW and DISTANCE variables is not responsible for the findings and that these two variables are adequately independent to be included in the same hedonic model regression. As importantly, no evidence of Area, Scenic Vista, or Nuisance Stigma is found in the sample, as none of the VIEW or DISTANCE variables are found to be statistically different from zero.

Table 12: Results from Distance and View Stability Models

		Base Model			Distance Stability			View Stability		
Variables of Interest	***n***	**Coef**	**SE**	**p Value**	**Coef**	**SE**	**p Value**	**Coef**	**SE**	**p Value**
No View	4207	Omitted	Omitted	Omitted				Omitted	Omitted	Omitted
Minor View	561	-0.01	0.01	0.39				-0.02	0.01	0.24
Moderate View	106	0.02	0.03	0.57				0.00	0.03	0.90
Substantial View	35	-0.01	0.07	0.92				-0.04	0.06	0.45
Extreme View	28	0.02	0.09	0.77				-0.03	0.06	0.58
Inside 3000 Feet	67	-0.05	0.06	0.31	-0.04	0.04	0.25			
Between 3000 Feet and 1 Mile	58	-0.05	0.05	0.20	-0.06	0.05	0.17			
Between 1 and 3 Miles	2019	0.00	0.02	0.80	-0.01	0.02	0.71			
Between 3 and 5 Miles	1923	0.02	0.01	0.26	0.01	0.01	0.30			
Outside 5 Miles	870	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted			

"Omitted" = reference category for fixed effects variables. "n" indicates number of cases in category when category = "1"

Model Information

Model Equation Number	**1**	**2**	**3**
Dependent Variable	**LN_SalePrice96**	**LN_SalePrice96**	**LN_SalePrice96**
Number of Cases	**4937**	**4937**	**4937**
Number of Predictors (k)	**37**	**33**	**33**
F Statistic	**442.8**	**496.7**	**495.9**
Adjusted R Squared	**0.77**	**0.77**	**0.77**

5.2. Continuous Distance Model

The potential impact of wind facilities on residential property values based on Area and Nuisance effects was explored with the Base Model by using five ordered categorical DISTANCE variables. This approach was used in order to impose the least restriction on the functional relationship between distance and property values (as discussed in footnote 52 on page 25). The literature on environmental disamenities, however, more commonly uses a continuous distance form (e.g., Sims et al., 2008), which imposes more structure on this relationship. To be consistent with the literature and to test if a more rigid structural relationship might uncover an effect that is not otherwise apparent with the five distance categories used in the Base Model, a hedonic model that relies upon a continuous distance variable is presented here. One important benefit of this model is that a larger amount of data (e.g., n = 4,937) is used to estimate the continuous DISTANCE coefficient then was used to estimate any of the individual categorical estimates in the Base Model (e.g., n = 67 inside 3000 feet, n = 2019 between one and three miles). The Continuous Distance Model therefore provides an important robustness test to the Base Model results.

5.2.1. Dataset and Model Form

A number of different functional forms can be used for a continuous DISTANCE variable, including linear, inverse, cubic, quadratic, and logarithmic. Of the forms that are considered, an inverse function seemed most appropriate.[71] Inverse functions are used when it is assumed that any effect is most pronounced near the disamenity and that those effects fade asymptotically as distance increases. This form has been used previously in the literature (e.g., Leonard et al., 2008) to explore the impact of disamenities on home values, and is calculated as follows:

$$\text{InvDISTANCE} = 1/\text{DISTANCE} \tag{4}$$

where
DISTANCE is the distances to the nearest turbine from each home as calculated at the time of sale for homes that sold in the post-construction period.

For the purpose of the Continuous Distance Model, the same dataset is used as in the Base Model, focusing again on post-construction transactions (n = 4,937). InvDISTANCE has a maximum of 6.67 (corresponding to homes that were 0.15 miles, or roughly 800 feet, from the nearest wind turbine), a minimum of 0.09 (corresponding to a distance of roughly 11 miles), and a mean of 0.38 (corresponding to a distance of 2.6 miles). This function was then introduced into the hedonic model in place of the DISTANCE categorical variables as follows:

$$\ln(\text{P}) = \beta_0 + \beta_1\text{N} + \sum_{\text{s}}\beta_2\text{S} + \sum_{\text{k}}\beta_3\text{X} + \sum_{\text{v}}\beta_4\text{VIEW} + \beta_5\text{InvDISTANCE} + \varepsilon \tag{5}$$

where
$\text{InvDISTANCE}_\text{i}$ is the inverse of the distance to the nearest turbine,
β_5 is a parameter estimate for the inverse of the distance to the nearest turbine, and

[71] The other distance functions (e.g., linear, quadratic, cubic & logarithmic) were also tested. Additionally, two-part functions with interactions between continuous forms (e.g., linear) and categorical (e.g., less than one mile) were investigated. Results from these models are briefly discussed below in footnote 72.

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all other components are as defined in equation (1).

The coefficient of interest in this model is β_5, which, if effects exist, would be expected to be negative, indicating an adverse effect from proximity to the wind turbines.

5.2.2. Analysis of Results

Results for the variables of interest in the Continuous Distance Model and the Base Model are shown in Table 13. (For brevity, the full set of results for the model is not shown in Table 13, but is instead included in Appendix H.) The model performs well with an adjusted R^2 of 0.77. All study area, spatial adjustment, and home and site characteristics are significant at the one percent level. The coefficients for VIEW are similar to those found in the Base Model, demonstrating stability in results, and none are statistically significant. These results support the previous findings of a lack of evidence of a Scenic Vista Stigma.

Our focus variable InvDISTANCE produces a coefficient (β_5) that is slightly negative at -1%, but that is not statistically different from zero (*p* value 0.41), implying again that there is no statistical evidence of a Nuisance Stigma effect nor an Area Stigma effect and confirming the results obtained in the Base Model.[72]

Table 13: Results from Continuous Distance Model

	Base Model				Continuous Distance			
Variables of Interest	**Coef**	**SE**	**p Value**	***n***	**Coef**	**SE**	**p Value**	***n***
No View	Omitted	Omitted	Omitted	4,207	Omitted	Omitted	Omitted	4,207
Minor View	-0.01	0.01	0.39	561	-0.01	0.01	0.32	561
Moderate View	0.02	0.03	0.57	106	0.01	0.03	0.77	106
Substantial View	-0.01	0.07	0.92	35	-0.02	0.07	0.64	35
Extreme View	0.02	0.09	0.77	28	0.01	0.10	0.85	28
Inside 3000 Feet	-0.05	0.06	0.31	67				
Between 3000 Feet and 1 Mile	-0.05	0.05	0.20	58				
Between 1 and 3 Miles	0.00	0.02	0.80	2,019				
Between 3 and 5 Miles	0.02	0.01	0.26	1,923				
Outside 5 Miles	Omitted	Omitted	Omitted	870				
InvDISTANCE					-0.01	0.02	0.41	4,937

"Omitted" = reference category for fixed effects variables. "n" = number of cases in category when category = "1"

Model Information

Model Equation Number	**1**	**5**
Dependent Variable	**LN_SalePrice96**	**LN_SalePrice96**
Number of Cases	**4937**	**4937**
Number of Predictors (k)	**37**	**34**
F Statistic	**442.8**	**481.3**
Adjusted R Squared	**0.77**	**0.77**

5.3. All Sales Model

The Base Model presented earlier relied on only those transactions that occurred after the construction of the relevant wind facility. This approach, however, leaves open two key questions. First, it is possible that the property values of all of the post-construction homes in the

[72] As mentioned in footnote 71 on page 36, a number of alternative forms of the continuous distance function were also explored, including two-part functions, with no change in the results presented here. In all cases the resulting continuous distance function was not statistically significant.

sample have been affected by the presence of a wind facility, and therefore that the reference homes in the Base Model (i.e., those homes outside of five miles with no view of a wind turbine) are an inappropriate comparison group because they too have been impacted.[73] Using only those homes that sold before the announcement of the wind facility (pre-announcement) as the reference group would, arguably, make for a better comparison because the sales price of those homes are not plausibly impacted by the presence of the wind facility.[74] Second, the Base Model does not consider homes that sold in the post-announcement but pre-construction period, and previous research suggests that property value effects might be very strong during this period, during which an assessment of actual impacts is not possible and buyers and sellers may take a more-protective and conservative stance (Wolsink, 1989). This subsection therefore presents the results of a hedonic model that uses the full set of transactions in the dataset, pre- and post-construction.

5.3.1. Dataset and Model Form

Unlike the Base Model, in this instance the full set of 7,459 residential transactions is included. The following model is then estimated:

$$\ln(\mathrm{P}) = \beta_0 + \beta_1 \mathrm{N} + \sum_{\mathrm{s}} \beta_2 \mathrm{S} + \sum_{\mathrm{k}} \beta_3 \mathrm{X} + \sum_{\mathrm{v}} \beta_4 \mathrm{VIEW} + \sum_{\mathrm{d}} \beta_5 \mathrm{DISTANCE} + \varepsilon \qquad (6)$$

where
VIEW is a vector of *v* categorical view variables (e.g., NONE, MINOR, MODERATE, etc.),
DISTANCE is a vector of *d* categorical distance variables (e.g., less than 3000 feet, between one and three miles, outside of five mile, etc.),
β_4 is a vector of *v* parameter estimates for the VIEW variables as compared to pre-construction transactions,
β_5 is a vector of *d* parameter estimates for the DISTANCE variables as compared to pre-announcement transactions, and
all other components are as defined in equation (1).

It is important to emphasize that the VIEW and DISTANCE parameters in equation (6) have different reference categories than they do in the Base Model - equation (1). In the Base Model, DISTANCE and VIEW are estimated in the post-construction period in reference to homes that sold outside of five miles and with no view of the turbines respectively.[75] In the All Sales Model, on the other hand, the coefficients for VIEW (β_4) are estimated in reference to all pre-construction transactions (spanning the pre-announcement and post-announcement-pre-construction periods) and the coefficients for DISTANCE (β_5) are estimated in reference to all pre-announcement transactions. In making a distinction between the reference categories for VIEW and DISTANCE, it is assumed that awareness of the view of turbines and awareness of

[73] This might be the case if there is an Area Stigma that includes the reference homes.

[74] As discussed in footnote 47 on page 19, it is conceivable that awareness might occur prior to the "announcement" date used for this analysis. If true, this bias is likely to be sporadic in nature and less of an issue in this model, when all pre-announcement transactions are pooled (e.g., both transactions near and far away from where the turbines were eventually located) than in models presented later (e.g., temporal aspects model). Nonetheless, if present, this bias may weakly draw down the pre-announcement reference category.

[75] See Section 4.1 and also footnote 51 on page 24 for more information on why the post-construction dataset and five-mile-no-view homes reference category are used in the Base Model.

the distance from them might not occur at the same point in the development process. Specifically, it is assumed that VIEW effects largely occur after the turbines are erected, in the post-construction period, but that DISTANCE effects might occur in the post-announcement-pre-construction timeframe. For example, after a wind facility is announced, it is not atypical for a map of the expected locations of the turbines to be circulated in the community, allowing home buyers and sellers to assess the distance of the planned facility from homes. Because of this assumed difference in when awareness begins for VIEW and DISTANCE, the DISTANCE variable is populated for transactions occurring in the post-announcement-pre-construction period as well as the post-construction period (see Table 14 below), but the VIEW variable is populated only for transactions in the post-construction period – as they were in the Base Model.[76]

Table 14: Frequency Summary for DISTANCE in All Sales Model

	< 0.57 Miles	0.57 - 1 Miles	1 - 3 Miles	3 - 5 Miles	> 5 Miles	Total
Post-Construction	67	58	2019	1923	870	**4937**
Post-Announcement-Pre-Construction	13	7	340	277	130	**767**
TOTAL	**80**	**65**	**2359**	**2200**	**1000**	**5704**

One beneficial consequence of the differences in reference categories for the VIEW and DISTANCE variables in this model, as opposed to the Base Model, is that this model can accommodate all of the possible VIEW and DISTANCE categories, including NO VIEW transactions and transactions of homes outside of five miles. Because of the inclusion of these VIEW and DISTANCE categories, the tests to investigate Area, Scenic Vista, and Nuisance Stigmas are slightly different in this model than in the Base Model. For Area Stigma, for example, how homes with no view of the turbines fared can now be tested; if they are adversely affected by the presence of the wind facility, then this would imply a pervasive Area Stigma impact. For Scenic Vista Stigma, the VIEW coefficients (MINOR, MODERATE, etc.) can be compared (using a *t*-Test) to the NO VIEW results; if they are significantly different, a Scenic Vista Stigma would be an obvious culprit. Finally, for Nuisance Stigma, the DISTANCE coefficients inside of one mile can be compared (using a *t*-Test) to those outside of five miles; if there is a significant difference between these two categories of homes, then homes are likely affected by their proximity to the wind facility.

5.3.2. Analysis of Results

Results for the variables of interest for this hedonic model are summarized in Table 15, and Base Model results are shown for comparison purposes. (For brevity, the full set of results for the model is not shown in Table 15, but is instead included in Appendix H.) The adjusted R^2 for the model is 0.75, down slightly from 0.77 for the Base Model, and indicating that this model has slightly more difficulty (i.e. less explanatory power) modeling transactions that occurred pre-

[76] It is conceivable that VIEW effects could occur before the turbines are constructed. In some cases, for example, developers will simulate what the project will look like after construction during the post-announcement but pre-construction timeframe. In these situations, home buyers and sellers might adjust home values accordingly based on the expected views of turbines. It is assumed, however, that such adjustments are likely to be reasonably rare, and VIEW effects are therefore estimated using only post-construction sales.

construction.[77] All study area, spatial adjustment, and home and site characteristics are significant at or above the one percent level and are similar in sign and magnitude to the estimates derived from the post-construction Base Model.

The VIEW coefficients (β_4) are clearly affected by the change in reference category. All of the VIEW parameter estimates are higher than the Base Model estimates for the same categories. Of particular interest is the NO VIEW coefficient, which represents the values of homes without a view of the turbines and that sold in the post-construction period, as compared to the mean value of homes that sold in the pre-construction period, all else being equal. These homes, on average, are estimated to sell for 2% (*p* value 0.08) more than similar pre-construction homes. If an Area Stigma existed, a negative coefficient for these NO VIEW homes would be expected. Instead, a positive and statistically significant coefficient is found.[78] It is outside the ability of this study to determine whether the increase is directly related to the wind turbines, or whether some other factor is impacting these results, but in either instance, no evidence of a pervasive Area Stigma associated with the presence of the wind facilities is found.

To test for the possibility of Scenic Vista Stigma, the coefficients for MINOR, MODERATE, SUBSTANTIAL, and EXTREME views can be compared to the NO VIEW coefficient using a simple *t*-Test. Table 16 presents these results. As shown, no significant difference is found for any of the VIEW coefficients when compared to NO VIEW transactions. This reinforces the findings earlier that, within the sample at least, there is no evidence of a Scenic Vista Stigma.

The DISTANCE parameter estimates (β_5) are also found to be affected by the change in reference category, and all are lower than the Base Model estimates for the same categories. This result likely indicates that the inflation-adjusted mean value of homes in the pre-announcement period is slightly higher, on average, than for those homes sold outside of five miles in the post-construction period. This difference could be attributed to the inaccuracy of the inflation index, a pervasive effect from the wind turbines, or to some other cause. Because the coefficients are not systematically statistically significant, however, this result is not pursued further. What is of interest, however, is the negative 8% estimate for homes located between 3000 feet and one mile of the nearest wind turbine (*p* value 0.03). To correctly interpret this result, and to compare it to the Base Model, one needs to discern if this coefficient is significantly different from the estimate for homes located outside of five miles, using a *t*-Test.

The results of this *t*-Test are shown in Table 17. The coefficient differences are found to be somewhat monotonically ordered. Moving from homes within 3000 feet (-0.06, *p* value 0.22), and between 3000 feet and one mile (-0.08, *p* value 0.04), to between one and three miles (0.00, *p* value 0.93) and between three and five miles (0.01, *p* value 0.32) the DISTANCE coefficients are found to generally increase. Nonetheless, none of these coefficients are statistically significant except one, homes that sold between 3000 feet and one mile. The latter finding suggests the possibility of Nuisance Stigma. It is somewhat unclear why an effect would be found in this model, however, when one was not evident in the Base Model. The most likely

[77] This slight change in performance is likely due to the inaccuracies of home and site characteristics and the inflation adjustment for homes that sold in the early part of the study period. This is discussed in more detail in footnote 50 on page 23.

[78] For more on the significance level used for this report, see footnote 68 on page 30.

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explanation is that the additional homes that are included in this model, specifically those homes that sold post-announcement but pre-construction, are driving the results. A thorough investigation of these "temporal" issues is provided in the next subsection.

In summation, no evidence is found of an Area or Scenic Vista Stigma in this alternative hedonic model, but some limited not-conclusive evidence of a Nuisance Stigma is detected. To further explore the reliability of this latter result, the analysis now turns to the Temporal Aspects Model.

Table 15: Results from All Sales Model

	Base Model				All Sales			
Variables of Interest	**Coef**	**SE**	**p Value**	***n***	**Coef**	**SE**	**p Value**	***n***
Pre-Construction Sales	n/a	n/a	n/a	n/a	Omitted	Omitted	Omitted	2,522
No View	Omitted	Omitted	Omitted	4,207	0.02	0.01	0.08	4,207
Minor View	-0.01	0.01	0.39	561	0.00	0.02	0.77	561
Moderate View	0.02	0.03	0.57	106	0.03	0.03	0.41	106
Substantial View	-0.01	0.07	0.92	35	0.03	0.07	0.53	35
Extreme View	0.02	0.09	0.77	28	0.06	0.08	0.38	28
Inside 3000 Feet	-0.05	0.06	0.31	67	-0.06	0.05	0.18	80
Between 3000 Feet and 1 Mile	-0.05	0.05	0.20	58	-0.08	0.05	0.03	65
Between 1 and 3 Miles	0.00	0.02	0.80	2,019	0.00	0.01	0.80	2,359
Between 3 and 5 Miles	0.02	0.01	0.26	1,923	0.01	0.01	0.59	2,200
Outside 5 Miles	Omitted	Omitted	Omitted	870	0.00	0.02	0.78	1,000
Pre-Announcement Sales	n/a	n/a	n/a	n/a	Omitted	Omitted	Omitted	1,755

"Omitted" = reference category for fixed effects variables. "n" = number of cases in category when category = "1"

Model Information

Model Equation Number	**1**	**6**
Dependent Variable	**LN_SalePrice96**	**LN_SalePrice96**
Number of Cases	**4937**	**7459**
Number of Predictors (k)	**37**	**39**
F Statistic	**442.8**	**579.9**
Adjusted R Squared	**0.77**	**0.75**

Table 16: Results from Equality Test of VIEW Coefficients in the All Sales Model

	No View	**Minor View**	**Moderate View**	**Substantial View**	**Extreme View**
n	4,207	561	106	35	28
Coefficient	0.02	0.00	0.03	0.03	0.06
Coefficient Difference *	Reference	-0.02	0.00	0.01	0.04
Variance	0.0001	0.0003	0.0009	0.0030	0.0050
Covariance	n/a	0.00011	0.00010	0.00009	0.00008
Df	n/a	7419	7419	7419	7419
***t*-Test**	n/a	-1.20	0.17	0.23	0.58
Significance	n/a	0.23	0.87	0.82	0.57

** Differences are rounded to the nearest second decimal place.*
"n" = number of cases in category when category = "1"

Table 17: Results from Equality Test of DISTANCE Coefficients in the All Sales Model

	Inside 3000 Feet	Between 3000 Feet and 1 Mile	Between 1 and 3 Miles	Between 3 and 5 Miles	Outside 5 Miles
n	80	65	2,359	2,200	1,000
Coefficient	-0.06	-0.08	0.00	0.01	0.00
Coefficient Difference *	-0.05	-0.08	0.00	0.01	Reference
Variance	0.0019	0.0015	0.0002	0.0002	0.0003
Covariance	0.00010	0.00013	0.00013	0.00015	n/a
Df	7419	7419	7419	7419	n/a
***t* Test**	-1.23	-2.06	0.09	1.00	n/a
Significance	0.22	0.04	0.93	0.32	n/a

** Differences are rounded to the nearest second decimal place.*
"n" = number of cases in category when category = "1"

5.4. Temporal Aspects Model

Based on the results of the All Sales Model, a more thorough investigation of how Nuisance and Area Stigma effects might change throughout the wind project development period is warranted. As discussed previously, there is some evidence that property value impacts may be particularly strong after the announcement of a disamenity, but then may fade with time as the community adjusts to the presence of that disamenity (e.g., Wolsink, 1989). The Temporal Aspects Model presented here allows for an investigation of how the different periods of the wind project development process affect estimates for the impact of DISTANCE on sales prices.

5.4.1. Dataset and Model Form

Here the full set of 7,459 residential transactions is used, allowing an exploration of potential property value impacts (focusing on the DISTANCE variable) throughout time, including in the pre-construction period. The following model is then estimated:

$$\ln(\mathrm{P}) = \beta_0 + \beta_1 \mathrm{N} + \sum_{\mathrm{s}} \beta_2 \mathrm{S} + \sum_{\mathrm{k}} \beta_3 \mathrm{X} + \sum_{\mathrm{v}} \beta_4 \mathrm{VIEW} + \sum_{\mathrm{y}} \beta_5 (\mathrm{DISTANCE} \cdot \mathrm{PERIOD}) + \varepsilon \qquad (7)$$

where
DISTANCE is a vector of categorical distance variables (e.g., less than one mile, between one and three miles, etc.),
PERIOD is a vector of categorical development period variables (e.g., after announcement and before construction, etc.),
β_5 is a vector of *y* parameter estimates for each DISTANCE and PERIOD category as compared to the transactions more than two years before announcement and outside of five miles, and all other components are as defined in equation (1).

The PERIOD variable contains six different options:
1) More than two years before announcement;
2) Less than two years before announcement;
3) After announcement but before construction;
4) Less than two years after construction;
5) Between two and four years after construction; and

6) More than four years after construction.

In contrast to the Base Model, the two DISTANCE categories inside of one mile are collapsed into a single "less than one mile" group. This approach increases the number of transactions in each crossed subcategory of data, and therefore enhances the stability of the parameter estimates and decreases the size of the standard errors, thus providing an increased opportunity to discover statistically significant effects. Therefore, in this model the DISTANCE variable contains four different options:

1) Less than one mile;
2) Between one and three miles;
3) Between three and five miles; and
4) Outside of five miles.[79]

The number of transactions in each of the DISTANCE and PERIOD categories is presented in Table 18.

The coefficients of interest are β_5, which represent the vector of marginal differences between homes sold at various distances from the wind facility (DISTANCE) during various periods of the development process (PERIOD) as compared to the reference group. The reference group in this model consists of transactions that occurred more than two years before the facility was announced for homes that were situated more than five miles from where the turbines were ultimately constructed. It is assumed that the value of these homes would not be affected by the future presence of the wind facility. The VIEW parameters, although included in the model, are not interacted with PERIOD and therefore are treated as controlling variables.[80]

Although the comparisons of these categorical variables between different DISTANCE and PERIOD categories is be interesting, it is the comparison of coefficients within each PERIOD and DISTANCE category that is the focus of this section. Such comparisons, for example, allow one to compare how the average value of homes inside of one mile that sold two years before announcement compare to the average value of homes inside of one mile that sold in the post-announcement-pre-construction period. For this comparison, a *t*-Test similar to that in the All Sales Model is used.

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[79] For homes that sold in the pre-construction time frame, no turbines yet existed, and therefore DISTANCE is created using a proxy: the Euclidian distance to where the turbines were eventually constructed. This approach introduces some bias when there is more than one facility in the study area. Conceivably, a home that sold in the post-announcement-pre-construction period of one wind facility could also be assigned to the pre-announcement period of another facility in the same area. For this type of sale, it is not entirely clear which PERIOD and DISTANCE is most appropriate, but every effort was made to apply the sale to the wind facility that was most likely to have an impact. In most cases this meant choosing the closest facility, but in some cases, when development periods were separated by many years, simply the earliest facility was chosen. In general, any bias created by these judgments is expected to be minimal because, in the large majority of cases, the development process in each study area was more-or-less continuous and focused in a specific area rather then being spread widely apart.

[80] As discussed earlier, the VIEW variable was considered most relevant for the post-construction period, so delineations based on development periods that extended into the pre-construction phase were unnecessary. It is conceivable, however, that VIEW effects vary in periods following construction, such as in the first two years or after that. Although this is an interesting question, the numbers of cases for the SUBSTANTIAL and EXTREME ratings – even if combined – when divided into the temporal periods were too small to be fruitful for analysis.

Table 18: Frequency Crosstab of DISTANCE and PERIOD

	More Than 2 Years Before Announcement	Less Than 2 Years Before Announcement	After Announcement Before Construction	Less Than 2 Years After Construction	Between 2 and 4 Years After Construction	More Than 4 Years After Construction	Total
Less Than 1 Mile	38	40	20	39	45	43	**225**
Between 1 and 3 Miles	283	592	340	806	502	709	**3,232**
Between 3 and 5 Miles	157	380	277	572	594	757	**2,737**
Outside of 5 Miles	132	133	130	218	227	425	**1,265**
TOTAL	**610**	**1,145**	**767**	**1,635**	**1,368**	**1,934**	**7,459**

5.4.2. Analysis of Results

Results for the variables of interest for this hedonic model are presented in Table 19; as with previous models, the full set of results is contained in Appendix H. Similar to the All Sales Model discussed in the previous section, the adjusted R^2 for the model is 0.75, down slightly from 0.77 for the Base Model, and indicating that this model has slightly more difficulty (i.e., less explanatory power) modeling transactions that occurred before wind facility construction. All study area, spatial adjustment, and home and site characteristics are significant at or above the one percent level, are of the appropriate sign, and are similar in magnitude to the estimates derived from the post-construction Base Model.

All of the DISTANCE / PERIOD interaction coefficients for distances outside of one mile are relatively small ($-0.04 < \beta_5 < 0.02$) and none are statistically significant. This implies that there are no statistically significant differences in property values between the reference category homes – homes sold more than two years before announcement that were situated outside of five miles from where turbines were eventually erected – and any of the categories of homes that sold outside of one mile at any other period in the wind project development process. These comparisons demonstrate, arguably more directly than any other model presented in this report that Area Stigma effects likely do not exist in the sample.

The possible presence of a Nuisance Stigma is somewhat harder to discern. For homes that sold inside of one mile of the nearest wind turbine, in three of the six periods there are statistically significant negative differences between average property values when compared to the reference category. Transactions completed more than two years before facility announcement are estimated to be valued at 13% less (*p* value 0.02) than the reference category, transactions less than two years before announcement are 10% lower (*p* value 0.06), and transactions after announcement but before construction are 14% lower (*p* value 0.04). For other periods, however, these marginal differences are considerably smaller and are not statistically different from the reference category. Sales prices in the first two years after construction are, on average, 9% less (*p* value 0.15), those occurring between three and four years following construction are, on average, 1% less (*p* value 0.86), and those occurring more than four years after construction are, on average, 7% less (*p* value 0.37).

Table 19: Results from Temporal Aspects Model

Variables of Interest		Temporal Aspects			
		Coef	SE	p Value	*n*
Inside 1 Mile	More Than 2 Years Before Announcement	-0.13	0.06	0.02	38
	Less Than 2 Years Before Announcement	-0.10	0.05	0.06	40
	After Announcement Before Construction	-0.14	0.06	0.04	21
	2 Years After Construction	-0.09	0.07	0.11	39
	Between 2 and 4 Years After Construction	-0.01	0.06	0.85	44
	More Than 4 Years After Construction	-0.07	0.08	0.22	42
Between 1-3 Miles	More Than 2 Years Before Announcement	-0.04	0.03	0.18	283
	Less Than 2 Years Before Announcement	0.00	0.03	0.91	592
	After Announcement Before Construction	-0.02	0.03	0.54	342
	2 Years After Construction	0.00	0.03	0.90	807
	Between 2 and 4 Years After Construction	0.01	0.03	0.78	503
	More Than 4 Years After Construction	0.00	0.03	0.93	710
Between 3-5 Miles	More Than 2 Years Before Announcement	0.00	0.04	0.92	157
	Less Than 2 Years Before Announcement	0.00	0.03	0.97	380
	After Announcement Before Construction	0.00	0.03	0.93	299
	2 Years After Construction	0.02	0.03	0.55	574
	Between 2 and 4 Years After Construction	0.01	0.03	0.65	594
	More Than 4 Years After Construction	0.01	0.03	0.67	758
Outside 5 Miles	More Than 2 Years Before Announcement	Omitted	Omitted	Omitted	132
	Less Than 2 Years Before Announcement	-0.03	0.04	0.33	133
	After Announcement Before Construction	-0.03	0.03	0.39	105
	2 Years After Construction	-0.03	0.03	0.44	215
	Between 2 and 4 Years After Construction	0.03	0.03	0.44	227
	More Than 4 Years After Construction	0.01	0.03	0.73	424

"Omitted" = reference category for fixed effects variables.
"n" indicates number of cases in category when category = "1"

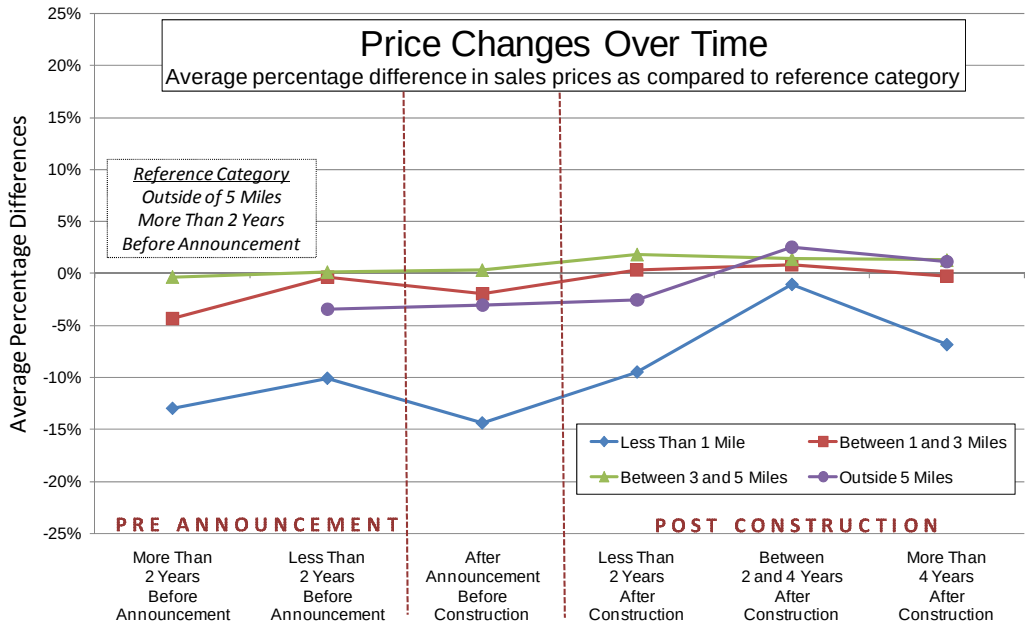
Model Information

Model Equation Number	**7**
Dependent Variable	**LN_SalePrice96**
Number of Cases	**7459**
Number of Predictors (k)	**56**
F Statistic	**404.5**
Adjusted R Squared	**0.75**

What these results suggest (as shown in Figure 8) is that homes inside of one mile in the sample, on average, were depressed in value (in relation to the reference category) before and after the announcement of the wind facility and up to the point that construction began, but that those values rebounded somewhat after construction commenced.[81] This conclusion also likely explains why a significant and negative effect for homes that sold between 3000 feet and one mile is found in the All Sales Model presented in Section 5.3: homes within this distance range that sold prior to facility construction were depressed in value and most likely drove the results for homes that sold after announcement. Regardless, these results are not suggestive of a pervasive Nuisance Stigma.

[81] As discussed in footnotes 47 (on page 19) and 74 (on page 38), the "announcement date" often refers to the first time the proposed facility appeared in the press. "Awareness" of the project in the community may precede this date, however, and therefore transactions occurring in the period "less than two years before announcement" could conceivably have been influenced by the prospective wind project, but it is considerably less likely that those in the period more than two years before announcement would have been influenced.

Figure 8: Results from the Temporal Aspects Model



The reference category consists of transactions of homes situated more than five miles from where the nearest turbine would eventually be located and that occurred more than two years before announcement of the facility

To explore Nuisance Stigma further, the analysis again turns to the *t*-Test and compares the coefficients for transactions that occurred more than two years before wind facility announcement (during which time the future wind facility is not expected to have any impact on sales prices) to the estimates for the DISTANCE coefficients in the periods that follow. These results are shown in Table 20. Focusing on those transactions inside of one mile, it is found that all coefficients are greater in magnitude than the reference category except during the post-announcement-pre-construction period (which is 1% less and is not statistically significant; *p* value 0.90), indicating, on average, that home values are increasing or staying stable from the pre-announcement reference period onward. These increases, however, are not statistically significant except in the period of two to four years after construction (0.12, *p* value 0.08). With respect to Nuisance Stigma, the more important result is that, relative to homes that sold well before the wind facility was announced, no statistically significant adverse effect is found in any period within a one mile radius of the wind facility. Therefore, the -5% (albeit not statistically significant) average difference that is found in the Base Model, and the -8% (statistically significant) result that is found in the All Sales Model (for homes between 3000 feet and one mile) appear to both be a reflection of depressed home prices that preceded the construction of the relevant wind facilities. If construction of the wind facilities were downwardly influencing the sales prices of these homes, as might be deduced from the Base or All Sales Models alone, a diminution in the inflation adjusted price would be seen as compared to pre-announcement levels. Instead, an increase is seen. As such, no persuasive evidence of a Nuisance Stigma is evident among this sample of transactions.[82]

[82] It should be noted that the numbers of study areas represented for homes situated inside of one mile but in the periods "more than two years before announcement" and "more than four years after construction" are fewer ($n = 5$) than in the other temporal categories ($n = 8$). Further, the "more than two years before announcement – inside of one mile" category is dominated by transactions from one study area (OKCC). For these reasons, there is less

Turning to the coefficient differences for distances greater than one mile in Table 20, again, no statistical evidence of significant adverse impacts on home values is uncovered. Where statistically significant differences are identified, the coefficients are greater than the reference category. These findings corroborate the earlier Area Stigma results, and re-affirm the lack of evidence for such an effect among the sample of residential transactions included in this analysis.

Table 20: Results from Equality Test of Temporal Aspects Model Coefficients

	More Than 2 Years Before Announcement	Less Than 2 Years Before Announcement	After Announcement Before Construction	Less Than 2 Years After Construction	Between 2 and 4 Years After Construction	More Than 4 Years After Construction
Less Than 1 Mile	Reference	0.03 (0.45)	-0.01 (-0.13)	0.04 (0.56)	0.12 (1.74)*	0.06 (0.88)
Between 1 and 3 Miles	Reference	0.04 (1.92)*	0.02 (0.86)	0.05 (2.47)**	0.05 (2.27)**	0.04 (1.82)*
Between 3 and 5 Miles	Reference	0.01 (0.37)	0.01 (0.34)	0.02 (0.77)	0.02 (0.78)	0.02 (0.79)
Outside of 5 Miles †	Reference	-0.04 (-0.86)	-0.03 (-0.91)	-0.03 (-0.77)	0.03 (0.81)	0.01 (0.36)

*Numbers in parenthesis are t-Test statistics. Significance = *** 1% level, ** 5% level, * 10% level, <blank> below the 10% level.*

† For homes outside of 5 miles, the coefficient differences are equal to the coefficients in the Temporal Aspects Model, and therefore the t-values were produced via the OLS.

5.5. Orientation Model

All of the hedonic models presented to this point use a VIEW variable that effectively assumes that the impact of a view of wind turbines on property values will not vary based on the orientation of the home to that view; the impact will be the same whether the view is seen from the side of the home or from the back or front. Other literature, however, has found that the impact of wind projects on property values may be orientation-dependent (Sims et al., 2008). To investigate this possibility further a parameter for orientation is included in the model.

5.5.1. Dataset and Model Form

The same dataset is used as in the Base Model, focusing on post-construction transactions (n = 4,937). To investigate whether the orientation of a home to the turbines (ORIENTATION) has a marginal impact on residential property values, over and above that of the VIEW impacts alone, the following hedonic model is estimated:[83]

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confidence in these two estimates (-13% and -7% respectively) than for the estimates for other temporal periods inside of one mile. Based on additional sensitivity analysis not included here, it is believed that if they are biased, both of these estimates are likely biased downward. Further, as discussed in footnote 47 on page 19, there is a potential for bias in the "announcement" date in that awareness of a project may precede the date that a project enters the public record (i.e., the "announcement" date used for this analysis). Taken together, these two issues might imply that the curve shown in Figure 8 for "less than one mile" transactions, instead of having a flat and then increasing shape, may have a more of an inverse parabolic (e.g., "U") shape. This would imply that a relative minimum in sales prices is reached in the period after awareness began of the facility but before construction commenced, and then, following construction, prices recovered to levels similar to those prior to announcement (and awareness). These results would be consistent with previous studies (e.g., Wolsink, 1989; Devine-Wright, 2004) but cannot be confirmed without the presence of more data. Further research on this issue is warranted. In either case, such results would not change the conclusion here of an absence of evidence of a pervasive Nuisance Stigma in the post-construction period.

[83] The various possible orientations of the home to the view of turbines will be, individually and collectively, referred to as "ORIENTATION" in this report.

$$\ln(\mathrm{P}) = \beta_0 + \beta_1 \mathrm{N} + \sum_{\mathrm{s}} \beta_2 \mathrm{S} + \sum_{\mathrm{k}} \beta_3 \mathrm{X} + \sum_{\mathrm{v}} \beta_4 \mathrm{VIEW} + \sum_{\mathrm{d}} \beta_5 \mathrm{DISTANCE} + \sum_{\mathrm{o}} \beta_6 \mathrm{ORIENTATION} + \varepsilon \quad (8)$$

where
ORIENTATION is a vector of *o* ORIENTATION variables (e.g., SIDE, FRONT, and BACK),
β_6 is a vector of *o* parameter estimates for ORIENTATION variables, and
all other components are as defined in equation (1).[84]

The ORIENTATION categories include FRONT, BACK, and SIDE, and are defined as follows:

- SIDE: The orientation of the home to the view of the turbines is from the side.
- FRONT: The orientation of the home to the view of the turbines is from the front.
- BACK: The orientation of the home to the view of the turbines is from the back.

The orientation of the home to the view of the wind facilities was determined in the course of the field visits to each home. If more than one orientation to the turbines best described the home (e.g., back and side, or front, back, and side) they were coded as such (e.g., turbines visible from back and side: SIDE = 1; BACK = 1; FRONT = 0).[85]

Not surprisingly, ORIENTATION is related to VIEW. Table 21 and Table 22 provide frequency and percentage crosstabs of ORIENTATION and VIEW. As shown, those homes with more dramatic views of the turbines generally have more ORIENTATION ratings applied to them. For instance, 25 out of 28 EXTREME VIEW homes have all three ORIENTATION ratings (i.e., FRONT, BACK, and SIDE). Virtually all of the MINOR VIEW homes, on the other hand, have only one ORIENTATION. Further, MINOR VIEW homes have roughly evenly spread orientations to the turbines across the various possible categories of FRONT, BACK, and SIDE. Conversely, a majority of the MODERATE and SUBSTANTIAL VIEW ratings coincide with an ORIENTATION from the back of the house.[86]

[84] Ideally, one would enter ORIENTATION in the model through an interaction with VIEW. There are two ways that could be accomplished: either with the construction of multiple fixed effects ("dummy") variables, which capture each sub-category of VIEW and ORIENTATION, or through a semi-continuous interaction variable, which would be created by multiplying the ordered categorical variable VIEW by an ordered categorical variable ORIENTATION. Both interaction scenarios are problematic, the former because it requires increasingly small subsets of data, which create unstable coefficient estimates, and the latter because there are no *a priori* expectations for the ordering of an ordered categorical ORIENTATION variable and therefore none could be created and used for the interaction. As a result, no interaction between the two variables is reported here.

[85] An "Angle" orientation was also possible, which was defined as being between Front and Side or Back and Side. An Angle orientation was also possible in combination with Back or Front (e.g., Back-Angle or Front-Angle). In this latter case, the orientation was coded as one of the two prominent orientations (e.g., Back or Front). An Angle orientation, not in combination with Front or Back, was coded as Side.

[86] The prevalence of BACK orientations for MODERATE and SUBSTANTIAL VIEW homes may be because BACK views might more-frequently be kept without obstruction, relative to SIDE views.

Table 21: Frequency Crosstab of VIEW and ORIENTATION

		VIEW				
		Minor	**Moderate**	**Substantial**	**Extreme**	**Total**
ORIENTATION	**Front**	217	33	17	27	**294**
	Back	164	67	24	25	**280**
	Side	194	17	15	27	**253**
	Total	**561**	**106**	**35**	**28**	**730**

Note: Total of ORIENTATION does not sum to 730 because multiple orientations are possible for each VIEW.

Table 22: Percentage Crosstab of VIEW and ORIENTATION

		VIEW				
		Minor	**Moderate**	**Substantial**	**Extreme**	**Total**
ORIENTATION	**Front**	39%	31%	49%	96%	**40%**
	Back	29%	63%	69%	89%	**38%**
	Side	35%	16%	43%	96%	**35%**

Note: Percentages are calculated as a portion of the total for each VIEW ratings (e.g., 24 of the 35 SUBSTANTIAL rated homes have a BACK ORIENTATION = 69%). Columns do not sum to 100% because multiple orientations are possible for each VIEW.

The parameter estimates of interest in this hedonic model are those for ORIENTATION (β_6) and VIEW (β_4). β_6 represent the marginal impact on home value, over and above that of VIEW alone, of having a particular orientation to the turbines. In the Base Model the VIEW coefficients effectively absorb the effects of ORIENTATION, but in this model they are estimated separately. Because a home's surrounding environment is typically viewed from the front or back of the house, one would expect that, to the extent that wind facility VIEW impacts property values, that impact would be especially severe for homes that have FRONT or BACK orientations to those turbines. If this were the case, the coefficients for these categories would be negative, while the coefficient for SIDE would be to be close to zero indicating little to no incremental impact from a SIDE ORIENTATION.

5.5.2. Analysis of Results

Results for the variables of interest for this hedonic model are shown in Table 23; as with previous models, the full set of results is contained in Appendix H. The model performs well with an adjusted R^2 of 0.77. All study area, spatial adjustment, and home and site characteristics are significant at or above the one percent level, are of the appropriate sign, and are similar in magnitude to the estimates derived from the post-construction Base Model. The coefficients for DISTANCE and VIEW are stable, in sign and magnitude, when compared to the Base Model results, and none of the marginal effects are statistically significant.

000607

The coefficients for the variables of interest (β_6) do not meet the *a priori* expectations. The estimated effect for SIDE ORIENTATION, instead of being close to zero, is -3% (*p* value 0.36), while BACK and FRONT, instead of being negative and larger, are estimated at 3% (*p* value 0.37) and -1% (*p* value 0.72), respectively. None of these variables are found to be even marginally statistically significant, however, and based on these results, it is concluded that there is no evidence that a home's orientation to a wind facility affects property values in a measurable way. Further, as with previous models, no statistical evidence of a Scenic Vista Stigma is found among this sample of sales transactions.

Table 23: Results from Orientation Model

	Base Model				Orientation Model			
Variables of Interest	**Coef**	**SE**	**p Value**	***n***	**Coef**	**SE**	**p Value**	***n***
No View	Omitted	Omitted	Omitted	4207	Omitted	Omitted	Omitted	4207
Minor View	-0.01	0.01	0.39	561	-0.01	0.06	0.88	561
Moderate View	0.02	0.03	0.57	106	0.00	0.06	0.96	106
Substantial View	-0.01	0.07	0.92	35	-0.01	0.09	0.85	35
Extreme View	0.02	0.09	0.77	28	0.02	0.17	0.84	28
Inside 3000 Feet	-0.05	0.06	0.31	67	-0.04	0.07	0.46	67
Between 3000 Feet and 1 Mile	-0.05	0.05	0.20	58	-0.05	0.05	0.26	58
Between 1 and 3 Miles	0.00	0.02	0.80	2019	0.00	0.02	0.83	2019
Between 3 and 5 Miles	0.02	0.01	0.26	1923	0.02	0.01	0.26	1923
Outside 5 Miles	Omitted	Omitted	Omitted	870	Omitted	Omitted	Omitted	870
Front Orientation					-0.01	0.06	0.72	294
Back Orientation					0.03	0.06	0.37	280
Side Orientation					-0.03	0.06	0.36	253

"Omitted" = reference category for fixed effects variables. "n" = number of cases in category when category = "1"

Model Information

Model Equation Number	**1**	**8**
Dependent Variable	**LN_SalePrice96**	**LN_SalePrice96**
Number of Cases	**4937**	**4937**
Number of Predictors (k)	**37**	**40**
F Statistic	**442.8**	**410.0**
Adjusted R Squared	**0.77**	**0.77**

5.6. Overlap Model

The Orientation Model, presented above, investigated, to some degree, how the potential effects of wind turbines might be impacted by how a home is oriented to the surrounding environment. In so doing, this model began to peel back the relationship between VIEW and VISTA, but stopped short of looking at the relationship directly. It would be quite useful, though, to understand the explicit relationship between the VISTA and VIEW variables. In particular, one might expect that views of wind turbines would have a particularly significant impact on residential property values when those views strongly overlap ("OVERLAP") the prominent scenic vista from a home. To investigate this possibility directly, and, in general, the relationship between VIEW and VISTA, a parameter for OVERLAP is included in the model.

000608

5.6.1. Dataset and Model Form

Data on the degree to which the view of wind turbines overlaps with the prominent scenic vista from the home (OVERLAP) were collected in the course of the field visits to each home.[87] The categories for OVERLAP included NONE, BARELY, SOMEWHAT, and STRONGLY, and are described in Table 24: [88]

Table 24: Definition of OVERLAP Categories

OVERLAP - NONE	The scenic vista does not contain any view of the turbines.
OVERLAP - BARELY	A small portion (~ 0 - 20%) of the scenic vista is overlapped by the view of turbines, and might contain a view of a few turbines, only a few of which can be seen entirely.
OVERLAP - SOMEWHAT	A moderate portion (~20-50%) of the scenic vista contains turbines, and likely contains a view of more than one turbine, some of which are likely to be seen entirely.
OVERLAP - STRONGLY	A large portion (~50-100%) of the scenic vista contains a view of turbines, many of which likely can be seen entirely.

A crosstab describing the OVERLAP designations and the VIEW categories is shown in Table 25. As would be expected, the more dramatic views of wind turbines, where the turbines occupy more of the panorama, are coincident with the OVERLAP categories of SOMEWHAT or STRONGLY. Nonetheless, STRONGLY are common for all VIEW categories. Similarly, SOMEWHAT is well distributed across the MINOR and MODERATE rated views, while BARELY is concentrated in the MINOR rated views.

The same dataset is used as in the Base Model, focusing on post-construction transactions (n = 4,937). To investigate whether the overlap of VIEW and VISTA has a marginal impact on residential property values, over and above that of the VIEW and VISTA impacts alone, the following hedonic model is estimated:[89]

$$\ln(\mathrm{P}) = \beta_0 + \beta_1 \mathrm{N} + \sum_{\mathrm{s}} \beta_2 \mathrm{S} + \sum_{\mathrm{k}} \beta_3 \mathrm{X} + \sum_{\mathrm{v}} \beta_4 \mathrm{VIEW} + \sum_{\mathrm{d}} \beta_5 \mathrm{DISTANCE} + \sum_{\mathrm{t}} \beta_6 \mathrm{VISTA} + \sum_{\mathrm{p}} \beta_7 \mathrm{OVERLAP} + \varepsilon \quad (9)$$

where
VIEW is a vector of v categorical view variables (e.g., MINOR, MODERATE, etc.),
VISTA is a vector of t categorical scenic vista variables (e.g., POOR, BELOW-AVERAGE, etc.),
OVERLAP is a vector of p categorical overlap variables (e.g., BARELY, SOMEWHAT, etc.),

[87] Scenic vista was rated while taking into account the entire panorama surrounding a home. But, for each home, there usually was a prominent direction that offered a preferred scenic vista. Often, but not always, the home was orientated to enjoy that prominent scenic vista. Overlap is defined as the degree to which the view of the wind facility overlaps with this prominent scenic vista.

[88] "…can be seen entirely" refers to being able to see a turbine from the top of the sweep of its blade tips to below the nacelle of the turbine where the sweep of the tips intersects the tower.

[89] Although VISTA appears in all models, and is usually included in the vector of home and site characteristics represented by X, it is shown separately here so that it can be discussed directly in the text that follows.

000609

β_4 is a vector of *v* parameter estimates for VIEW fixed effects variables as compared to transactions of homes without a view of the turbines,
β_6 is a vector of *t* parameter estimates for VISTA fixed effect variables as compared to transactions of homes with an AVERAGE scenic vista,
β_7 is a vector of *o* parameter estimates for OVERLAP fixed effect variables as compared to transactions of homes where the view of the turbines had no overlap with the scenic vista, and all other components are as defined in equation (1).

The variables of interest in this model are VIEW, VISTA and OVERLAP, and the coefficients β_4, β_6, and β_7 are therefore the primary focus. Theory would predict that the VISTA coefficients in this model would be roughly similar to those derived in the Base Model, but that the VIEW coefficients may be somewhat more positive as the OVERLAP variables explain a portion of any negative impact that wind projects have on residential sales prices. In that instance, the OVERLAP coefficients would be negative, indicating a decrease in sales price when compared to those homes that experience no overlap between the view of wind turbines and the primary scenic vista.

Table 25: Frequency Crosstab of OVERLAP and VIEW

		VIEW					
		None	**Minor**	**Moderate**	**Substantial**	**Extreme**	**Total**
OVERLAP	**None**	4,207	317	3	0	0	**4,527**
	Barely	0	139	10	1	0	**150**
	Somewhat	0	81	42	7	2	**132**
	Strongly	0	24	51	27	26	**128**
	Total	**4,207**	**561**	**106**	**35**	**28**	**4,937**

5.6.2. Analysis of Results

Results for the variables of interest for this hedonic model are shown in Table 26; as with previous models, the full set of results is contained in Appendix H. The model performs well with an adjusted R^2 of 0.77. All study area, spatial adjustment, and home and site characteristics are significant at or above the one percent level, are of the appropriate sign, and are similar in magnitude to the estimates derived from the post-construction Base Model.

As expected from theory, the VISTA parameters are stable across models with no change in coefficient sign, magnitude, or significance. Counter to expectations, however, the VIEW coefficients, on average, decrease in value. MINOR VIEW is now estimated to adversely affect a home's sale price by 3% (*p* value 0.10) and is weakly significant, but none of the other VIEW categories are found to be statistically significant. Oddly, the OVERLAP rating of BARELY is found to significantly increase home values by 5% (*p* value 0.08), while none of the other OVERLAP ratings are found to have a statistically significant impact.

Taken at face value, these results are counterintuitive. For instance, absent any overlap of view with the scenic vista (NONE), a home with a MINOR view sells for 3% less than a home with no view of the turbines. If, alternatively, a home with a MINOR view BARELY overlaps the prominent scenic vista, it not only enjoys a 2% increase in value over a home with NO VIEW of the turbines but a 5% increase in value over homes with views of the turbines that do not overlap

with the scenic vista. In other words, the sales price increases when views of turbines overlap the prominent scenic vista, at least in the BARELY category. A more likely explanation for these results are that the relatively high correlation (0.68) between the VIEW and OVERLAP parameters is spuriously driving one set of parameters up and the other down. More importantly, when the parameters are combined, they offer a similar result as was found in the Base Model. Therefore, it seems that the degree to which the view of turbines overlaps the scenic vista has a negligible effect on sales prices among the sample of sales transactions analyzed here.[90]

Despite these somewhat peculiar results, other than MINOR, none of the VIEW categories are found to have statistically significant impacts, even after accounting for the degree to which those views overlap the scenic vista. Similarly, none of the OVERLAP variables are simultaneously negative and statistically significant. This implies, once again, that a Scenic Vista Stigma is unlikely to be present in the sample. Additionally, none of the DISTANCE coefficients are statistically significant, and those coefficients remain largely unchanged from the Base Model, reaffirming previous results in which no significant evidence of either an Area or a Nuisance Stigma was found.

[90] An alternative approach to this model was also considered, one that includes an interaction term between VIEW and VISTA. For this model it is assumed that homes with higher rated scenic vistas might have higher rated views of turbines, and that these views of turbines would decrease the values of the scenic vista. To construct the interaction, VISTA, which can be between one and five (e.g., POOR=1,…PREMIUM=5), was multiplied by VIEW, which can be between zero and four (e.g. NO VIEW=0, MINOR=1,…EXTREME=4). The resulting interaction (VIEW*VISTA) therefore was between zero and sixteen (there were no PREMIUM VISTA homes with an EXTREME VIEW), with zero representing homes without a view of the turbines, one representing homes with a POOR VISTA and a MINOR VIEW, and sixteen representing homes with either a PREMIUM VISTA and a SUBSTANTIAL VIEW or an ABOVE AVERAGE VISTA and an EXTREME VIEW. The interaction term, when included in the model, was relatively small (-0.013) and weakly significant (*p* value 0.10 – not White's corrected). The VISTA estimates were unchanged and the VIEW parameters were considerably larger and positive. For instance, EXTREME was 2% in the Base Model and 16% in this "interaction" model. Similarly, SUBSTANTIAL was -1% in the Base Model and 13% in this model. Therefore, although the interaction term is negative and weakly significant, the resulting VIEW estimates, to which it would need to be added, fully offset this negative effect. These results support the idea that the degree to which a VIEW overlaps VISTA has a likely negligible effect on sales prices, while also confirming that there is a high correlation between the interaction term and VIEW variables.

Table 26: Results from Overlap Model

Variables of Interest	Base Model				Overlap Model			
	Coef	SE	p Value	*n*	Coef	SE	p Value	*n*
No View	Omitted	Omitted	Omitted	4,207	Omitted	Omitted	Omitted	4,207
Minor View	-0.01	0.01	0.39	561	-0.03	0.02	0.10	561
Moderate View	0.02	0.03	0.57	106	-0.02	0.04	0.65	106
Substantial View	-0.01	0.07	0.92	35	-0.05	0.09	0.43	35
Extreme View	0.02	0.09	0.77	28	-0.03	0.10	0.73	28
Inside 3000 Feet	-0.05	0.06	0.31	67	-0.05	0.06	0.32	67
Between 3000 Feet and 1 Mile	-0.05	0.05	0.20	58	-0.05	0.05	0.27	58
Between 1 and 3 Miles	0.00	0.02	0.80	2,019	0.00	0.02	0.82	2,019
Between 3 and 5 Miles	0.02	0.01	0.26	1,923	0.02	0.01	0.26	1,923
Outside 5 Miles	Omitted	Omitted	Omitted	870	Omitted	Omitted	Omitted	870
Poor Vista	-0.21	0.02	0.00	310	-0.21	0.02	0.00	310
Below Average Vista	-0.08	0.01	0.00	2,857	-0.08	0.01	0.00	2,857
Average Vista	Omitted	Omitted	Omitted	1,247	Omitted	Omitted	Omitted	1,247
Above Average Vista	0.10	0.02	0.00	448	0.10	0.02	0.00	448
Premium Vista	0.13	0.04	0.00	75	0.13	0.04	0.00	75
View Does Not Overlap Vista					Omitted	Omitted	Omitted	320
View Barely Overlaps Vista					0.05	0.03	0.08	150
View Somewhat Overlaps Vista					0.01	0.03	0.66	132
View Strongly Overlaps Vista					0.05	0.05	0.23	128

"Omitted" = reference category for fixed effects variables. "n" = number of cases in category when category = "1"

Model Information

Model Equation Number	**1**	**9**
Dependent Variable	**LN_SalePrice96**	**LN_SalePrice96**
Number of Cases	**4937**	**4937**
Number of Predictors (k)	**37**	**40**
F Statistic	**442.8**	**409.7**
Adjusted R Squared	**0.77**	**0.77**

6. Repeat Sales Analysis

In general, the Base and Alternative Hedonic Models presented in previous sections come to the same basic conclusion: wind power facilities in this sample have no demonstrable, widespread, sizable, and statistically significant affect on residential property values. These hedonic models contain 29 or more controlling variables (e.g., house and site characteristics) to account for differences in home values across the sample. Although these models perform well and explain nearly 80% of the variation in sales prices among homes in the sample, it is always possible that variables not included in (i.e., "omitted from") the hedonic models could be correlated with the variables of interest, therefore biasing the results.

A common method used to control for omitted variable bias in the home assessment literature is to estimate a repeat sales model (Palmquist, 1982). This technique focuses on just those homes that have sold on more than one occasion, preferably once before and once after the introduction of a possible disamenity, and investigates whether the price appreciation between these transactions is affected by the presence of that disamenity. In this section a repeat sales analysis is applied to the dataset, investigating in a different way the presence of the three possible property value stigmas associated with wind facilities, and therefore providing an important cross-check to the hedonic model results. The section begins with a brief discussion of the general form of the Repeat Sales Model and a summary of the literature that has employed this approach to investigate environmental disamenities. The dataset and model used in the analysis is then described, followed by a summary of the results from that analysis.

6.1. Repeat Sales Models and Environmental Disamenities Literature

Repeat sales models use the annual sales-price appreciation rates of homes as the dependent variable. Because house, home site, and neighborhood characteristics are relatively stable over time for any individual home, many of those characteristics need not be included in the repeat sales model, thereby increasing the degrees of freedom and allowing sample size requirements to be significantly lower and coefficient estimates to be more efficient (Crone and Voith, 1992). A repeat sales analysis is not necessarily preferred over a traditional hedonic model, but is rather an alternative analysis approach that can be used to test the robustness of the earlier results (for further discussion see Jackson, 2003). The repeat sales model takes the basic form:

Annual Appreciation Rate (AAR) = *f* (TYPE OF HOUSE, OTHER FACTORS)

where
TYPE OF HOUSE provides an indication of the segment of the market in which the house is situated (e.g., high end vs. low end), and
OTHER FACTORS include, but are not limited to, changes to the environment (e.g., proximity to a disamenity).

The dependent variable is the adjusted annual appreciation rate and is defined as follows:

$$AAR = \exp\left[\frac{\ln\left(P_1 / P_2\right)}{t_1 - t_2}\right] - 1 \qquad (10)$$

where

000613

P_1 is the adjusted sales price at the first sale (in 1996 dollars),
P_2 is the adjusted sales price at the second sale (in 1996 dollars),
t_1 is the date of the first sale,
t_2 is the date of the second sale, and
$(t_1 - t_2)$ is determined by calculating the number of days that separate the sale dates and dividing by 365.

As with the hedonic regression model, the usefulness of the repeat sales model is well established in the literature when investigating possible disamenities. For example, a repeat sales analysis was used to estimate spatial and temporal sales price effects from incinerators by Kiel and McClain (1995), who found that appreciation rates, on average, are not sensitive to distance from the facility during the construction phase but are during the operation phase. Similarly, McCluskey and Rausser (2003) used a repeat sales model to investigate effects surrounding a hazardous waste site. They found that appreciation rates are not sensitive to the home's distance from the disamenity before that disamenity is identified by the EPA as hazardous, but that home values are impacted by distance after the EPA's identification is made.

6.2. Dataset

The 7,459 residential sales transactions in the dataset contain a total of 1,253 transactions that involve homes that sold on more than one occasion (i.e., a "pair" of sales of the same home). For the purposes of this analysis, however, the key sample consists of homes that sold once before the announcement of the wind facility, and that subsequently sold again after the construction of that facility. Therefore any homes that sold twice in either the pre-announcement or post-construction periods were not used in the repeat sales sample.[91] These were excluded because either they occurred before the effect would be present (for pre-announcement pairs) or after (for post-announcement pairs). This left a total of 368 pairs for the analysis, which was subsequently reduced to 354 usable pairs.[92]

The mean AAR for the sample is 1.0% per year, with a low of -10.5% and a high of 13.4%. Table 27 summarizes some of the characteristics of the homes used in the repeat sales model. The average house in the sample has 1,580 square feet of above-ground finished living area, sits on a parcel of 0.67 acres, and originally sold for $70,483 (real 1996 dollars). When it sold a second time, the average home in the sample was located 2.96 miles from the nearest wind turbine (14 homes were within one mile, 199 between one and three miles, 116 between three and five miles, and 25 outside of five miles). Of the 354 homes, 14% (n = 49) had some view of the facility (35 were rated MINOR, five MODERATE, and nine either SUBSTANTIAL or EXTREME). Because of the restriction to those homes that experienced repeat sales, the sample is relatively small for those homes in close proximity to and with dramatic views of wind facilities.

[91] 752 pairs occurred after construction began, whereas 133 pairs occurred before announcement.

[92] Of the 368 pairs, 14 were found to have an AAR that was either significantly above or below the mean for the sample (mean +/- 2 standard deviations). These pairs were considered highly likely to be associated with homes that were either renovated or left to deteriorate between sales, and therefore were removed from the repeat sales model dataset. Only two of these 14 homes had views of the wind turbines, both of which were MINOR. All 14 of the homes were situated either between one and three miles from the nearest turbine (n = 8) or between three and five miles away (n = 6).

Table 27: List of Variables Included in the Repeat Sales Model

Variable Name	Description	Type	Sign	Freq.	Mean	Std. Dev.	Min.	Max.
SalePrice96_Pre	The Sale Price (adjusted for inflation into 1996 dollars) of the home as of the first time it had sold	C	+	354	$ 70,483	$ 37,798	$ 13,411	$ 291,499
SalePrice96_Pre_Sqr	SalePrice96_Pre Squared (shown in millions)	C	–	354	$ 6,393	$ 8,258	$ 180	$ 84,972
Acres	Number of Acres that sold with the residence	C	+	354	0.67	1.34	0.07	10.96
Sqft_1000	Number of square feet of finished above ground living area (in 1000s)	C	+	354	1.58	0.56	0.59	4.06
No View	If the home had no view of the turbines when it sold for the second time (Yes = 1, No = 0)	Omitted	n/a	305	0.86	0.35	0	1
Minor View	If the home had a Minor View of the turbines when it sold for the second time (Yes = 1, No = 0)	OC	–	35	0.10	0.30	0	1
Moderate View	If the home had a Moderate View of the turbines when it sold for the second time (Yes = 1, No = 0)	OC	–	5	0.01	0.12	0	1
Substantial/Extreme View	If the home had a Substantial or Extreme View of the turbines when it sold for the second time (Yes = 1, No = 0)	OC	–	9	0.03	0.12	0	1
Less than 1 Mile	If the home was within 1 mile (5280 feet) of the turbines when it sold for the second time (Yes = 1, No = 0)	OC	–	14	0.02	0.13	0	1
Between 1 and 3 Miles	If the home was between 1 and 3 miles of the turbines when it sold for the second time (Yes = 1, No = 0)	OC	–	199	0.56	0.50	0	1
Between 3 and 5 Miles	If the home was between 3 and 5 miles of the turbines when it sold for the second time (Yes = 1, No = 0)	OC	–	116	0.33	0.47	0	1
Outside 5 Miles	If the home was outside 5 miles of the turbines when it sold for the second time (Yes = 1, No = 0)	Omitted	n/a	25	0.07	0.26	0	1

"C" Continuous, "OC" Ordered Categorical (1 = yes, 0 = no) values are interpreted in relation to the "Omitted" category. This table does not include the study area fixed effects variables that are included in the model (e.g., WAOR, TXHC, NYMC). The reference case for these variables is the WAOR study area.

6.3. Model Form

To investigate the presence of Area, Scenic Vista, and Nuisance Stigmas, the adjusted annual appreciation rate (AAR) is calculated for the 354 sales pairs in the manner described in equation (10), using inflation adjusted sales prices. The following model is then estimated:

$$\text{AAR} = \beta_0 + \sum_{s} \beta_1 \text{S} + \sum_{k} \beta_2 \text{X} + \sum_{v} \beta_3 \text{VIEW} + \sum_{d} \beta_4 \text{DISTANCE} + \varepsilon \qquad (11)$$

where

AAR represents the inflation-adjusted Annual Appreciation Rate for repeat sales,

S is the vector of *s* Study Area fixed effects variables (e.g., WAOR, OKCC, etc.),

X is a vector of *k* home, site and sale characteristics (e.g., acres, square feet, original sales price),

VIEW is a vector of *v* categorical view variables (e.g., MINOR, MODERATE, etc.),

DISTANCE is a vector of *d* categorical distance variables (e.g., less than one mile, between one and three miles, etc.),

β_0 is the constant or intercept across the full sample,

β_1 is a vector of *s* parameter estimates for the study area fixed effects as compared to sales that occurred in the WAOR study area,

β_2 is a vector of *k* parameter estimates for the home, site, and sale characteristics,

β_3 is a vector of *v* parameter estimates for the VIEW variables as compared to transactions of homes with no view of the turbines,

β_4 is a vector of *d* parameter estimates for the DISTANCE variables as compared to transactions of homes outside of five miles, and

ε is a random disturbance term.

000615

Effectively, this model seeks to identify reasons that AARs vary among those sales pairs in the sample. Reasons for such differences in AARs might include variations in home and site characteristics, the study area in which the sale occurs, or the degree to which the home is in proximity to or has a dramatic view of a wind facility. As such, the model as shown by equation (11) has three primary groups of parameters: variables of interest; home, site, and sale characteristics; and study area fixed effects.

The variables of interest are VIEW and DISTANCE, and the coefficients β_3 and β_4 are therefore the primary focus of this analysis. Because of the small numbers of homes in the sample situated inside of 3000 feet and between 3000 feet and one mile, they are collapsed into a single category (inside one mile). For the same reason, homes with SUBSTANTIAL or EXTREME VIEWS are collapsed into a single category (SUBSTANTIAL/EXTREME). In this model, therefore, the influence on appreciation rates of the following variables of interest is estimated: MINOR, MODERATE, and SUBSTANTIAL/EXTREME VIEWS, and less than one mile, between one and three mile, and between three and five mile DISTANCES. For the VIEW fixed-effects variables, the reference category is NO VIEW; for DISTANCE, it is homes outside of five miles. As with previous models, if effects exist, it is expected that all of the coefficients would be negative and monotonically ordered.

The number of home, site, and sale characteristics included in a repeat sales model is typically substantially lower than in a hedonic model. This is to be expected because, as discussed earlier, the repeat sales model explores variations in AARs for sales pairs from individual homes, and home and site characteristics are relatively stable over time for any individual home. Nonetheless, various characteristics have been found by others (e.g., Kiel and McClain, 1995; McCluskey and Rausser, 2003) to affect appreciation rates. For the purposes of the Repeat Sales Model, these include the number of square feet of living space (SQFT_1000), the number of acres (ACRES), the inflation-adjusted price of the home at the first sale (SalePrice96_Pre), and that sales price squared (SalePrice96_Pre_Sqr). Of those characteristics, the SQFT_1000 and ACRES coefficients are expected to be positive indicating that, all else being equal, an increase in living area and lot size increases the relative appreciation rate. Conversely, it is expected that the combined estimated effect of the initial sales prices (SalePrice96_Pre and SalePrice96_Pre_Sqr) will trend downward, implying that as the initial sales price of the house increases the appreciation rate decreases. These expectations are in line with the previous literature (Kiel and McClain, 1995; McCluskey and Rausser, 2003).

Finally, the study-area fixed effects variables (β_1) are included in this model to account for differences in inflation adjusted appreciation rates that may exist across study areas (e.g., WAOR, TXHC, NYMC). The WAOR study area is the reference category, and all study-area coefficients therefore represent the marginal change in AARs compared to WAOR (the intercept represents the marginal change in AAR for WAOR by itself). These study area parameters provide a unique look into Area Stigma effects. Recall that the appreciation rates used in this model are adjusted for inflation by using an inflation index from the nearby municipal statistical area (MSA). These MSAs are sometimes quite far away (as much as 20 miles) and therefore would be unaffected by the wind facility. As such, any variation in the study area parameters (and the intercept) would be the result of local influences not otherwise captured in the inflation

adjustment, and represent another test for Area Stigma; if effects exist, it is expected that the β_0 and β_1 coefficients will be negative.

As with the hedonic models presented earlier, the assumptions of homoskedasticity, absence of spatial autocorrelation, reasonably little multicollinearity, and appropriate controls for outliers are addressed as described in the associated footnote and in Appendix G.[93]

6.4. Analysis of Results

The results from the Repeat Sales Model are presented in Table 28. The model performs relatively poorly overall, with an Adjusted R^2 of just 0.19 (and an *F*-test statistic of 5.2). Other similar analyses in the literature have produced higher performance statistics but have done so with samples that are considerably larger or more homogenous than ours.[94] The low R^2 found here should not be cause for undue concern, however, given the relatively small sample spread across ten different study areas. Moreover, many of the home and site characteristics are found to be statistically significant, and of the appropriate sign. The coefficient for the adjusted initial sales price (SalePrice96_Pre), for example, is statistically significant, small, and negative (-0.000001, *p* value 0.00), while the coefficient for the adjusted initial sales price squared (SalePrice96_Pre_Sqr) is also statistically significant and considerably smaller (<0.000000, *p* value 0.00). These results imply, consistent with the prior literature, that for those homes in the sample, an increase in initial adjusted sales price decreases the average percentage appreciation rate. ACRES (0.002, *p* value 0.10) and SQFT_1000 (0.02, *p* value 0.00) are both positive, as expected, and statistically significant.

Of particular interest are the intercept term and the associated study-area fixed effect coefficients, and what they collectively say about Area Stigma. The coefficient for the intercept (β_0) is 0.005 (*p* value 0.81), which is both extremely small and not statistically significant. Likewise, the study-area fixed effects are all relatively small (less than 0.03 in absolute terms) and none are statistically significant. As discussed above, if a pervasive Area Stigma existed, it would be expected to be represented in these coefficients. Because all are small and statistically insignificant, it can again be concluded that there is no persuasive evidence of an Area Stigma among this sample of home transactions.

[93] All results are produced using White's corrected standard errors to control for heteroskedasticity. Spatial autocorrelation, with this small sample, is impossible to control. Because of the small sample, an even smaller number of neighboring sales exist, which are required to construct the spatial matrix. As such, spatial autocorrelation is not addressed in the repeat sales model. As with the hedonic models, some multicollinearity might exist, but that multicollinearity is unlikely to be correlated with the variables of interest. Outliers are investigated and dealt with as discussed in footnote 91 on page 56.

[94] McCluskey and Rausser (2003) had a sample of over 30,000 repeat sales and had an *F*-test statistic of 105; Kiel and McClain (1995) produced an R^2 that ranged from 0.40 to 0.63 with samples ranging from 53 to 145, but all sales took place in North Andover, MA.

000617

Table 28: Results from Repeat Sales Model

	Coef.	SE	p Value	*n*
Intercept	0.005	0.02	0.81	354
WAOR	Omitted	Omitted	Omitted	6
TXHC	-0.01	0.02	0.63	57
OKCC	0.03	0.02	0.11	102
IABV	0.02	0.02	0.14	59
ILLC	-0.01	0.02	0.38	18
WIKCDC	0.02	0.03	0.50	8
PASC	-0.01	0.02	0.67	32
PAWC	0.02	0.02	0.16	35
NYMCOC	0.02	0.02	0.23	24
NYMC	0.03	0.02	0.13	13
SalePrice96_Pre	-0.000001	0.0000002	0.00	354
SalePrice96_Pre_Sqr	0.0000000	0.0000000	0.00	354
Acres	0.002	0.001	0.10	354
Sqft_1000	0.02	0.01	0.00	354
No View	Omitted	Omitted	Omitted	305
Minor View	-0.02	0.01	0.02	35
Moderate View	0.03	0.03	0.29	5
Substantial/Extreme View	-0.02	0.01	0.09	9
Less than 1 Mile	0.03	0.01	0.01	14
Between 1 and 3 Miles	0.01	0.01	0.59	199
Between 3 and 5 Miles	0.01	0.01	0.53	116
Outside 5 Miles	Omitted	Omitted	Omitted	25

"Omitted" = reference category for fixed effects variables

"n" indicates number of cases in category when category = "1"

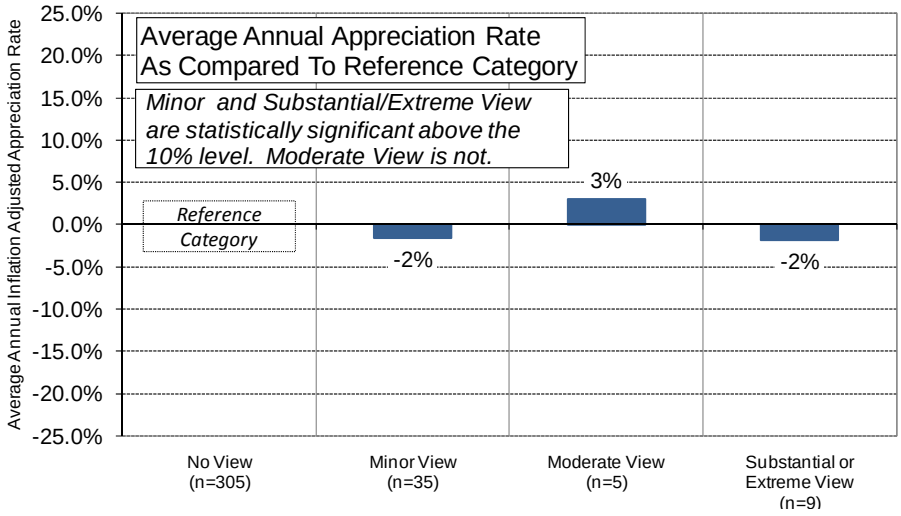
Model Information

Model Equation Number	**11**
Dependent Variable	**SalePrice96_AAR**
Number of Cases	**354**
Number of Predictors (k)	**19**
F Statistic	**5.2**
Adjusted R2	**0.19**

Turning to the variables of interest, mixed results (see Figure 9 and Figure 10) are found. For homes with MINOR or SUBSTANTIAL/EXTREME VIEWS, despite small sample sizes, appreciation rates after adjusting for inflation are found to decrease by roughly 2% annually (*p* values of 0.02 and 0.09, respectively) compared to homes with NO VIEW. Though these findings initially seem to suggest the presence of Scenic Vista Stigma, the coefficients are not monotonically ordered, counter to what one might expect: homes with a MODERATE rated view appreciated on average 3% annually (*p* value 0.29) compared to homes with NO VIEW. Adding to the suspicion of these VIEW results, the DISTANCE coefficient for homes situated inside of one mile, where eight out of the nine SUBSTANTIAL/EXTREME rated homes are located, is positive and statistically significant (0.03, *p* value 0.01). If interpreted literally, these results suggest that a home inside of one mile with a SUBSTANTIAL/EXTREME rated view would experience a decrease in annual appreciation of 2% compared to homes with no views of turbines, but simultaneously would experience an increase of 3% in appreciation compared to homes outside of five miles. Therefore, when compared to those homes outside of five miles and with no view of the wind facilities, these homes would experience an overall increase in AAR by 1%. These results are counterintuitive and are likely driven by the small number of sales pairs

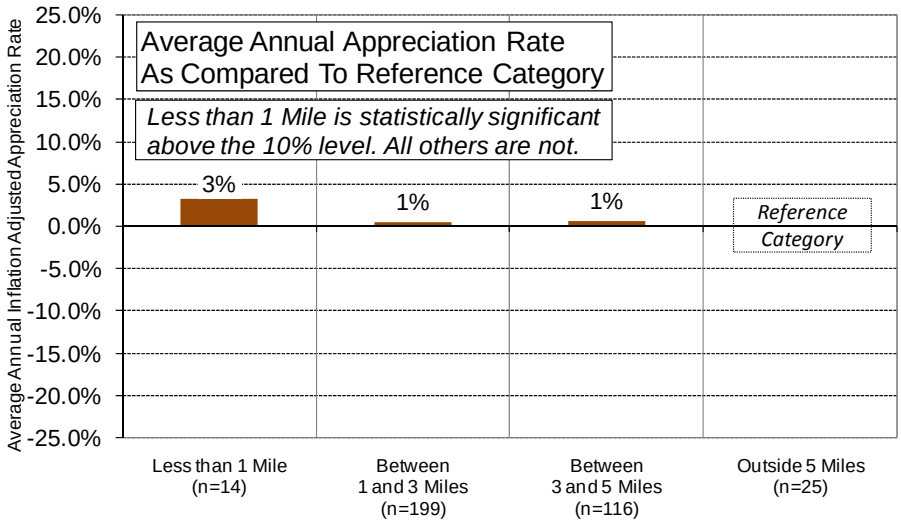
that are located within one mile of the wind turbines and experience a dramatic view of those turbines.

Figure 9: Repeat Sales Model Results for VIEW



The reference category consists of tranasctions of homes that had no view of the turbines

Figure 10: Repeat Sales Model Results for DISTANCE



The reference category consists of tranasctions of homes that are situated outside of five miles from the nearest turbine

Regardless of the reason for this result, again no persuasive evidence of consistent and widespread adverse effects is found from the presence of the wind facilities in the sample, reinforcing the findings from the previous hedonic analysis. Specifically, there is no evidence that an Area Stigma exists in that homes outside of one mile and inside of five miles do not appreciate differently than homes farther away. Similarly, there is no evidence of a Nuisance Stigma. Appreciation rates for homes inside of one mile are not adversely affected; in fact, significantly higher appreciation rates are found for these homes than for those homes located outside of five miles from the nearest wind facility. Finally, though some evidence is found that a Scenic Vista Stigma may exist in the sample of repeat sales, it is weak, fairly small, and

somewhat counter-intuitive. This result is likely driven by the small number of sales pairs that are located within one mile of the wind turbines and that experience a dramatic view of those turbines.

7. Sales Volume Analysis

The analysis findings to this point suggest that, among the sample of sales transactions analyzed in this report, wind facilities have had no widespread and statistically identifiable impact on residential property values. A related concern that has not yet been addressed is that of sales volume: does the presence of wind facilities either increase or decrease the rate of home sales transactions? On the one hand, a decrease in sales volumes might be expected. This might occur if homeowners expect that their property values will be impacted by the presence of the wind facility, and therefore simply choose not to sell their homes as a result, or if they try to sell but are not easily able to find willing buyers. Alternatively, an increase in sales volume might be expected if homeowners that are located near to or have a dominating view of wind turbines are uncomfortable with the presence of those turbines. Though those homes may sell at a market value that is not impacted by the presence of the wind facilities, self-selection may lead to accelerated transaction volumes shortly after facility announcement or construction as homeowners who view the turbines unfavorably sell their homes to individuals who are not so stigmatized. To address the question of whether and how sales volumes are impacted by nearby wind facilities, sales volumes are analyzed for those homes located at various distances from the wind facilities in the sample, during different facility development periods.

7.1. Dataset

To investigate whether sales volumes are affected by the presence of wind facilities two sets of data are assembled: (1) the number of homes available to sell annually within each study area, and (2) the number of homes that actually did sell annually in those areas. Homes potentially "available to sell" are defined as all single family residences within five miles of the nearest turbine that are located on a parcel of land less than 25 acres in size, that have only one residential structure, and that had a market value (for land and improvements) above $10,000.[95] Homes that "did sell" are defined as every valid sale of a single family residence within five miles of the nearest turbine that are located on a parcel of land less than 25 acres in size, that have only one residential structure, and that sold for more than $10,000.

The sales data used for this analysis are slightly different from those used in the hedonic analysis reported earlier. As mentioned in Section 3.3, a number of study areas were randomly sampled to limit the transactions outside of 3 miles if the total number of transactions were to exceed that which could efficiently be visited in the field (n ~1,250). For the sales volume analysis, however, field data collection was not required, and all relevant transactions could therefore be used. Secondly, two study areas did not provide the data necessary for the sales volume analysis (WAOR and OKCC), and are therefore excluded from the sample. Finally, data for some homes that were "available to sell" were not complete, and rather than including only a small selection of these homes, these subsets of data were simply excluded from the analysis. These excluded homes include those located outside of five miles of the nearest wind turbine, and those available to sell or that did sell more than three years before wind facility announcement.[96] The resulting

[95] "Market value" is the estimated price at which a home would sell as of a given point in time.

[96] For instance, some providers supplied sales data out to ten miles, but only provided homes available to sell out to five miles. As well, data on homes that did sell were not consistently available for periods many years before announcement.

dataset spans the period starting three years prior to facility announcement and ending four years after construction. All homes in this dataset are situated inside of five miles, and each is located in one of the eight represented study areas.[97]

The final set of homes potentially "available to sell" and that actually "did sell" are then segmented into three distance categories: inside of one mile, between one and three miles, and between three and five miles. For each of these three distance categories, in each of the eight study areas, and for each of the three years prior to announcement, the period between announcement and construction, and each of the four years following construction, the number of homes that sold as a percentage of those available to sell is calculated.[98] This results in a total of 24 separate sales volume calculations in each study area, for a total of 192 calculations across all study areas. Finally, these sales volumes are averaged across all study areas into four development period categories: less than three years before announcement, after announcement but before construction, less than two years after construction, and between two and four years after construction.[99] The resulting average annual sales volumes, by distance band and development period, are shown in Table 29 and Figure 11.

Table 29: Sales Volumes by PERIOD and DISTANCE

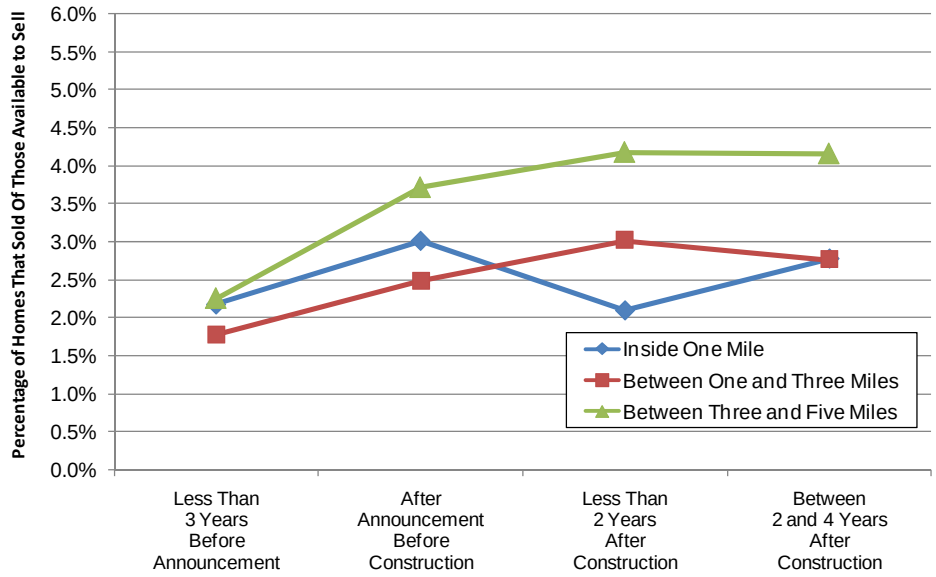
	Inside 1 Mile	Between 1 and 3 Miles	Between 3 and 5 Miles
Less Than 3 Years Before Announcement	2.2%	1.8%	2.3%
After Announcement Before Construction	3.0%	2.5%	3.7%
Less Than 2 Years After Construction	2.1%	3.0%	4.2%
Between 2 and 4 Years After Construction	2.8%	2.8%	4.2%

[97] The number of homes "available to sell" is constructed for each year after 1996 based on the year the homes in each study area were built. For many homes in the sample, the year built occurred more than three years before wind facility announcement, and therefore those homes are "available to sell" in all subsequent periods. For some homes, however, the home was built during the wind facility development process, and therefore becomes "available" some time after the first period of interest. For those homes, the build year is matched to the development dates so that it becomes "available" during the appropriate period. For this reason, the number of homes "available to sell" increases in later periods.

[98] For the period after announcement and before construction, which in all study areas was not exactly 12 months, the sales volume numbers are adjusted so that they corresponded to an average over a 12 month period.

[99] These temporal groupings are slightly different from those used in the hedonic Temporal Aspects Model. Namely, the period before announcement is not divided into two parts – more than two years before announcement and less than two years before announcement – but rather only one – less than three years before announcement. This simplification is made to allow each of the interaction categories to have enough data to be meaningful.

Figure 11: Sales Volumes by PERIOD and DISTANCE



7.2. Model Form

To investigate whether the rate of sales transactions is measurably affected by the wind facilities, the various resulting sales volumes shown above in Table 29 and Figure 11 are compared using a *t*-Test, as follows:

$$t = \frac{(\bar{x}_1 - \bar{x}_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \qquad (12)$$

where

$\bar{x}_1$ and $\bar{x}_2$ are the mean sales volumes from the two categories being compared,

s_1^2 and s_2^2 are variances of the sales volumes from the two categories being compared, and

n_1 and n_2 are numbers of representative volumes in the two categories.[100]

The degrees of freedom used to calculate the *p*-value of the *t* statistic equals the lower of $(n_1 - 1)$ or $(n_2 - 1)$.

Three sets of *t*-Tests are conducted. First, to test whether sales volumes have changed with time and are correlated with wind facility construction, the volumes for each DISTANCE group in later periods (x_1) are compared to the volume in that same group in the pre-announcement period (x_2). Second, to test whether sales volumes are impacted by distance to the nearest wind turbine, the volumes for each PERIOD group at distances closer to the turbines (x_1) are compared to the volume in that same group in the three to five mile distance band (x_2). Finally, for reasons that will become obvious later, the sales volumes for each PERIOD group at distances within one

[100] The number of representative volumes could differ between the two categories. For instance, the "less than three years before announcement" category represents three years – and therefore three volumes – for each study area for each distance band, while the "less than two years after construction" category represents two years – and therefore two volumes – for each study area for each distance band.

mile and outside of three miles of the turbines (x_1) are compared to the sales volume in that same group in the one to three mile distance band (x_2). These three tests help to evaluate whether sales volumes are significantly different after wind facilities are announced and constructed, and whether sales volumes near the turbines are affected differently than for those homes located farther away.[101]

7.3. Analysis of Results

Table 29 and Figure 11 above show the sales volumes in each PERIOD and DISTANCE category, and can be interpreted as the percentage of homes that are available to sell that did sell in each category, on an annual average basis. The sales volume between one and three miles and before facility announcement is the lowest, at 1.8%, whereas the sales volumes for homes located between three and five miles in both periods following construction are the highest, at 4.2%.

The difference between these two sales volumes can be explained, in part, by two distinct trends that are immediately noticeable from the data presented in Figure 11. First, sales volumes in all periods are highest for those homes located in the three to five mile distance band. Second, sales volumes at virtually all distances are higher after wind facility announcement than they were before announcement.[102]

To test whether these apparent trends are borne out statistically the three sets of *t*-Tests described earlier are performed, the results of which are shown in Table 30, Table 31, and Table 32. In each table, the difference between the subject volume (x_1) and the reference volume (x_2) is listed first, followed by the *t* statistic, and whether the statistic is significant at or above the 90% level ("*").

Table 30 shows that mean sales volumes in the post-announcement periods are consistently greater than those in the pre-announcement period, and that those differences are statistically significant in four out of the nine categories. For example, the post-construction sales volumes for homes in the three to five mile distance band in the period less than two years after construction (4.2%) and between three and four years after construction (4.2%) are significantly greater than the pre-announcement volume of 2.3% (1.9%, $t = 2.40$; 1.9%, $t = 2.31$). Similarly, the post-construction sales volumes between one and three miles are significantly greater than the pre-announcement volume. These statistically significant differences, it should be noted, could be as much related to the low reference volume (i.e., sales volume in the period less than

[101] An alternative method to this model would be to pool the homes that "did sell" with the homes "available to sell" and construct a Discrete Choice Model where the dependent variable is zero (for "no sale") or one (for "sale") and the independent variables would include various home characteristics and the categorical distance variables. This would allow one to estimate the probability that a home sells dependent on distance from the wind facility. Because home characteristics data for the homes "available to sell," was not systematically collected it was not possible to apply this method to the dataset.

[102] It is not entirely clear why these trends exist. Volumes may be influenced upward in areas farther from the wind turbines, where homes, in general, might be more densely sited and homogenous, both of which might be correlated with greater home sales transactions. The converse might be true in more rural areas, nearer the wind turbines, where homes may be more unique or homeowners less prone to move. The increasing sales volumes seen in periods following construction, across all distance bands, may be driven by the housing bubble, when more transactions were occurring in general.

three years before announcement), as they are to the sales volumes to which the reference category is compared. Finally, when comparing post-construction volumes inside of a mile, none are statistically different than the 2.2% pre-announcement level.

Table 30: Equality Test of Sales Volumes between PERIODS

	Inside 1 Mile	Between 1 and 3 Miles	Between 3 and 5 Miles
Less Than 3 Years Before Announcement	Reference	Reference	Reference
After Announcement Before Construction	0.8% (0.72)	0.7% (0.99)	1.5% (1.49)
Less Than 2 Years After Construction	-0.1% (-0.09)	1.2% (2.45) *	1.9% (2.4) *
Between 2 and 4 Years After Construction	0.6% (0.54)	1% (2.24) *	1.9% (2.31) *

Numbers in parenthesis represent t-Test statistics. "" = significantly different at or below the 10% level*

Turning to sales volumes in the same development period but between the different distance bands, consistent but less statistically significant results are uncovered (see Table 31). Although all sales volumes inside of three miles, for each period, are less than their peers outside of three miles, those differences are statistically significant in only two out of eight instances. Potentially more important, when one compares the sales volumes inside of one mile to those between one and three miles (see Table 32), small differences are found, none of which are statistically significant. In fact, on average, the sales volumes for homes inside of one mile are greater or equal to the volumes of those homes located between one and three miles in two of the three post-announcement periods. Finally, it should be noted that the volumes for the inside one mile band, in the period immediately following construction, are less than those in the one to three mile band in the same period. Although not statistically significant, this difference might imply an initial slowing of sales activity that, in later periods, returns to more normal levels. This possibility is worth investigating further and is therefore recommended for future research.

Table 31: Equality Test of Volumes between DISTANCES using 3-5 Mile Reference

	Inside 1 Mile	Between 1 and 3 Miles	Between 3 and 5 Miles
Less Than 3 Years Before Announcement	-0.1% (-0.09)	-0.5% (-0.88)	Reference
After Announcement Before Construction	-0.7% (-0.56)	-1.2% (-1.13)	Reference
Less Than 2 Years After Construction	-2.1% (-2.41) *	-1.2% (-1.48)	Reference
Between 2 and 4 Years After Construction	-1.4% (-1.27)	-1.4% (-1.82) *	Reference

Numbers in parenthesis represent t-Test statistics. "" = significantly different at or below the 10% level*

Table 32: Equality Test of Sales Volumes between DISTANCES using 1-3 Mile Reference

	Inside 1 Mile	Between 1 and 3 Miles	Between 3 and 5 Miles
Less Than 3 Years Before Announcement	0.4% (0.49)	Reference	0.5% (0.88)
After Announcement Before Construction	0.5% (0.47)	Reference	1.2% (1.13)
Less Than 2 Years After Construction	-0.9% (-1.38)	Reference	1.2% (1.48)
Between 2 and 4 Years After Construction	0% (0.01)	Reference	1.4% (1.82) *

Numbers in parenthesis represent t-Test statistics. "" = significantly different at or below the 10% level*

Taken together, these results suggest that sales volumes are not conclusively affected by the announcement and presence of the wind facilities analyzed in this report. At least among this sample, sales volumes increased in all distance bands after the announcement and construction of the wind facilities. If this result was driven by the presence of the wind facilities, however, one would expect that such impacts would be particularly severe for those homes in close proximity to wind facilities. In other words, sales volumes would be the most affected inside of one mile, where views of the turbines are more frequent and where other potential nuisances are more noticeable than in areas farther away. This is not borne out in the data - no statistically significant differences are found for sales volumes inside of one mile as compared to those between one and three miles, and sales volumes outside of three miles are higher still. Therefore, on the whole, this analysis is unable to find persuasive evidence that wind facilities have a widespread and identifiable impact on overall residential sales volumes. It is again concluded that neither Area nor Nuisance Stigma are in evidence in this analysis.

8. Wind Projects and Property Values: Summary of Key Results

This report has extensively investigated the potential impacts of wind power facilities on the value (i.e., sales prices) of residential properties that are in proximity to and/or that have a view of those wind facilities. In so doing, three different potential impacts of wind projects on property values have been identified and analyzed: Area Stigma, Scenic Vista Stigma, and Nuisance Stigma. To assess these potential impacts, a primary (Base) hedonic model has been applied, seven alternative hedonic models have been explored, a repeat sales analysis has been conducted, and possible impacts on sales volumes have been evaluated. Table 33 outlines the resulting ten tests conducted in this report, identifies which of the three potential stigmas those tests were designed to investigate, and summarizes the results of those investigations. This section synthesizes these key results, organized around the three potential stigmas.

Table 33: Impact of Wind Projects on Property Values: Summary of Key Results

	Is there statistical evidence of:			
Statistical Model	**Area Stigma?**	**Scenic Vista Stigma?**	**Nuisance Stigma?**	**Section Reference**
Base Model	No	No	No	*Section 4*
View Stability	Not tested	No	Not tested	*Section 5.1*
Distance Stability	No	Not tested	No	*Section 5.1*
Continuous Distance	No	No	No	*Section 5.2*
All Sales	No	No	Limited	*Section 5.3*
Temporal Aspects	No	No	No	*Section 5.4*
Orientation	No	No	No	*Section 5.5*
Overlap	No	Limited	No	*Section 5.6*
Repeat Sales	No	Limited	No	*Section 6*
Sales Volume	No	Not tested	No	*Section 7*

"No"……. *No statistical evidence of a negative impact*
"Yes"……. *Strong statistical evidence of a negative impact*
"Limited"……. *Limited and inconsistent statistical evidence of a negative impact*
"Not tested"……. *This model did not test for this stigma*

8.1. Area Stigma

Area Stigma is defined as a concern that the general area surrounding a wind energy facility will appear more developed, which may adversely affect home values in the local community regardless of whether any individual home has a view of the wind turbines. Though these impacts might be expected to be especially severe at close range to the turbines, the impacts could conceivably extend for a number of miles around a wind facility. Modern wind turbines are visible from well outside of five miles in many cases, so if an Area Stigma exists, it is possible that all of the homes in the study areas inside of five miles would be affected.

As summarized in Table 33, Area Stigma is investigated with the Base, Distance Stability, Continuous Distance, All Sales, Temporal Aspects, Orientation, and Overlap hedonic models. It is also tested, somewhat differently, with the Repeat Sales and Sales Volume analyses. In each case, if an Area Stigma exists, it is expected that the sales prices (and/or sales volume) of homes

000627

located near wind facilities would be broadly affected by the presence of those facilities, with effects decreasing with distance.

The Base Model finds little evidence of an Area Stigma, as the coefficients for the DISTANCE variables are all relatively small and none are statistically different from zero. For homes in this sample, at least, there is no statistical evidence from the Base Model that the distance from a home to the nearest wind turbine impacts sales prices, regardless of the distance band. Perhaps a more direct test of Area Stigma, however, comes from the Temporal Aspects Model. In this model, homes in all distance bands that sold after wind facility announcement are found to sell, on average, for prices that are not statistically different from those for homes that sold more than two years prior to wind facility announcement. Again, no persuasive evidence of an Area Stigma is evident.

The Repeat Sales and Sales Volume Models also investigate Area Stigma. The Repeat Sales Model's 354 homes, each of which sold once before facility announcement and again after construction, show average inflation-adjusted annual appreciation rates that are small and not statistically different from zero. If homes in all study areas were subject to an Area Stigma, one would expect a negative and statistically significant intercept term. Similarly, if homes in any individual study area experienced an Area Stigma, the fixed effect terms would be negative and statistically significant. Neither of these expectations is borne out in the results. The Sales Volume Model tells a similar story, finding that the rate of residential transactions is either not significantly different between the pre- and post-announcement periods, or is greater in later periods, implying, in concert with the other tests, that increased levels of transactions do not signify a rush to sell, and therefore lower prices, but rather an increase in the level of transactions with no appreciable difference in the value of those homes.

The All Sales, Distance Stability, Continuous Distance, Orientation, and Overlap Models corroborate these basic findings. In the All Sales and Distance Stability Models, for example, the DISTANCE coefficients for homes that sold outside of one mile but within five miles, compared to those that sold outside of five miles, are very similar: they differ by no more than 2%, and this small disparity is not statistically different from zero. The same basic findings resulted from the Orientation and Overlap Models. Further, homes with No View as estimated in the All Sales Model are found to appreciate in value, after adjusting for inflation, when compared to homes that sold before wind facility construction (0.02, *p* value 0.06); an Area Stigma effect should be reflected as a negative coefficient for this parameter. Finally, despite using all 4,937 cases in a single distance variable and therefore having a correspondingly small standard error, the Continuous Distance Model discovers no measurable relationship between distance from the nearest turbine and the value of residential properties.

Taken together, the results from these models are strikingly similar: there is no evidence of a widespread and statistically significant Area Stigma among the homes in this sample. Homes in these study areas are not, on average, demonstrably and measurably stigmatized by the arrival of a wind facility, regardless of when they sold in the wind project development process and regardless of whether those homes are located one mile or five miles away from the nearest wind facility.

Drawing from the previous literature on environmental disamenities discussed in Section 2.1, one likely explanation for this result is simply that any effects that might exist may have faded to a level indistinguishable from zero at distances outside of a mile from the wind facilities. For other disamenities, some of which would seemingly be more likely to raise concerns, effects have been found to fade quickly with distance. For example, property value effects near a chemical plant have been found to fade outside of two and a half miles (Carroll et al., 1996), near a lead smelter (Dale et al., 1999) and fossil fuel plants (Davis, 2008) outside of two miles, and near landfills and confined animal feeding operations outside of 2,400 feet and 1,600 feet, respectively (Ready and Abdalla, 2005). Further, homes outside of 300 feet (Hamilton and Schwann, 1995) or even as little as 150 feet (Des-Rosiers, 2002) from a high voltage transmission line have been found to be unaffected. A second possible explanation for these results could be related to the view of the turbines. In the sample used for this analysis, a large majority of the homes outside of one mile (n = 4,812) that sold after wind-facility construction commenced cannot see the turbines (n = 4,189, 87%), and a considerably larger portion have – at worst – a minor view of the turbines (n = 4,712, 98%). Others have found that the sales prices for homes situated at similar distances from a disamenity (e.g., HVTL) depend, in part, on the , view of that disamenity (Des-Rosiers, 2002). Similarly, research has sometimes found that annoyance with a wind facility decreases when the turbines cannot be seen (Pedersen and Waye, 2004). Therefore, for the overwhelming majority of homes outside of a mile that have either a minor rated view or no view at all of the turbines, the turbines may simply be out of sight, and therefore, out of mind.

8.2. Scenic Vista Stigma

Scenic Vista Stigma is defined as concern that a home may be devalued because of the view of a wind energy facility, and the potential impact of that view on an otherwise scenic vista. It has as its basis an admission that home values are, to some degree, derived from the quality of what can be seen from the property and that if those vistas are altered, sales prices might be measurably affected. The Base, View Stability, Continuous Distance, All Sales, Temporal Aspects, Orientation, Overlap, and Repeat Sales Models each test whether Scenic Vista Stigma is present in the sample.

The Base Model, as well as subsequent Alternative Hedonic Models, demonstrates persuasively that the quality of the scenic vista – absent wind turbines – impacts sales prices. Specifically, compared to homes with an AVERAGE VISTA, those having a POOR or a BELOW AVERAGE rating are estimated to sell for 21% (p value 0.00) and 8% (p value 0.00) less, on average. Similarly, homes with an ABOVE AVERAGE or PREMIUM rating are estimated to sell for 10% (p value 0.00) and 13% (p value 0.00) more than homes with an AVERAGE vista rating. Along the same lines, homes in the sample with water frontage or situated on a cul-de-sac sell for 33% (p value 0.00) and 10% (p value 0.00) more, on average, than those homes that lack these characteristics. Taken together, these results demonstrate that home buyers and sellers consistently take into account what can be seen from the home when sales prices are established, and that the models presented in this report are able to clearly identify those impacts.[103]

[103] Of course, cul-de-sacs and water frontage bestow other benefits to the home owner beyond the quality of the scenic vista, such as safety and privacy in the case of a cul-de-sac, and recreational potential and privacy in the case of water frontage.

Despite this finding, those same hedonic models are unable to identify a consistent and statistically significant Scenic Vista Stigma associated with wind facilities. Home buyers and sellers, at least among this sample, do not appear to be affected in a measurable way by the visual presence of wind facilities. Regardless of which model was estimated, the value of homes with views of turbines that were rated MODERATE, SUBSTANTIAL, or EXTREME are found to be statistically indistinguishable from the prices of homes with no view of the turbines. Specifically, the 25 homes with EXTREME views in the sample, where the home site is "unmistakably dominated by the [visual] presence of the turbines," are not found to have measurably different property values, and neither are the 31 homes with a SUBSTANTIAL view, where "the turbines are dramatically visible from the home."[104] The same finding holds for the 106 homes that were rated as having MODERATE views of the wind turbines. Moreover, the Orientation and Overlap Models show that neither the orientation of the home with respect to the view of wind turbines, nor the overlap of that view with the prominent scenic vista, have measurable impacts on home prices.

The All Sales Model compares homes with views of the turbines (in the post-construction period) to homes that sold before construction (when no views were possible), and finds no statistical evidence of adverse effects within any VIEW category. Moreover, when a *t*-Test is performed to compare the NO VIEW coefficient to the others, none of the coefficients for the VIEW ratings are found to be statistically different from the NO VIEW homes. The Repeat Sales Model comes to a similar result, with homes with MODERATE views appreciating at a rate that was not measurably different from that of homes with no views (0.03, *p* value 0.29). The same model also finds that homes with SUBSTANTIAL/EXTREME views appreciate at a rate 2% slower per year (*p* value 0.09) than their NO VIEW peers. Homes situated inside of one mile, however, are found to appreciate at a rate 3% more (*p* value 0.01) than reference homes located outside of five miles. Eight of the nine homes situated inside of one mile had either a SUBSTANTIAL or EXTREME view. Therefore, to correctly interpret these results, one would add the two coefficients for these homes, resulting in a combined 1% increase in appreciation as compared to the reference homes situated outside of five miles with no view of turbines, and again yielding no evidence of a Scenic Vista Stigma.

Although these results are consistent across most of the models, there are some individual coefficients from some models that differ. Specifically, homes with MINOR rated views in the Overlap and Repeat Sales Models are estimated to sell for 3% less (*p* value 0.10) and appreciate at a rate 2% less (*p* value 0.02) than NO VIEW homes. Taken at face value, these MINOR VIEW findings imply that homes where "turbines are visible, but, either the scope is narrow, there are many obstructions, or the distance between the home and the facility is large" are systematically impacted in a modest but measurable way. Homes with more dramatic views of a wind facility in the same models, on the other hand, are found to not be measurably affected. Because of the counterintuitive nature of this result, and because it is contradicted in the results of other models presented earlier, it is more likely that there is some aspect of these homes that was not modeled appropriately in the Overlap and Repeat Sales Models, and that the analysis is picking up the effect of omitted variable(s) rather than a systematic causal effect from the wind facilities.

[104] See Section 3.2.3 and Appendix C for full description of VIEW ratings.

Taken together, the results from all of the models and all of the VIEW ratings support, to a large degree, the Base Model findings of no evidence of a Scenic Vista Stigma. Although there are 160 residential transactions in the sample with more dramatic views than MINOR, none of the model specifications is able to find any evidence that those views of wind turbines measurably impacted average sales prices, despite the fact that those same models consistently find that home buyers and sellers place value on the quality of the scenic vista.

8.3. Nuisance Stigma

Nuisance Stigma is defined as a concern that factors that may occur in close proximity to wind turbines, such as sound and shadow flicker, will have a unique adverse influence on home values. If these factors impact residential sales prices, those impacts are likely to be concentrated within a mile of the wind facilities. The Base, Distance Stability, Continuous Distance, All Sales, Temporal Aspects, Orientation, Overlap, Repeat Sales, and Sales Volume Models all investigate the possible presence of a Nuisance Stigma.

The Base Model finds that those homes within 3000 feet and those between 3000 feet and one mile of the nearest wind turbine sold for roughly 5% less than similar homes located more than five miles away, but that these differences are not statistically significant (*p* values of 0.40 and 0.30, respectively). These results remain unchanged in the Distance Stability Model, as well as in the Orientation and Overlap Models. Somewhat similarly, in the All Sales Model, when all transactions occurring after wind facility announcement are assumed to potentially be impacted (rather than just those occurring after construction, as in the Base Model), and a comparison is made to the average of all transactions occurring pre-announcement (rather than the average of all transactions outside of five miles, as in the Base Model), these same coefficients grow to -6% (*p* value 0.23) and -8% (*p* value 0.08) respectively. Although only one of these coefficients was statistically significant, they are large enough to warrant further scrutiny.

The Temporal Aspects Model provides a clearer picture of these findings. It finds that homes that sold prior to wind facility announcement and that were situated within one mile of where the turbines were eventually located sold, on average, for between 10% and 13% less than homes located more than five miles away and that sold in the same period. Therefore, the homes nearest the wind facility's eventual location were already depressed in value before the announcement of the facility. Most telling, however, is what occurred after construction. Homes inside of one mile are found to have inflation-adjusted sales prices that were either statistically undistinguishable from, or in some cases greater than, pre-announcement levels. Homes sold in the first two years after construction, for example, have higher prices (0.07, *p* value 0.32), as do those homes that sold between two and four years after construction (0.13, *p* value 0.06) and more than four years after construction (0.08, *p* value 0.24). In other words, there is no indication that these homes experienced a decrease in sales prices after wind facility construction began. Not only does this result fail to support the existence of a Nuisance Stigma, but it also indicates that the relatively large negative coefficients estimated in the Base and All Sales Models are likely caused by conditions that existed prior to wind facility construction and potentially prior to facility announcement.[105]

[105] See footnote 82 on page 46 for a discussion of possible alternative explanations to this scenario.

000631

These results are corroborated by the Continuous Distance Model, which finds no statistically significant relationship between an inverse DISTANCE function and sales prices (-0.01, sig 0.46). Similarly, in the Repeat Sales Model, homes within one mile of the nearest turbine are not found to be adversely affected; somewhat counter-intuitively, they are found to appreciate faster (0.03, *p* value 0.01) than their peers outside of five miles. Finally, the Sales Volume analysis does not find significant and consistent results that would suggest that the ability to sell one's home within one mile of a wind facility is substantially impacted by the presence of that facility.

Taken together, these models present a consistent set of results: the sales prices of homes in this sample that are within a mile of wind turbines, where various nuisance effects have been posited, are not measurably affected compared to those homes that are located more than five miles away from the facilities or that sold well before the wind projects were announced. These results imply that widespread Nuisance Stigma effects are either not present in the sample, or are too small or sporadic to be statistically identifiable.

Though these results may appear counterintuitive, it may simply be that property value impacts fade rapidly with distance, and that few of the homes in the sample are close enough to the subject wind facilities to be substantially impacted. As discussed earlier, studies of the property value impacts of high voltage transmission lines often find that effects fade towards zero at as little distance as 200 feet (see, e.g., Gallimore and Jayne, 1999; Watson, 2005). None of the homes in the present sample are closer than 800 feet to the nearest wind turbine, and all but eight homes are located outside of 1000 feet of the nearest turbine. It is therefore possible that, if any effects do exist, they exist at very close range to the turbines, and that those effects are simply not noticeable outside of 800 feet. Additionally, almost half of the homes in the sample that are located within a mile of the nearest turbine have either no view or a minor rated view of the wind facilities, and some high voltage transmission line (HVTL) studies have found a decrease in adverse effects if the towers are <u>not</u> visible (Des-Rosiers, 2002) and, similarly, decreases in annoyance with wind facility sounds if turbines cannot be seen (Pedersen and Waye, 2004). Finally, effects that existed soon after the announcement or construction of the wind facilities might have faded over time. More than half of the homes in the sample sold more than three years after the commencement of construction, while studies of HVTLs have repeatedly found that effects fade over time (Kroll and Priestley, 1992) and studies of attitudes towards wind turbines have found that such attitudes often improve after facility construction (Wolsink, 1989). Regardless of the explanation, the fact remains that, in this sizable sample of residential transactions, no persuasive evidence of a widespread Nuisance Stigma is found, and if these impacts do exist, they are either too small or too infrequent to result in any widespread and consistent statistically observable impact.

9. Conclusions

Though surveys generally show that public acceptance towards wind energy is high, a variety of concerns with wind development are often expressed at the local level. One such concern that is often raised in local siting and permitting processes is related to the potential impact of wind projects on the property values of nearby residences.

This report has investigated the potential impacts of wind power facilities on the sales prices of residential properties that are in proximity to and/or that have a view of those wind facilities. It builds and improve on the previous literature that has investigated these potential effects by collecting a large quantity of residential transaction data from communities surrounding a wide variety of wind power facilities, spread across multiple parts of the U.S. Each of the homes included in this analysis was visited to clearly determine the degree to which the wind facility was visible at the time of home sale and to collect other essential data. To frame the analysis, three potentially distinct impacts of wind facilities on property values are considered: Area, Scenic Vista, and Nuisance Stigma. To assess these potential impacts, the authors applied a base hedonic model, explored seven alternative hedonic models, conducted a repeat sales analysis, and evaluated possible impacts on sales volumes. The result is the most comprehensive and data-rich analysis to date on the potential impacts of wind projects on nearby property values.

Although each of the analysis techniques used in this report has strengths and weaknesses, the results are strongly consistent in that each model fails to uncover conclusive evidence of the presence of any of the three property value stigmas. Based on the data and analysis presented in this report, no evidence is found that home prices surrounding wind facilities are consistently, measurably, and significantly affected by either the view of wind facilities or the distance of the home to those facilities. Although the analysis cannot dismiss the possibility that individual or small numbers of homes have been or could be negatively impacted, if these impacts do exist, they are either too small and/or too infrequent to result in any widespread and consistent statistically observable impact. Moreover, to the degree that homes in the present sample are similar to homes in other areas where wind development is occurring, the results herein are expected to be transferable.

Finally, although this work builds on the existing literature in a number of respects, there remain a number of areas for further research. The primary goal of subsequent research should be to concentrate on those homes located closest to wind facilities, where the least amount of data are available. Additional research of the nature reported in this paper could be pursued, but with a greater number of transactions, especially for homes particularly close to wind facilities. Further, it is conceivable that cumulative impacts might exist whereby communities that have seen repetitive development are affected uniquely, and these cumulative effects may be worth investigating. A more detailed analysis of sales volume impacts may also be fruitful, as would an assessment of the potential impact of wind facilities on the length of time homes are on the market in advance of an eventual sale. Finally, it would be useful to conduct a survey of those homeowners living close to existing wind facilities, and especially those residents who have bought and sold homes in proximity to wind facilities after facility construction, to assess their opinions on the impacts of wind project development on their home purchase and sales decisions.

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Appendix A: Study Area Descriptions

The analysis reported in the body of the report used data from ten different wind-project study areas, across nine different states and 14 counties, and surrounding 24 different wind facilities. Each of the study areas is unique, but as a group they provide a good representation of the range of wind facility sizes, hub heights, and locations of recent wind development activity in the U.S. (see Figure A - 1 and Table A - 1). This appendix describes each of the ten study areas, and provides the following information: a map of the study area; a description of the area; how the data were collected; statistics on home sales prices in the sample and census-reported home values for the towns, county, and state that encompass the area; data on the wind facilities contained within the study area; and frequency tables for the variables of interest (i.e., views of turbines, distance to nearest turbine ,and development period).

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Figure A - 1: Map of Study Areas

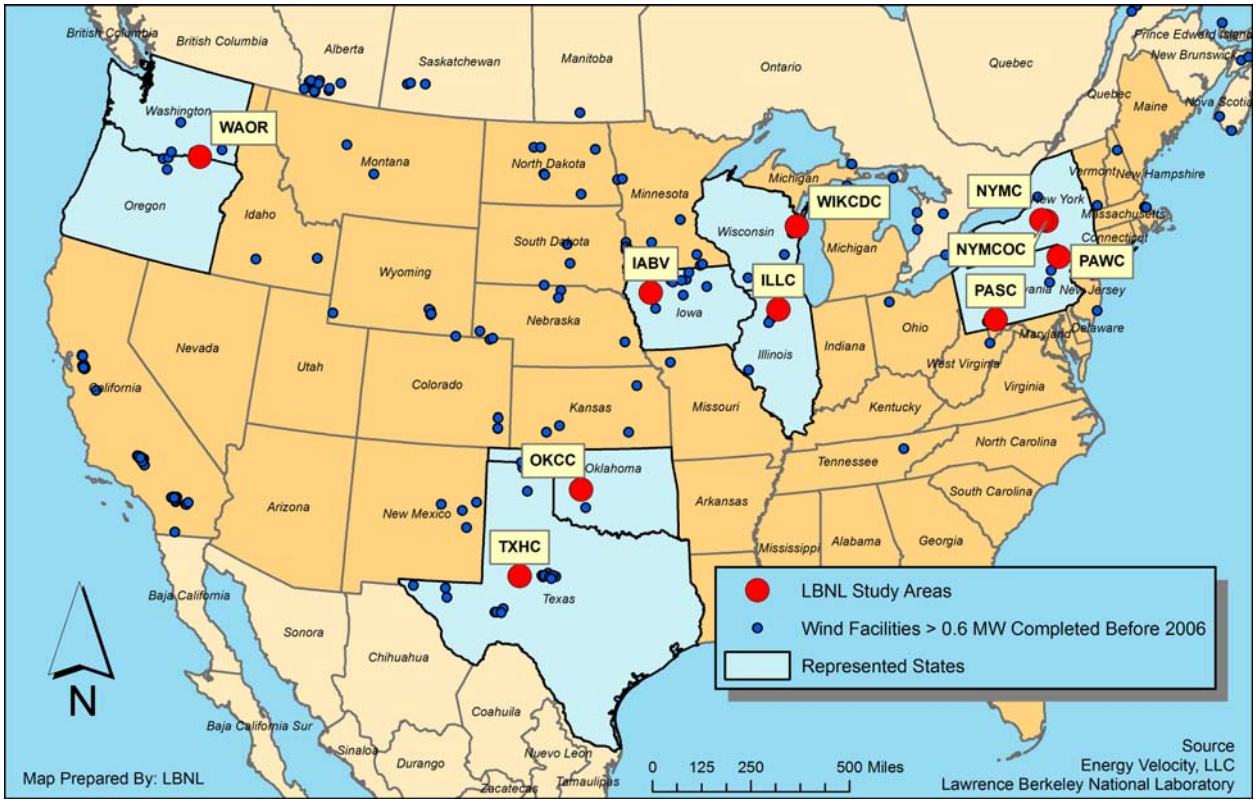
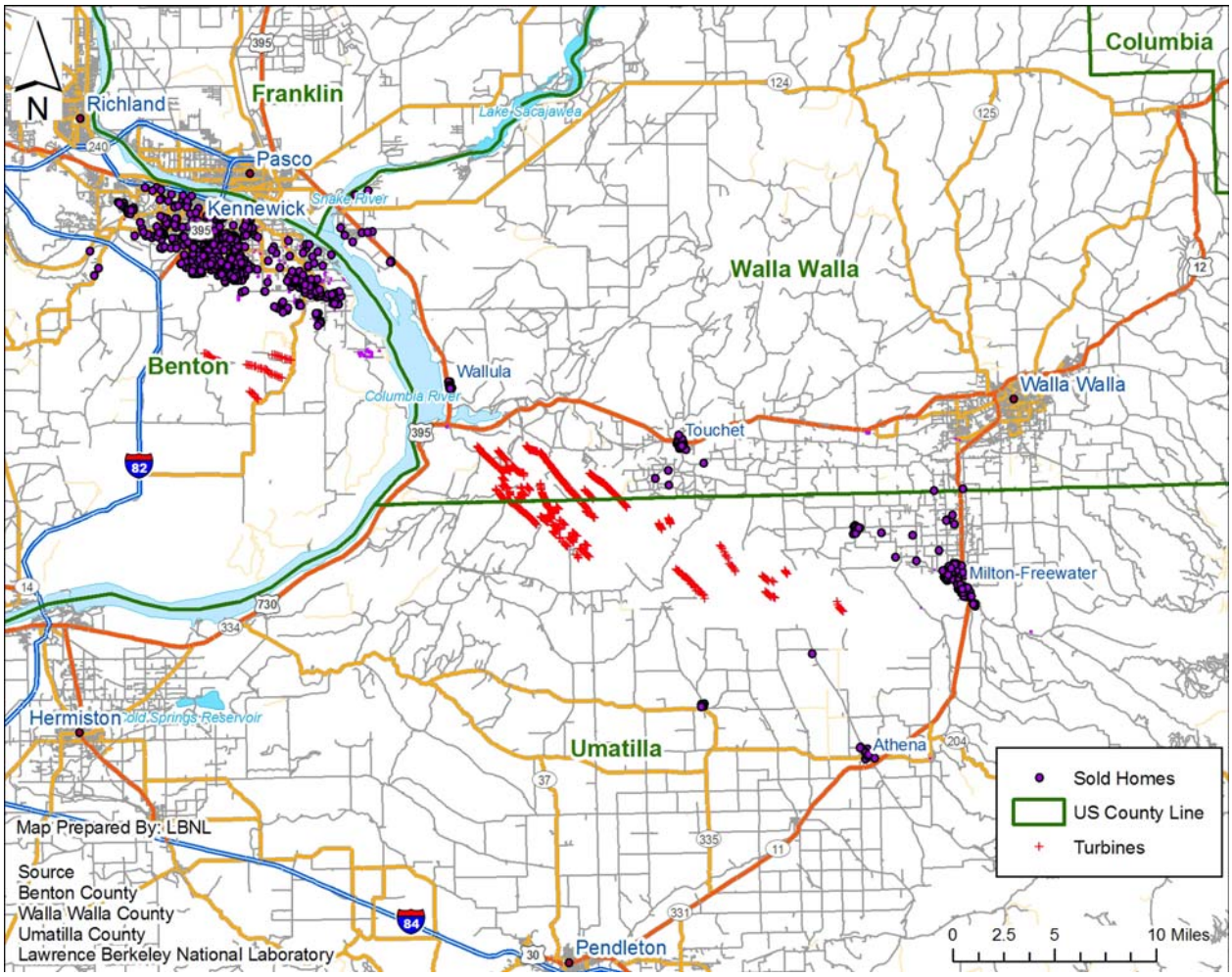


Table A - 1: Summary of Study Areas

Study Area Code	Study Area Counties, States	Facility Names	Number of Turbines	Number of MW	Max Hub Height (meters)	Max Hub Height (feet)
WAOR	Benton and Walla Walla Counties, WA and Umatilla County, OR	Vansycle Ridge, Stateline, Nine Canyon I & II, Combine Hills	582	429	60	197
TXHC	Howard County, TX	Big Spring I & II	46	34	80	262
OKCC	Custer County, OK	Weatherford I & II	98	147	80	262
IABV	Buena Vista County, IA	Storm Lake I & II, Waverly, Intrepid I & II	381	370	65	213
ILLC	Lee County, IL	Mendota Hills, GSG Wind	103	130	78	256
WIKCDC	Kewaunee and Door Counties, WI	Red River, Lincoln	31	20	65	213
PASC	Somerset County, PA	Green Mountain, Somerset, Meyersdale	34	49	80	262
PAWC	Wayne County, PA	Waymart	43	65	65	213
NYMCOC	Madison and Oneida Counties, NY	Madison	7	12	67	220
NYMC	Madison County, NY	Fenner	20	30	66	218
		TOTAL	**1345**	**1286**		

A.1 WAOR Study Area: Benton and Walla Walla Counties (Washington), and Umatilla County (Oregon)

Figure A - 2: Map of WAOR Study Area



Note: "Sold Homes" include all sold homes both before and after construction.

Area Description

This study area combines data from the three counties - Benton and Walla Walla in Washington, and Umatilla in Oregon - that surround the Vansycle Ridge, Stateline, Combine Hills, and Nine Canyon wind projects. Wind development began in this area in 1997 and, within the sample of wind projects, continued through 2003. In total, the wind facilities in this study area include 582 turbines and 429 MW of nameplate capacity, with hub heights that range from 164 feet to almost 200 feet. The wind facilities are situated on an East-West ridge that straddles the Columbia River, as it briefly turns South. The area consists of undeveloped highland/plateau grassland, agricultural tracks for winter fruit, and three towns: Kennewick (Benton County), Milton-Freewater (Umatilla County), and Walla Walla (Walla Walla County). Only the first two of these towns are represented in the dataset because Walla Walla is situated more than 10 miles from the nearest wind turbine. Also in the area are Touchet and Wallula, WA, and Athena, OR,

all very small communities with little to no services. Much of the area to the North and South of the ridge, and outside of the urban areas, is farmland, with homes situated on small parcels adjoining larger agricultural tracts.

Data Collection and Summary

Data for this study area were collected from a myriad of sources. For Benton County, sales and home characteristic data and GIS parcel shapefiles were collected with the assistance of county officials Eric Beswick, Harriet Mercer, and Florinda Paez, while state official Deb Mandeville (Washington Department of State) provided information on the validity of the sales. In Walla Walla County, county officials Bill Vollendorff and Tiffany Laposi provided sales, house characteristic, and GIS data. In Umatilla County, county officials Jason Nielsen, Tracie Diehl, and Tim McElrath provided sales, house characteristic, and GIS data.

Based on the data collection, more than 8,500 homes are found to have sold within ten miles of the wind turbines in this study area from January 1996 to June 2007. Completing field visits to this number of homes would have been overly burdensome; as a result, only a sample of these home sales was used for the study. Specifically, all valid sales within three miles of the nearest turbine are used, and a random sample of those homes outside of three miles but inside of five miles in Benton County and inside ten miles in Walla Walla and Umatilla Counties. This approach resulted in a total of 790 sales, with prices that ranged from $25,000 to $647,500, and a mean of $134,244. Of those 790 sales, 519 occurred after wind facility construction commenced, and 110 could see the turbines at the time of sale, though all but four of these homes had MINOR views. No homes within this sample were located within one mile of the nearest wind turbine, with the majority occurring outside of three miles.

Area Statistics

Study Period Begin	Study Period End	Number of Sales	Median Price	Mean Price	Minimum Price	Maximum Price
1/23/1996	6/29/2007	790	$ 125,803	$ 134,244	$ 25,000	$ 647,500

Facility Statistics

Facility Name	Number of MW	Number of Turbines	Announce Date	Construction Begin Date	Completion Date	Turbine Maker	Hub Height (Meters)
Vansycle Ridge	25	38	Aug-97	Feb-98	Aug-98	Vestas	50
Stateline Wind Project, Phase I (OR)	83	126	Jun-00	Sep-01	Dec-01	Vestas	50
Stateline Wind Project, Phase I (WA)	177	268	Jun-00	Feb-01	Dec-01	Vestas	50
Stateline Wind Project, Phase II	40	60	Jan-02	Sep-02	Dec-02	Vestas	50
Nine Canyon Wind Farm	48	37	Jun-01	Mar-02	Sep-02	Bonus	60
Combine Hills Turbine Ranch I	41	41	Apr-02	Aug-03	Dec-03	Mitsubishi	55
Nine Canyon Wind Farm II	16	12	Jun-01	Jun-03	Dec-03	Bonus	60

Source: AWEA & Ventyx Inc.

Variables of Interest Statistics

Development Period	Pre Announcement	Post Announcement Pre Construction	1st Year After Construction	2nd Year After Construction	2+ Years After Construction	Total
Benton/Walla Walla, WA & Umatilla, OR (WAOR)	226	45	76	59	384	790

View of Turbines	Pre Construction	None	Minor	Moderate	Substantial	Extreme	Total
Benton/Walla Walla, WA & Umatilla, OR (WAOR)	271	409	106	4	0	0	790

Distance to Nearest Turbine	Pre Construction	< 0.57 Miles	0.57 - 1 Miles	1 - 3 Miles	3 - 5 Miles	> 5 Miles	Total
Benton/Walla Walla, WA & Umatilla, OR (WAOR)	271	0	0	20	277	222	790

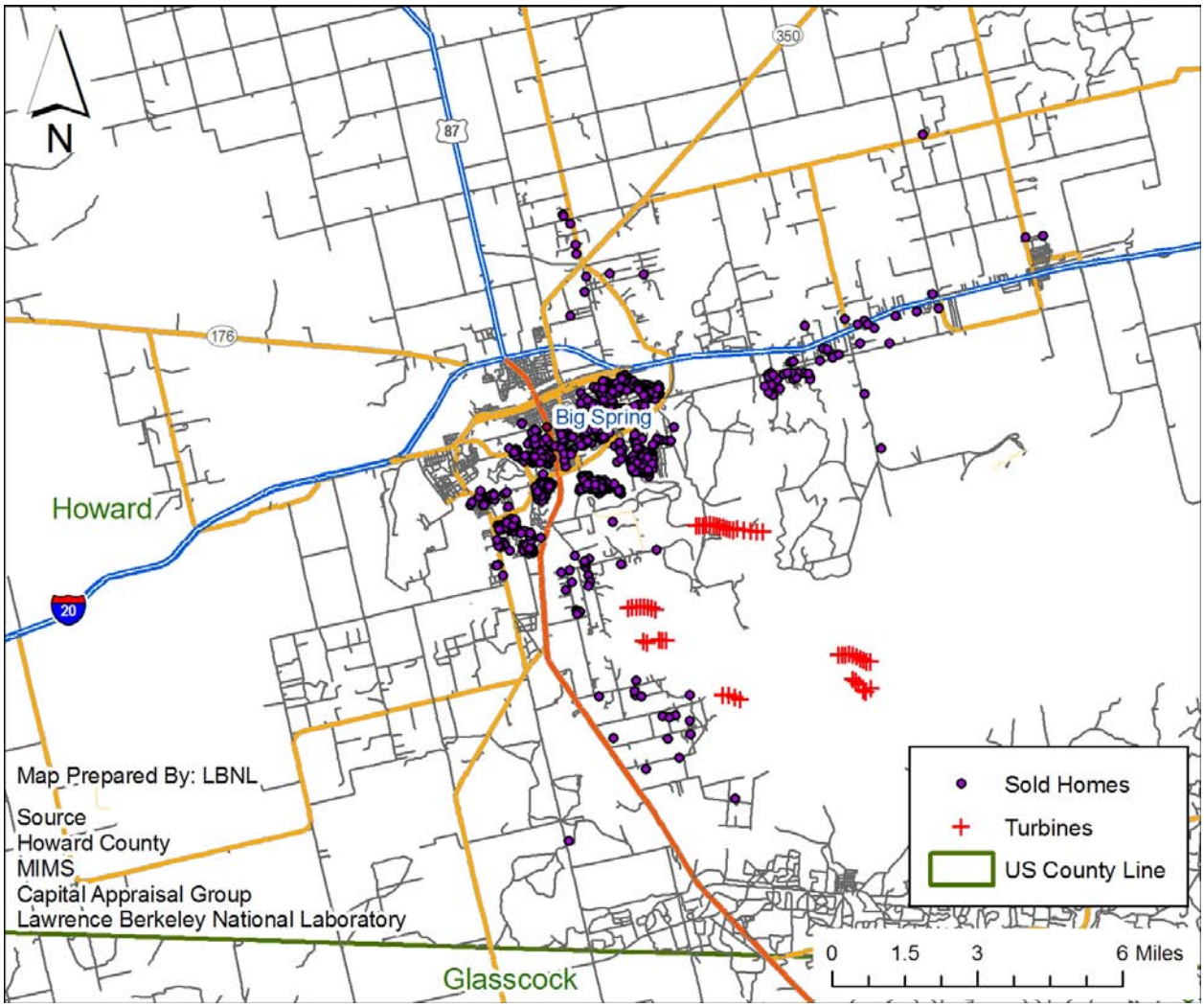
Census Statistics

Name	Type	2007 Population	% Change Since 2000	Population Per Mile^2	Median Age	Median Income	Median House 2007	% Change Since 2000
Kennewich, WA	City	62,182	12.5%	2,711	32.3	$ 45,085	$ 155,531	46%
Walla Walla, WA	City	30,794	4.0%	2,847	33.8	$ 38,391	$ 185,706	91%
Milton Freewater, OR	Town	6,335	-2.0%	3,362	31.7	$ 30,229	$ 113,647	47%
Touchet, WA	Town	413	n/a	340	33.6	$ 47,268	$ 163,790	81%
Benton	County	159,414	3.6%	94	34.4	$ 51,464	$ 162,700	46%
Walla Walla	County	57,709	1.0%	45	34.9	$ 43,597	$ 206,631	89%
Umatilla	County	73,491	0.6%	23	34.6	$ 38,631	$ 138,200	47%
Washington	State	6,488,000	10.1%	89	35.3	$ 55,591	$ 300,800	79%
Oregon	State	3,747,455	9.5%	36	36.3	$ 48,730	$ 257,300	69%
US	Country	301,139,947	6.8%	86	37.9	$ 50,233	$ 243,742	46%

Source: City-Data.com & Wikipedia. "% Change Since 2000" refers to the percentage change between 2000 and 2007 for the figures in the column to the left (population or median house price). "Town" signifies any municipality with less than 10,000 inhabitants. "n/a" signifies data not available.

A.2 TXHC Study Area: Howard County (Texas)

Figure A - 3: Map of TXHC Study Area



Note: "Sold Homes" include all sold homes both before and after construction.

Area Description

This study area is entirely contained within Howard County, Texas, and includes the city of Big Spring, which is situated roughly 100 miles South of Lubbock and 275 miles West of Dallas in West Texas. On top of the Northern end of the Edwards Plateau, which runs from the Southeast to the Northwest, sits the 46 turbine (34 MW) Big Spring wind facility, which was constructed in 1998 and 1999. Most of the wind turbines in this project have a hub height of 213 feet, but four are taller, at 262 feet. The plateau and the wind facility overlook the city of Big Spring which, when including its suburbs, wraps around the plateau to the South and East. Surrounding the town are modest farming tracks and arid, undeveloped land. These lands, primarily to the South of the facility towards Forsan (not shown on map), are dotted with small oil rigs. Many of the homes in Big Spring do not have a view of the wind facility, but others to the South and East do have such views.

Data Collection and Summary

County officials Brett McKibben, Sally Munoz, and Sheri Proctor were extremely helpful in answering questions about the data required for this project, and the data were provided by two firms that manage it for the county. Specifically, Erin Welch of the Capital Appraisal Group provided the sales and house characteristic data and Paul Brandt of MIMS provided the GIS data.

All valid single-family home sales transactions within five miles of the nearest turbine and occurring between January 1996 and March 2007 were included in the dataset, resulting in 1,311 sales.[106] These sales ranged in price from $10,492 to $490,000, with a mean of $74,092. Because of the age of the wind facility, many of the sales in the sample occurred after wind facility construction had commenced (n = 1,071). Of those, 104 had views of the turbines, with 27 having views more dramatic than MINOR. Four homes sold within a mile of the facility, with the rest falling between one and three miles (n = 584), three to five miles (n = 467), and outside of five miles (n = 16).

Area Statistics

Study Period Begin	Study Period End	Number of Sales	Median Price	Mean Price	Minimum Price	Maximum Price
1/2/1996	3/30/2007	1,311	$66,500	$74,092	$10,492	$490,000

Facility Statistics

Facility Name	Number of MW	Number of Turbines	Announce Date	Construction Begin Date	Completion Date	Turbine Maker	Hub Height (Meters)
Big Spring I	27.7	42	Jan-98	Jul-98	Jun-99	Vestas	65
Big Spring II	6.6	4	Jan-98	Jul-98	Jun-99	Vestas	80

Source: AWEA & Ventyx Inc.

Variables of Interest Statistics

Development Period	Pre Announcement	Post Announcement Pre Construction	1st Year After Construction	2nd Year After Construction	2+ Years After Construction	Total
Howard, TX (TXHC)	169	71	113	131	827	1311

View of Turbines	Pre Construction	None	Minor	Moderate	Substantial	Extreme	Total
Howard, TX (TXHC)	240	967	77	22	5	0	1311

Distance to Nearest Turbine	Pre Construction	< 0.57 Miles	0.57 - 1 Miles	1 - 3 Miles	3 - 5 Miles	> 5 Miles	Total
Howard, TX (TXHC)	240	0	4	584	467	16	1311

[106] If parcels intersected the five mile boundary, they were included in the sample, but were coded as being outside of five miles.

Census Statistics

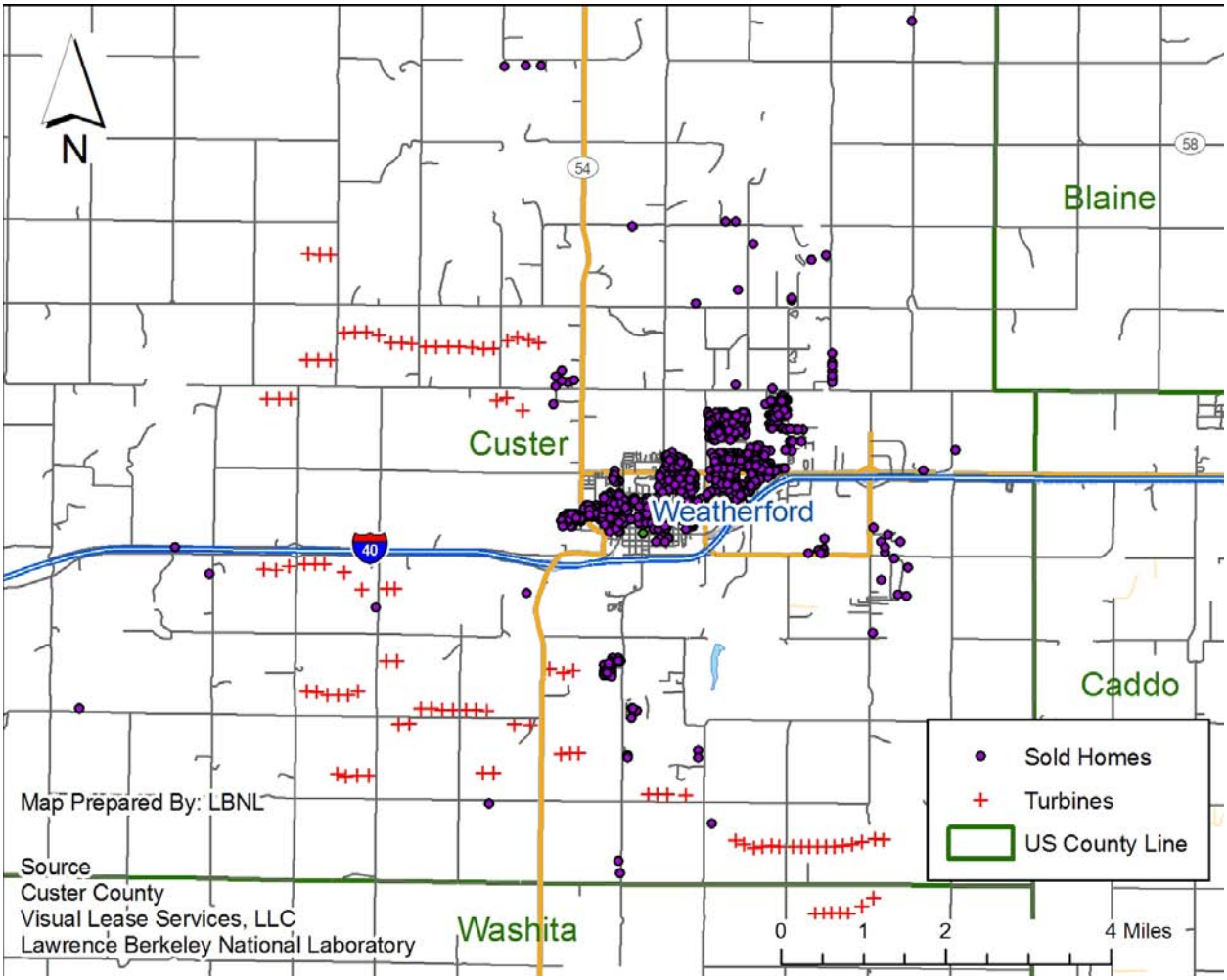
Name	Type	2007 Population	% Change Since 2000	Population Per Mile^2	Median Age	Median Income	Median House 2007	% Change Since 2000
Big Spring	City	24,075	-5.4%	1,260	35.1	$ 32,470	$ 54,442	50%
Forsan	Town	220	-4.0%	758	36.8	$ 50,219	$ 64,277	84%
Howard	County	32,295	-1.9%	36	36.4	$ 36,684	$ 60,658	58%
Texas	State	23,904,380	14.6%	80	32.3	$ 47,548	$ 120,900	47%
US	Country	301,139,947	6.8%	86	37.9	$ 50,233	$ 243,742	46%

Source: City-Data.com & Wikipedia. "% Change Since 2000" refers to the percentage change between 2000 and 2007 for the figures in the column to the left (population or median house price). "Town" signifies any municipality with less than 10,000 inhabitants.

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A.3 OKCC Study Area: Custer County (Oklahoma)

Figure A - 4: Map of OKCC Study Area



Note: "Sold Homes" include all sold homes both before and after construction.

Area Description

This study area is entirely contained within Custer County, Texas, and includes the Weatherford wind facility, which is situated near the city of Weatherford, 70 miles due west of Oklahoma City and near the western edge of the state. The 98 turbine (147 MW) Weatherford wind facility straddles Highway 40, which runs East-West, and U.S. County Route 54, which runs North-South, creating an "L" shape that is more than six miles long and six miles wide. Development began in 2004, and was completed in two phases ending in 2006. The turbines are some of the largest in the sample, with a hub height of 262 feet. The topography of the study area is mostly flat plateau, allowing the turbines to be visible from many parts of the town and the surrounding rural lands. There are a number of smaller groupings of homes that are situated to the North and South of the city, many of which are extremely close to the turbines and have dramatic views of them.

Data Collection and Summary

County Assessor Debbie Collins and mapping specialist Karen Owen were extremely helpful in gathering data and answering questions at the county level. Data were obtained directly from the county and from Visual Lease Services, Inc and OKAssessor, where representatives Chris Mask, Terry Wood, Tracy Leniger, and Heather Brown helped with the request.

All valid single-family residential transactions within five miles of the nearest wind turbine and occurring between July 1996 and June 2007 were included in the dataset, resulting in 1,113 sales.[107] These sales ranged in price from $11,000 to $468,000, with a mean of $100,445. Because of the relatively recent construction of the facility, 58% of the sales (n = 637) occurred before construction, leaving 476 sales with possible views of the turbines. Of those 476 sales, 25 had more-dramatic view ratings than MINOR and 17 sales occurred inside of one mile.

Area Statistics

Study Period Begin	Study Period End	Number of Sales	Median Price	Mean Price	Minimum Price	Maximum Price
7/7/1996	6/29/2007	1,113	$91,000	$100,445	$11,000	$468,000

Facility Statistics

Facility Name	Number of MW	Number of Turbines	Announce Date	Construction Begin Date	Completion Date	Turbine Maker	Hub Height (Meters)
Weatherford Wind Energy Center	106.5	71	Mar-04	Dec-04	May-05	GE Wind	80
Weatherford Wind Energy Center Expansion	40.5	27	May-05	Oct-05	Jan-06	GE Wind	80

Source: AWEA & Ventyx Inc.

Variables of Interest Statistics

Development Period	Pre Announcement	Post Announcement Pre Construction	1st Year After Construction	2nd Year After Construction	2+ Years After Construction	Total
Custer, OK (OKCC)	484	153	193	187	96	1113

View of Turbines	Pre Construction	None	Minor	Moderate	Substantial	Extreme	Total
Custer, OK (OKCC)	637	375	76	6	7	12	1113

Distance to Nearest Turbine	Pre Construction	< 0.57 Miles	0.57 - 1 Miles	1 - 3 Miles	3 - 5 Miles	> 5 Miles	Total
Custer, OK (OKCC)	637	16	1	408	50	1	1113

[107] Portions of the town of Weatherford, both North and South of the town center, were not included in the sample due to lack of available data. The homes that were mapped, and for which electronic data were provided, however, were situated on all sides of these unmapped areas and were similar in character to those that were omitted. None of the unmapped homes were within a mile of the nearest wind turbine.

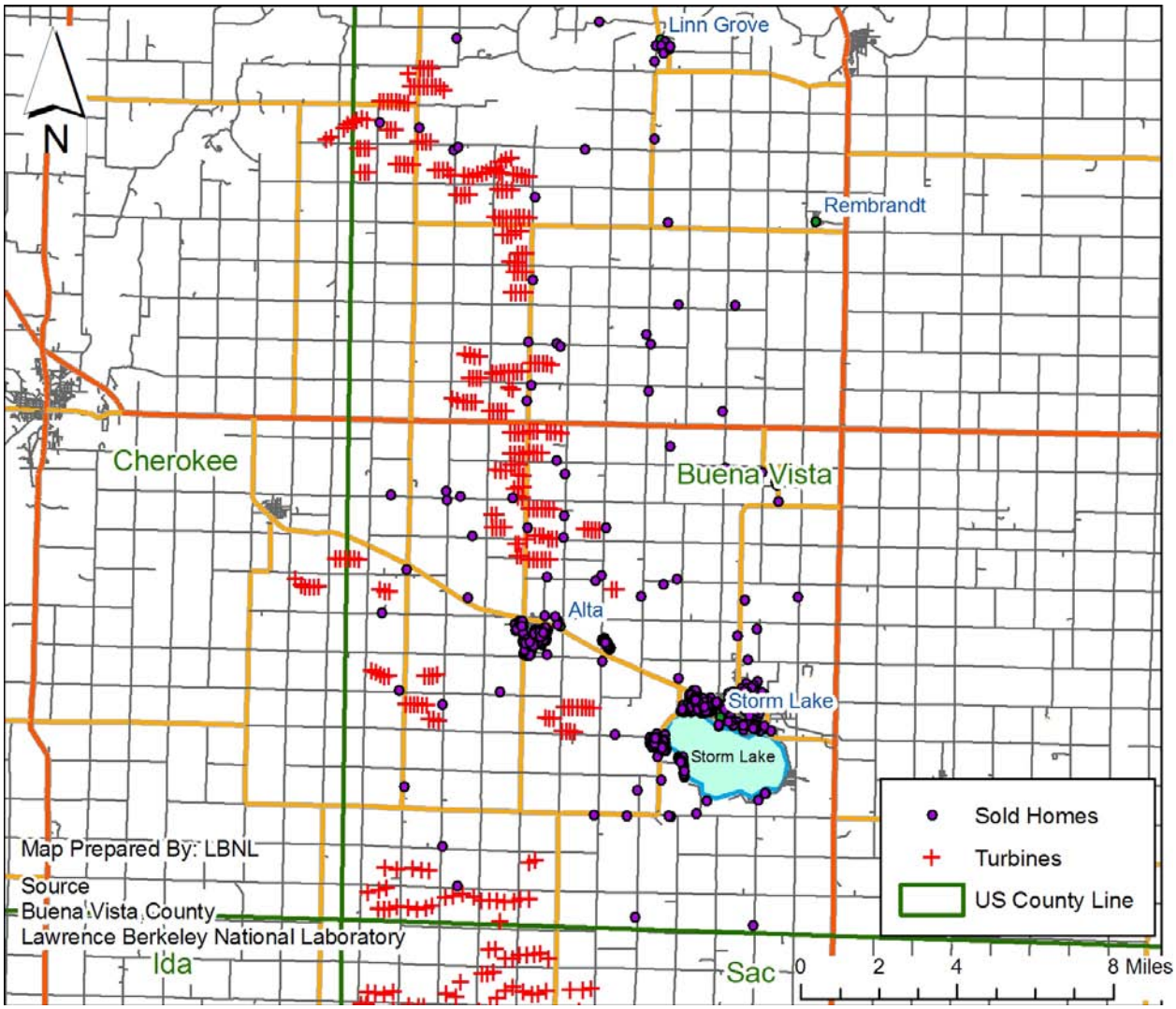
Census Statistics

Name	Type	2007 Population	% Change Since 2000	Population Per Mile^2	Median Age	Median Income	Median House 2007	% Change Since 2000
Weatherford	City	10,097	1.2%	1,740	24.1	$ 32,543	$ 113,996	45%
Hydro	Town	1,013	-3.7%	1,675	39.2	$ 35,958	$ 66,365	68%
Custer	County	26,111	3.6%	26	32.7	$ 35,498	$ 98,949	52%
Oklahoma	State	3,617,316	4.8%	53	35.5	$ 41,567	$ 103,000	46%
US	Country	301,139,947	6.8%	86	37.9	$ 50,233	$ 243,742	46%

Source: City-Data.com & Wikipedia. "% Change Since 2000" refers to the percentage change between 2000 and 2007 for the figures in the column to the left (population or median house price). "Town" signifies any municipality with less than 10,000 inhabitants.

A.4 IABV Study Area: Buena Vista County (Iowa)

Figure A - 5: Map of IABV Study Area



Note: "Sold Homes" include all sold homes both before and after construction.

Area Description

This study area includes the sizable Storm Lake and Intrepid wind facilities, which are mostly situated in Buena Vista County, located in Northwestern Iowa, 75 miles East of Sioux City. The facilities also stretch into Sac County to the South and Cherokee County to the West. The facilities total 381 turbines (370 MW) and are more than 30 miles long North to South and eight miles wide East to West. Development began on the first Storm Lake facility in 1998 and the last of the Intrepid development was completed in 2006. The largest turbines have a hub height of 213 feet at the hub, but most are slightly smaller at 207 feet. The majority of the homes in the sample surround Storm Lake (the body of water), but a large number of homes are situated on small residential plots located outside of the town and nearer to the wind facility. Additionally, a number of sales occurred in Alta - a small town to the East of Storm Lake -thatis straddled by the

wind facilities and therefore provides dramatic views of the turbines. In general, except for the depression in which Storm Lake sits, the topography is very flat, largely made up corn fields, and the turbines are therefore visible from quite far away. The housing market is driven, to some extent, by the water body, Storm Lake, which is a popular recreational tourist destination, and therefore development is occurring to the East and South of the lake. Some development is also occurring, to a lesser degree, to the East of Alta.

Data Collection and Summary

County Assessor Kathy A. Croker and Deputy Assessor Kim Carnine were both extremely helpful in answering questions and providing GIS data. Sales and home characteristic data were provided by Vanguard Appraisals, Inc., facilitated by the county officials. David Healy from MidAmerican provided some of the necessary turbine location GIS files.

The county provided data on valid single-family residential transactions between 1996 and 2007 for 1,743 homes inside of five miles of the nearest wind turbine. This sample exceeded the number for which field data could reasonably be collected; as a result, only a sample of these homes sales was used for the study. Specifically, all transactions that occurred within three miles of the nearest turbine were used, in combination with a random sample (totaling roughly 10%) of those homes between three and five miles. This approach resulted in 822 sales, with prices that ranged from $12,000 to $525,000, and a mean of $94,713. Development of the wind facilities in this area occurred relatively early in the sample period, and therefore roughly 75% of the sales (*n* = 605) occurred after project construction had commenced. Of those 605 sales, 105 had views of the turbines, 37 of which were ranked with a view rating more dramatic than MINOR, and 30 sales occurred within one mile of the nearest wind turbine.

Area Statistics

Study Period Begin	Study Period End	Number of Sales	Median Price	Mean Price	Minimum Price	Maximum Price
1/2/1996	3/30/2007	822	$79,000	$94,713	$12,000	$525,000

Facility Statistics

Facility Name	Number of MW	Number of Turbines	Announce Date	Construction Begin Date	Completion Date	Turbine Maker	Hub Height (Meters)
Storm Lake I	112.5	150	Feb-98	Oct-98	Jun-99	Enron	63
Storm Lake II	80.3	107	Feb-98	Oct-98	Apr-99	Enron	63
Waverly	1.5	2	Feb-98	Oct-98	Jun-99	Enron	65
Intrepid	160.5	107	Mar-03	Oct-04	Dec-04	GE Wind	65
Intrepid Expansion	15.0	15	Jan-05	Apr-05	Dec-05	Mitsubishi	65

Source: AWEA & Ventyx Inc.

Variables of Interest Statistics

Development Period	Pre Announcement	Post Announcement Pre Construction	1st Year After Construction	2nd Year After Construction	2+ Years After Construction	Total
Buena Vista, IA (IABV)	152	65	80	70	455	822

View of Turbines	Pre Construction	None	Minor	Moderate	Substantial	Extreme	Total
Buena Vista, IA (IABV)	217	500	68	18	8	11	822

Distance to Nearest Turbine	Pre Construction	< 0.57 Miles	0.57 - 1 Miles	1 - 3 Miles	3 - 5 Miles	> 5 Miles	Total
Buena Vista, IA (IABV)	217	22	8	472	101	2	822

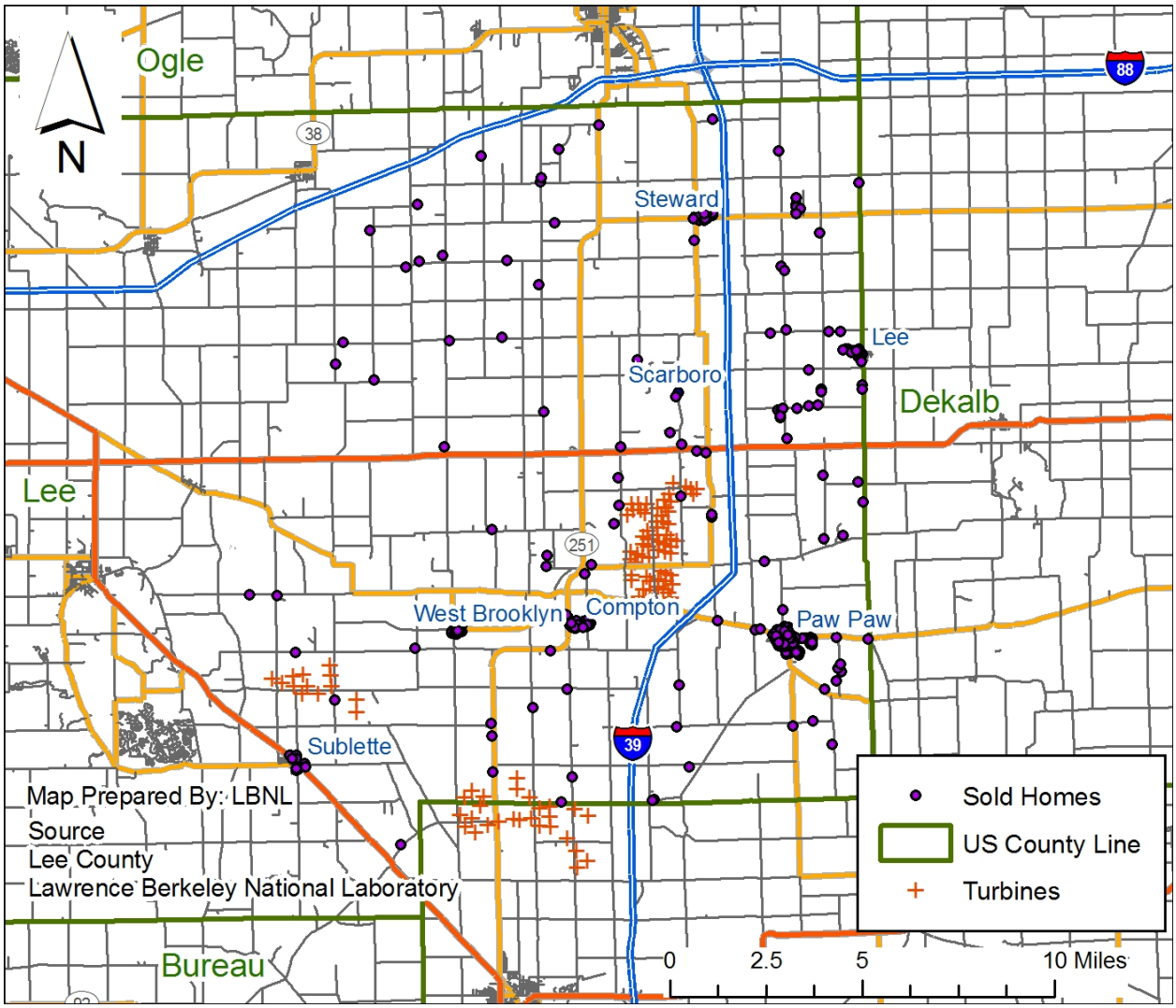
Census Statistics

Name	Type	2007 Population	% Change Since 2000	Population Per Mile^2	Median Age	Median Income	Median House 2007	% Change Since 2000
Storm Lake	City	9,706	-3.9%	2,429	31.7	$ 39,937	$ 99,312	41%
Alta	Town	1,850	-1.0%	1,766	35.1	$ 40,939	$ 98,843	48%
Buena Vista	County	19,776	-3.1%	36	36.4	$ 42,296	$ 95,437	45%
Iowa	State	3,002,555	2.6%	52	36.6	$ 47,292	$ 117,900	43%
US	Country	301,139,947	6.8%	86	37.9	$ 50,233	$ 243,742	46%

Source: City-Data.com & Wikipedia. "% Change Since 2000" refers to the percentage change between 2000 and 2007 for the figures in the column to the left (population or median house price). "Town" signifies any municipality with less than 10,000 inhabitants.

A.5 ILLC Study Area: Lee County (Illinois)

Figure A - 6: Map of ILLC Study Area



Note: "Sold Homes" include all sold homes both before and after construction.

Area Description

This study area is situated roughly 80 miles due West of Chicago, in Lee County, Illinois, and includes two wind facilities. The 63 turbine (53 MW) Mendota Hills Wind Project sits just West of North-South Highway 39, and 10 miles South of East-West Highway 88. Development began on the facility in 2001 and was completed in 2003. The second facility, the 40 turbine (80 MW) GSG Wind Farm is South and West of the Mendota Hills facility, and is broken into two parts: roughly one third of the turbines are situated two miles due north of the small town of Sublette, with the remainder located roughly six miles to the southeast and spanning the line separating Lee from La Salle County. Development began on this project in the fall of 2006 and was completed in April of the following year. The town of Paw Paw, which is East of Highway 38 and both facilities, is the largest urban area in the study area, but is further away from the

facilities than the towns of Compton, West Brooklyn, Scarboro, and Sublette. Also, to the North of the facilities are the towns of Lee, to the East of Highway 38, and Steward, just to the West. Although many home sales occurred in these towns, a significant number of additional sales occurred on small residential tracts in more-rural areas or in small developments. The topography of the area is largely flat, but falls away slightly to the East towards Paw Paw. The area enjoyed significant development during the real estate boom led by commuters from the Chicago metropolitan area, which was focused in the Paw Paw area but was also seen in semi-rural subdivisions to the Southwest and North of the wind facility.

Data Collection and Summary

County Supervisor Wendy Ryerson was enormously helpful in answering questions and providing data, as were Carmen Bollman and GIS Director, Brant Scheidecker, who also work in the county office. Wendy and Carmen facilitated the sales and home characteristic data request and Brant provided the GIS data. Additionally, real estate brokers Neva Grevengoed of LNG Realtor, Alisa Stewart of AC Corner Stone, and Beth Einsely of Einsely Real Estate were helpful in understanding the local market.

The county provided information on 412 valid single-family transactions that occurred between 1998 and 2007 within 10 miles of the nearest wind turbine, all of which were included in the sample.[108] These sales ranged in price from $14,500 to $554,148, with a mean of $128,301. Of those sales, 213 occurred after construction commenced on the wind facility and, of those, 36 had views of the turbines – nine of which were rated more dramatically than MINOR. Only two sales occurred within one mile of the nearest wind turbine.

Area Statistics

Study Period Begin	Study Period End	Number of Sales	Median Price	Mean Price	Minimum Price	Maximum Price
5/1/1998	3/2/2007	412	$113,250	$128,301	$14,500	$554,148

Facility Statistics

Facility Name	Number of MW	Number of Turbines	Announce Date	Construction Begin Date	Completion Date	Turbine Maker	Hub Height (Meters)
Mendota Hills	50.4	63	Nov-01	Aug-03	Nov-03	Gamesa	65
GSG Wind Farm	80	40	Dec-05	Sep-06	Apr-07	Gamesa	78

Source: AWEA & Ventyx Inc.

[108] This county was not able to provide data electronically back to 1996, as would have been preferred, but because wind project development did not occur until 2001, there was ample time in the study period to establish pre-announcement sale price levels.

Variables of Interest Statistics

Development Period	Pre Announcement	Post Announcement Pre Construction	1st Year After Construction	2nd Year After Construction	2+ Years After Construction	Total
Lee, IL (ILLC)	115	84	62	71	80	412

View of Turbines	Pre Construction	None	Minor	Moderate	Substantial	Extreme	Total
Lee, IL (ILLC)	199	177	27	7	1	1	412

Distance to Nearest Turbine	Pre Construction	< 0.57 Miles	0.57 - 1 Miles	1 - 3 Miles	3 - 5 Miles	> 5 Miles	Total
Lee, IL (ILLC)	199	1	1	85	69	57	412

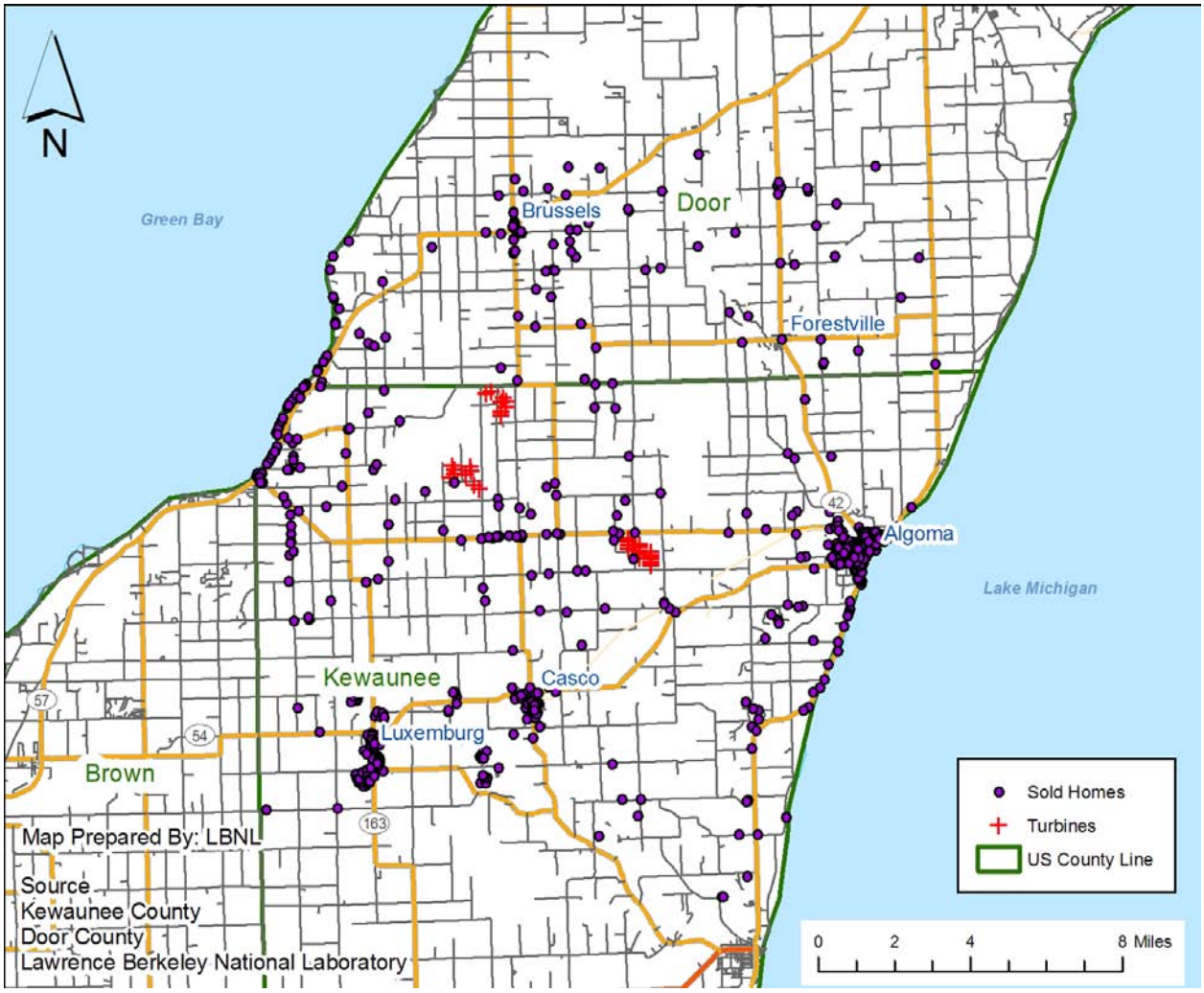
Census Statistics

Name	Type	2007 Population	% Change Since 2000	Population Per Mile^2	Median Age	Median Income	Median House 2007	% Change Since 2000
Paw Paw	Town	884	2.6%	1,563	38.0	$ 48,399	$ 151,954	n/a
Compton	Town	337	-2.9%	2,032	32.8	$ 44,023	$ 114,374	n/a
Steward	Town	263	-3.0%	2,116	35.2	$ 59,361	$ 151,791	n/a
Sublette	Town	445	-2.4%	1,272	37.7	$ 55,910	$ 133,328	n/a
Lee	County	35,450	-1.7%	49	37.9	$ 47,591	$ 136,778	64%
Illinois	State	12,852,548	3.5%	223	34.7	$ 54,124	$ 208,800	60%
US	Country	301,139,947	7.0%	86	37.9	$ 50,233	$ 243,742	46%

Source: City-Data.com & Wikipedia. "% Change Since 2000" refers to the percentage change between 2000 and 2007 for the figures in the column to the left (population or median house price). "Town" signifies any municipality with less than 10,000 inhabitants. "n/a" signifies data not available.

A.6 WIKCDC Study Area: Kewaunee and Door Counties (Wisconsin)

Figure A - 7: Map of WIKCDC Study Area



Note: "Sold Homes" include all sold homes both before and after construction.

Area Description

This study area includes the Red River (17 turbines, 14 MW) and Lincoln (14 turbines, 9 MW) wind facilities. It is situated on the "thumb" jutting into Lake Michigan, Northeast of Green Bay, Wisconsin, and spans two counties, Kewaunee and Door. There is a mix of agricultural, small rural residential, waterfront, and urban land use in this area. The three largest towns are Algoma to the East of the facilities and on the lake, Casco, which is six miles due South of the turbines, and Luxemburg, four miles West of Casco. There is a smaller village, Brussels, to the North in Door County. The remainder of the homes is situated on the water or in small rural residential parcels between the towns. Topographically, the "thumb" is relatively flat except for a slight crown in the middle, and then drifting lower to the edges. The East edge of the "thumb" ends in bluffs over the water, and the western edge drops off more gradually, allowing those parcels to

enjoy small beaches and easy boat access. There is some undulation of the land, occasionally allowing for relatively distant views of the wind turbines, which stand at a hub height of 213 feet.

Data Collection and Summary

Kewaunee and Door Counties did not have a countywide system of electronic data storage for either sales or home characteristic data. Therefore, in many cases, data had to be collected directly from the town or city assessor. In Kewaunee County, Joseph A. Jerabek of the town of Lincoln, Gary Taicher of the town of Red River, Melissa Daron of the towns of Casco, Pierce, and West Kewaunee, Michael Muelver of the town of Ahnapee and the city of Algoma, William Gerrits of the town of Casco, Joseph Griesbach Jr. of the town of Luxemburg, and David Dorschner of the city of Kewaunee all provided information. In Door County, Scott Tennessen of the town of Union and Gary Maccoux of the town of Brussels were similarly very helpful in providing information. Additionally, Andy Pelkey of Impact Consultants, Inc., John Holton of Associated Appraisal Consultants, Andy Bayliss of Dash Development Group, and Lue Van Asten of Action Appraisers & Consultants all assisted in extracting data from the myriad of storage systems used at the town and city level. The State of Wisconsin provided additional information on older sales and sales validity, with Mary Gawryleski, James Bender, and Patrick Strabala from the Wisconsin Department of Revenue being extremely helpful. GIS data were obtained from Steve Hanson from Kewaunee County and Tom Haight from Door County.

After collecting data from each municipality, a total of 810 valid single-family home sales transactions were available for analysis, ranging in time from 1996 to 2007. These sales ranged in price from $20,000 to $780,000, with a mean of $116,698. Because development of the wind facilities occurred relatively early in the study period, a large majority of the sales transactions, 75% (n = 725), occurred after project construction had commenced. Of those, 64 had views of the turbines, 14 of which had more dramatic than MINOR views, and 11 sales occurred within one mile.

Area Statistics

Study Period Begin	Study Period End	Number of Sales	Median Price	Mean Price	Minimum Price	Maximum Price
2/2/1996	6/30/2007	810	$98,000	$116,698	$20,000	$780,000

Facility Statistics

Facility Name	Number of MW	Number of Turbines	Announce Date	Construction Begin Date	Completion Date	Turbine Maker	Hub Height (Meters)
Red River	11.2	17	Apr-98	Jan-99	Jun-99	Vestas	65
Lincoln	9.2	14	Aug-98	Jan-99	Jun-99	Vestas	65

Source: AWEA & Ventyx Inc.

Variables of Interest Statistics

Development Period	Pre Announcement	Post Announcement Pre Construction	1st Year After Construction	2nd Year After Construction	2+ Years After Construction	Total
Kewaunee/Door, WI (WIKCDC)	44	41	68	62	595	810

View of Turbines	Pre Construction	None	Minor	Moderate	Substantial	Extreme	Total
Kewaunee/Door, WI (WIKCDC)	85	661	50	9	2	3	810

Distance to Nearest Turbine	Pre Construction	< 0.57 Miles	0.57 - 1 Miles	1 - 3 Miles	3 - 5 Miles	> 5 Miles	Total
Kewaunee/Door, WI (WIKCDC)	85	7	4	63	213	438	810

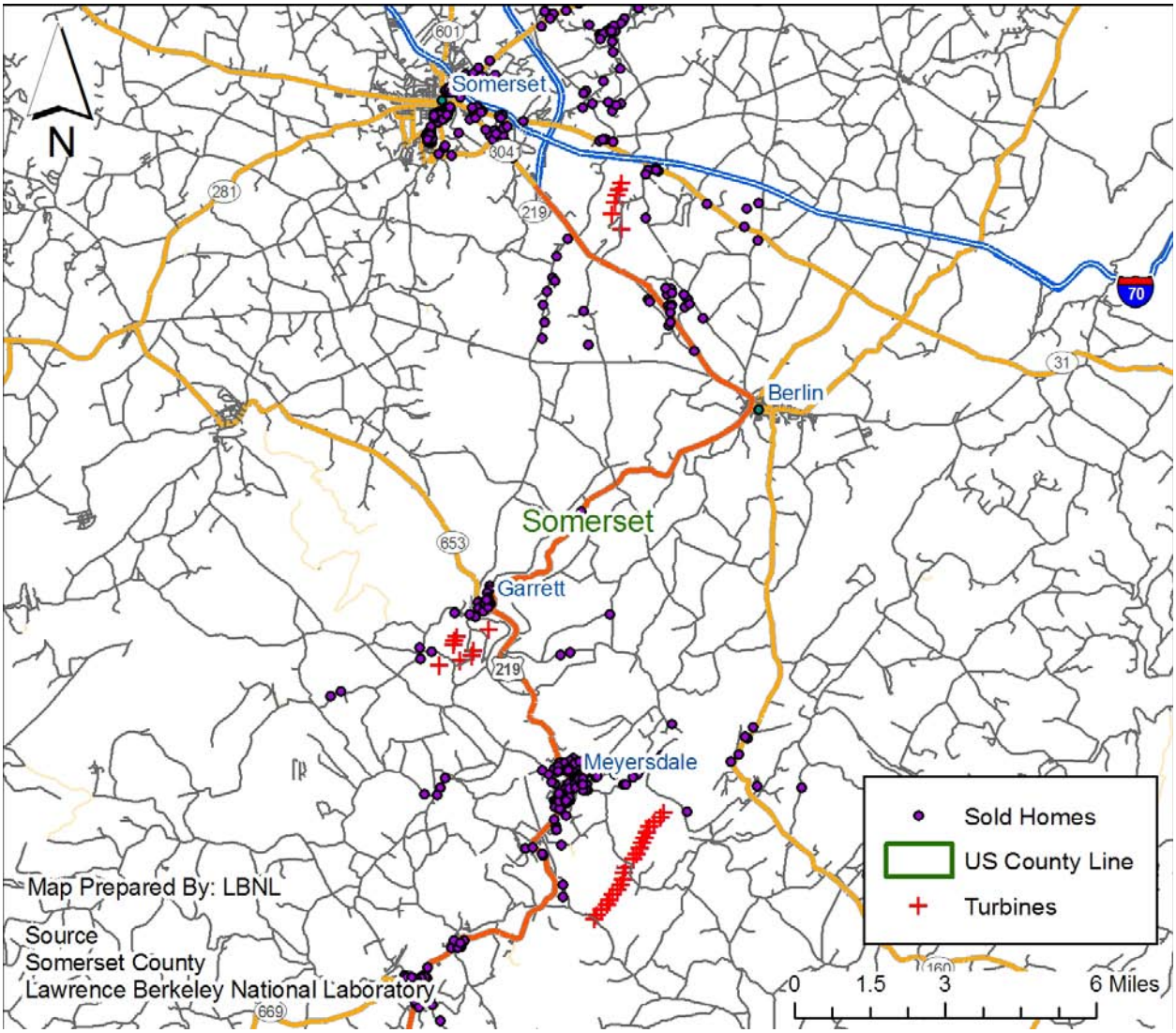
Census Statistics

Name	Type	2007 Population	% Change Since 2000	Population Per Mile^2	Median Age	Median Income	Median House 2007	% Change Since 2000
Algoma	Town	3,186	-4.7%	1,305	41.8	$ 39,344	$ 112,295	51%
Casco	Town	551	-2.8%	985	35.6	$ 53,406	$ 141,281	n/a
Luxemburg	Town	2,224	15.3%	1,076	32.0	$ 53,906	$ 167,403	n/a
Kewaunee	County	20,533	1.4%	60	37.5	$ 50,616	$ 148,344	57%
Door	County	27,811	2.4%	58	42.9	$ 44,828	$ 193,540	57%
Wisconsin	State	5,601,640	0.3%	103	36.0	$ 50,578	$ 168,800	50%
US	Country	301,139,947	6.8%	86	37.9	$ 50,233	$ 243,742	46%

Source: City-Data.com & Wikipedia. "% Change Since 2000" refers to the percentage change between 2000 and 2007 for the figures in the column to the left (population or median house price). "Town" signifies any municipality with less than 10,000 inhabitants. "n/a" signifies data not available.

A.7 PASC Study Area: Somerset County (Pennsylvania)

Figure A - 8: Map of PASC Study Area



Note: "Sold Homes" include all sold homes both before and after construction.

Area Description

This study area includes three wind facilities, Somerset (6 turbines, 9 MW, 210 ft hub height) to the North, Meyersdale (20 turbines, 30 MW, 262 ft hub height) to the South, and Green Mountain (8 turbines, 10 MW, 197 ft hub height) between them. All of the projects are located in Somerset County, roughly 75 miles southeast of Pittsburg in the Southwest section of Pennsylvania. None of the three facilities are separated by more than 10 miles, so all were included in one study area. To the North of the facilities is East-West U.S. Highway 70, which flanks the city of Somerset. Connecting Somerset with points South is County Route 219, which zigzags Southeast out of Somerset to the smaller towns of Berlin (not included in the data), Garret to the Southwest, and Meyersdale, which is Southeast of Garret. These towns are flanked by two ridges that run from the Southwest to the Northeast. Because of these ridges and the

relatively high elevations of all of the towns, this area enjoys winter recreation, though the coal industry, which once dominated the area, is still an integral part of the community with mining occurring in many places up and down the ridges. Although many of the home sales in the sample occurred in the towns, a number of the sales are for homes situated outside of town corresponding to either rural, rural residential, or suburban land uses.

Data Collection and Summary

The County Assessor, Jane Risso, was extremely helpful, and assisted in providing sales and home characteristic data. Glen Wagner, the IT director, worked with Gary Zigler, the county GIS specialist, to extract both GIS and assessment data from the county records. Both Gary and Jane were extremely helpful in fielding questions and providing additional information as needs arose.

The county provided a total of 742 valid residential single-family home sales transactions within four miles of the nearest wind turbine. All of the sales within three miles were used (n = 296), and a random sample (~ 44%) of those between three and four miles were used, yielding a total of 494 sales that occurred between May 1997 and March 2007. These sales ranged in price from $12,000 to $360,000, with a mean of $69,770. 291 sales (~ 60% of the 494) occurred after construction commenced on the nearest wind facility. Of these 291 sales, 73 have views of the turbines, 18 of which are more dramatic than MINOR, and 35 sales occurred within one mile.[109]

Area Statistics

Study Period Begin	Study Period End	Number of Sales	Median Price	Mean Price	Minimum Price	Maximum Price
5/1/1997	3/1/2007	494	$62,000	$69,770	$12,000	$360,000

Facility Statistics

Facility Name	Number of MW	Number of Turbines	Announce Date	Construction Begin Date	Completion Date	Turbine Maker	Hub Height (Meters)
GreenMountain Wind Farm	10.4	8	Jun-99	Dec-99	May-00	Nordex	60
Somerset	9.0	6	Apr-01	Jun-01	Oct-01	Enron	64
Meyersdale	30.0	20	Jan-03	Sep-03	Dec-03	NEG Micon	80

Source: AWEA & Ventyx Inc.

[109] This study area was one of the earliest to have field work completed, and therefore the field data collection process was slower resulting in a lower number of transactions than many other study areas.

Variables of Interest Statistics

Development Period	Pre Announcement	Post Announcement Pre Construction	1st Year After Construction	2nd Year After Construction	2+ Years After Construction	Total
Somerset, PA (PASC)	175	28	46	60	185	494

View of Turbines	Pre Construction	None	Minor	Moderate	Substantial	Extreme	Total
Somerset, PA (PASC)	203	218	55	15	2	1	494

Distance to Nearest Turbine	Pre Construction	< 0.57 Miles	0.57 - 1 Miles	1 - 3 Miles	3 - 5 Miles	> 5 Miles	Total
Somerset, PA (PASC)	203	17	18	132	124	0	494

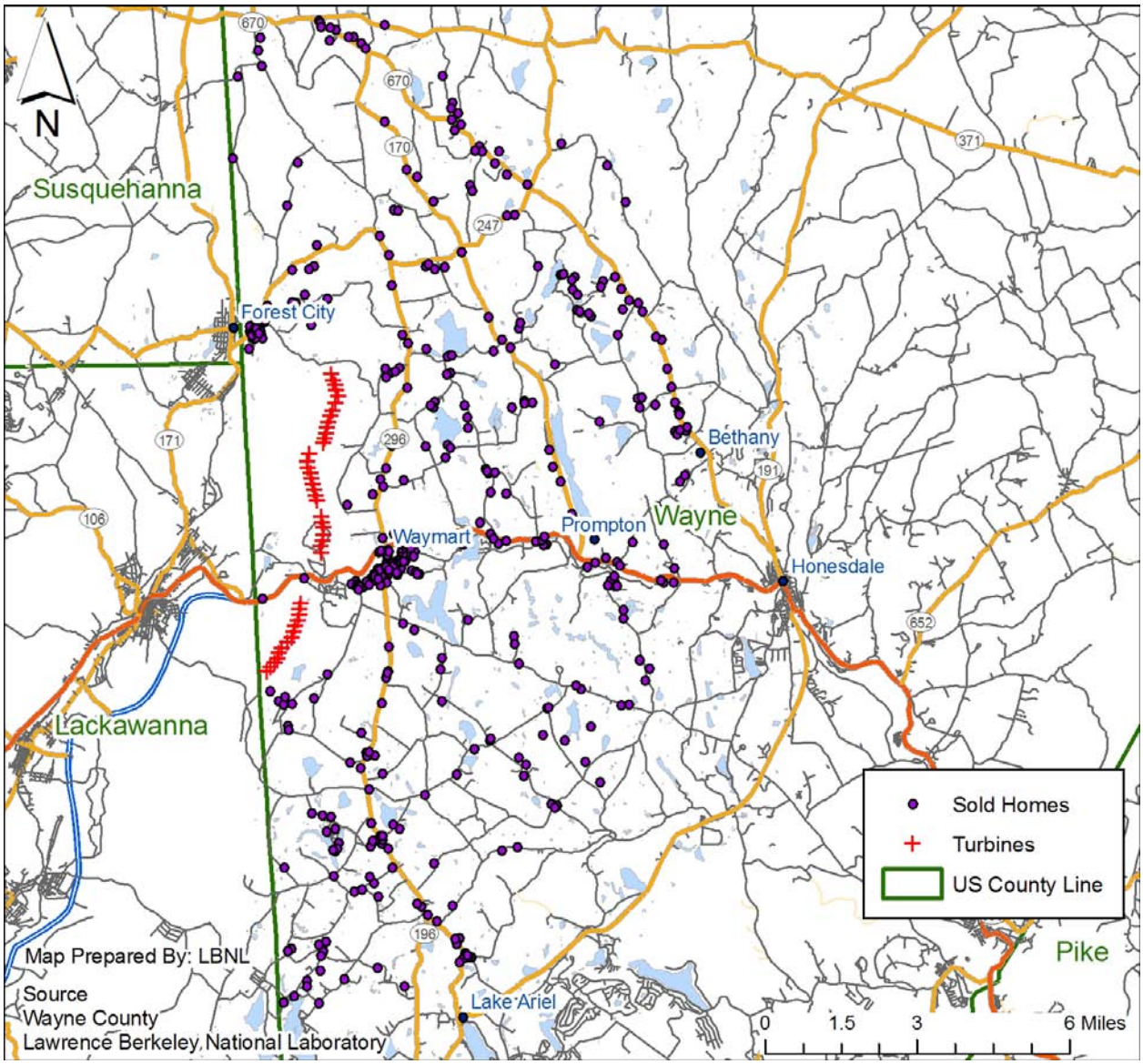
Census Statistics

Name	Type	2007 Population	% Change Since 2000	Population Per Mile^2	Median Age	Median Income	Median House 2007	% Change Since 2000
Somerset	Town	6,398	-4.8%	2,333	40.2	$ 35,293	$ 123,175	n/a
Berlin	Town	2,092	-4.0%	2,310	41.1	$ 35,498	$ 101,704	n/a
Garrett	Town	425	-4.7%	574	34.5	$ 29,898	$ 54,525	n/a
Meyersdale	Town	2,296	-6.6%	2,739	40.9	$ 29,950	$ 79,386	n/a
Somerset Cou	County	77,861	-2.7%	72	40.2	$ 35,293	$ 94,500	41%
Pennsylvania	State	12,440,621	1.3%	277	38.0	$ 48,576	$ 155,000	60%
US	Country	301,139,947	6.8%	86	37.9	$ 50,233	$ 243,742	46%

Source: City-Data.com & Wikipedia. "% Change Since 2000" refers to the percentage change between 2000 and 2007 for the figures in the column to the left (population or median house price). "Town" signifies any municipality with less than 10,000 inhabitants. "n/a" signifies data not available.

A.8 PAWC Study Area: Wayne County (Pennsylvania)

Figure A - 9: Map of PAWC Study Area



Note: "Sold Homes" include all sold homes both before and after construction.

Area Description

This study area includes the Waymart wind facility, which sits atop the North-South ridge running along the line separating Wayne County from Lackawanna and Susquehanna Counties in Northeast Pennsylvania. The 43 turbine (65 MW, 213 ft hub height) facility was erected in 2003, and can be seen from many locations in the study area and especially from the towns of Waymart, which sits East of the facility, and Forest City, which straddles Wayne and Susquehanna Counties North of the facility. The study area is dominated topographically by the ridgeline on which the wind turbines are located, but contains rolling hills and many streams, lakes, and natural ponds. Because of the undulating landscape, views of the wind facility can be

maintained from long distances, while some homes relatively near the turbines have no view of the turbines whatsoever. The area enjoys a substantial amount of second home ownership because of the bucolic scenic vistas, the high frequency of lakes and ponds, and the proximity to larger metropolitan areas such as Scranton, roughly 25 miles to the Southwest, and Wilkes-Barre a further 15 miles Southwest.

Data Collection and Summary

John Nolan, the County Chief Assessor, was very helpful in overseeing the extraction of the data from county records. GIS specialist Aeron Lankford provided the GIS parcel data as well as other mapping layers, and Bruce Grandjean, the IT and Data Specialist, provided the sales and home characteristic data as well as fielding countless questions as they arose. Additionally, real estate brokers Dotti Korpics of Bethany, Kent Swartz of Re Max, and Tom Cush of Choice #1 Country Real Estate were instrumental providing context for understanding the local market.

The county provided data on 551 valid single-family transactions that occurred between 1996 and 2007, all of which were included in the sample. These sales ranged in price from $20,000 to $444,500, with a mean of $111,522. Because of the relatively recent development of the wind facility, only 40% (*n* = 222) of the sales transaction occurred after the construction of the facility had commenced. Of those sales, 43 (19%) had views of the turbines, ten of which had more dramatic than MINOR views, and 11 were situated within one mile.

Area Statistics

Study Period Begin	Study Period End	Number of Sales	Median Price	Mean Price	Minimum Price	Maximum Price
7/12/1996	9/25/2006	551	$96,000	$111,522	$20,000	$444,500

Facility Statistics

Facility Name	Number of MW	Number of Turbines	Announce Date	Construction Begin Date	Completion Date	Turbine Maker	Hub Height (Meters)
Waymart Wind Farm	64.5	43	Feb-01	Jun-03	Oct-03	GE Wind	65

Source: AWEA & Ventyx Inc.

Variables of Interest Statistics

Development Period	Pre Announcement	Post Announcement Pre Construction	1st Year After Construction	2nd Year After Construction	2+ Years After Construction	Total
Wayne, PA (PAWC)	223	106	64	71	87	551

View of Turbines	Pre Construction	None	Minor	Moderate	Substantial	Extreme	Total
Wayne, PA (PAWC)	329	179	33	8	2	0	551

Distance to Nearest Turbine	Pre Construction	< 0.57 Miles	0.57 - 1 Miles	1 - 3 Miles	3 - 5 Miles	> 5 Miles	Total
Wayne, PA (PAWC)	329	1	10	95	55	61	551

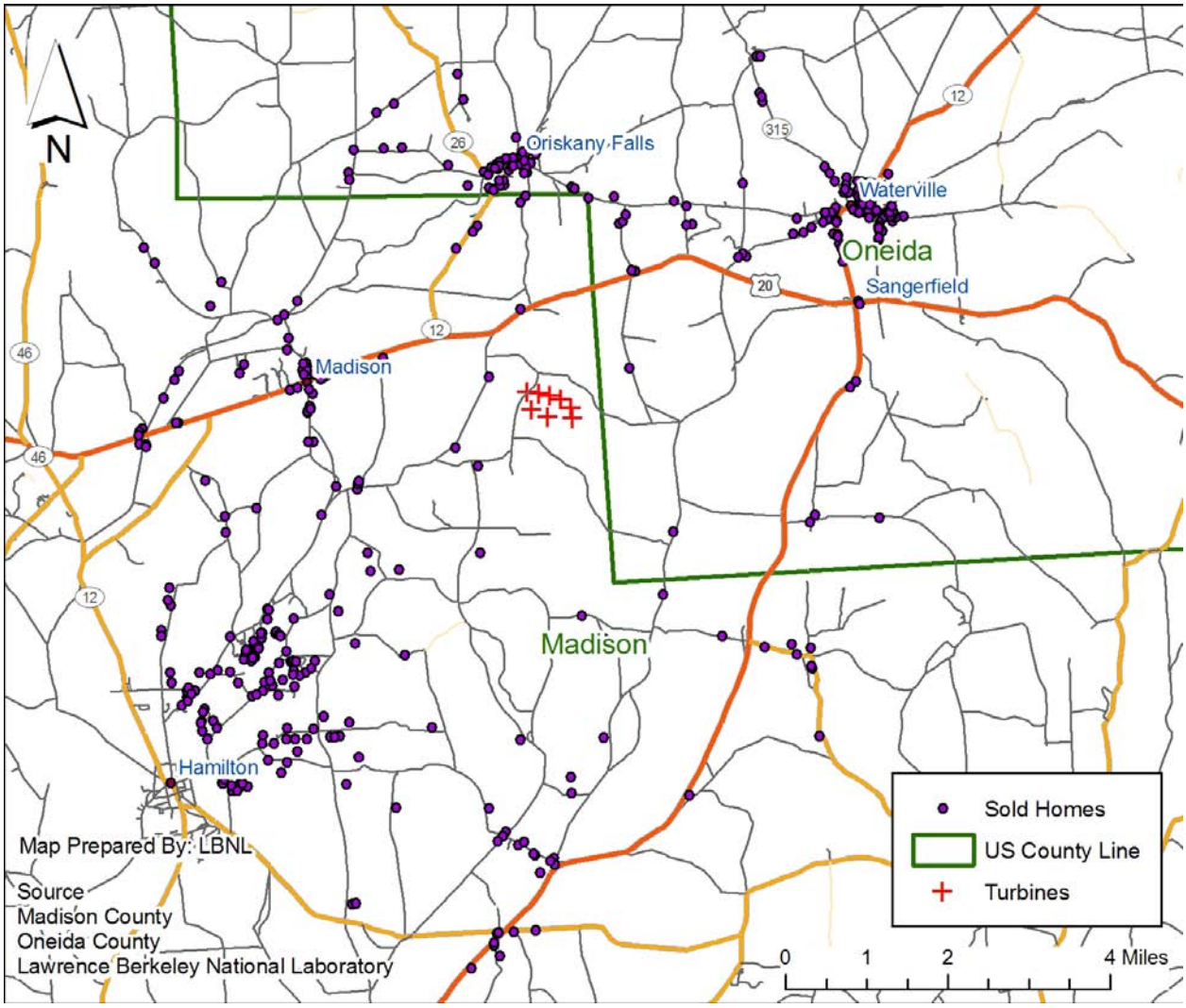
Census Statistics

Name	Type	2007 Population	% Change Since 2000	Population Per Mile^2	Median Age	Median Income	Median House 2007	% Change Since 2000
Waymart	Town	3,075	116.0%	1,111	41.7	$ 43,797	$ 134,651	56%
Forest City	Town	1,743	-5.2%	1,929	45.6	$ 32,039	$ 98,937	67%
Prompton	Town	237	-1.6%	149	41.9	$ 30,322	$ 162,547	56%
Wayne	County	51,708	5.9%	71	40.8	$ 41,279	$ 163,060	57%
Lackawanna	County	209,330	-1.9%	456	40.3	$ 41,596	$ 134,400	48%
Pennsylvania	State	12,440,621	1.3%	277	38.0	$ 48,576	$ 155,000	60%
US	Country	301,139,947	6.8%	86	37.9	$ 50,233	$ 243,742	46%

Source: City-Data.com & Wikipedia. "% Change Since 2000" refers to the percentage change between 2000 and 2007 for the figures in the column to the left (population or median house price). "Town" signifies any municipality with less than 10,000 inhabitants.

A.9 NYMCOC Study Area: Madison and Oneida Counties (New York)

Figure A - 10: Map of NYMCOC Study Area



Note: "Sold Homes" include all sold homes both before and after construction.

Area Description

This study area surrounds the seven turbine (12 MW, 220 ft hub height) Madison wind facility, which sits atop an upland rise in Madison County, New York. The area is roughly 20 miles Southwest of Utica and 40 miles Southeast of Syracuse. The facility is flanked by the towns moving from the Southwest, clockwise around the rise, from Hamilton and Madison in Madison County, NY, to Oriskany Falls, Waterville, and Sangerfield in Oneida County, NY. Hamilton is the home of Colgate University, whose staff lives throughout the area around Hamilton and stretching up into the town of Madison. Accordingly, some development is occurring near the college. To the Northeast, in Oneida County, the housing market is more depressed and less development is apparent. The study area in total is a mix of residential, rural residential, and

rural landscapes, with the largest portion being residential homes in the towns or immediately on their outskirts. The topography, although falling away from the location of the wind facility, does not do so dramatically, so small obstructions can obscure the views of the facility.

Data Collection and Summary

Data were obtained from both Madison and Oneida Counties for this study area. In Madison County, Kevin Orr, Mike Ellis, and Carol Brophy, all of County's Real Property Tax Services Department, were extremely helpful in obtaining the sales, home characteristic, and GIS data. In Oneida County, Jeff Quackenbush and Richard Reichert in the Planning Department were very helpful in obtaining the county data. Additionally, discussions with real estate brokers Susanne Martin of Martin Real Estate, Nancy Proctor of Prudential, and Joel Arsenault of Century 21 helped explain the housing market and the differences between Madison and Oneida Counties.

Data on 463 valid sales transactions of single family residential homes that occurred between 1996 and 2006 were obtained, all of which were located within seven miles of the wind facility. These sales ranged in price from $13,000 to $380,000, with a mean of $98,420. Roughly 75% (*n* = 346) of these sales occurred after construction commenced on the wind facility, of which 20 could see the turbines, all of which were rated as having MINOR views, except one which had a MODERATE rating; only two sales involved homes that were situated inside of one mile.

Area Statistics

Study Period Begin	Study Period End	Number of Sales	Median Price	Mean Price	Minimum Price	Maximum Price
1/6/1996	12/26/2006	463	$77,500	$98,420	$13,000	$380,000

Facility Statistics

Facility Name	Number of MW	Number of Turbines	Announce Date	Construction Begin Date	Completion Date	Turbine Maker	Hub Height (Meters)
Madison Windpower	11.6	7	Jan-00	May-00	Sep-00	Vestas	67

Source: AWEA & Ventyx Inc.

Variables of Interest Statistics

Development Period	Pre Announcement	Post Announcement Pre Construction	1st Year After Construction	2nd Year After Construction	2+ Years After Construction	Total
Madison/Oneida, NY (MYMCOC)	108	9	48	30	268	463

View of Turbines	Pre Construction	None	Minor	Moderate	Substantial	Extreme	Total
Madison/Oneida, NY (MYMCOC)	117	326	19	1	0	0	463

Distance to Nearest Turbine	Pre Construction	< 0.57 Miles	0.57 - 1 Miles	1 - 3 Miles	3 - 5 Miles	> 5 Miles	Total
Madison/Oneida, NY (MYMCOC)	117	1	1	80	193	71	463

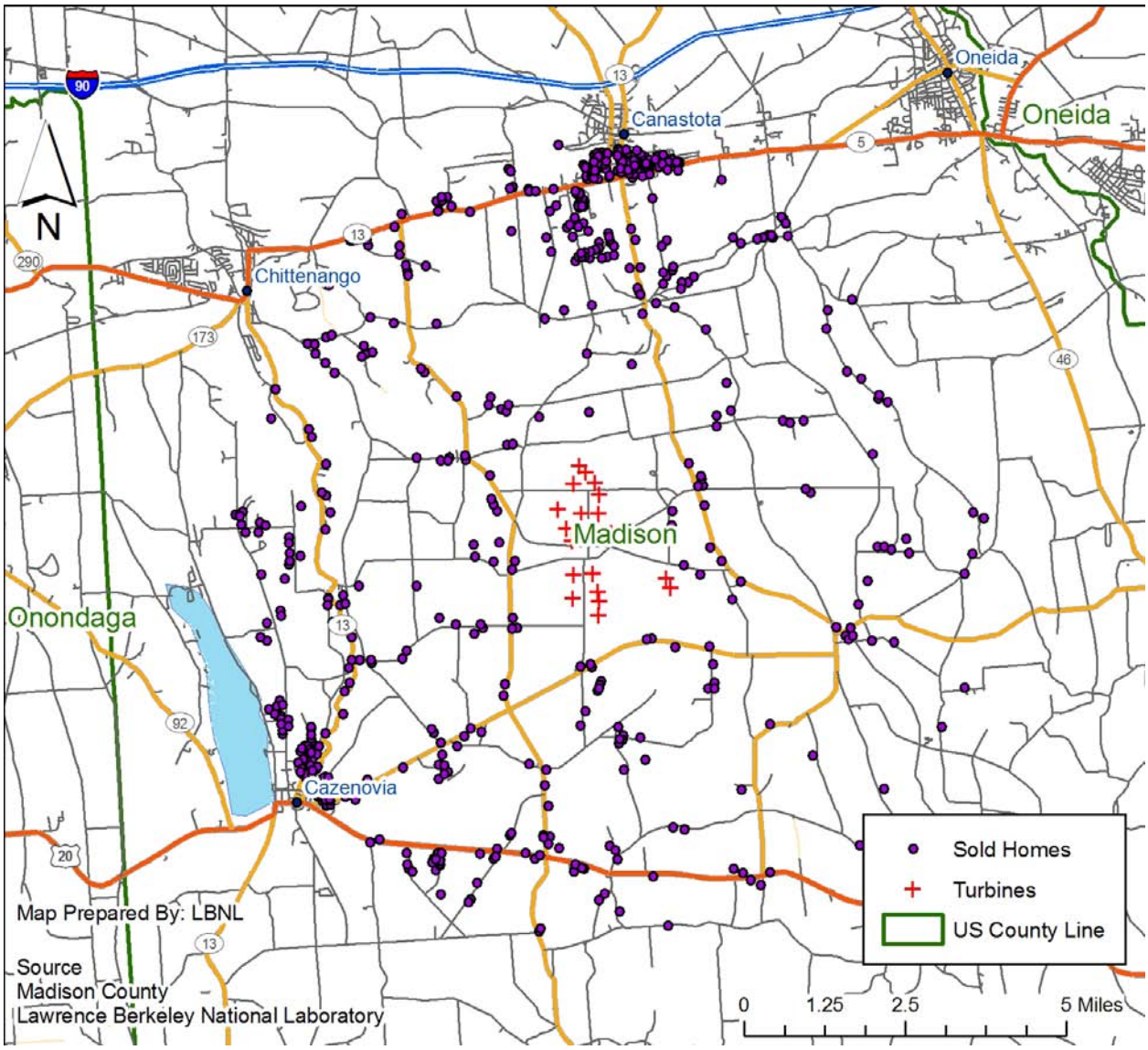
Census Statistics

Name	Type	2007 Population	% Change Since 2000	Population Per Mile^2	Median Age	Median Income	Median House 2007	% Change Since 2000
Madison	Town	304	-2.9%	605	38.1	$ 36,348	$ 94,734	n/a
Hamilton	Town	3,781	7.9%	1,608	20.8	$ 48,798	$ 144,872	n/a
Orinkany Fal	Town	1,413	-2.9%	1,703	40.8	$ 47,689	$ 105,934	n/a
Waterville	Town	1,735	-3.2%	1,308	37.8	$ 46,692	$ 104,816	n/a
Sangerfield	Town	2,626	-1.4%	85	37.6	$ 47,563	$ 106,213	n/a
Madison	County	69,829	0.6%	106	36.1	$ 53,600	$ 109,000	39%
Oneida	County	232,304	-1.3%	192	38.2	$ 44,636	$ 102,300	40%
New York	State	19,297,729	1.7%	408	35.9	$ 53,514	$ 311,000	109%
US	Country	301,139,947	6.8%	86	37.9	$ 50,233	$ 243,742	46%

Source: City-Data.com & Wikipedia. "% Change Since 2000" refers to the percentage change between 2000 and 2007 for the figures in the column to the left (population or median house price). "Town" signifies any municipality with less than 10,000 inhabitants. "n/a" signifies data not available.

A.10 NYMC Study Area: Madison County (New York)

Figure A - 11: Map of NYMC Study Area



Note: "Sold Homes" include all sold homes both before and after construction.

Area Description

This study area surrounds the 20 turbine (30 MW, 218 ft hub height) Fenner wind facility in Madison County, New York, roughly 20 miles East of Syracuse and 40 miles West of Utica in the middle of New York. The study area is dominated by two roughly parallel ridges. One, on which the Fenner facility is located, runs Southeast to Northwest and falls away towards the town of Canastota. The second ridge runs roughly North from Cazenovia, and falls away just South of the town of Chittenango. Surrounding these ridges is an undulating landscape with many water features, including the Chittenango Falls and Lake Cazenovia. A number of high-priced homes are situated along the ridge to the North of Cazenovia, some of which are afforded

views of the lake and areas to the West, others with views to the East over the wind facility, and a few having significant panoramic views. The west side of the study area has a number of drivers to its real estate economy: it serves as a bedroom community for Syracuse, is the home to Cazenovia College, and enjoys a thriving summer recreational population. Canastota to the North, and Oneida to the East, are older industrial towns, both of which now serve as feeder communities for Syracuse because of easy access to Highway 90. Between the towns of Cazenovia and Canastota are many rural residential properties, some of which have been recently developed, but most of which are homes at least a half century old.

Data Collection and Summary

Data were obtained from the Madison County Real Property Tax Services department directed by Carol Brophy. As the first study area that was investigated, IT and mapping specialists Kevin Orr and Mike Ellis were subjected to a large number of questions from the study team and were enormously helpful in helping shape what became the blueprint for other study areas. Additionally, real estate brokers Nancy Proctor of Prudential, Joel Arsenault of Century 21, Don Kinsley of Kingsley Real Estate, and Steve Harris of Cazenovia Real Estate were extremely helpful in understanding the local market.

Data on 693 valid sales transactions of single family residential structures that occurred between 1996 and 2006 were obtained, most of which were within five miles of the wind facility. These sales ranged in price from $26,000 to $575,000, with a mean of $124,575. Roughly 68% of these sales (n = 469) occurred after construction commenced on the wind facility, 13 of which were inside of one mile, and 74 of which had views of the turbines. Of that latter group, 24 have more dramatic than MINOR views of the turbines.

Area Statistics

Study Period Begin	Study Period End	Number of Sales	Median Price	Mean Price	Minimum Price	Maximum Price
1/31/1996	9/29/2006	693	$109,900	$124,575	$26,000	$575,000

Facility Statistics

Facility Name	Number of MW	Number of Turbines	Announce Date	Construction Begin Date	Completion Date	Turbine Maker	Hub Height (Meters)
Fenner Wind Power Project	30	20	Dec-98	Mar-01	Nov-01	Enron	66

Source: AWEA & Ventyx Inc.

Variables of Interest Statistics

Development Period	Pre Announcement	Post Announcement Pre Construction	1st Year After Construction	2nd Year After Construction	2+ Years After Construction	Total
Madison, NY (NYMC)	59	165	74	70	325	693

View of Turbines	Pre Construction	None	Minor	Moderate	Substantial	Extreme	Total
Madison, NY (NYMC)	224	395	50	16	8	0	693

Distance to Nearest Turbine	Pre Construction	< 0.57 Miles	0.57 - 1 Miles	1 - 3 Miles	3 - 5 Miles	> 5 Miles	Total
Madison, NY (NYMC)	224	2	11	80	374	2	693

Census Statistics

Name	Type	2007 Population	% Change Since 2000	Population Per Mile^2	Median Age	Median Income	Median House 2007	% Change Since 2000
Cazenovia	Town	2,835	8.6%	1,801	32.3	$ 58,172	$ 159,553	n/a
Chittenango	Town	4,883	-0.5%	2,000	36.0	$ 58,358	$ 104,845	n/a
Canastota	Town	4,339	-1.7%	1,306	37.3	$ 45,559	$ 93,349	n/a
Oneida	City	10,791	-1.7%	490	36.9	$ 47,173	$ 99,305	n/a
Morrisville	Town	2,155	0.6%	1,869	20.4	$ 45,852	$ 102,352	n/a
Madison	County	69,829	0.6%	106	36.1	$ 53,600	$ 109,000	39%
New York	State	19,297,729	1.7%	408	35.9	$ 53,514	$ 311,000	109%
US	Country	301,139,947	6.8%	86	37.9	$ 50,233	$ 243,742	46%

Source: City-Data.com & Wikipedia. "% Change Since 2000" refers to the percentage change between 2000 and 2007 for the figures in the column to the left (population or median house price). "Town" signifies any municipality with less than 10,000 inhabitants. "n/a" signifies data not available.

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Appendix B: Methodology for Calculating Distances with GIS

For each of the homes in the dataset, accurate measurements of the distance to the nearest wind turbine at the time of sale were needed, and therefore the exact locations of both the turbines and the homes was required. Neither of these locations was available from a single source, but through a combination of techniques, turbine and home locations were derived. This section describes the data and techniques used to establish accurate turbine and home locations, and the process for then calculating distances between the two.

There were a number of possible starting points for mapping accurate wind turbine locations. First, the Energy Velocity data, which covered all study areas, provided a point estimate for project location, but did not provide individual turbine locations. The Federal Aviation Administration (FAA), because of permitting and aviation maps, maintains data on turbine locations, but at the time of this study, that data source did not cover all locations, contained data on structures that no longer exist, and was difficult to use.[110] Finally, in some cases, the counties had mapped the wind turbines into GIS.

In the end, because no single dataset was readily available to serve all study areas, instead the variety of data sources described above was used to map and/or confirm the location of every turbine in the 10 study areas. The process began with high-resolution geocoded satellite and aerial ortho imagery that the United States Department of Agriculture (USDA) collects and maintains under its National Agriculture Imagery Program (NAIP), and which covers virtually all of the areas in this investigation. Where needed, older ortho imagery from the USDA was used. Combining these data with the Energy Velocity data, and discussions with local officials, and maps provided by the county or the developer, locating and mapping all of the turbines in each study area was possible.

Home locations were provided directly by some counties; in other cases, a parcel centroid was created as a proxy.[111] In some situations, the centroid did not correspond to the actual house location, and therefore required further refinement. This refinement was only required and conducted if the parcel was near the wind turbines, where the difference of a few hundred feet, for example, could alter its distance rating in a meaningful fashion, or when the parcel included a considerable amount of acreage, where inaccuracy in home location could be considerable. Therefore, parcels inside of 1.5 miles of the nearest wind turbine and of any size, and parcels outside of 1.5 miles and larger than 5 acres, were both examined using the USDA NAIP imagery to determine the exact home location. In cases where the parcel centroid was not centered over the home, the location was adjusted, using the ortho image as a guide, to the actual house location.

With both turbine and home locations identified, the next step was to determine distances between the two. To do so, the date when each transaction in the sample occurred was taken into

[110] A newer FAA database is now available that clears up many of these earlier concerns.

[111] A "parcel centroid" is the mathematical center point of a polygon, and was determined by XTools Pro (www.xtoolspro.com).

account, combined with the determination of which turbines were in existence at what time.[112] This required breaking the transactions in the sample into three categories: 1) those occurring before any wind facility was announced in the study area, 2) those occurring after the first wind facility was announced in the area but before all development was complete in the area, and 3) those occurring after all wind development in the area was complete. Any sale that occurred before wind development was announced in the study area was coded with a distance to the nearest turbine derived from the actual turbine locations after all wind development had occurred.[113] Homes that sold after all wind development had occurred were treated similarly, with distances derived from the set of turbines in place after all development had taken place. The final set of homes - those that sold after announcement of the first facility, but before the construction of the last - had to be treated, essentially, on a case by case basis. Some homes were located within five miles of one wind facility but more than five miles from another wind facility in the same study area (e.g., many homes in PASC). In this case the distance to that closer facility could be applied in a similar fashion as would be the case if only one facility was erected (e.g., NYMC or PAWC). Another group of homes, those that sold during the development of the first facility in the study area, were given the distance to that facility, regardless of distance to the other facilities in the study area. The final and most complicated group of homes consisted of those that were within five miles of multiple wind facilities, and that sold after the first facility had been erected. In those cases, the exact configuration of turbines was determined for each stage of the development process. In study areas with multiple facilities that were developed over multiple periods, there might be as many as six possible configurations (e.g., IABV). In this final scenario, the distance to the closest turbine was used, assuming it had been "announced" at the time of sale.

Once the above process was complete, the mechanics of calculating distances from the turbines to the homes was straightforward. After establishing the location of a set of turbines, for instance those constructed in the first development in the area, a euclidian distance raster was derived that encompassed every home in the study area. [114] The calculations were made using a 50-foot resolution state-plane projection and North American Datum from 1983 (NAD83). As discussed above, similar rasters were created for each period in the development cycle for each study area, depending on the turbine configuration at that time. Ultimately, a home's sale date was matched to the appropriate raster, and the underlying distance was extracted. Taking everything into account discussed above, it is expected that these measurements are accurate to

[112] It is recognized that the formal date of sale will follow the date at which pricing decisions were made. It is also recognized, as mentioned in Section 3, that wind facility announcement and construction dates are likely to be preceded by "under the radar" discussions in the community. Taken together, these two factors might have the effect, in the model, of creating some apparent lag in when effects are shown, compared to the earlier period in which effects may begin to occur. For this to bias the results, however, effects would have to disappear or dramatically lesson with time (e.g., less than one year after construction) such that the effects would not be uncovered with the models in later periods. Based on evidence from other potentially analogous infrastructure (e.g., HVTL), any fading of effects would likely occur over many years, so it is assumed that any bias is likely minimal.

[113] These distances were used to compare homes sold, for instance, within 1 mile of where the turbines were eventually erected with similar homes sold after the turbines were erected (see, for example, the Temporal Aspects Model).

[114] A "Raster" is a grid of, in this case, 50 feet by 50 feet squares, each of which contains a number representing the number of feet from the center of the square to the nearest turbine.

within roughly 150 feet inside of 1.5 miles and within a maximum of roughly 1150 feet outside of 1.5 miles.[115]

[115] The resolution of the raster is 50 feet, so the hypotenuse is 70 feet. If the home is situated in the top left of a raster cell and the turbine is situated in the bottom right of a diagonally adjacent cell, they could be separated by as much as 140 feet, yet the raster distance would only be 50 feet, a difference of 90 feet. Moreover, the resolution of the Ortho image is 40 feet so that location could additionally be off by another 55 feet along the diagonal. These two uncertainties total to roughly 150 feet for homes inside of 1.5 miles. Outside of 1.5 miles the variation between centroid and house location for parcels smaller than 5 acres could be larger still. If a 4.9 acre parcel had a highly irregular rectangular shape of 102 by 2100 feet, for instance, the centroid could be as much as 1050 feet from the property line. If the home was situated 50 feet from the property line then the actual house location could be off by as much as 1000 feet. Adding this to the 150 feet from above leads to a total discrepancy of 1150 feet (0.22 miles) for homes outside of 1.5 miles on parcels smaller than 5 acres. Of course, these extreme scenarios are highly unlikely to be prevalent.

Appendix C: Field Data Collection Instrument

Figure A - 12: Field Data Collection Instrument

House # (Control/ Key #)			County		
House Address					
Home Characteristics			**House Photo Number(s)**		
Cul-De-Sac?	No(0) / Yes(1)		Waterfront?		No(0) / Yes(1)
Scenic Vista Characteristics			**Vista Photo Numbers**		
Overall Quality of Scenic Vista: Poor (1), Below Average (2), Average (3), Above Average (4), Premium (5)					
View of Turbines Characteristics			**View Photo Numbers**		
Total # of Turbines visible			Orientation of Home to View: See Below		
# of Turbines- blade tips only visible			Side (S), Front (F), Back (B), Angled (A)		
# of Turbines- nacelle/hub visible					
# of Turbines- tower visible			View Scope: Narrow(1), Medium(2), Wide(3)		
The Degree to which the View of Turbines Dominate the Site? Non-Existent (0), Minor (1), Moderate (2), Substantial (3), Extreme (4)					
Degree to which the Turbines Overlap the Prominent Scenic Vista? Not at all (0), Barely (1), Somewhat (2), Strongly (3), Entirely (4)					
Notes:					

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Figure A - 13: Field Data Collection Instrument - Instructions - Page 1

Home Characteristics

Cul-De-Sac? No(0)/Yes(1)	Is the home situated on a cul-de-sac?
Waterfront? No(0)/Yes(1)	Is the home situated on the waterfront?

"Vista" Characteristics

Overall Quality of Scenic Vista: Poor (1)	This rating is reserved for vistas of unmistakably poor quality. These vistas are often dominated by visually discordant man-made alterations (not considering turbines), or are uncomfortable spaces for people, lack interest, or have virtually no recreational potential.
Overall Quality of Scenic Vista: Below Average (2)	The home's vista is of the below average quality. These vistas contain visually discordant man-made alterations (not considering turbines) but are not dominated by them. They are not inviting spaces for people, but are not uncomfortable. They have little interest, mystery and have minor recreational potential.
Overall Quality of Scenic Vista: Average (3)	The home's vista is of the average quality. These vistas include interesting views which can be enjoyed often only a narrow scope. These vistas may contain some visually discordant man-made alterations (not considering turbines), are moderately comfortable spaces for people, have some interest, and have minor recreational potential.
Overall Quality of Scenic Vista: Above Average (4)	The vista from the home is of above average quality. These vistas include interesting views which often can be enjoyed in a medium to wide scope. They might contain some man made alterations (not considering turbines), yet still possess significant interest and mystery, are moderately balanced and have some potential for recreation.
Overall Quality of Scenic Vista: Premium (5)	This rating is reserved for vistas of unmistakably premium quality. These vistas would include "picture post card" views which can be enjoyed in a wide scope. They are often free or largely free of any discordant man made alterations (not considering turbines), possess significant interest, memorable qualities, mystery and are well balanced and likely have a high potential for recreation.
Degree Turbines Overlap Prominent Vista? Not at all (0))	The vista does not contain any view of the turbines.
Degree Turbines Overlap Prominent Vista? Barely (1)	A small portion (~ 0 - 20%) of the vista is overlapped by the view of turbines therefore the vista might contain a view of a few turbines, only a few of which can be seen entirely (from below the sweep of the blades to the top of their tips).
Degree Turbines Overlap Prominent Vista? Somewhat (2)	A moderate portion (~20-50%) of the vista contains turbines, and likely contains a view of more than one turbine, some of which are likely to be seen entirely (from below the sweep of the blades to the top of their tips).
Degree Turbines Overlap Prominent Vista? Strongly (3)	A large portion (~50-80%) of the vista contains a view of turbines, many of which likely can be seen entirely (from below the sweep of the blades to the top of their tips).
Degree Turbines Overlap Prominent Vista? Entirely (4)	This rating is reserved for situations where the turbines overlap virtually the entire (~80-100%) vista from the home. The vista likely contains a view of many turbines, virtually all of which can be seen entirely (from below the sweep of the blades to the top of their tips).

Figure A - 14: Field Data Collection Instrument - Instructions - Page 2

View of Turbines Characterist

House Orientation to View of Turbines: Side (S)	Orientation of home to the view of the turbines is from the side.
House Orientation to View of Turbines: Front (F)	Orientation of home to the view of the turbines is from the front.
House Orientation to Vista of Turbines: Back (B)	Orientation of home to the view of the turbines is from the back.
House Orientation to Vista of Turbines: Angled (A)	Orientation of home to the view of the turbines is from an angle.
View of Turbines Scope: Narrow(1)	The view of the turbines is largely blocked by trees, large shrubs or man made features in the foreground (0-300 feet) allowing 0 - 30 degrees of view of the wind facility
View of Turbines Scope: Medium(2)	The view of turbines is partially blocked by trees, large shrubs or man made features in the foreground (0-300 feet) allowing only 30-90 degrees of view of the wind facility.
View of Turbines Scope: Wide(3)	The view of the turbines is free or almost free from blockages by trees, large shrubs or man made features in the foreground (0-300 feet) allowing at least 90 degrees of view of the wind facility.
Degree to which View of Turbines Dominates the Site? None (0)	The turbines are not visible at all frrom this home.
Degree to which View of Turbines Dominates the Site? Minor (1)	The turbines are visible but either the scope is narrow, there are many obstructions, or the distance between the home and the facility is large.
Degree to which View of Turbines Dominates the Site? Moderate (2)	The turbines are visible but the scope is either narrow or medium, there might be some obstructions, and the distance between the home and the facility is most likely a few miles.
Degree to which View of Turbines Dominates the Site? Substantial (3)	The turbines are dramatically visible from the home. The turbines are likely visible in a wide scope, and most likely the distance between the home and the facility is short.
Degree to which View of Turbines Dominates the Site? Extreme (4)	This rating is reserved for sites that are unmistakably dominated by the presence of the windfarm. The turbines are dramatically visible from the home and there is a looming quality to their placement. The turbines are often visible in a wide scope, or the distance to the facility is very small.

Appendix D: Vista Ratings with Photos

POOR VISTA





BELOW AVERAGE VISTA





AVERAGE VISTA





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ABOVE AVERAGE VISTA





PREMIUM VISTA





Appendix E: View Ratings with Photos

MINOR VIEW



3 turbines visible from front orientation, nearest 1.4 miles (TXHC)



5 turbines visible from front orientation, nearest 0.9 miles (NYMC)

MODERATE VIEW



18 turbines visible from back orientation, nearest 1.6 miles (ILLC)



6 turbines visible from back orientation, nearest 0.8 miles (PASC)

SUBSTANTIAL VIEW



90 turbines visible from all orientations, nearest 0.6 miles (IABV)



27 turbines visible from multiple orientations, nearest 0.6 miles (TXHC)

EXTREME VIEW



6 turbines visible from multiple orientations, nearest 0.2 miles (WIKCDC)



212 turbines visible from all orientations, nearest 0.4 miles (IABV)

Appendix F: Selecting the Primary ("Base") Hedonic Model

Equation (1) as described in Section 4.2 is presented in this report as the primary (or "Base") model to which all other models are compared. As noted earlier, in the Base Hedonic Model and in all subsequent models presented in Section 5 all variables of interest, spatial adjustments, and home and site characteristics are pooled, and therefore their estimates represent the average across all study areas. Ideally, one would have enough data to estimate a model at the study area level - a fully unrestricted model - rather than pooled across all areas. In this appendix, alternative model forms are presented that unrestrict these variables at the level of study areas. As shown here, these investigations ultimately encouraged the selection of the somewhat simpler pooled Base Model as the primary model, and to continue to use restricted or pooled models in the alternative hedonic analyses.

F.1 Discussion of Fully Unrestricted Model Form

The Base Model described by equation (1) has variables that are pooled, and the coefficients for these variables therefore represent the average across all study areas (after accounting for study area fixed effects). An alternative (and arguably superior) approach would be to estimate coefficients at the level of each study area, thereby allowing coefficient values to vary among study areas.[116] This fully interacted – or unrestricted – model would take the following form:

$$\ln(\mathrm{P}) = \beta_0 + \sum_{\mathrm{s}} \beta_1 (\mathrm{N} \cdot \mathrm{S}) + \sum_{\mathrm{c}} \beta_2 (\mathrm{Y}) + \sum_{\mathrm{k}} \beta_3 (\mathrm{X} \cdot \mathrm{S}) + \sum_{\mathrm{v}} \beta_4 (\mathrm{VIEW} \cdot \mathrm{S}) + \sum_{\mathrm{d}} \beta_5 (\mathrm{DISTANCE} \cdot \mathrm{S}) + \varepsilon \quad \text{(F13)}$$

where

P represents the inflation-adjusted sale price,
N is the spatially weighted neighbors' predicted sale price,
S is a vector of *s* study areas (e.g., WAOR, OKCC, etc.),
Y is a vector of *c* study area locational characteristics (e.g., census tract, school district, etc.),
X is a vector of k home and site characteristics (e.g., acres, square feet, number of bathrooms, condition of the home, age of home, VISTA, etc.),
VIEW is a vector of v categorical view of turbine variables (e.g., MINOR, MODERATE, etc.),
DISTANCE is a vector of d categorical distance to turbine variables (e.g., less than 3000 feet, between one and three miles, etc.),
β_0 is the constant or intercept across the full sample,
β_1 is a vector of *s* parameter estimates for the spatially weighted neighbor's predicted sale price for S study areas,
β_2 is a vector of *c* parameter estimates for the study area locational fixed effect variables,
β_3 is a vector of *k* parameter estimates for the home and site characteristics for S study areas,
β_4 is a vector of *v* parameter estimates for the VIEW variables as compared to homes sold with no view of the turbines for S study areas,

[116] For instance, the marginal contribution of Acres (the number of acres) to the selling price would be estimated for each study area (i.e., Acres_WAOR, Acres_TXHC etc.), as would the variables of interest: VIEW and DISTANCE.

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β_5 is a vector of *d* parameter estimates for the DISTANCE variables as compared to homes sold situated outside of five miles for S study areas, and
ε is a random disturbance term.

To refresh, the fully restricted equation (1) takes the following form:

$$\ln(P) = \beta_0 + \beta_1 N + \sum_s \beta_2 S + \sum_k \beta_3 X + \sum_v \beta_4 VIEW + \sum_d \beta_5 DISTANCE + \varepsilon \quad (1)$$

where
P represents the inflation-adjusted sale price,
N is the spatially weighted neighbors' predicted sale price,
S is the vector of *s* Study Area fixed effects variables (e.g., WAOR, OKCC, etc.),
X is a vector of *k* home and site characteristics (e.g., acres, square feet, number of bathrooms, condition of the home, age of home, VISTA, etc.),
VIEW is a vector of *v* categorical view of turbine variables (e.g., MINOR, MODERATE, etc.),
DISTANCE is a vector of *d* categorical distance to turbine variables (e.g., less than 3000 feet, between one and three miles, etc.),
β_0 is the constant or intercept across the full sample,
β_1 is a parameter estimate for the spatially weighted neighbor's predicted sale price,
β_2 is a vector of *s* parameter estimates for the study area fixed effects as compared to homes sold in the Washington/Oregon (WAOR) study area,
β_3 is a vector of *k* parameter estimates for the home and site characteristics,
β_4 is a vector of *v* parameter estimates for the VIEW variables as compared to homes sold with no view of the turbines,
β_5 is a vector of *d* parameter estimates for the DISTANCE variables as compared to homes sold situated outside of five miles, and
ε is a random disturbance term.

The significant change between equations (1) and (F13) is that each of the primary groups of variables in equation (F13) is interacted with the study areas (S) so that parameters can be estimated at the study area level. For example, whereas ACRES is estimated in equation (1) across all study areas, in equation (F13) it is estimated for each study area (i.e., Acres_WAOR, Acres_TXHC, etc).[117] Similarly, when considering the possible impact of wind facilities on residential sales prices, equation (1) seeks average effects that exist over the entire sample, while equation (F13) instead looks for differential effects in each individual study area. Additionally, in equation (F13), instead of estimating fixed effects using inter-study area parameters alone (e.g., WAOR, TXHC), a set of intra-study area effects (Y) - school district and census tract delineations - are added.[118] These latter coefficients represent not only effects that are presumed

[117] This change is made because, theoretically, the contribution to sales prices of home or site characteristics may differ between study areas – for instance Central_AC in Texas vs. New York – and therefore estimating them at the study area level may increase the explanatory power of the model.

[118] In the evaluation and selection of the best model to use as the "Base Model" a set of census tract and school district delineations were used instead of the study area fixed effects. These more-granular fixed effects were extracted from GIS using house locations and census tract and school district polygons. Often, the school district and census tract delineations were not mutually exclusive. For example, in Wisconsin the WIKCDC study area contains four school districts and six census tracts, none of which completely overlap. Alternatively, in some study

to exist over each entire study area (inter-study area effects), but also intra-study area effects such as differences in home valuation due to school districts, distances to amenities, and other locationally bound influences. As with the inter-study area coefficients, because of the myriad influences captured by these variables, interpretation of any single coefficient can be difficult. However, it is expected that such coefficients would be influential, indicating significant differences in value between homes in each study area and across study areas due to school district quality and factors that differ between census tracts (e.g., crime rates).

Although the fully unrestricted model described by equation (F13) is arguably superior to the fully restricted model described in equation (1) because of its ability to resolve differences between and within study areas that are not captured by the Base Model, there are three potential drawbacks:

- Model parsimony and performance;
- Standard error magnitudes; and
- Parameter estimate stability.

Each of these potential drawbacks is discussed in turn below:

Model parsimony and performance: In general, econometricians prefer a simpler, more parsimonious statistical model. In this instance, variables should be added to a model only if their addition is strongly supported by theory and if the performance of the model is substantially improved by their inclusion. As such, if a model with a relatively small number of parameters performs well, it should be preferred to a model with more parameters unless the simple model can be "proven to be inadequate" (Newman, 1956). To prove the inadequacy of a simpler model requires a significant increase in performance to be exhibited from the more complex model. In this case, as presented later, performance is measured using the combination of Adjusted R^2, Modified R^2, and the Schwarz information criterion (see footnote 119 on page 127).

Standard error magnitudes: The magnitude of the standard errors for the variables of interest, as well as the other controlling variables, are likely to increase in the unrestricted model form because the number of cases for each variable will decrease when they are estimated at the study area level. Within each study area, there are a limited number of home transactions that meet the criteria for inclusion in the model, but even more limiting is the number of home transactions within each study area that have the characteristics of interest. For example, in Lee County, IL (ILLC), there are 205 post-construction home sales, while in Wayne County, PA (PAWC) there are 222. More importantly, in those areas, the data include a total of one and eleven sales inside of one mile, respectively, and a total of one and two homes with either EXTREME or SUBSTANTIAL rated views of turbines. With so few observations, there is increased likelihood that a single or small group of observations will strongly influence the sample mean of an independent variable. Since the standard error is derived from the variance of the parameter estimate, which in turn is derived from the summed deviation of each observation's actual level relative to its sample mean, this standard error is more likely to be larger than if a larger sample were considered. If the presence of wind facilities does have a detrimental effect on property

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areas the school district and census tracts perfectly overlapped, and in those cases either both were omitted as the reference category or one was included and the other withdrawn from the model to prevent perfect collinearity.

values, that effect seems likely to be relatively small, at least outside of the immediate vicinity of the wind turbines. The smaller sample sizes for the independent variables that come with the unrestricted model, which may decrease statistical precision by producing larger standard errors, would likely decrease the ability to accurately identify these possible effects statistically. To explore the magnitude of this concern, the difference in standard errors of the variables of interest is investigated among the restricted and unrestricted models.

Parameter estimate stability: In an unrestricted model, parameter estimates are more likely to be unstable because the sample of home transactions with any particular characteristic may be small and thus not representative of the population as a whole. As mentioned above, there are a limited number of transactions within each study area that have the characteristics of interest. Restricting the sample size by using an unrestricted model increases the likelihood that a limited number of observations, which in the population as a whole represent a very small segment, will drive the results in one direction or another, thereby leading to erroneous conclusions. The difference in parameter estimates is investigated by comparing the coefficients for the unrestricted variables of interest to those for the restricted variables of interest. Additionally, the sign of any significant variables will be investigated for the unrestricted models, which might help uncover potentially spurious results.

F.2 Analysis of Alterative Model Forms

Here the spectrum of alternative models is explored, from the fully restricted equation (1) to the fully unrestricted equation (F13). To do so, not only are these two ends of the spectrum estimated, but also 14 intermediate models are estimated that consist of every combination of restriction of the four variable groups (i.e., variables of interest, spatial adjustments, study area delineations, and home and site characteristics). This produces a total of 16 models over which to assess model parsimony and performance, standard error size, and coefficient stability. This process allows for an understanding of model performance but, more importantly, to ultimately define a "Base Model" that is parsimonious (i.e., has the fewest parameters), robust (i.e., high adjusted R^2), and best fits the purpose of investigating wind facility impacts on home sales prices.

Table A - 2 presents the performance statistics for each of the 16 models defined above, moving from the fully restricted model equation (1) ("Model 1") to the fully unrestricted model equation (F13) ("Model 16"). In columns 2 – 5 of the table, the "R" represents a restriction for this variable group (i.e., not crossed with the study areas) and the "U" represents the case when the variable group is unrestricted (i.e., crossed with the study areas). Also shown are summary model statistics (i.e., Adjusted R^2, Modified R^2, and Schwarz information criterion - "SIC"), as well as the number of estimated parameters (k). [119] All models were run using the post-construction data subset of the sample of home sales transactions (n = 4,937).

[119] Goldberger (1991), as cited by Gujarati (2003), suggests using a Modified $R^2 = (1 - k/n) * R^2$ to adjust for added parameters. For example, Models 1 and 14 have Modified R^2 of 0.76, yet Adjusted R^2 of 0.77 and 0.78 respectively. Therefore the Modified R^2 penalizes their measure of explanatory power more than the Adjusted R^2 when taking into account the degrees of freedom. Similarly, the Schwarz information criterion penalizes the models for increased numbers of parameters (Schwarz, 1978). More importantly, practitioners often rely on the Schwarz criterion – over the Modified or Adjusted R^2 statistics - to rank models with the same dependent variable by their relative parsimony (Gujarati, 2003). Therefore it will be used for that purpose here.

Model Parsimony and Performance

Overall, the fully restricted model (1) performs well with only 37 independent variables, producing an Adjusted R^2 of 0.77. Despite the limited number of explanatory variables, the model explains ~77% of the variation in home prices in the sample. When the fully unrestricted model 16 (equation F13) is estimated, which lies at the other end of the spectrum, it performs only slightly better, with an Adjusted R^2 of 0.81, but with an additional 285 explanatory variables. It is therefore not surprising that the Modified R^2 is 0.76 for Model 1 and is only 0.77 for Model 16. Similarly, the Schwarz information criterion (SIC) increases from 0.088 to 0.110 when moving from model 1 to model 16 indicating relatively less parsimony. Combined, these metrics show that the improvement in the explanatory power of model 16 over model 1 is not enough to overcome the lack of parsimony. Turning to the 14 models that lie between Models 1 and 16, in general, little improvement in performance is found over Model 1, and considerably less parsimony, providing little initial justification to pursue a more complex specification than equation (1).

Table A - 2: Summarized Results of Restricted and Unrestricted Model Forms

Model [1]	Study Area [2]	Spatial Adjustment	Home and Site Characteristics	Variables of Interest	Adj R^2	Modified R^2	SIC	*k* †
1	R	R	R	R	0.77	0.76	0.088	37
2	U	R	R	R	0.74	0.73	0.110	111
3	R	U	R	R	0.77	0.76	0.088	46
4	R	R	U	R	0.80	0.78	0.095	188
5	R	R	R	U	0.77	0.76	0.093	88
6	U	U	R	R	0.78	0.76	0.094	120
7	R	U	U	R	0.80	0.77	0.096	197
8	R	R	U	U	0.80	0.77	0.101	239
9	U	R	U	R	0.80	0.77	0.107	262
10	U	R	R	U	0.76	0.75	0.107	162
11	R	U	R	U	0.77	0.76	0.094	97
12	U	U	U	R	0.81	0.77	0.103	271
13	R	U	U	U	0.80	0.77	0.103	248
14	U	U	R	U	0.78	0.76	0.100	171
15	U	R	U	U	0.80	0.76	0.113	313
16	U	U	U	U	0.81	0.77	0.110	322

"R" indicates parameters are pooled ("restricted") across the study areas.
"U" indicates parameters are not pooled ("unrestricted"), and are instead estimated at the study area level.

1 - *Model numbers do not correspond to equation numbers listed in the report; equation (1) is Model 1, and equation (F1) is Model 16.*

2 - *In its restricted form "Study Area" includes only inter-study area delineations, while unrestricted "Study Area" includes intra-study area delineations of school district and census tract.*

† - *Numbers of parameters do not include intercept or omitted variables.*

The individual contributions to model performance from unrestricting each of the variable groups in turn (as shown in Models 2-5) further emphasizes the small performance gains that are earned despite the sizable increases in the number of parameters. As a single group, the

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unrestricted Home and Site Characteristics model (Model 4) makes the largest impact on model performance, at least with respect to the Adjusted R^2 (0.80), but this comes with the addition of 151 estimated parameters a slight improvement in the Modified R^2 (0.78) and a worsening SIC (0.095). Adding unrestricted Study Area delineations (Model 2), on the other hand, adversely affects performance (Adj. R^2 = 0.74, Modified R^2 = 0.73) and adds 74 estimated parameters (SIC = 0.110). Similarly, unrestricting the Spatial Adjustments (Model 3) offers little improvement in performance (Adj. R^2 = 0.77, Modified R^2 = 0.76) despite adding nine additional variables (SIC = 0.088). Finally, unrestricting the Variables of Interest (Model 5) does not increase model performance (Adj. R^2 = 0.77, Modified R^2 = 0.76) and adds 51 variables to the model (SIC = 0.093). This pattern of little model improvement yet considerable increases in the number of estimated parameters (i.e., less parsimony) continues when pairs or trios of variable groups are unrestricted. With an Adjusted R^2 of 0.77, the fully restricted equation (1) performs more than adequately, and is, by far, the most parsimonious.

Standard Error Magnitudes

Table A - 3 summarizes the standard errors for the variables of interest for all of the 16 models, grouped into restricted and unrestricted model categories. The table specifically compares the medians, minimums, and maximums of the standard errors for the models with restricted variables of interest (1, 2, 3, 4, 6, 7, 9 and 12) to those with unrestricted variables of interest (5, 8, 10, 11, 13, 14, 15 and 16).[120] The table demonstrates that the unrestricted standard errors for the variables of interest are significantly larger than the restricted standard errors. In fact, the minimum standard errors in the unrestricted models are often higher than the maximum standard errors produced in the restricted models. For example, the maximum standard error for an EXTREME VIEW in the restricted models is 0.09, yet the minimum in the unrestricted models is 0.12, with a maximum of 0.34. To put this result in a different light, a median standard error for the unrestricted EXTREME VIEW variable of 0.25 would require an effect on house prices larger than 50% to be considered statistically significant at the 90% level. Clearly, the statistical power of the unrestricted models is weak.[121] Based on other disamenities, as discussed in Section 2.1, an effect of this magnitude is very unlikely. Therefore, based on these standard errors, there is no apparent reason to unrestrict the variables of interest.

[120] For the restricted models, the medians, minimums, and maximums are derived across all eight models for each variable of interest. For the unrestricted models, they are derived across all study areas and all eight models for each variable of interest.

[121] At 90% confidence a standard error of 0.25 would produce a confidence interval of roughly +/- 0.42 (0.25 * 1.67). An effect of this magnitude represents a 52% change in sales prices because sales price is in a natural log form (*e* ^ 0.42-1 = 0.52).

Table A - 3: Summary of VOI Standard Errors for Restricted and Unrestricted Models

Standard Errors	Restricted Models			Unrestricted Models		
	Standard Errors			Standard Errors		
	Median	Min	Max	Median	Min	Max
Minor View	0.01	0.01	0.02	0.05	0.03	0.07
Moderate View	0.03	0.03	0.03	0.10	0.06	0.18
Substantial View	0.05	0.05	0.06	0.19	0.10	0.29
Extreme View	0.08	0.08	0.09	0.25	0.12	0.34
Inside 3000 Feet	0.05	0.05	0.06	0.21	0.09	0.33
Between 3000 Feet and 1 Mile	0.04	0.04	0.05	0.13	0.08	0.40
Between 1 and 3 Miles	0.02	0.02	0.02	0.05	0.02	0.11
Between 3 and 5 Miles	0.01	0.01	0.02	0.05	0.02	0.10

Parameter Estimate Stability

Table A - 4 summarizes the coefficient estimates for the variables of interest for all of the 16 models. The table specifically compares the medians, minimums, and maximums of the coefficients for the models with restricted variables of interest (1, 2, 3, 4, 6, 7, 9 and 12) to those with unrestricted variables of interest (5, 8, 10, 11, 13, 14, 15 and 16). As shown, the coefficients in the unrestricted models diverge significantly from those in the restricted models. For example, in the restricted models, the median coefficient for homes inside of 3000 feet is -0.03, with a minimum of -0.06 and a maximum of -0.01, yet in the unrestricted models the median coefficient is 0.06, with a minimum of -0.38 and a maximum of 0.32. Similarly, a MODERATE VIEW in the restricted models has a median of 0.00, with a minimum of -0.01 and a maximum of 0.03, whereas the unrestricted models produce coefficients with a median of -0.05 and with a minimum of -0.25 and a maximum of 0.35.

Table A - 4: Summary of VOI Coefficients for Restricted and Unrestricted Models

Parameters	Restricted Models			Unrestricted Models		
	Coefficients			Coefficients		
	Median	Min	Max	Median	Min	Max
Minor View	-0.02	-0.03	0.00	-0.02	-0.16	0.24
Moderate View	0.00	-0.01	0.03	-0.05	-0.25	0.35
Substantial View	-0.01	-0.04	0.02	-0.08	-0.31	0.13
Extreme View	0.03	0.02	0.05	-0.03	-0.23	0.09
Inside 3000 Feet	-0.03	-0.06	-0.01	0.06	-0.38	0.32
Between 3000 Feet and 1 Mile	-0.04	-0.06	-0.01	-0.10	-0.44	0.52
Between 1 and 3 Miles	-0.01	-0.03	0.02	0.00	-0.23	0.40
Between 3 and 5 Miles	0.02	0.01	0.04	0.05	-0.05	0.32

Turning from the levels of the coefficients to the stability of their statistical significance and sign across models more reasons for concern are found. Table A - 5 summarizes the results of the unrestricted models, and presents the number of statistically significant variables of interest as a percent of the total estimated. The table also breaks these results down into two groups, those

with coefficients above zero and those with coefficients below zero.[122] It should be emphasized here that it is the *a priori* expectation that, if effects exist, all of these coefficients would be less than zero, indicating an adverse effect on home prices from proximity to and views of wind turbines. Despite that expectation, when the variables of interest are unrestricted it is found that they are as likely to be above zero as they are below.[123] In effect, the small numbers of cases available for analysis at the study area level produce unstable results, likely because the estimates are being unduly influenced by either study area specific effects that are not captured by the model or by a limited number of observations that represents a larger fraction of the overall sample in that model.[124]

Table A - 5: Summary of Significant VOI Above and Below Zero in Unrestricted Models

Significant Variables	Unrestricted Models		
	Total	Below Zero	Above Zero
Minor View	32%	14%	18%
Moderate View	23%	11%	13%
Substantial View	4%	4%	0%
Extreme View	0%	0%	0%
Inside 3000 Feet	23%	15%	8%
Between 3000 Feet and 1 Mile	30%	14%	16%
Between 1 and 3 Miles	56%	32%	24%
Between 3 and 5 Miles	45%	3%	43%

F.3 Selecting a Base Model

To conclude, it was found that all three concerns related to the estimation and use of an unrestricted model form are borne out in practice. Despite experimenting with 16 different combinations of interactions, little overall improvement in performance is discovered. Where performance gains are found they are at the expense of parsimony as reflected in the lack of increase in the Modified R^2 and the relatively higher Schwartz information criterion. Further, divergent and spurious coefficients of interest and large standard errors are associated with those coefficients. Therefore the fully restricted model, equation (1), is used in this report as the "Base Model".

[122] The "Total" percentage of significant coefficients is calculated by counting the total number of significant coefficients across all 8 unrestricted models for each variable of interest, and dividing this total by the total number of coefficients. Therefore, a study area that did not have any homes in a group (for example, homes with EXTREME VIEWS) was not counted in the "total number of coefficients" sum. Any differences between the sum of "above" and "below" zero groups from the total are due to rounding errors.

[123] The relatively larger number of significant variables for the MINOR rated view, MODERATE rated view, Mile 1 to 3, and Mile 3 to 5 parameters are likely related to the smaller standard errors for those categories, which result from larger numbers of cases.

[124] Another possible explanation for spurious results in general is measurement error, when parameters do not appropriately represent what one is testing for. In this case though, the VIEW variables have been adequately "ground truthed" during the development of the measurement scale, and are similar to the VISTA variables, which were found to be very stable across study areas. DISTANCE, or for that matter, distance to any disamenity, has been repeatedly found to be an appropriate proxy for the size of effects. As a result, it is not believed that measurement error is a likely explanation for the results presented here.

Appendix G: OLS Assumptions, and Tests for the Base Model

A number of criteria must be met to ensure that the Base Model and Alternative Hedonic Models produce unbiased coefficient estimates and standard errors: 1) appropriate controls for outliers and influencers; 2) homoskedasticity; 3) absence of serial or spatial autocorrelation; and 4) reasonably limited multicollinearity. Each of these criteria, and how they are addressed, is discussed below.

Outliers and Influencers: Home sale prices that are well away from the mean, also called outliers and influencers, can cause undue influence on parameter estimates. A number of formal tests are available to identify these cases, the most common being Mahalanobis' Distance ("M Distance") (Mahalanobis, 1936) and standardized residual screening. M Distance measures the degree to which individual observations influence the mean of the residuals. If any single observation has a strong influence on the residuals, it should be inspected and potentially removed. An auxiliary, but more informal, test for identifying these potentially influential observations is to see when the standardized absolute value of the residual exceeds some threshold. Both the Base Model and the All Sales Model were run using the original dataset of 7,464 transactions and the 4,940 transactions which occurred post-construction respectively. For both models the standardized residuals and the M Distance statistics were saved.[125] The histograms of these two sets of statistics from the two regressions are shown in Figure A - 15 through Figure A - 18.

[125] For the M Distance statistics all variables of interest were removed from the model. If they were left in the M-Distance statistics could be influenced by the small numbers of cases in the variables of interest. If these parameters were strongly influenced by a certain case, it could drive the results upward. Inspecting the controlling variables in the model, and how well they predicted the sale prices of the transactions in the sample, was of paramount importance therefore the variables of interest were not included.

Figure A - 15: Histogram of Standardized Residuals for Base Model

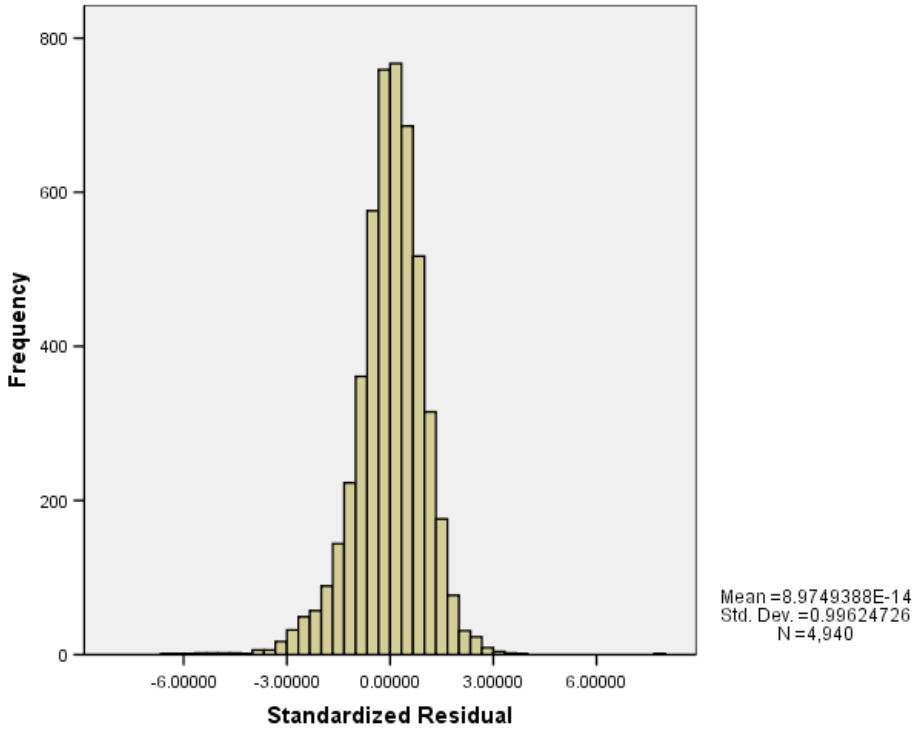


Figure A - 16: Histogram of Mahalanobis Distance Statistics for Base Model

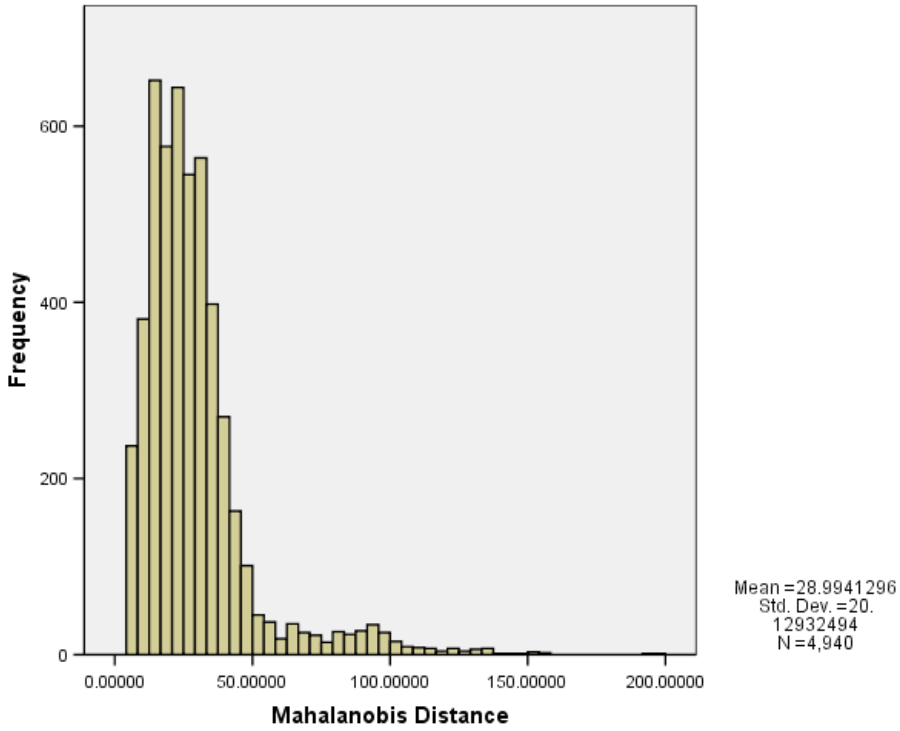


Figure A - 17: Histogram of Standardized Residuals for All Sales Model

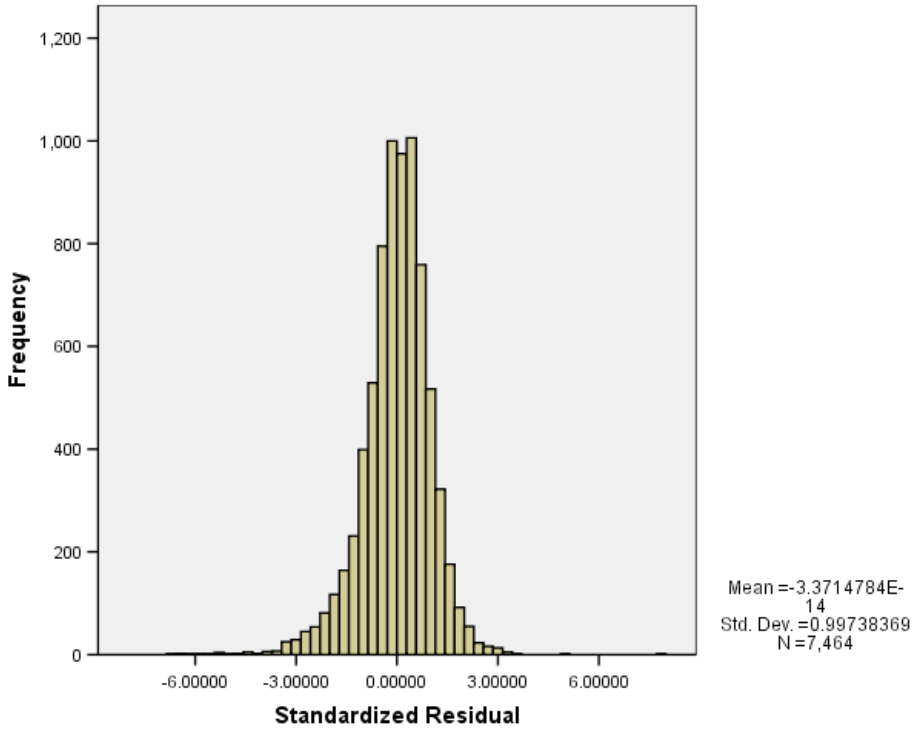
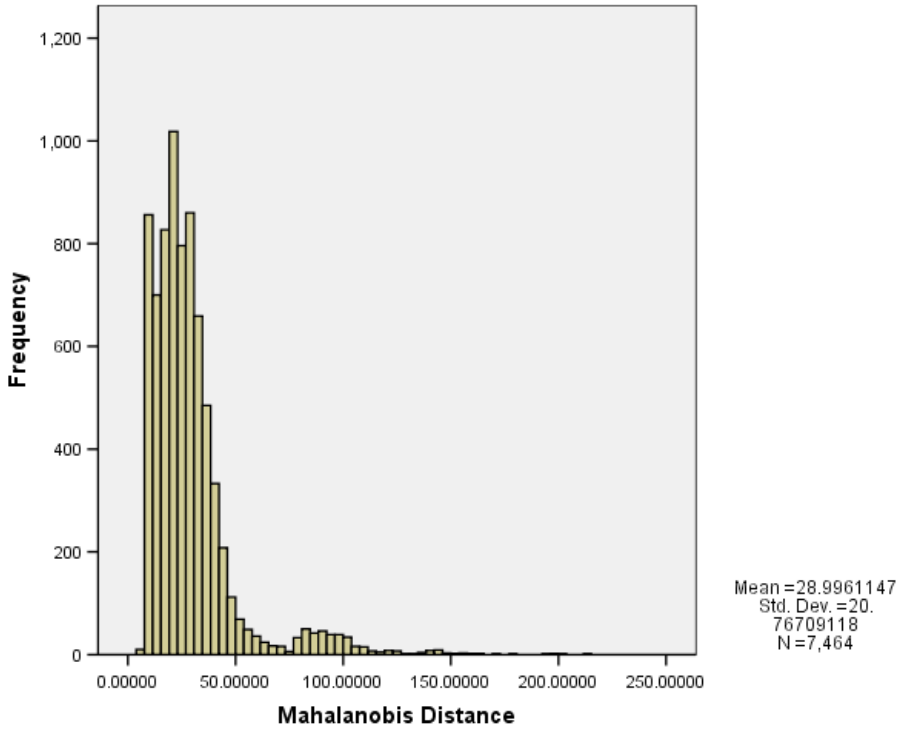


Figure A - 18: Histogram of Mahalanobis Distance Statistics for All Sales Model



The M Distance histograms suggested that a cutoff of 150 may be appropriate, which would exclude 15 cases from the All Sales Model and seven cases from the Base Model (all of the latter of which were among the 15 outliers in the All Sales Model). The Standardized Residual histograms suggested a cutoff of 4, 5, or 6, which would exclude 13, 8, and 3 cases from the Base Model, and 22, 12, and 5 cases from the All Sales Model. A case-by-case investigation of each of these sales transactions was then conducted by comparing their home characteristics (e.g., square feet, baths, age, etc.) against their study area and panel model cohorts to ensure that none had been inappropriately coded. None of the M Distance flagged cases seemed to be inappropriately coded, and none of those cases were removed from the final dataset as a result. Five cases that were flagged from the All Sales Model (which corresponded to three cases in the Base Model) with a Standardized Residual greater than six, however, were clearly outliers. One had a sale price that was more than $200,000 more than any other transaction in the model, and the other four had exceptionally low prices, yet high numbers of corresponding characteristics that would suggest higher home sales prices (such as over 2000 square feet – all four cases – or more than two bathrooms – three cases).

As a result of these investigations, these five cases were removed from the model. One of the five cases occurred prior to announcement, one occurred after announcement and before construction, and the other three occurred after construction began. None were within three miles of the nearest wind turbine except one, which was 0.6 miles from the nearest turbine and had a MINOR view of the wind facility. The other two had no views of the turbines. Although there was hesitancy in removing any cases from the model, these transactions were considered appropriately influential and keeping them in the model would bias the results inappropriately. Further, the one home that was situated inside of one mile was surrounded by five other transactions in the same study area that also occurred after construction began and were a similar distance from the turbines, but that were not flagged by the outliers screen. Therefore, its removal was considered appropriate given that other homes in the sample would likely experience similar effects.

After removing these five cases, the sensitivity of the model results were tested to the inclusion or exclusion of the “greater than five” and “greater than four” Standardized Residuals observations and the cases flagged by the M Distance screen, finding that parameter estimates for the variables of interest moved slightly with these cases removed but not enough to change the results significantly. Because they did not show a unique grouping across the variables of interest, nor any unusual potentially inappropriate coding, and, more importantly, did not substantially influence the results, no substantive reason was found to remove any additional transactions from the sample. Therefore, the final dataset included a total of 7,459 cases, of which 4,937 occurred post-construction.

Homoskedasticity: A standard formal test for the presence of homoskedastic error terms is the White's statistic (White, 1980). However, the requirements to perform this test were overly burdensome for the computing power available. Instead, an informal test was applied, which plots the regression errors against predicted values and various independent variables to observe whether a "heteroskedastic pattern" is in evidence (Gujarati, 2003). Although no evidence of heteroskedasticity was found using this method, to be conservative, nonetheless all models were

run with White's heteroskedasticity correction to the parameter estimates' standard errors (which will not adversely influence the errors if they are homoskedastic).

Serial Autocorrelation: A standard formal test for the presence of serial autocorrelation in the error term is the Durbin-Watson statistic (Durbin and Watson, 1951). Applying this test as proposed by Durbin and Watson to the full panel dataset was problematic because the test looks at the error structure based on the order that observations are included in the statistical regression model. Any ordering choice over the entire panel data set invariably involves mixing home transactions from various study areas. Ideally, one would segment the data by study area for purposes of calculating this test, but that method was not easily implemented with the statistical software package used for this analysis (i.e., SAS). Instead, study area specific regression models were run with the data chronologically ordered in each to produce twelve different Durbin-Watson statistics, one for each study area specific model. The Durbin-Watson test statistics ranged from 1.98–2.16, which are all within the acceptable range.[126] Given that serial autocorrelation was not found to be a significant concern for each study area specific model, it is assumed that the same holds for the full dataset used in the analysis presented in this report.

Spatial Autocorrelation: It is well known that the sales price of a home can be systematically influenced by the sales prices of those homes that have sold nearby (Dubin, 1998; LeSage, 1999). Both the seller and the buyer use information from comparable surrounding sales to inform them of the appropriate transaction price, and nearby homes often experience similar amenities and disamenities. Therefore, the price for any single home is likely to be weakly dependent of the prices of homes in close temporal and spatial proximity. This lack of independence of home sale prices could bias the hedonic results (Dubin, 1998; LeSage, 1999), if not adequately addressed. A number of techniques are available to address this concern (Case et al., 2004; Espey et al., 2007), but because of the large sample and computing limits, a variation of the Spatial Auto Regressive Model (SAR) was chosen (Espey et al., 2007).

Specifically, an independent variable is included in the models: the predicted values of the weighted nearest neighbor's natural log of sales price in 1996 dollars.[127] To construct this vector of predicted prices, an auxiliary regression is developed using the spatially weighted average natural log of sales price in 1996 dollars as the independent variable and the spatially weighted average set of home characteristics as the dependent variables. This regression was used to produce the predicted weighted nearest neighbor's natural log of sales price in 1996 dollars that is then included in the Base and Alternative Models. This process required the following steps:

1) Selecting the neighbors for inclusion in the calculation;
2) Calculating a weighted sales price from these neighbors' transactions;
3) Selecting and calculating the weighted neighbors home characteristics; and
4) Forecasting the weighted average neighbor's sales price.

- **Selecting the neighbors**: To select the neighbors whose home transactions would most likely have affected the sales price of the subject home under review, all of the homes that

[126] The critical values for the models were between 1.89 and 2.53, assuming 5% significance, greater than 20 variables, and more than 200 cases (Gujarati, 2003).

[127] The predicted value was used, instead of the actual value, to help correct for simultaneity or endogeneity problems that might otherwise exist.

sold within the preceding six months of a subject home's sale date in the same study area are identified and, from those, the five nearest neighbors based on Euclidian distance are selected. The inverse of each selected nearest neighbors' distance (in quarter miles) to the subject home was then calculated. Each of these values was then divided by the sum of the five nearest neighbor's inverse distance values to create a neighbor's distance weight (NDW) for each of the five nearest neighbors.[128]

- **Creating the weighted sales price**: Each of the neighbor's natural log of sales price in 1996 dollars (LN_Saleprice96) is multiplied by its distance weight (NDW). Then, each weighted neighbor's LN_Saleprice96 is summed to create a weighted nearest neighbor LN_Saleprice96 (Nbr_LN_Saleprice96).

- **Selecting and calculating the weighted neighbors home characteristics**: Nine independent variables are used from each of the neighbor's homes: square feet, age of the home at the time of sale, age of the home at the time of sale squared, acres, number of full baths, and condition (1-5, with Poor = 1, Below Average = 2, etc.). A weighted average is created of each of the characteristics by multiplying each of the neighbor's individual characteristics by their NDW, and then summing those values across the five neighbors to create the weighted average nearest neighbors' home characteristic.[129] Then each of the independent variables is interacted with the study area to allow each one to be independently estimated for each study area.

- **Forecasting the weighted average neighbors sales price**: To create the final predicted neighbor's price, the weighted nearest neighbor LN_Saleprice96 is regressed on the weighted average nearest neighbors' home characteristics to produce a predicted weighted nearest neighbor LN_Saleprice96 (Nbr_LN_SalePrice96_hat). These predicted values are then included in the Base and Alternative Models as independent variables to account for the spatial and temporal influence of the neighbors' home transactions.

In all models, the coefficient for this spatial adjustment parameter meets the expectations for sign and magnitude and is significant well above the 99% level, indicating both the presence of spatial autocorrelation and the appropriateness of the control for it.

Multicollinearity: There are several standard formal tests for detecting multicollinearity within the independent variables of a regression model. The Variance-Inflation Factor and Condition Index is applied to test for this violation of OLS assumptions. Specifically, a Variance-Inflation Factor (VIF) greater than 4 and/or a Condition Index of greater than 30 (Kleinbaum et al., 1988) are strong indicators that multicollinearity may exist. Multicollinearity is found in the model using both tests. Such a result is not uncommon in hedonic models because a number of characteristics, such as square feet or age of a home, are often correlated with other characteristics, such as the number of acres, bathrooms, and fireplaces. Not surprisingly, age of the home at the time of sale (AgeofHome) and the age of the home squared (AgeatHome_Sqrd)

[128] Put differently, the weight is the contribution of that home's inverse distance to the total sum of the five nearest neighbors' inverse distances.

[129] Condition requires rounding to the nearest integer and then creating a dummy from the 1-5 integers.

exhibited some multicollinearity (VIF equaled 11.8 and 10.6, respectively). Additionally, the home condition shows a fairly high Condition Index with square feet, indicating collinearity. More importantly, though, are the collinearity statistics for the variables of interest. The VIF for the VIEW variables range from 1.17 to 1.18 and for the DISTANCE variables they range from 1.2 to 3.6, indicating little collinearity with the other variables in the model. To test for this in another way, a number of models are compared with various identified highly collinear variables removed (e.g., AgeatSale, Sqft) and found that the removal of these variables had little influence on the variables of interest. Therefore, despite the presence of multicollinearity in the model, it is not believed that the variables of interest are inappropriately influenced. Further, any corrections for these issues might cause more harm to the model's estimating efficiency than taking no further action (Gujarati, 2003); as such, no specific adjustments to address the presence of multicollinearity are pursued further.

Appendix H: Alternative Models: Full Hedonic Regression Results

Table A - 6: Full Results for the Distance Stability Model

	Coef.	SE	p Value	*n*
Intercept	7.61	0.18	0.00	
Nbr_LN_SalePrice96_hat	0.29	0.02	0.00	4,937
AgeatSale	-0.006	0.0004	0.00	4,937
AgeatSale_Sqrd	0.00002	0.000003	0.00	4,937
Sqft_1000	0.28	0.01	0.00	4,937
Acres	0.02	0.00	0.00	4,937
Baths	0.09	0.01	0.00	4,937
ExtWalls_Stone	0.21	0.02	0.00	1,486
CentralAC	0.09	0.01	0.00	2,575
Fireplace	0.11	0.01	0.00	1,834
FinBsmt	0.08	0.02	0.00	673
Cul_De_Sac	0.10	0.01	0.00	992
Water_Front	0.33	0.04	0.00	87
Cnd_Low	-0.45	0.05	0.00	69
Cnd_BAvg	-0.24	0.02	0.00	350
Cnd_Avg	Omitted	Omitted	Omitted	2,727
Cnd_AAvg	0.13	0.01	0.00	1,445
Cnd_High	0.23	0.02	0.00	337
Vista_Poor	-0.21	0.02	0.00	310
Vista_BAvg	-0.08	0.01	0.00	2,857
Vista_Avg	Omitted	Omitted	Omitted	1,247
Vista_AAvg	0.10	0.02	0.00	448
Vista_Prem	0.13	0.04	0.00	75
WAOR	Omitted	Omitted	Omitted	519
TXHC	-0.75	0.03	0.00	1,071
OKCC	-0.44	0.02	0.00	476
IABV	-0.24	0.02	0.00	605
ILLC	-0.08	0.03	0.00	213
WIKCDC	-0.14	0.02	0.00	725
PASC	-0.30	0.03	0.00	291
PAWC	-0.07	0.03	0.01	222
NYMCOC	-0.20	0.03	0.00	346
NYMC	-0.15	0.02	0.00	469
Mile_Less_0_57	-0.04	0.04	0.29	67
Mile_0_57to1	-0.06	0.05	0.27	58
Mile_1to3	-0.01	0.02	0.71	2,019
Mile_3to5	0.01	0.01	0.26	1,923
Mile_Gtr5	Omitted	Omitted	Omitted	870

"Omitted" = reference category for fixed effects variables

"n" indicates number of cases in category when category = "1"

Model Information

Model Equation Number	**2**
Model Name	**Distance Stability**
Dependent Variable	**LN_SalePrice96**
Number of Cases	**4937**
Number of Predictors (k)	**33**
F Statistic	**496.7**
Adjusted R Squared	**0.77**

Table A - 7: Full Results for the View Stability Model

	Coef.	SE	Sig	*n*
Intercept	7.64	0.18	0.00	
Nbr_LN_SalePrice96_hat	0.29	0.02	0.00	4,937
AgeatSale	-0.006	0.0004	0.00	4,937
AgeatSale_Sqrd	0.00002	0.000003	0.00	4,937
Sqft_1000	0.28	0.01	0.00	4,937
Acres	0.02	0.00	0.00	4,937
Baths	0.09	0.01	0.00	4,937
ExtWalls_Stone	0.21	0.02	0.00	1,486
CentralAC	0.09	0.01	0.00	2,575
Fireplace	0.11	0.01	0.00	1,834
FinBsmt	0.08	0.02	0.00	673
Cul_De_Sac	0.10	0.01	0.00	992
Water_Front	0.34	0.04	0.00	87
Cnd_Low	-0.45	0.05	0.00	69
Cnd_BAvg	-0.24	0.02	0.00	350
Cnd_Avg	Omitted	Omitted	Omitted	2,727
Cnd_AAvg	0.13	0.01	0.00	1,445
Cnd_High	0.23	0.02	0.00	337
Vista_Poor	-0.21	0.02	0.00	310
Vista_BAvg	-0.08	0.01	0.00	2,857
Vista_Avg	Omitted	Omitted	Omitted	1,247
Vista_AAvg	0.10	0.02	0.00	448
Vista_Prem	0.13	0.04	0.00	75
WAOR	Omitted	Omitted	Omitted	519
TXHC	-0.75	0.02	0.00	1,071
OKCC	-0.45	0.02	0.00	476
IABV	-0.25	0.02	0.00	605
ILLC	-0.09	0.03	0.00	213
WIKCDC	-0.14	0.02	0.00	725
PASC	-0.31	0.03	0.00	291
PAWC	-0.08	0.03	0.00	222
NYMCOC	-0.20	0.03	0.00	346
NYMC	-0.15	0.02	0.00	469
Post_Con_NoView	Omitted	Omitted	Omitted	4,207
View_Minor	-0.02	0.01	0.25	561
View_Mod	0.00	0.03	0.90	106
View_Sub	-0.04	0.06	0.56	35
View_Extrm	-0.03	0.06	0.61	28

"Omitted" = reference category for fixed effects variables

"n" indicates number of cases in category when category = "1"

Model Information

Model Equation Number	**3**
Model Name	**View Stability**
Dependent Variable	**LN_SalePrice96**
Number of Cases	**4937**
Number of Predictors (k)	**33**
F Statistic	**495.9**
Adjusted R Squared	**0.77**

Table A - 8: Full Results for the Continuous Distance Model

	Coef.	SE	p Value	*n*
Intercept	7.64	0.18	0.00	
Nbr_LN_SalePrice96_hat	0.29	0.02	0.00	4,937
AgeatSale	-0.006	0.0004	0.00	4,937
AgeatSale_Sqrd	0.00002	0.000003	0.00	4,937
Sqft_1000	0.28	0.01	0.00	4,937
Acres	0.02	0.00	0.00	4,937
Baths	0.09	0.01	0.00	4,937
ExtWalls_Stone	0.21	0.02	0.00	1,486
CentralAC	0.09	0.01	0.00	2,575
Fireplace	0.11	0.01	0.00	1,834
FinBsmt	0.08	0.02	0.00	673
Cul_De_Sac	0.10	0.01	0.00	992
Water_Front	0.34	0.04	0.00	87
Cnd_Low	-0.45	0.05	0.00	69
Cnd_BAvg	-0.24	0.02	0.00	350
Cnd_Avg	Omitted	Omitted	Omitted	2,727
Cnd_AAvg	0.13	0.01	0.00	1,445
Cnd_High	0.23	0.02	0.00	337
Vista_Poor	-0.21	0.02	0.00	310
Vista_BAvg	-0.08	0.01	0.00	2,857
Vista_Avg	Omitted	Omitted	Omitted	1,247
Vista_AAvg	0.10	0.02	0.00	448
Vista_Prem	0.13	0.04	0.00	75
WAOR	Omitted	Omitted	Omitted	519
TXHC	-0.75	0.02	0.00	1,071
OKCC	-0.44	0.02	0.00	476
IABV	-0.25	0.02	0.00	605
ILLC	-0.09	0.03	0.00	213
WIKCDC	-0.14	0.02	0.00	725
PASC	-0.31	0.03	0.00	291
PAWC	-0.07	0.03	0.00	222
NYMCOC	-0.20	0.03	0.00	346
NYMC	-0.15	0.02	0.00	469
No View	Omitted	Omitted	Omitted	4,207
Minor View	-0.01	0.01	0.33	561
Moderate View	0.01	0.03	0.77	106
Substantial View	-0.02	0.07	0.72	35
Extreme View	0.01	0.10	0.88	28
InvDISTANCE	-0.01	0.02	0.46	4,937

"Omitted" = reference category for fixed effects variables
"n" indicates number of cases in category when category = "1"

Model Information

Model Equation Number	**5**
Model Name	**Continuous Distance Model**
Dependent Variable	**LN_SalePrice96**
Number of Cases	**4937**
Number of Predictors (k)	**34**
F Statistic	**481.3**
Adjusted R Squared	**0.77**

Table A - 9: Full Results for the All Sales Model

	Coef.	SE	p Value	*n*
Intercept	9.08	0.14	0.00	
Nbr_LN_SP96_hat_All_OI	0.16	0.01	0.00	7,459
AgeatSale	-0.007	0.0003	0.00	7,459
AgeatSale_Sqrd	0.00003	0.000002	0.00	7,459
Sqft_1000	0.28	0.01	0.00	7,459
Acres	0.02	0.00	0.00	7,459
Baths	0.08	0.01	0.00	7,459
ExtWalls_Stone	0.21	0.01	0.00	2,287
CentralAC	0.12	0.01	0.00	3,785
Fireplace	0.11	0.01	0.00	2,708
FinBsmt	0.09	0.01	0.00	990
Cul_De_Sac	0.09	0.01	0.00	1,472
Water_Front	0.35	0.03	0.00	107
Cnd_Low	-0.43	0.04	0.00	101
Cnd_BAvg	-0.21	0.02	0.00	519
Cnd_Avg	Omitted	Omitted	Omitted	4,357
Cnd_AAvg	0.13	0.01	0.00	2,042
Cnd_High	0.22	0.02	0.00	440
Vista_Poor	-0.25	0.02	0.00	470
Vista_BAvg	-0.09	0.01	0.00	4,301
Vista_Avg	Omitted	Omitted	Omitted	1,912
Vista_AAvg	0.10	0.01	0.00	659
Vista_Prem	0.09	0.03	0.00	117
WAOR	Omitted	Omitted	Omitted	790
TXHC	-0.82	0.02	0.00	1,311
OKCC	-0.53	0.02	0.00	1,113
IABV	-0.31	0.02	0.00	822
ILLC	-0.05	0.02	0.02	412
WIKCDC	-0.17	0.01	0.00	810
PASC	-0.37	0.03	0.00	494
PAWC	-0.15	0.02	0.00	551
NYMCOC	-0.25	0.02	0.00	463
NYMC	-0.15	0.02	0.00	693
Pre-Construction Sales	Omitted	Omitted	Omitted	2,522
No View	0.02	0.01	0.06	4,207
Minor View	0.00	0.02	0.76	561
Moderate View	0.03	0.03	0.38	106
Substantial View	0.03	0.07	0.63	35
Extreme View	0.06	0.08	0.43	28
Inside 3000 Feet	-0.06	0.05	0.23	80
Between 3000 Feet and 1 Mile	-0.08	0.05	0.08	65
Between 1 and 3 Miles	0.00	0.01	0.79	2,359
Between 3 and 5 Miles	0.01	0.01	0.58	2,200
Outside 5 Miles	0.00	0.02	0.76	1,000
Pre-Announcement Sales	Omitted	Omitted	Omitted	1,755

"Omitted" = reference category for fixed effects variables

"n" indicates number of cases in category when category = "1"

Model Information

Model Equation Number	**6**
Model Name	**All Sales Model**
Dependent Variable	**LN_SalePrice96**
Number of Cases	**7459**
Number of Predictors (k)	**39**
F Statistic	**579.9**
Adjusted R Squared	**0.75**

Table A - 10: Full Results for the Temporal Aspects Model

	Coef.	SE	p Value	*n*
Intercept	9.11	0.14	0.00	
Nbr_LN_SP96_hat_All_OI	0.16	0.01	0.00	7,459
AgeatSale	-0.007	0.0003	0.00	7,459
AgeatSale_Sqrd	0.00003	0.000002	0.00	7,459
Sqft_1000	0.28	0.01	0.00	7,459
Acres	0.02	0.00	0.00	7,459
Baths	0.08	0.01	0.00	7,459
ExtWalls_Stone	0.21	0.01	0.00	2,287
CentralAC	0.12	0.01	0.00	3,785
Fireplace	0.12	0.01	0.00	2,708
FinBsmt	0.09	0.01	0.00	990
Cul_De_Sac	0.09	0.01	0.00	1,472
Water_Front	0.35	0.03	0.00	107
Cnd_Low	-0.43	0.04	0.00	101
Cnd_BAvg	-0.21	0.02	0.00	519
Cnd_Avg	Omitted	Omitted	Omitted	4,357
Cnd_AAvg	0.13	0.01	0.00	2,042
Cnd_High	0.22	0.02	0.00	440
Vista_Poor	-0.25	0.02	0.00	470
Vista_BAvg	-0.09	0.01	0.00	4,301
Vista_Avg	Omitted	Omitted	Omitted	1,912
Vista_AAvg	0.10	0.01	0.00	659
Vista_Prem	0.09	0.03	0.00	117
WAOR	Omitted	Omitted	Omitted	790
TXHC	-0.82	0.02	0.00	1,311
OKCC	-0.52	0.02	0.00	1,113
IABV	-0.30	0.02	0.00	822
ILLC	-0.04	0.02	0.05	412
WIKCDC	-0.17	0.02	0.00	810
PASC	-0.37	0.03	0.00	494
PAWC	-0.14	0.02	0.00	551
NYMCOC	-0.25	0.02	0.00	463
NYMC	-0.15	0.02	0.00	693

"Omitted" = reference category for fixed effects variables

"n" indicates number of cases in category when category = "1"

Note: Results for variables of interest shown on following page

	Coef.	SE	p Value	*n*
No View	Omitted	Omitted	Omitted	6,729
Minor View	-0.02	0.01	0.20	561
Moderate View	0.00	0.03	0.97	106
Substantial View	0.01	0.07	0.87	35
Extreme View	0.04	0.07	0.59	28
Pre_Anc_Gtr2Yr_Lt1Mile	-0.13	0.06	0.02	38
Pre_Anc_2Yr_Lt1Mile	-0.10	0.05	0.06	40
Post_Anc_Pre_Con_Lt1Mile	-0.14	0.06	0.02	21
Post_Con_2Yr_Lt1Mile	-0.09	0.07	0.15	39
Post_Con_2_4Yr_Lt1Mile	-0.01	0.06	0.86	44
Post_Con_Gtr5Yr_Lt1Mile	-0.07	0.08	0.37	42
Pre_Anc_Gtr2Yr_1_3Mile	-0.04	0.03	0.19	283
Pre_Anc_2Yr_1_3Mile	0.00	0.03	0.91	592
Post_Anc_Pre_Con_1_3Mile	-0.02	0.03	0.53	342
Post_Con_2Yr_1_3Mile	0.00	0.03	0.90	807
Post_Con_2_4Yr_1_3Mile	0.01	0.03	0.78	503
Post_Con_Gtr5Yr_1_3Mile	0.00	0.03	0.93	710
Pre_Anc_Gtr2Yr_3_5Mile	0.00	0.04	0.93	157
Pre_Anc_2Yr_3_5Mile	0.00	0.03	0.98	380
Post_Anc_Pre_Con_3_5Mile	0.00	0.03	0.93	299
Post_Con_2Yr_3_5Mile	0.02	0.03	0.56	574
Post_Con_2_4Yr_3_5Mile	0.01	0.03	0.66	594
Post_Con_Gtr5Yr_3_5Mile	0.01	0.03	0.68	758
Pre_Anc_Gtr2Yr_Gtr5Mile	Omitted	Omitted	Omitted	132
Pre_Anc_2Yr_Gtr5Mile	-0.03	0.04	0.39	133
Post_Anc_Pre_Con_Gtr5Mile	-0.03	0.03	0.36	105
Post_Con_2Yr_Gtr5Mile	-0.03	0.03	0.44	215
Post_Con_2_4Yr_Gtr5Mile	0.03	0.03	0.42	227
Post_Con_Gtr5Yr_Gtr5Mile	0.01	0.03	0.72	424

"Omitted" = reference category for fixed effects variables
"n" indicates number of cases in category when category = "1"

Model Information

Model Equation Number	**7**
Model Name	**Temporal Aspects Model**
Dependent Variable	**LN_SalePrice96**
Number of Cases	**7459**
Number of Predictors (k)	**56**
F Statistic	**404.5**
Adjusted R2	**0.75**

Table A - 11: Full Results for the Orientation Model

	Coef.	SE	p Value	*n*
Intercept	7.62	0.18	0.00	
Nbr_LN_SalePrice96_hat	0.29	0.02	0.00	4,937
AgeatSale	-0.006	0.0004	0.00	4,937
AgeatSale_Sqrd	0.00002	0.000003	0.00	4,937
Sqft_1000	0.28	0.01	0.00	4,937
Acres	0.02	0.00	0.00	4,937
Baths	0.09	0.01	0.00	4,937
ExtWalls_Stone	0.21	0.02	0.00	1,486
CentralAC	0.09	0.01	0.00	2,575
Fireplace	0.11	0.01	0.00	1,834
FinBsmt	0.08	0.02	0.00	673
Cul_De_Sac	0.10	0.01	0.00	992
Water_Front	0.33	0.04	0.00	87
Cnd_Low	-0.44	0.05	0.00	69
Cnd_BAvg	-0.24	0.02	0.00	350
Cnd_Avg	Omitted	Omitted	Omitted	2,727
Cnd_AAvg	0.13	0.01	0.00	1,445
Cnd_High	0.24	0.02	0.00	337
Vista_Poor	-0.21	0.02	0.00	310
Vista_BAvg	-0.08	0.01	0.00	2,857
Vista_Avg	Omitted	Omitted	Omitted	1,247
Vista_AAvg	0.10	0.02	0.00	448
Vista_Prem	0.13	0.04	0.00	75
WAOR	Omitted	Omitted	Omitted	519
TXHC	-0.75	0.03	0.00	1,071
OKCC	-0.44	0.02	0.00	476
IABV	-0.24	0.02	0.00	605
ILLC	-0.08	0.03	0.00	213
WIKCDC	-0.14	0.02	0.00	725
PASC	-0.31	0.03	0.00	291
PAWC	-0.07	0.03	0.01	222
NYMCOC	-0.20	0.03	0.00	346
NYMC	-0.15	0.02	0.00	469
No View	Omitted	Omitted	Omitted	4,207
Minor View	-0.01	0.06	0.92	561
Moderate View	0.00	0.06	0.97	106
Substantial View	-0.01	0.09	0.87	35
Extreme View	0.02	0.17	0.89	28
Inside 3000 Feet	-0.04	0.07	0.55	67
Between 3000 Feet and 1 Mile	-0.05	0.05	0.37	58
Between 1 and 3 Miles	0.00	0.02	0.83	2,019
Between 3 and 5 Miles	0.02	0.01	0.22	1,923
Outside 5 Miles	Omitted	Omitted	Omitted	870
Front Orientation	-0.01	0.06	0.82	294
Back Orientation	0.03	0.06	0.55	280
Side Orientation	-0.03	0.06	0.55	253

"Omitted" = reference category for fixed effects variables

"n" indicates number of cases in category when category = "1"

Model Information

Model Equation Number	**8**
Model Name	**Orientation Model**
Dependent Variable	**LN_SalePrice96**
Number of Cases	**4937**
Number of Predictors (k)	**40**
F Statistic	**410.0**
Adjusted R Squared	**0.77**

Table A - 12: Full Results for the Overlap Model

	Coef.	SE	p Value	*n*
Intercept	7.61	0.18	0.00	
Nbr_LN_SalePrice96_hat	0.29	0.02	0.00	4,937
AgeatSale	-0.006	0.0004	0.00	4,937
AgeatSale_Sqrd	0.00002	0.000003	0.00	4,937
Sqft_1000	0.28	0.01	0.00	4,937
Acres	0.02	0.00	0.00	4,937
Baths	0.09	0.01	0.00	4,937
ExtWalls_Stone	0.21	0.02	0.00	1,486
CentralAC	0.09	0.01	0.00	2,575
Fireplace	0.11	0.01	0.00	1,834
FinBsmt	0.08	0.02	0.00	673
Cul_De_Sac	0.10	0.01	0.00	992
Water_Front	0.34	0.04	0.00	87
Cnd_Low	-0.45	0.05	0.00	69
Cnd_BAvg	-0.24	0.02	0.00	350
Cnd_Avg	Omitted	Omitted	Omitted	2,727
Cnd_AAvg	0.13	0.01	0.00	1,445
Cnd_High	0.24	0.02	0.00	337
Vista_Poor	-0.21	0.02	0.00	310
Vista_BAvg	-0.08	0.01	0.00	2,857
Vista_Avg	Omitted	Omitted	Omitted	1,247
Vista_AAvg	0.10	0.02	0.00	448
Vista_Prem	0.13	0.04	0.00	75
WAOR	Omitted	Omitted	Omitted	519
TXHC	-0.75	0.03	0.00	1,071
OKCC	-0.44	0.02	0.00	476
IABV	-0.24	0.02	0.00	605
ILLC	-0.09	0.03	0.00	213
WIKCDC	-0.14	0.02	0.00	725
PASC	-0.31	0.03	0.00	291
PAWC	-0.07	0.03	0.00	222
NYMCOC	-0.20	0.03	0.00	346
NYMC	-0.15	0.02	0.00	469
No View	Omitted	Omitted	Omitted	4,207
Minor View	-0.03	0.02	0.10	561
Moderate View	-0.02	0.04	0.67	106
Substantial View	-0.05	0.09	0.57	35
Extreme View	-0.03	0.10	0.77	28
Inside 3000 Feet	-0.05	0.06	0.41	67
Between 3000 Feet and 1 Mile	-0.05	0.05	0.38	58
Between 1 and 3 Miles	0.00	0.02	0.82	2,019
Between 3 and 5 Miles	0.02	0.01	0.22	1,923
Outside 5 Miles	Omitted	Omitted	Omitted	870
View Does Not Overlap Vista	Omitted	Omitted	Omitted	320
View Barely Overlaps Vista	0.05	0.03	0.09	150
View Somewhat Overlaps Vista	0.01	0.03	0.67	132
View Strongly Overlaps Vista	0.05	0.05	0.31	128

"Omitted" = reference category for fixed effects variables

"n" indicates number of cases in category when category = "1"

Model Information

Model Equation Number	**9**
Model Name	**Overlap Model**
Dependent Variable	**LN_SalePrice96**
Number of Cases	**4937**
Number of Predictors (k)	**40**
F Statistic	**409.7**
Adjusted R Squared	**0.77**

CONSULTATION REPORT:

WIND FARM SURVEY
AND THE
IMPACT ON PROPERTY VALUES

File # 3354

Prepared for

Brady Wind, LLC
Orin Shakerdge, Esq.
NextEra Energy Resources, LLC
700 Universe Blvd., LAW/JB
Juno Beach, FL 33408

Prepared by:

Rose M. Hoefs
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Date of the Report: December 14, 2015

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December 14, 2015

Orin Shakerdge, Esq.
NextEra Energy Resources, LLC
700 Universe Blvd., LAW/JB
Juno Beach, FL 33408

Re: Consultation Report
Wind Farm Survey and the Impact on Property Values

Dear Mr. Shakerdge,

Pursuant to your request, we have completed a quantitative survey of individual properties located in areas of wind farms across the State of North Dakota. The intended use of the survey is to provide market reactions regarding wind farms, placing emphasis on externalities created by the construction of such, and the resulting impact on property values. The survey was developed in compliance with USPAP Ethics and Competency Rules.

The Consultation Report represents succinct discussions concerning the data, reasoning, and analyses used. The depth of discussion is specific to the needs of the client and for the survey's intended use. Additional documentation is retained in the work file of the appraiser. No responsibility is assumed for legal matters, nor is any opinion rendered on the property title or on property value.

Neither our employment nor compensation is contingent on the outcome of the survey. The undersigned has no present or contemplated future interest in any of the surveyed properties. All opinions are developed through the course of accepted analytical procedures.

Rose M. Hoefs takes full responsibility for the survey and its content. The assignment is based on an impartial or unbiased perspective; it is not made for favoring a specific cause of any particular party. The Appraiser has no present or contemplated future interest in the data, as presented, and all opinions have been developed through the course of accepted analytical procedures. Careful consideration has been given to provide an accurate analysis of the data, related markets and to any possible benefits and detriments.

It has been a privilege to be of service. If you have any questions or comments after reading the survey, please inquire.

Respectfully submitted,
RM Hoefs & Associates, Inc.



Rose M. Hoefs
Certified General Appraiser

ND Certified General Appraiser's License #1063
MN Certified General Appraiser's License #4002095
SD Certified General Appraiser's License #1333CG

CERTIFICATION

I hereby certify that:

I, Rose M. Hoefs, Certified General Appraiser, completed this Consultation Report / Wind Farm Survey and take full responsibility for its contents. Field inspections were made of the data contained in this consultation report. The data are as represented.

The statements of fact contained in the report are true and correct. The reported analyses, opinions and conclusions are limited only by the reported assumptions, limiting conditions and legal instructions, and are my personal, impartial and unbiased professional analysis, opinions and conclusions.

This consulting assignment is not based on a requested direction of the data. The appraiser has no present or prospective direct or indirect interest in any of the surveyed data, the specific transactions or any personal interest with respect to the parties involved.

The development and reporting of this consultation assignment complies with the Ethics and Competency Rules of the Uniform Standards of Professional Appraisal Practice, and the Appraisal Institute's Code of Professional Ethics.

Except as hereinafter provided, the client may distribute entire copies of this survey to selected third parties; however, no portion of this survey can be disseminated to the public by advertising media, public relations media, news media, sales media, or other media for public communication without the prior written consent of the appraiser.

RM Hoefs and Associates, Inc. has not performed any appraisal services regarding the sale data contained in this survey within the three-year period immediately preceding the acceptance of this assignment.

Rose M. Hoefs is a Candidate for Designation with the Appraisal Institute; therefore, the use of this report is subject to the requirements of the Appraisal Institute, relating to review by its duly authorized representative(s). As of the date of this report, Ms. Hoefs completed the Standards and Ethics Requirements of the Appraisal Institute for Associate Members.

SIGNED _____ DATE December 14, 2015

Rose M. Hoefs, Supervisory Appraiser (Certified General)
RM Hoefs & Associates, Inc.

North Dakota Certified General License	#1063
Minnesota Certified General License	#4002095
SD Certified General Appraiser's License	#1333CG

TABLE OF CONTENTS

CERTIFICATION iv
TABLE OF CONTENTS v

SCOPE OF WORK 1

I. STATEMENT OF COMPETENCY 1
II. CONTINGENT AND LIMITING CONDITIONS 1
III. EXTRAORDINARY ASSUMPTIONS AND DISCLOSURES 2
IV. SCOPE OF THE CONSULTATION 2
Assignment Conditions 2
Intended Use and Users of the Survey 2

SURVEY 3

INTRODUCTION 3
DEVELOPMENT STANDARDS 3
PUBLIC CONCERNS 4
PROXIMITY STUDY / PAIRED SALES ANALYSIS 4
BARNES COUNTY, NORTH DAKOTA 5
STEELE COUNTY, NORTH DAKOTA 69
CAVALIER COUNTY, NORTH DAKOTA 92
DICKEY AND LAMOURE COUNTIES, NORTH DAKOTA 104
BURLEIGH COUNTY, NORTH DAKOTA 131

ADDENDA 145

ENGAGEMENT CONTRACT 146
QUALIFICATIONS OF ROSE M. HOEFS 154
RM HOEFS & ASSOCIATES, INC. 158
COPYRIGHT PROTECTION 161
END OF REPORT 161

SCOPE OF WORK

I. STATEMENT OF COMPETENCY

This consulting assignment was accepted by R. M. Hoefs & Associates, Inc. from the client, Brady Wind. LLC. Rose M. Hoefs has completed prior assignments on similar projects. Her knowledge and experience is established, being confirmed through the successful completion of numerous appraisals, consulting assignments and also by the completion and passing of educational courses offered by the Appraisal Institute. The appraiser is an advanced candidate of the Appraisal Institute and is a General Appraiser, board-certified through the North Dakota Real Estate Appraiser Qualification and Ethics Board the State of Minnesota Department of Commerce and the South Dakota Department of Labor and Regulation. (See enclosed Qualifications).

In preparation of this assignment, various articles were researched, including those in the text ***Towers, Turbines and Transmission Lines, Impacts on Property Values*** regarding a diminution in property values due to the construction of wind turbines and wind farms. The preceding steps have been taken to facilitate the completion of this assignment in a competent and professional manner, complying fully with the Competency Provision of the Uniform Standards of Professional Appraisal Practice.

II. CONTINGENT AND LIMITING CONDITIONS

This survey is subject to the following contingent and limiting conditions, which are an integral part of this survey along with all certifications, definitions, facts, statements, assumptions, disclosures hypotheses, analyses, and opinions.

1. By this notice, all persons, companies, corporations or government agencies using or relying on this report in any manner bind themselves to accept these Contingent and Limiting Conditions and all other limiting conditions contained elsewhere in this report. This survey does not address any unforeseeable events that could alter the market conditions reflected in the analysis.

2. Illustrative materials are included only to assist the reader in visualizing the properties included in the survey.

3. As a part of the survey process, information was gathered and analyzed to form opinions that pertain solely to the survey. Information, regarding the sale data, their neighborhoods, or other topics discussed in the report, was obtained from a variety of sources deemed reliable and believed to be true and correct in accordance with the extent of research. Any exhibits in the report are intended to assist the reader in visualizing the subject property and its surroundings. The exhibits are not surveys unless specifically identified as such.

4. This document communicates the result of a consulting assignment. No expertise is claimed in property inspection, engineering, construction, legal or architecture. The appraiser assumes no liability for such as these elements are outside of her control and beyond the scope of work as detailed in the report or outside reasonable “due diligence”.

5. All contents of this report are prepared solely for the identified client. The liability of the appraiser is limited solely to the client. There is no accountability, warranty, or liability to any third party. For that portion of work product or services giving rise to liability, the appraiser’s maximum liability for services rendered under this engagement is limited to the fee collected and paid to RM Hoefs & Associates, Inc. In no event shall the appraiser be liable for consequential, special incidental or punitive loss, damages or expense, even if advised of their possible existence. The use of this report by third parties is solely at their risk.

6. It is assumed that testimony or attendance in court or at any court hearing is not required by reason of rendering this survey unless such arrangements are made a reasonable time in advance. The appraiser retains the right to expand upon the data contained in the survey and to review and consider any data that becomes available between the date of the survey and the date of court testimony or hearing. The appraiser also retains the right to amend the survey to reflect such data, and to make any required or necessary adjustments to the value opinions.

7. Possession of this report or a copy thereof does not carry with it the right of publication. The survey may not be used for any purpose other than its intended use nor may it be used by any person(s) or entity other than the intended users.

III. EXTRAORDINARY ASSUMPTIONS AND DISCLOSURES

This survey employs the following extraordinary assumptions:

- Sale data; i.e. size, topography, legal description, dimensions, etc., are collected from publicly available sources and/or a party to the sale. All information is assumed to be reasonably correct.
- The appraiser did not attempt to study, dig, probe, investigate, detect, remove materials or discover unfavorable physical features.
- No special expertise is implied as related to water conditions, drainage, soil conditions, and other physical components of the sales, other than what is of record or provided by a party to the sale.

The preceding extraordinary assumptions and disclosures are integral to the process upon which the conclusions in this document are based.

IV. SCOPE OF THE CONSULTATION

Assignment Conditions
The development and reporting of this consultation assignment complies with the Ethics and Competency Rules of the Uniform Standards of Professional Appraisal Practice, and the Appraisal Institute's Code of Professional Ethics.

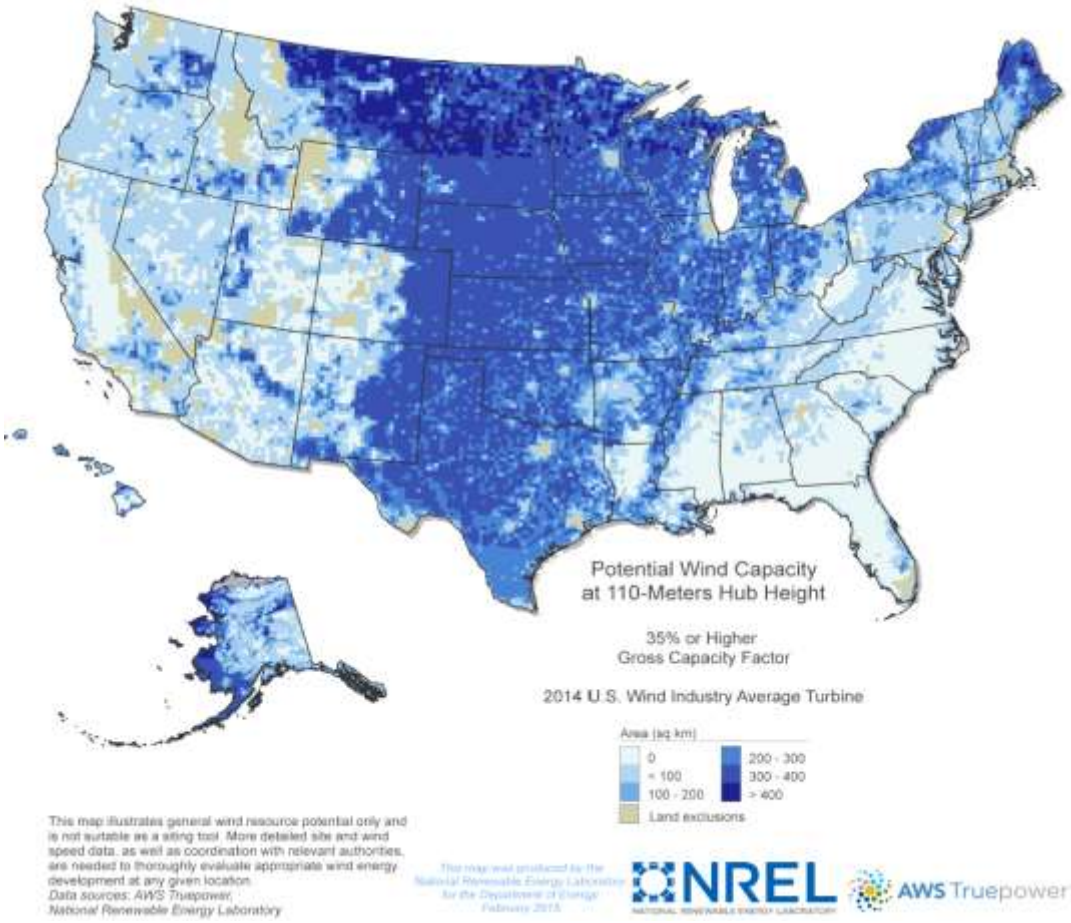
Intended Use and Users of the Survey
The contract was secured by Orin Shakerdge, Esquire, NextEra Energy Resources, LLC, the client and intended user of this report.

Purpose of the Consultation
The purpose of this consultation assignment is to develop, without advocacy, a survey of market reactions to wind farms and/or wind turbines. Investigations and inquiries undertaken to arrive at appropriately supported conclusions include the analysis of the market and relevant comparable data through a qualitative survey commonly known as a paired sale analysis. While subjective in nature, this type of survey focuses on descriptive data (comparison of positives and negatives) as opposed to quantitative analysis which focuses on actual numerical outcomes (percentages or actual dollar amounts). The goal of the analysis is to provide definable market patterns.

SURVEY

INTRODUCTION

Wind turbines have been used throughout history as a means of generating energy, draining land, pumping water, milling grain and other industrial purposes. For the last decade, the United States has increased its reliance on wind energy not only to mitigate global warming but also to supplement and eventually supplant oil and gas reserves. A recent report released by Wind Vision forecasts that by 2050, 35% of all the energy used in the United States will be from wind. The following map indicates the Great Plains states have the highest potential for wind farm development, with North Dakota, Montana, Minnesota and South Dakota having the greatest potential.



DEVELOPMENT STANDARDS

While surveys indicate that public acceptance of wind energy in the United States is generally high, local concerns can impact the location of a wind farm and impede the development process. Very little was published to address those concerns until 2012, when the U. S. Fish and Wildlife Service published *U.S. Fish and Wildlife Service land-Based Wind Energy Guidelines*. To date, this document is the most comprehensive available, establishing requisites for wind farm development. As a result, the American Wind Energy Association has worked diligently to address not only environmental concerns and issues regarding the construction of turbines and wind farms, but also to work hand-in-hand with the National Audubon Society and the National Wildlife Federation to address avian and wildlife issues. As a condition of the permitting process for wind farm development, impact studies are required which address concerns regarding wind speed, development constraints and various environmental issues.

PUBLIC CONCERNS

Concerns voiced by the public are similar to those expressed regarding high voltage transmission lines; namely the aesthetics of the large steel towers and a diminution in property values, more commonly defined as:

- Scenic view stigma: concerns that individual properties may be devalued due to the view of a wind turbine or wind farms.
- Area stigma: concerns that property values within the wind farm area may be devalued.
- Nuisance stigma: concerns that noise and shadow flickers have an adverse influence on property values.

PROXIMITY STUDY / PAIRED SALES ANALYSIS

Given, the preceding, it is the intent of this study to measure the effect wind turbines have on property values via a proximity study of paired sales. The analysis is one of the most useful applications in determining detrimental conditions related to negative externalities, including noise, visual impacts, stigma and/or fear. To determine if legitimate detrimental conditions exist, sales of properties improved with wind turbines are compared to sales of nearby properties without wind turbines. If present, a measurable and consistent difference will be evident in the sale prices of the properties. If not, the differences will not be significant. Ideally, the data (sales) should be similar in all respects; however, in reality, the market place is not ideal, and therefore, the search for data is extremely difficult and at times, nearly impossible. For the study conclusions to be reliable and not misleading, the sale data must be within the same market area, relatively comparable in physical characteristics, and occurring within a reasonable period of one another.

Research included twelve wind farms in Barnes, Burleigh, Cavalier, Dickey – LaMoure, Griggs, Steele, Oliver and Ward Counties. Of the twelve, paired sales were found in five. Data is limited since the majority of wind farms are located in rural areas where farms and ranches are passed down from generation to generation within the family structure. Market participants (buyers and sellers of the preceding sales) were surveyed regarding perceived detrimental conditions. A review of the data indicates that out of the 26 participants,

- 25 did not consider any negative impact;
- one participant would not provide an opinion of impact;
- one property was improved with a mobile home dwelling; the buyer stated no impact;
- two farmsteads adjacent to wind farms were retained by the sellers of the adjacent land.

Although the analysis used in this research has its strengths and weaknesses, the end result is that all of the data are consistent in that no evidence was found as to a diminution in value associated with the location of wind farms or turbines.

BARNES COUNTY, NORTH DAKOTA

The surveyed area is located adjacent to and east of Lake Ashtabula, beginning about 9.5 miles northeast of Valley City. The area is primarily rural in nature, with farmsteads interspersed at one to two mile increments. Lake Ashtabula is located one to two miles west. Steele and Griggs Counties lie north-northeast. The topography is one of rolling hills with some steep ravines. The area is generally treeless, with the exception of sporadic mature tree claims or wooded swales. The soils are glacial till, and range from level to undulating with drainage varying from poor to well drained. Agricultural uses include crop and hay production as well as pasture for livestock. As is typical for this area, saline soils are present.

Overall, the wind farms suggest little physical impact to the land other than the area used for turbine placement and access. Typically, the access roads appeared to use a minimal amount of land to access the turbines.

The paired sales are summarized as follows, representing six sales (1, 6, 7, 8, 9 and 12) of properties improved with wind turbines and six without turbines (2, 3, 4, 5, 10 and 11). All of the data are situated adjacent to or near wind farms.

No	Legal Description					Date	Sale Price	Deeded Acres	PI	Sale Price/ Deeded Acre	Turbines Present	Adjacent Wind Farm	Negative Influence	Premium Paid
1	SW	33	142	57	Barnes	4/7/2015	$ 320,000	160.00	54.5	$ 2,000	2.00	yes	no	no
2	NE	35	142	57	Barnes	1/20/2015	$ 520,000	160.00	63.9	$ 3,250	none	yes	no	no
3	NW	33	142	57	Barnes	12/29/2014	$ 357,500	160.00	49.6	$ 2,234	none	yes	no	no
4	NE	2	141	57	Barnes	12/26/2014	$ 540,000	164.02	69.7	$ 3,292	none	yes	no	yes
5	E2SE	34	142	57	Barnes	12/22/2012	$ 320,000	80.00	73.9	$ 4,000	none	yes	no	yes
6	Parts	32 & 29	142	57	Barnes	12/22/2012	$1,920,000	480.00	58.4	$ 4,000	4.00	yes	no	yes
7	NE	6	141	57	Barnes	12/21/2012	$ 275,000	162.80	65.0	$ 1,689	2.00	yes	no	no
	Wind Royalties						$ 375,000	162.80	65.0	$ 2,303	2.00	yes	no	yes
8	NE & E2SW	4	141	57	Barnes	10/31/2012	$ 899,999	239.39	71.6	$ 3,760	2.00	yes	no	no
9	E2SE & SWSW	8	141	57	Barnes	2/23/2012	$ 275,000	105.75	47.4	$ 2,600	1.00	yes	no	yes*
10	SW	25	142	57	Barnes	11/18/2010	$ 215,000	160.00	64.7	$ 1,344	none	yes	no	no
11	SW Parts 9	9 & 10	142	57	Barnes	9/9/2010	$ 250,000	196.27	63.4	$ 1,274	none	yes	no	no
12	NE	33	142	57	Barnes	3/10/2010	$ 170,200	157.49	66.8	$ 1,081	1.00	yes	no	yes
	Wind Royalties						$ 217,500	157.49	66.8	$ 1,381	1.00	yes	no	yes

The sales were then grouped according to date of sale and, with the exception of Sale 7, to their productivity index. Approximately 33.8% of the soils of Sale 7 are saline; therefore, the soils are marginal at best. For that reason, it was placed last in its grouping.

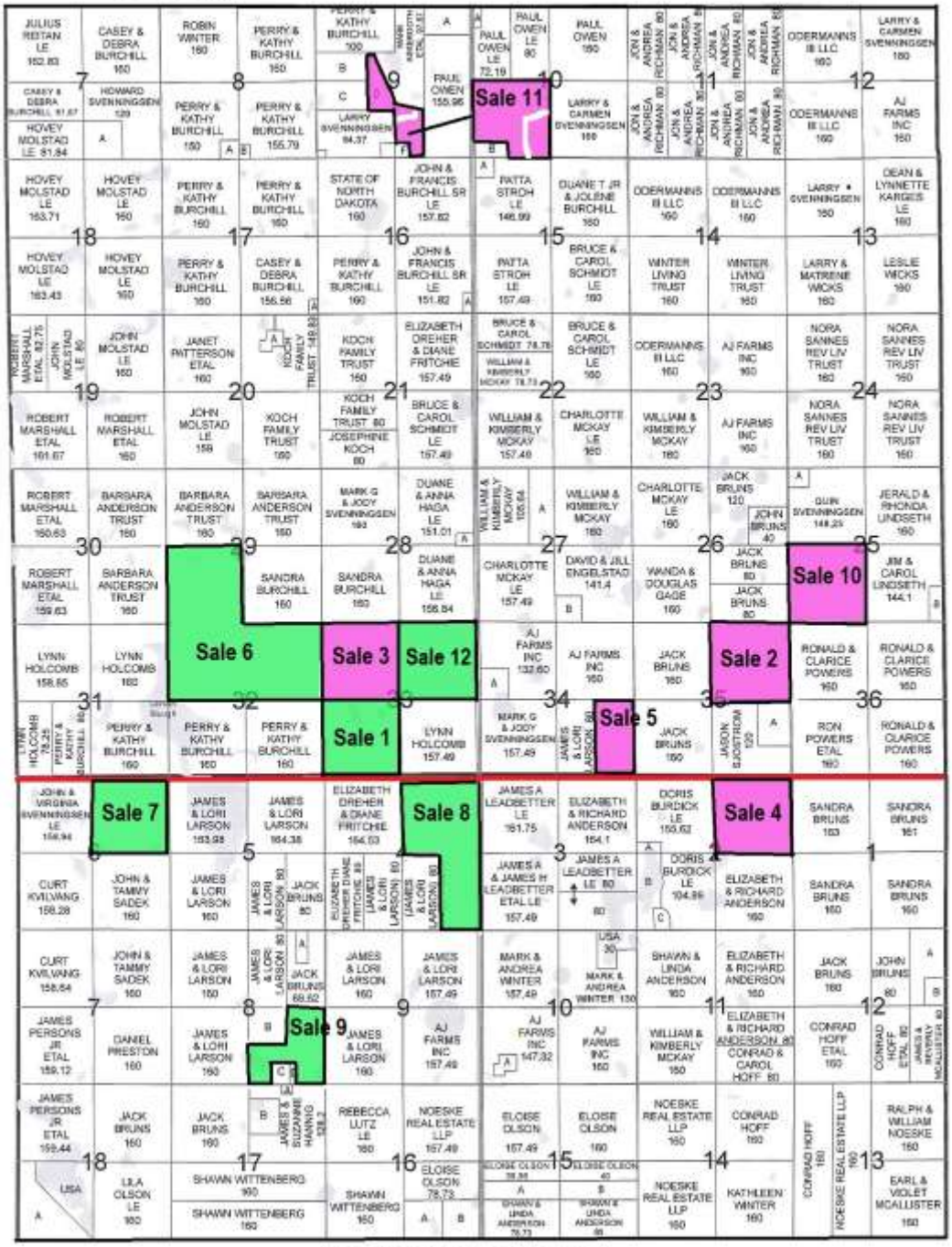
No	Legal Description					Date	Sale Price	Deeded Acres	PI	Sale Price/ Deeded Acre	Turbines Present	Adjacent Wind Farm	Negative Influence	Premium Paid	Market Adjustment Comments
4	NE	2	141	57	Barnes	12/26/2014	$ 540,000	164.02	69.7	$ 3,292	none	yes	no	yes	Premium paid for land due to increasing prices; 9.25 acres are saline; upward adjustment required
2	NE	35	142	57	Barnes	1/20/2015	$ 520,000	160.00	63.9	$ 3,250	none	yes	no	no	35 acres in CRP; 24.19 acres are saline present; positive adjustment
1	SW	33	142	57	Barnes	4/7/2015	$ 320,000	160.00	54.5	$ 2,000	**2.00**	yes	no	no	Turbine present; does not own wind royalties; an upward adjustment is required.
3	NW	33	142	57	Barnes	12/29/2014	$ 357,500	160.00	49.6	$ 2,234	none	yes	no	yes	Wind Farms to east and west
5	E2SE	34	142	57	Barnes	12/22/2012	$ 320,000	80.00	73.9	$ 4,000	none	yes	no	yes	Premium paid for land due to increasing prices
8	NE & E2SW	4	141	57	Barnes	10/31/2012	$ 899,999	239.39	71.6	$ 3,760	**2.00**	yes	no	no	Turbines present; does not own wind royalties
6	Parts	32 & 29	142	57	Barnes	12/22/2012	$ 1,920,000	480.00	58.4	$ 4,000	**4.00**	yes	no	yes	Premium paid for land due to increasing prices. Turbines present; does not own wind royalties; positive adjustment for wind royalties ; 11.9 acres are saline; upward adjustment required
9	E2SE & SWSW	8	141	57	Barnes	2/23/2012	$ 275,000	105.75	47.4	$ 2,600	**1 & met tower**	yes	no	yes*	Turbine present; does not own wind royalties; no negative impact to farmstead; upward adjustment required for turbine and tower
7	NE	6	141	57	Barnes	12/21/2012	$ 375,000	162.80	65.0	$ 2,303	**2.00**	yes	no	yes	Purchased wind royalties @ $50,000/turbine; 55.04 acres are saline (33.8% of total; soils are substantially inferior requiring upward adjustment when compared to Sales 2 and 4.
12	NE	33	142	57	Barnes	3/10/2010	$ 217,500	157.49	66.8	$ 1,381	**1.00**	yes	no	yes	Wind royalties @ $47,300 total or $300 per acre
10	SW	25	142	57	Barnes	11/18/2010	$ 215,000	160.00	64.7	$ 1,344	none	yes	no	no	Wind Farms nearby; positive adjustment required for 19.41 saline acres.
11	SW Parts 9	9 & 10	142	57	Barnes	9/9/2010	$ 250,000	196.27	63.4	$ 1,274	none	yes	no	no	Land under turbines was retained by seller; no impact to farmstead; 13.83 acres are saline

The sale prices of Group 1 are indicative of current values. Group 2 consists of data that closed during a period from 2011 through 2013 when agricultural land prices were increasing rapidly. Price increases were due in part to (1) high commodity prices and (2) an ethanol plant at Casselton, North Dakota, which drove up local corn prices. Group 3 consists of sales prior to the 2011 – 2013 increasing market. Although the representative market value ranges are different, each group depicts a strong correlation of productivity index to sale price whether the sale is improved or unimproved. The variances within each data set are attributable to the conditions of the soils (salinity) and/or wind royalties. None of the groups evidence market resistance. The sellers of Sales 9 and 11 retained their farmsteads which are situated adjacent to wind farms. No aesthetic impact was noted. Sale 11 represents an anomaly to the market as the turbine pad sites (rather than royalty rights) were retained by the seller.

Barnes County

GRAND PRAIRIE PLAT

T142N — CODE: AM — R 57W



NOLTIMIER PLAT

T141N — CODE: AX — R 57W

Land Sale No. 1



Property Identification

Record ID	5970
Property Type	Vacant Land
Address	24th Street and 122nd Avenue SE, Barnes County, North Dakota
Location	Grand Prairie Township
Tax ID	13-3330300
Legal Description	SW4 Section 33, T142N R57W, Barnes County, North Dakota

Sale Data

Grantor	Leigh Ann Hafner
Grantee	Derek E. and Laura M. Bruns
Sale Date	April 07, 2015
Deed Book/Page	WD 280259
Property Rights	Leased Fee; fractional interest; wind royalties reserved by grantor
Conditions of Sale	Assemblage to current farming operation
Financing	Cash to seller
Sale History	Records were researched for 3 years; no transfers were found.
Verification	Derek Bruns, Grantee; (701) 840-1472, 11/19/2015; County records
Sale Price	$320,000

Land Data

Zoning	AG, Agricultural
Topography	Level to rolling; slopes from 0 to 35%
Utilities	Assumed telephone and electricity available
Shape	Square
Roads	Gravel
Access	22nd St SE

Productivity Index	54.5
Adjusted Productivity Index	62.0 (less slough and waste)
Wind Farm	Wind Farm directly east, west and southeast of tract
Wind Turbines on Tract	Two

Land Size Information

Gross Acres	160.00 Acres
Tillable Acres	120.00 Acres, 75.00%
Slough and Waste	40.00 Acres, 25.00%

Indicators

Sale Price/Gross Acre	$2,000
Sale Price/Tillable Acre	$2,667

Remarks

The sale was confirmed by Derek Bruns, Grantee, who stated he was approached by the seller to purchase the land since he was leasing it. The price paid was based on appraisal completed for sale purposes. Of the total, 120 acres are tillable, and the balance is wet or waste. The parcel is improved with 2 wind turbines; the tract to the east (E2 Section 33) is improved with 3 turbines. Mr. Bruns stated the price was not impacted by the wind turbines as he can farm around them. The seller reserved the wind royalty payments to the turbines at the time of sale.

The primary soils include Barnes-Buse-Langhei loams, Barnes-Buse loams, Kranzburg-Lismore silty clay loams. The slopes range from 0-35%. The non-irrigated soil classifications are II, IV, VI, VII, and VIII, with various susceptibility to erosion, water, and climate. The PI for this subject ranges from 9 to 88, with an overall weighted average of 54.5 for the entire tract. Of the total acreage 48.4% is Not Prime Farmland, 34.7% is Prime Farmland, 14.3% is Prime Farmland if Drained, with the remaining 2.6% being Farmland of Statewide Importance. The soils are a range of predominantly non-hydric (71.7%), partially hydric (14.3%), predominantly hydric (9.2%), and non-hydric (4.8%).



Aerial Map



map center: 47° 4' 24.4, 97° 54' 25.07

0ft 820ft 1640ft

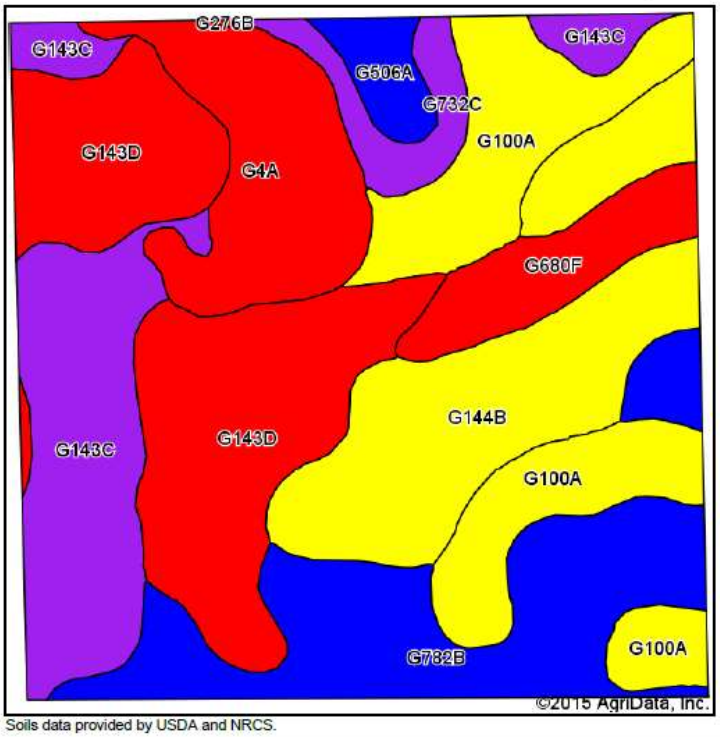
Maps Provided By:
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33-142N-57W
Barnes County
North Dakota

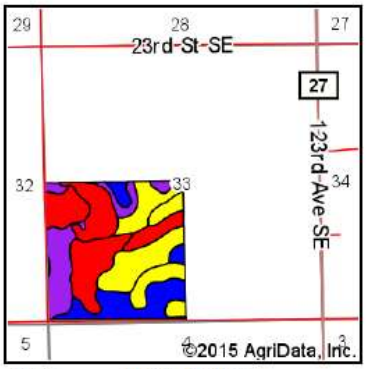
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11/30/2015

Soil Map



Soils data provided by USDA and NRCS.



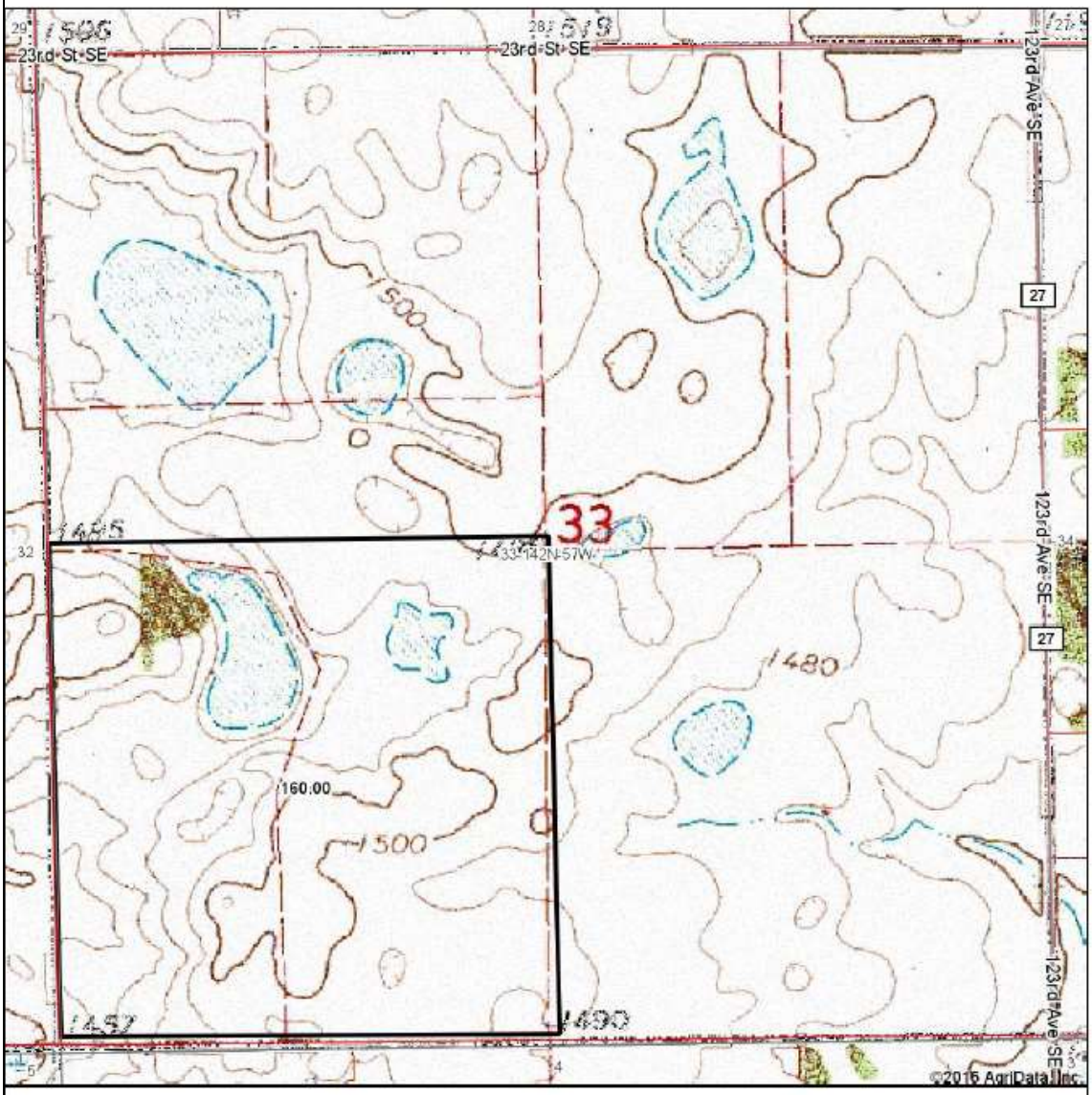
State: **North Dakota**
County: **Barnes**
Location: **33-142N-57W**
Township: **Grand Prairie**
Acres: **160**
Date: **11/30/2015**

Maps Provided By:
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Area Symbol: ND003, Soil Area Version: 20

Code	Soil Description	Acres	Percent of field	PI Legend	Water Table	Non-Irr Class *c	Range Production (lbs/acre/yr)	Productivity Index
G143D	Barnes-Buse-Langhei loams, 9 to 15 percent slopes	33.10	20.7%		> 6.5ft.	VIe	2650	41
G144B	Barnes-Buse loams, 3 to 6 percent slopes	25.30	15.8%		4.9ft.	IIe	2988	69
G782B	Kranzburg-Lismore silty clay loams, 2 to 6 percent slopes	25.08	15.7%		4.9ft.	IIe	3031	81
G100A	Hamerly-Tonka complex, 0 to 3 percent slopes	23.80	14.9%		4.9ft.	IIe	4114	64
G143C	Barnes-Buse-Langhei loams, 6 to 9 percent slopes	21.91	13.7%		> 6.5ft.	IVe	2763	56
G4A	Southam silty clay loam, 0 to 1 percent slopes	15.33	9.6%		0ft.	VIIIw	1217	9
G680F	Buse-Sioux complex, 9 to 35 percent slopes	7.76	4.9%		> 6.5ft.	VIIe	1957	22
G732C	Lanona-Buse complex, 6 to 9 percent slopes	4.58	2.9%		> 6.5ft.	IVe	2765	56
G506A	Overly-Bearden silty clay loams, 0 to 2 percent slopes	3.14	2.0%		4.9ft.	IIc	3548	88
						Weighted Average	**2846.4**	**54.5**

Topography Map



map center: 47° 4' 24.4, 97° 54' 25.07

0ft 820ft 1640ft

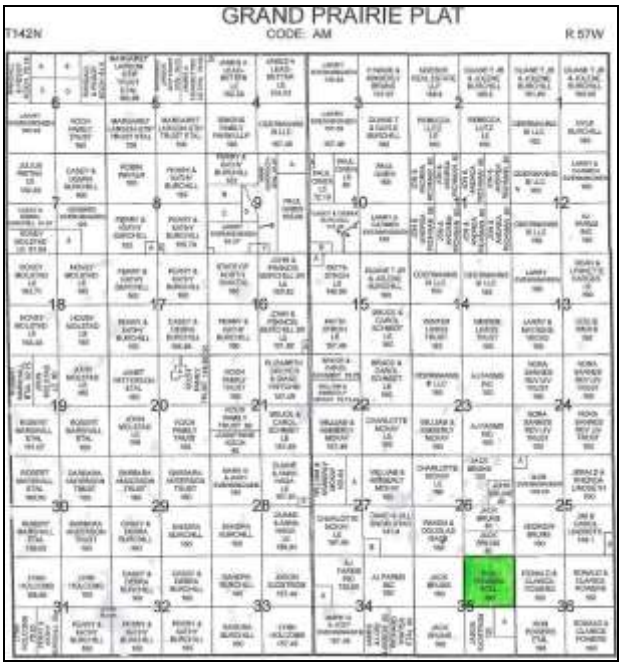
33-142N-57W
Barnes County
North Dakota

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N W E S

11/30/2015

Land Sale No. 2



Property Identification

Record ID	5968
Property Type	Vacant Land
Address	125th Avenue SE and 23rd Street SE, Barnes County, North Dakota
Location	Grand Prairie Township
Tax ID	13-3510100
Legal Description	NE4 Section 35, T142N R57W, Barnes County, North Dakota

Sale Data

Grantor	Louis Powers et al
Grantee	Andrew K.G. Bruns
Sale Date	January 20, 2015
Deed Book/Page	WD 279615
Property Rights	Leased fee; Surface rights; fractional interest; reservation of minerals
Conditions of Sale	Assemblage to current farming operation
Financing	Cash to seller
Sale History	Records were searched for a 3 year period; no transfer was found.
Verification	Andrew Bruns, Grantee; (701) 840-0248, 11/25/15; County records
Sale Price	$520,000

Land Data

Zoning	AG, Agricultural
Topography	Level to undulating, slopes 6 – 9%
Utilities	Assumed telephone and electricity available
Shape	Square
Roads	Gravel
Access	125th Ave SE
Productivity Index	63.9
Wind Farm	Wind Farm located ½ mile SW
Wind Turbines on Tract	None

Land Size Information

Gross Acres	160.000 Acres; 24.19 acres have saline present (15.12%)
Tillable Acres	125.000 Acres, 78.13%
CRP	35.000 Acres, 21.87%

Indicators

Sale Price/Gross Acre	$3,250

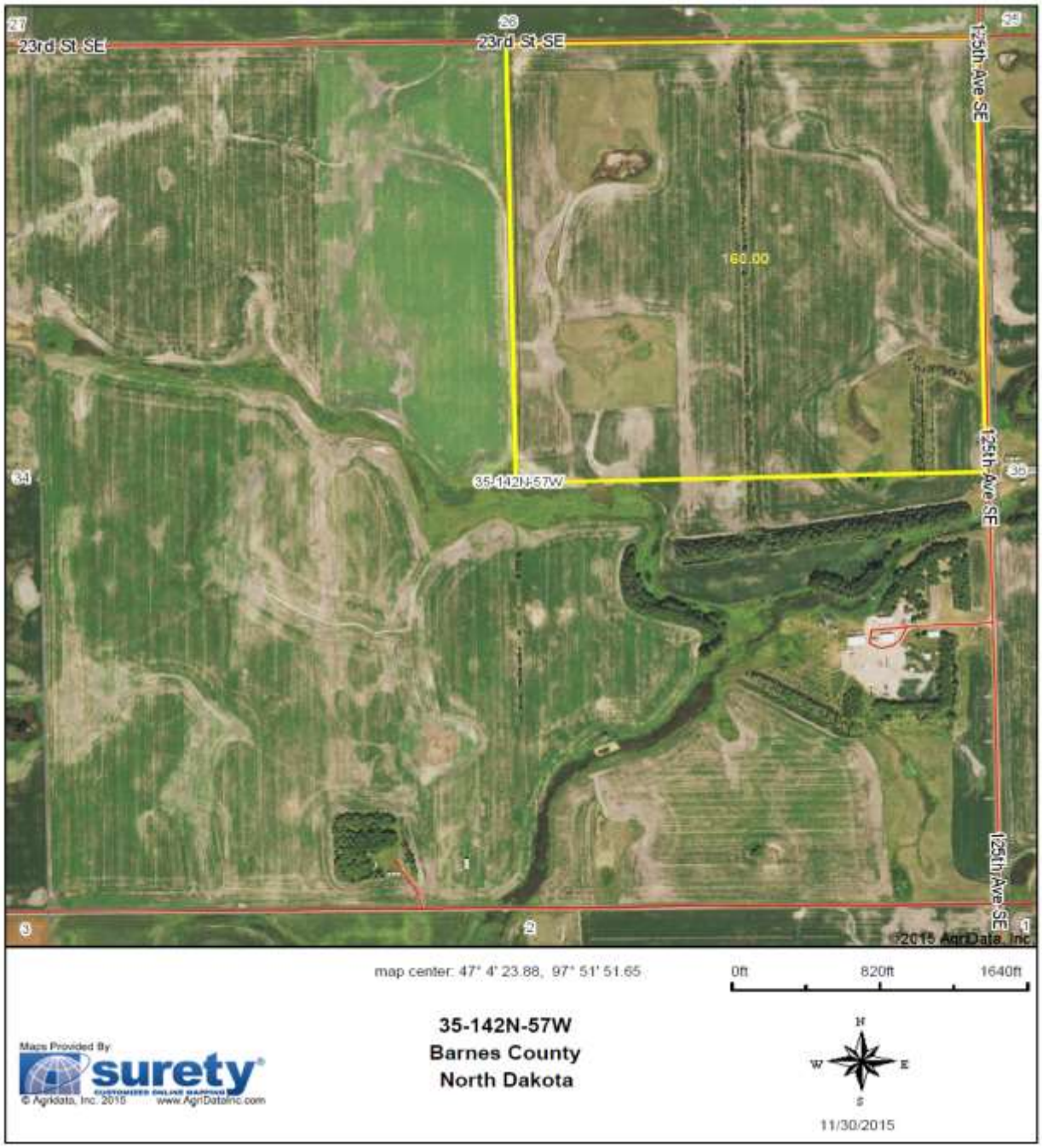
Remarks

The sale was confirmed by Andrew Bruns, Grantee, who purchased the land at an estate auction as an assemblage to his farming operation to maintain his farm operation. Mr. Bruns believes he paid a market price. Prior to the purchase, Mr. Bruns leased the land, but would not disclose the amount. Mr. Bruns stated the land has 125 acres tillable and the balance of 35 acres is CRP. Mr. Bruns again does not know the CRP value but stated there is 2 years left. Mr. Bruns farms with his brother and father and his father handles the business aspects. It is noted that the land in CRP is tillable, but not as productive as the balance of the acreage.

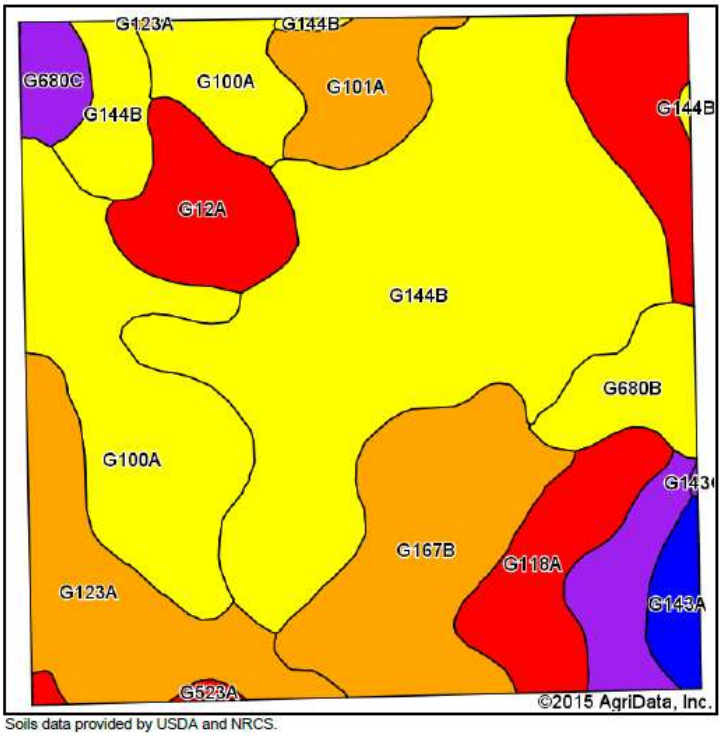
The primary soils include Barnes-Buse loams and Hamerly-Tonka complex. The slopes range from 0-9%. The non-irrigated soil classifications are II, IV, and VI, with various susceptibility to erosion, water, and climate. The PI for this subject ranges from 22 to 85, with an overall weighted average of 63.937.8 for the entire tract. Of the total acreage 51.7% is Prime Farmland, 17.1% is Farmland of Statewide Importance, 15.9% is Prime Farmland if Drained, with the remaining 15.3% being Not Prime Farmland. The soils are a range of predominantly non-hydric (60.3%), partially hydric (15.9%), predominantly hydric (15.3%), and non-hydric (8.5%). 24.19 acres have saline present. Saline negatively impacts plant growth and as a result, sale prices.



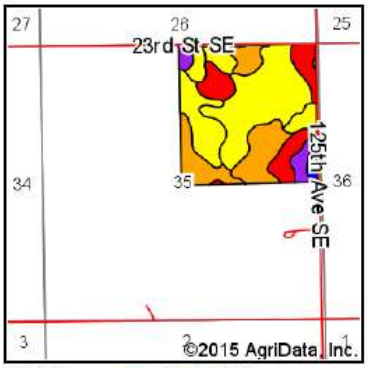
Aerial Map


23rd St SE
23rd St SE
125th Ave SE
125th Ave SE
125th Ave SE
160.00
35-142N-57W
©2015 AgriData, Inc
map center: 47° 4' 23.88, 97° 51' 51.65
0ft
820ft
1640ft
Maps Provided By
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35-142N-57W
Barnes County
North Dakota
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11/30/2015

Soil Map



Soils data provided by USDA and NRCS.



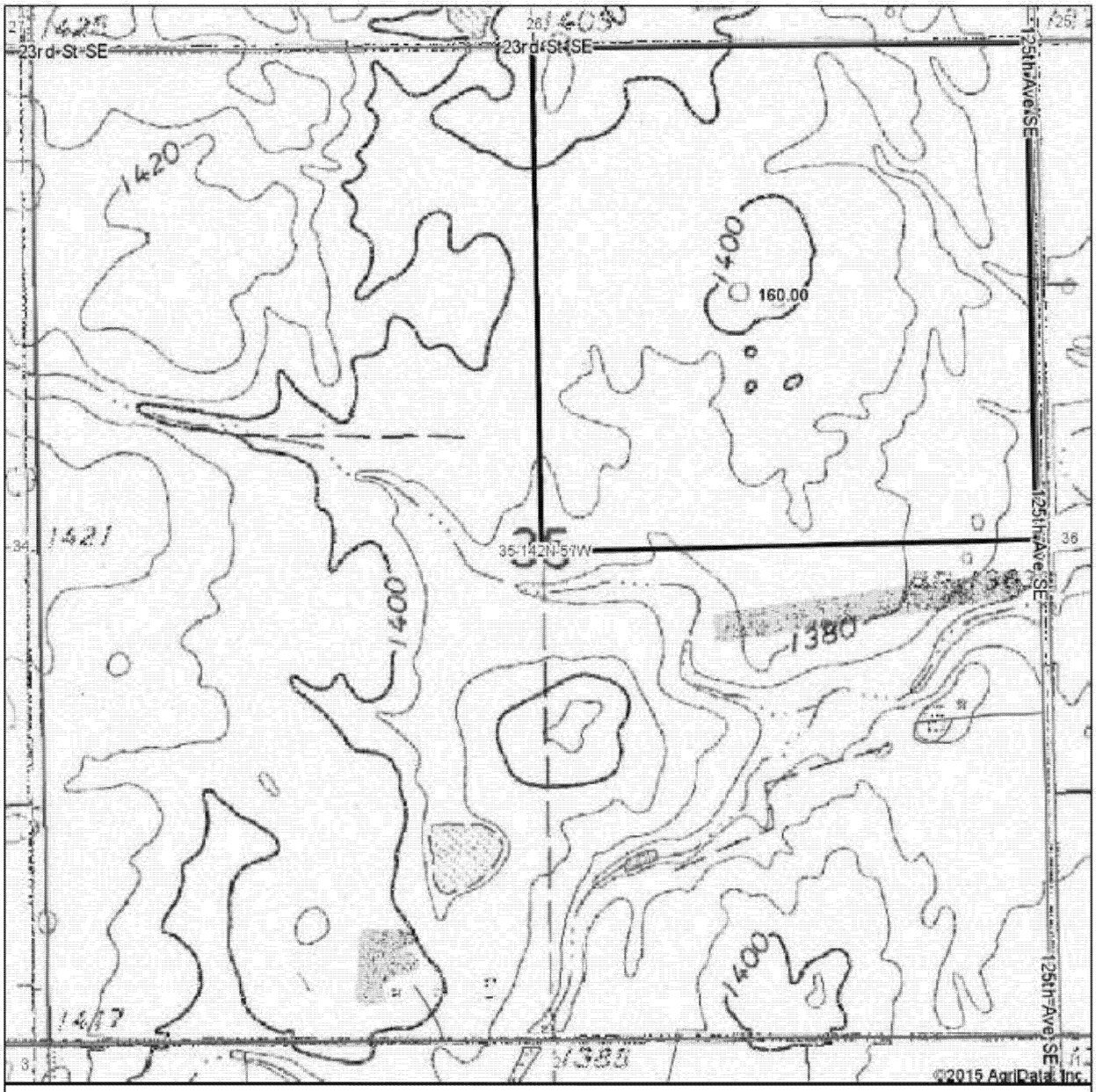
State: **North Dakota**
County: **Barnes**
Location: **35-142N-57W**
Township: **Grand Prairie**
Acres: **160**
Date: **11/30/2015**

Maps Provided By:
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Area Symbol: ND003, Soil Area Version: 20

Code	Soil Description	Acres	Percent of field	PI Legend	Water Table	Non-Irr Class *c	Range Production (lbs/acre/yr)	Productivity Index
G144B	Barnes-Buse loams, 3 to 6 percent slopes	55.73	34.8%		4.9ft.	IIe	2988	69
G100A	Hamerly-Tonka complex, 0 to 3 percent slopes	25.05	15.7%		2.5ft.	IIe	4114	64
G167B	Balaton-Wyard loams, 0 to 6 percent slopes	17.79	11.1%		4.9ft.	IIe	3245	73
G118A	Vallers loam, saline, 0 to 1 percent slopes	16.07	10.0%		0.7ft.	IVw	3892	42
G123A	Svea-Cavour loams, 0 to 3 percent slopes	13.75	8.6%		4ft.	IIc	2703	73
G12A	Vallers, saline-Parnell complex, 0 to 1 percent slopes	8.12	5.1%		0.7ft.	IVw	4453	31
G680C	Barnes-Sioux complex, 3 to 9 percent slopes	8.04	5.0%		4.9ft.	IIe	2302	55
G101A	Hamerly-Wyard loams, 0 to 3 percent slopes	6.67	4.2%		2.5ft.	IIe	4014	77
G680B	Barnes-Sioux complex, 1 to 6 percent slopes	5.37	3.4%		4.9ft.	IIe	2416	63
G143A	Barnes-Svea loams, 0 to 3 percent slopes	2.67	1.7%		4.9ft.	IIc	3405	85
G523A	Lowe-Fluvaquents, channeled complex, 0 to 2 percent slopes, frequently flooded	0.67	0.4%		2.5ft.	VIw	2276	22
G143C	Barnes-Buse-Langhei loams, 6 to 9 percent slopes	0.07	0.0%		> 6.5ft.	IVe	2763	56
						Weighted Average	**3326.5**	**63.9**

Topography Map



map center: 47° 4' 23.88, 97° 51' 51.65

0ft 820ft 1640ft

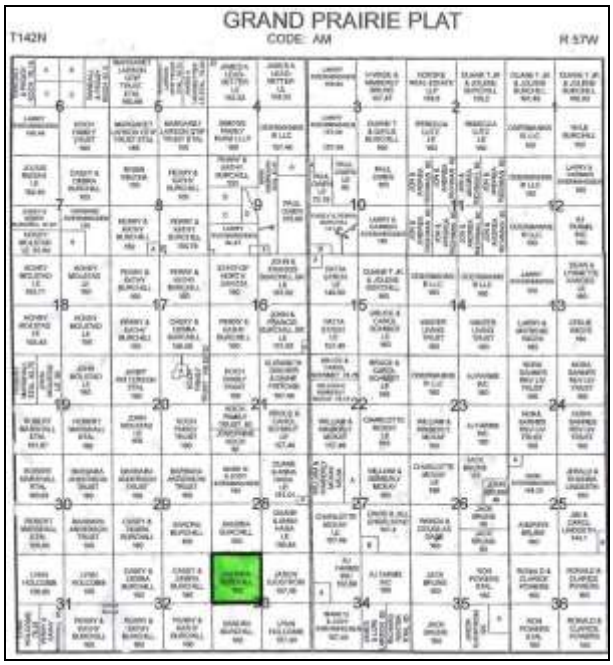
35-142N-57W
Barnes County
North Dakota

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N W E S

11/30/2015

Land Sale No. 3



Property Identification

Record ID	5969
Property Type	Vacant Land
Address	23rd Street and 122nd Avenue SE, Barnes County, North Dakota
Location	Grand Prairie Township
Tax ID	13-3320200
Legal Description	NW4 Section 33, T142N R57W, Barnes County, North Dakota

Sale Data

Grantor	Leigh Ann Hafner
Grantee	Andrew Bruns
Sale Date	December 29, 2014
Deed Book/Page	WD 279497
Property Rights	Leased Fee
Conditions of Sale	Assemblage to current farming operation
Financing	Cash to seller
Sale History	Records were searched for 3 years; no transfer was found.
Verification	Andrew Bruns, Grantee; (701) 845-3346, 11/19/2015;: County records
Sale Price	$357,500

Land Data

Zoning	AG, Agricultural
Topography	Level to rolling hills, slopes 0 to 9%
Utilities	Assumed telephone and electricity available
Shape	Square
Roads	Gravel
Access	23rd St SE

Productivity Index	49.6
Adjusted Productivity Index	58.9 (Less sloughs and waste)
Wind Farm	Wind Farms directly east west and south of tract
Wind Turbines on Tract	None

Land Size Information

Gross Acres	160.00 Acres
Tillable Acres	118.00 Acres, 73.75%
Sloughs and Waste	41.00 Acres, 26.25%

Indicators

Sale Price/Gross Acre	$2,234
Sale Price/ Tillable Acre	$3,030

Remarks

The sale was confirmed by Andrew Bruns, who stated he has been leasing the land and approached the Grantor wanting to maintain his farm operation. Mr. Bruns had the land appraised prior to the purchase and believes he paid market price. Of the total, 118 acres are tillable; 41 acres are slough and waste. This tract is not improved with wind turbines, but lies between Wind Farms on the east, west and south. Mr. Bruns indicated that the wind farms had no impact on the price.

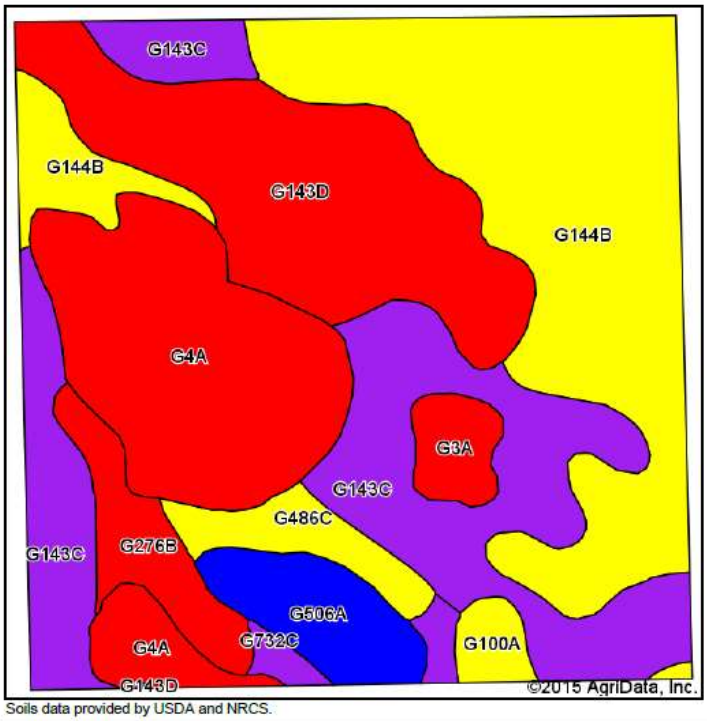
The primary soils include Barnes-Buse loams, Barnes-Buse-Langhei loams, and Southam silty clay loam. The slopes range from 0-15%. The non-irrigated soil classifications are II, III, IV, V, VI, and VIII, with various susceptibility to erosion, water, stones, and climate. The PI for this subject ranges from 9 to 88, with an overall weighted average of 49.6 for the entire tract. Of the total acreage 61.1% is Not Prime Farmland, 33.4% is Prime Farmland, 4.1% is Farmland of Statewide Importance, with the remaining 1.4% being Prime Farmland if Drained. The soils are a range of predominantly non-hydric (76.7%), predominantly hydric (19.0%), non-hydric (2.9%), and partially hydric (1.4%).



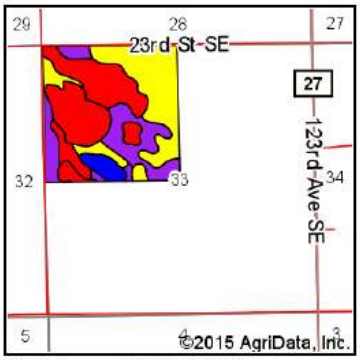
Aerial Map


237d St SE
23rd St SE
123rd Ave SE
160.00
33-142N-57W
27
map center: 47° 4' 24.4", 97° 54' 25.07"
0ft
820ft
1640ft
33-142N-57W
Barnes County
North Dakota
11/30/2015

Soil Map



Soils data provided by USDA and NRCS.



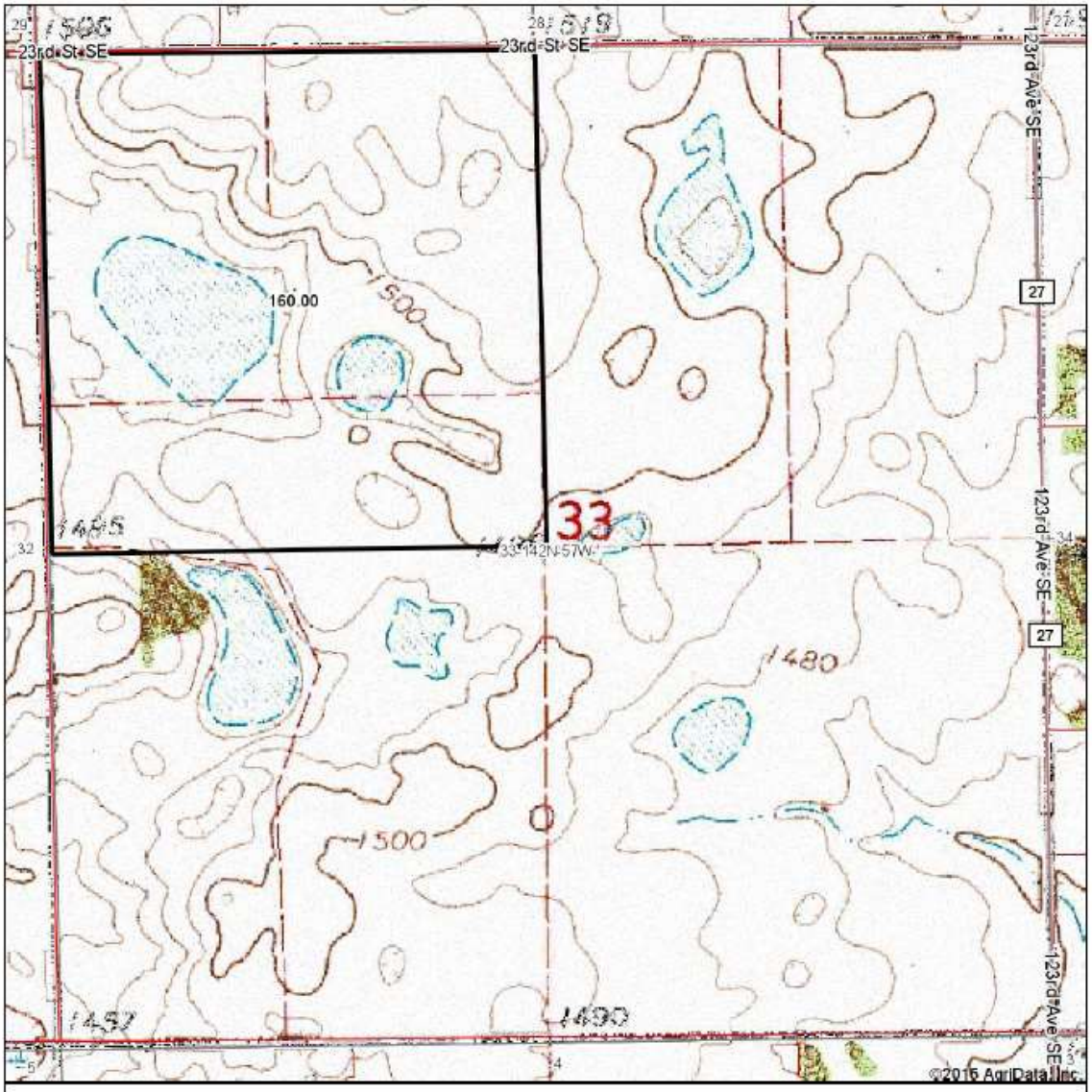
State: **North Dakota**
County: **Barnes**
Location: **33-142N-57W**
Township: **Grand Prairie**
Acres: **160**
Date: **11/30/2015**

Maps Provided By: surety CUSTOMIZED ONLINE MAPPING
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Area Symbol: ND003, Soil Area Version: 20

Code	Soil Description	Acres	Percent of field	PI Legend	Water Table	Non-Irr Class *c	Range Production (lbs/acre/yr)	Productivity Index
G144B	Barnes-Buse loams, 3 to 6 percent slopes	46.72	29.2%		4.9ft.	IIe	2988	69
G143C	Barnes-Buse-Langhei loams, 6 to 9 percent slopes	33.32	20.8%		> 6.5ft.	IVe	2763	56
G4A	Southam silty clay loam, 0 to 1 percent slopes	27.67	17.3%		0ft.	VIIIw	1217	9
G143D	Barnes-Buse-Langhei loams, 9 to 15 percent slopes	27.23	17.0%		> 6.5ft.	VIe	2650	41
G506A	Overly-Bearden silty clay loams, 0 to 2 percent slopes	6.84	4.3%		4.9ft.	IIc	3548	88
G276B	Renshaw-Sioux complex, 2 to 6 percent slopes	6.28	3.9%		> 6.5ft.	IVs	2002	40
G486C	Eckman-Zell loams, 6 to 9 percent slopes	4.61	2.9%		4.9ft.	IIIe	2850	64
G3A	Parnell silty clay loam, 0 to 1 percent slopes	3.13	2.0%		0ft.	Vw	5336	25
G100A	Hamerly-Tonka complex, 0 to 3 percent slopes	2.24	1.4%		4.9ft.	IIe	4114	64
G732C	Lanona-Buse complex, 6 to 9 percent slopes	1.96	1.2%		> 6.5ft.	IVe	2765	56
						Weighted Average	**2617.6**	**49.6**

Topography Map



map center: 47° 4' 24.4, 97° 54' 25.07

0ft 820ft 1640ft

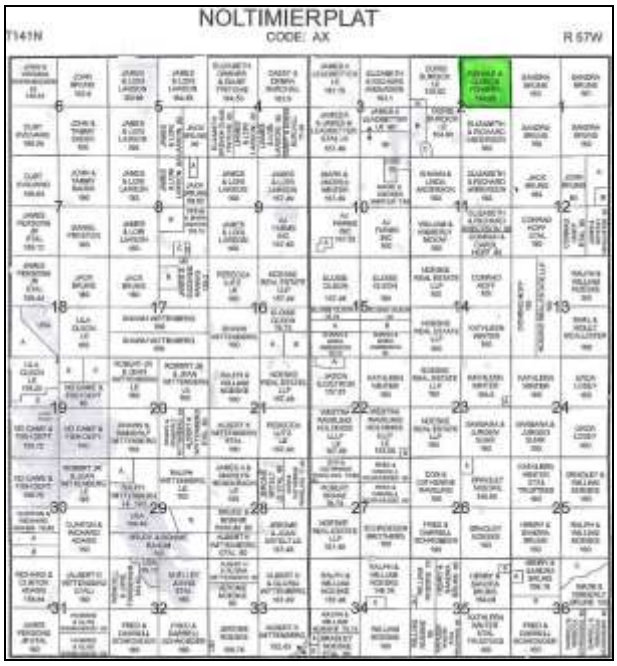
33-142N-57W
Barnes County
North Dakota

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N W E S

11/30/2015

Land Sale No. 4



Property Identification

Record ID	5967
Property Type	Vacant Land
Address	125th Avenue SE and 24th Street SE, Barnes County, North Dakota
Location	Noltimier Township
Tax ID	24-0210100
Legal Description	NE4 Section 2, T141N R57W, Barnes County, North Dakota

Sale Data

Grantor	Ronald K. and Clarise E. Powers
Grantee	Jason and Hilary Sjostrom
Sale Date	December 26, 2014
Deed Book/Page	CFD 279646
Property Rights	Fee simple to pass at the time W/D is issued
Conditions of Sale	Investment
Financing	Financing: Contract for Deed: $540,000, inclusive of 1.72% interest per year. The first payment of $90,000 due on completion of the title opinion, 5 further payments of $90,000 to be paid yearly on or before January 5th of each year from 2015 to and including 2019.
Sale History	Records were searched for a 3 year period; no transfer was found.
Verification	Jason Sjostrom; (701) 367-4548, November 25, 2015; Other sources: County records
Sale Price	$540,000

Land Data

Zoning	AG, Agricultural
Topography	Level to undulating, 0 to 9% slopes
Utilities	Assumed telephone and electricity available
Shape	Square
Roads	Gravel

Land Sale No. 4 (Cont.)

Access	125th Ave SE
Productivity Index	69.7
Wind Farm	Wind Farms directly south, southeast
Wind Turbines on Tract	None

Land Size Information

Gross Acres	164.02 Acres; 9.25 acres have saline present
Tillable Acres	161.00 Acres, 98.16%
Slough / Waste / Trees	3.02 Acres 1.84%

Indicators

Sale Price/Gross Acre	$3,292
Sale Price/ Tillable Acre	$3,354

Remarks

The sale was confirmed by Jason Sjostrom, Grantee, purchased the land from the Grantor as an investment, and rents it to the Grantor's son. Mr. Sjostrom believes he paid a small premium for the vacant land due to increasing market conditions; however, there was no impact from the wind farms located to the south, southeast. The tract is nearly 100% tillable. A row of evergreens is in CRP, for which the buyer receives $180 per year for the remaining 5 or 6 year period.

The primary soils include Balaton-Wyard loams, Barnes-Svea loams, Barnes-Buse loams, and Hamerly-Wyard loams. The slopes range from 0-9%. The non-irrigated soil classifications are II, IV, and V, with various susceptibility to erosion, water, and climate. The PI for this subject ranges from 22 to 81, with an overall weighted average of 69.7 for the entire tract. Of the total acreage 81.3% is Prime Farmland, 8.8% is Farmland of Statewide Importance, 6.2% is Not Prime Farmland, with the remaining 3.7% being Prime Farmland if Drained. The soils are a range of predominantly hydric (85.2%), predominantly non-hydric (9.9%), and non-hydric (4.9%). 9.25 acres are saline soils which affects plant growth and pricing. 9.25 acres have saline present. Saline impacts plant growth and sale prices.



Aerial Map



map center: 47° 3' 31.61, 97° 51' 51.48

0ft 823ft 1647ft

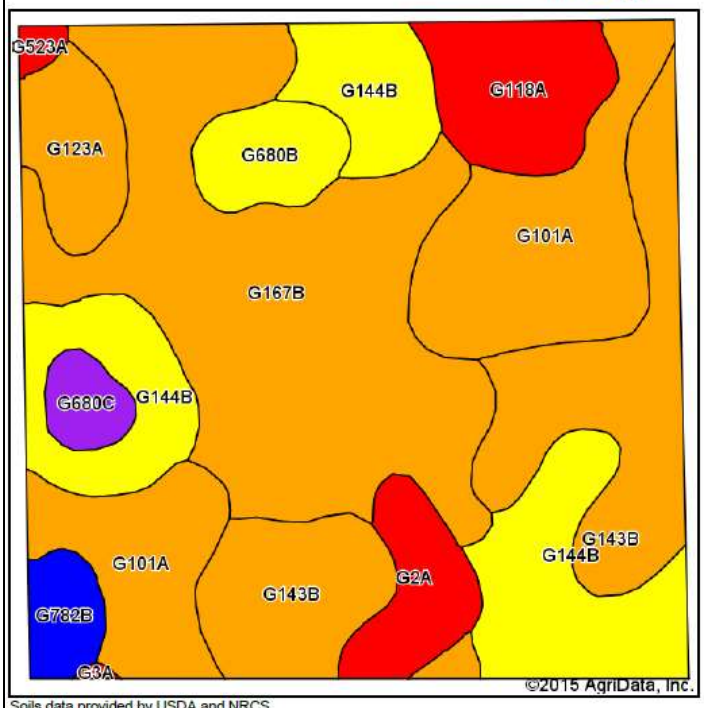
Maps Provided By surety
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2-141N-57W
Barnes County
North Dakota

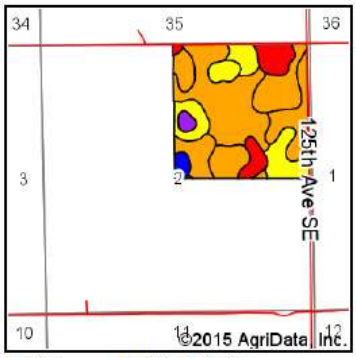
N W E S

11/25/2015

Soil Map



Soils data provided by USDA and NRCS.



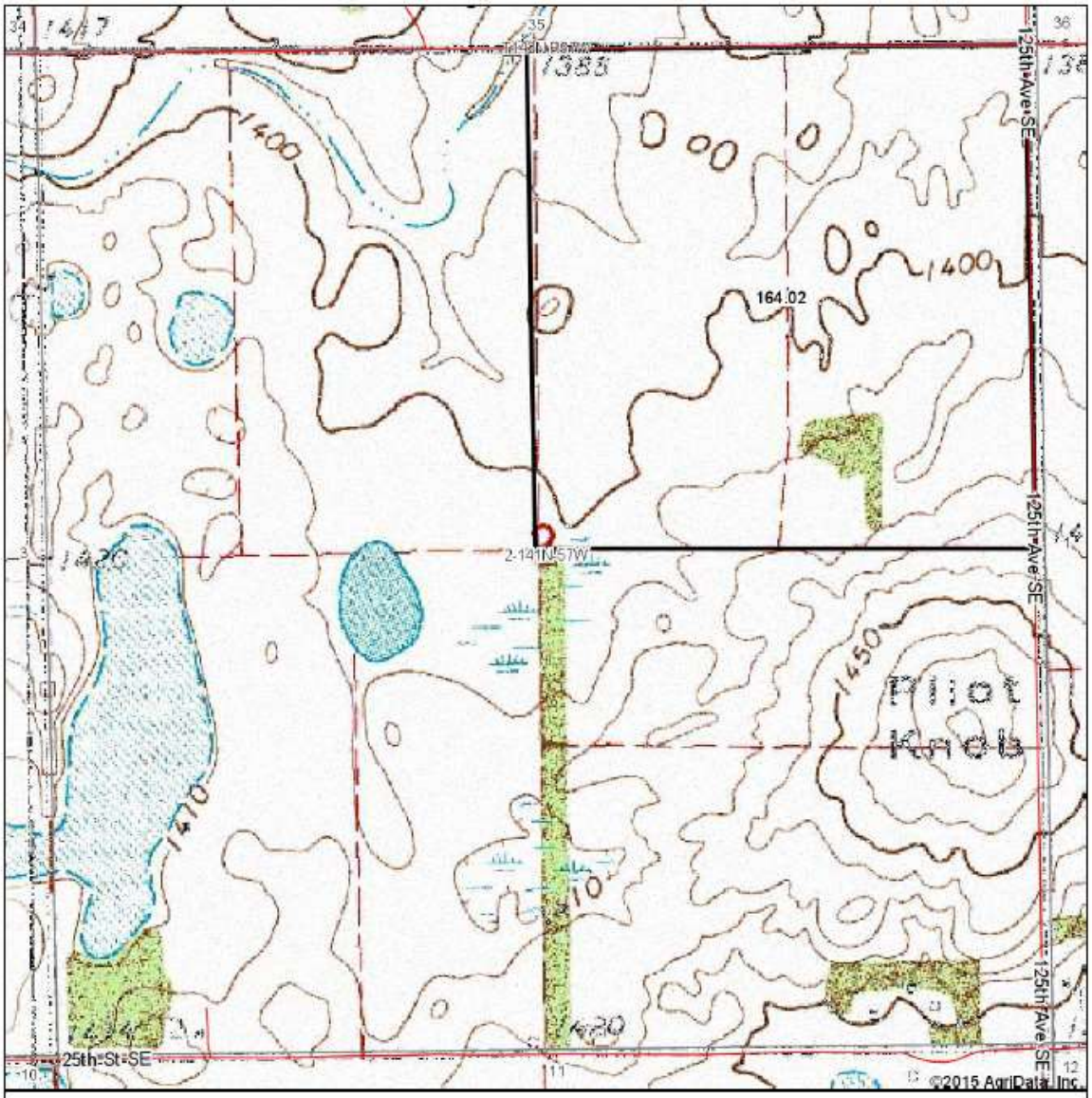
State: **North Dakota**
County: **Barnes**
Location: **2-141N-57W**
Township: **Noltimier**
Acres: **164.02**
Date: **11/25/2015**

Maps Provided By:
surety CUSTOMIZED ONLINE MAPPING
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Area Symbol: ND003, Soil Area Version: 20

Code	Soil Description	Acres	Percent of field	PI Legend	Non-Irr Class *c	Productivity Index
G167B	Balaton-Wyard loams, 0 to 6 percent slopes	46.94	28.6%		IIe	73
G143B	Barnes-Svea loams, 3 to 6 percent slopes	28.20	17.2%		IIe	75
G144B	Barnes-Buse loams, 3 to 6 percent slopes	27.64	16.9%		IIe	69
G101A	Hamerly-Wyard loams, 0 to 3 percent slopes	27.42	16.7%		IIe	77
G118A	Vallers loam, saline, 0 to 1 percent slopes	9.25	5.6%		IVw	42
G123A	Svea-Cavour loams, 0 to 3 percent slopes	6.34	3.9%		IIc	73
G2A	Tonka silt loam, 0 to 1 percent slopes	6.18	3.8%		IVw	42
G680B	Barnes-Sioux complex, 1 to 6 percent slopes	5.26	3.2%		IIe	63
G782B	Kranzburg-Lismore silty clay loams, 2 to 6 percent slopes	3.24	2.0%		IIe	81
G680C	Barnes-Sioux complex, 3 to 9 percent slopes	2.63	1.6%		IIe	55
G523A	Lowe-Fluvaquents, channeled complex, 0 to 2 percent slopes, frequently flooded	0.74	0.5%		VIw	22
G3A	Parnell silty clay loam, 0 to 1 percent slopes	0.18	0.1%		Vw	25
					Weighted Average	**69.7**

Topography Map



map center: 47° 3' 31.61, 97° 51' 51.48

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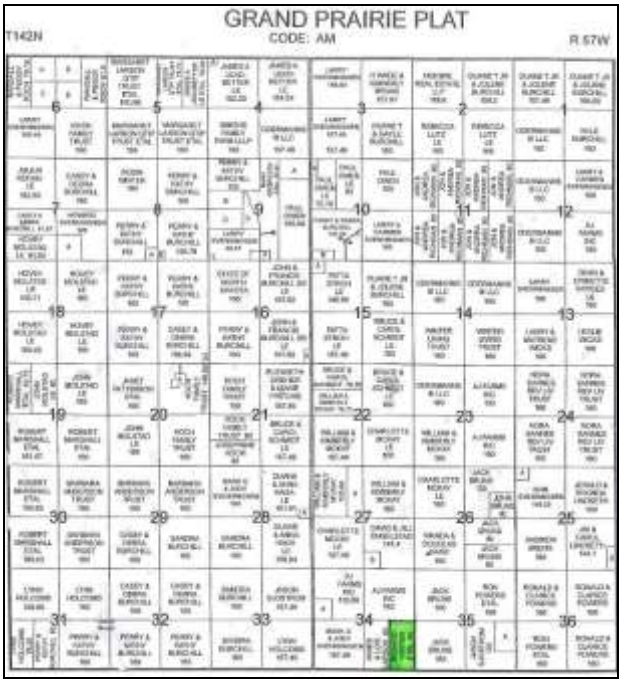
2-141N-57W
Barnes County
North Dakota

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N W E S

11/25/2015

Land Sale No. 5



Property Identification

Record ID	5974
Property Type	Vacant Land
Address	23rd Street SE and 123rd Avenue SE, Barnes County, North Dakota
Location	Grand Prairie Township
Tax ID	13-3440400
Legal Description	E2SE4 Section 34, T142N R57W, Barnes County, North Dakota.

Sale Data

Grantor	Joyce S. Larson Revocable Living Trust U/T/A
Grantee	Mark C. Winter et al
Sale Date	December 22, 2012
Deed Book/Page	TD 274326
Property Rights	Leased fee (share crop basis)
Conditions of Sale	Assemblage / atypical with premium
Financing	Cash to seller
Sale History	Records were searched for a 3 year period; no transfer was found.
Verification	Mark Winter, Grantee; (701) 845-3082, 11/18/2015; County records
Sale Price	$320,000

Land Data

Zoning	AG, Agricultural
Topography	Level to undulating; slopes 0 – 9%
Utilities	Assumed telephone and electricity available
Shape	Rectangular
Roads	Gravel
Access	23rd St SE
Productivity Index	73.9

Land Sale No. 5 (Cont.)

Wind Farm	Wind Farms directly west
Wind Turbines on Tract	None

Land Size Information

Gross Acres	80.00 Acres
Tillable Acres	67.00 Acres, 83.75%
Wetlands Land Size	13.00 Acres, 16.25%

Indicators

Sale Price/Gross Acre	$4,000
Sale Price/ Tillable Acre	$4,776

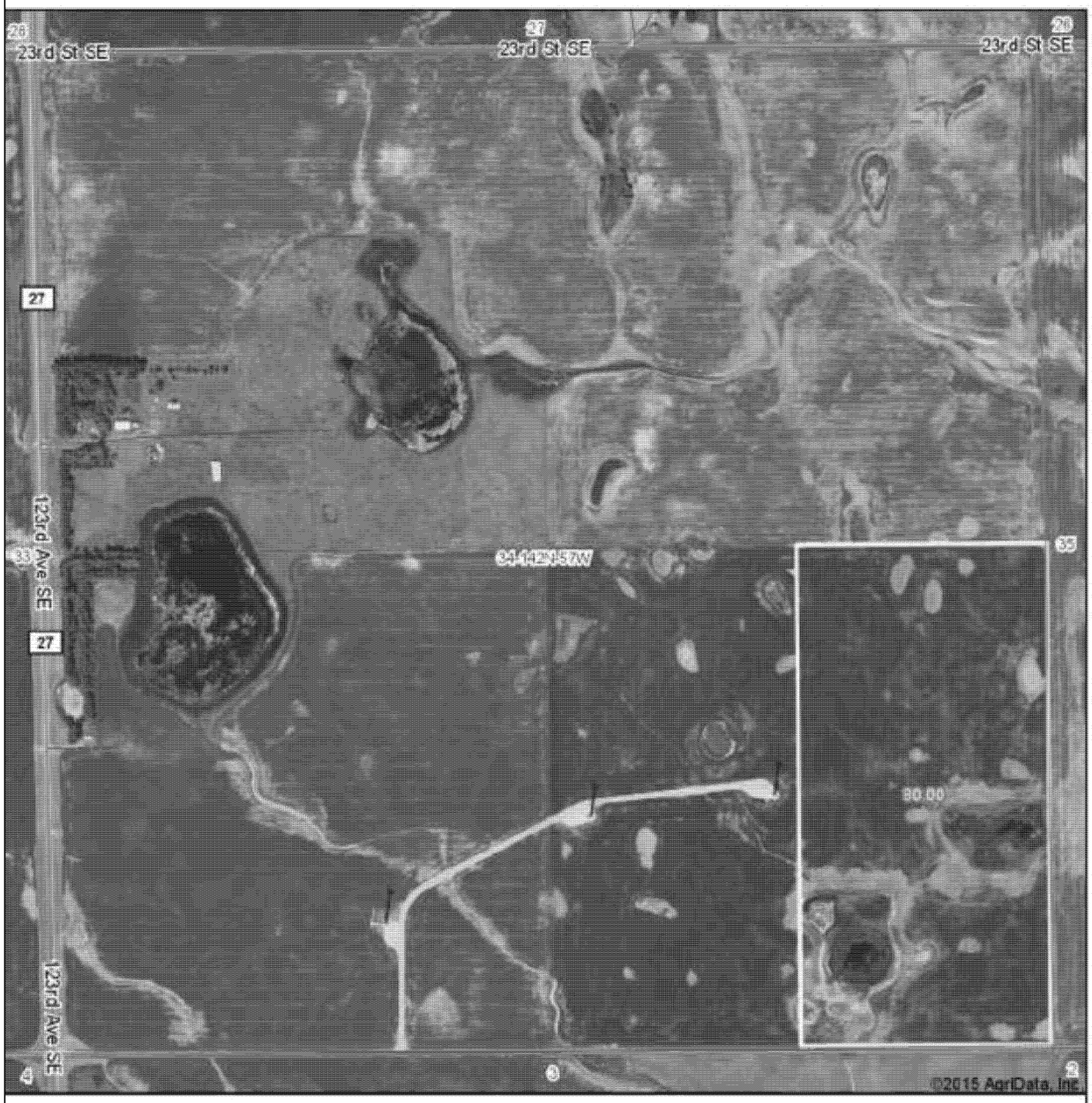
Remarks

The sale was confirmed by Mark Winter, Grantee, who stated he purchased the land as an assemblage to the existing farming operation. He had been leasing it, when approached by the Grantor. Since market prices were premium, Mr. Winter was not looking to buy as prices, but purchased the tract as the Grantor had health issues and needed to sell. The lease was on a share crop basis with wheat/beans on a 70% share for the Grantee and 30% share for the Grantor; corn was at a share of 75% - 25%. The sale price was determined by the sale of other tracts in the area. The fact that those tracts may have had wind towers on them was not a part of the consideration for the price paid. He also stated that no consideration was given to the abutting wind farm.

The primary soils include Kranzburg-Lismore silty clay loams, Hamerly-Tonka complex, and Barnes-Buse loams. The slopes range from 0-9%. The non-irrigated soil classifications are II, IV, and V, with various susceptibility to erosion and water. The PI for this subject ranges from 25 to 81, with an overall weighted average of 73.9 for the entire tract. Of the total acreage 77.8% is Prime Farmland, 18.6% is Prime Farmland if Drained, with the remaining 3.6% being Not Prime Farmland. The soils are a range of predominantly hydric (77.9%), partially hydric (18.6%), and predominantly non-hydric (3.5%).



Aerial Map



map center: 47° 4' 24.18, -97° 53' 8.52

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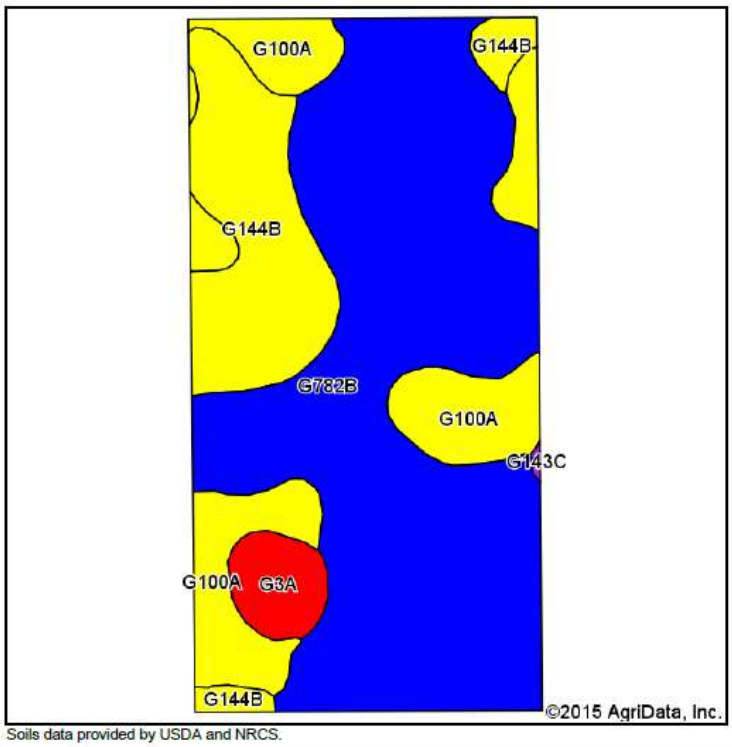
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34-142N-57W
Barnes County
North Dakota

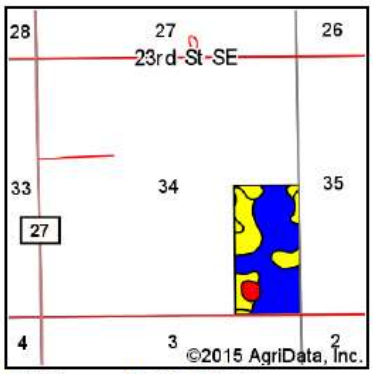
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12/1/2015

Soil Map



Soils data provided by USDA and NRCS.



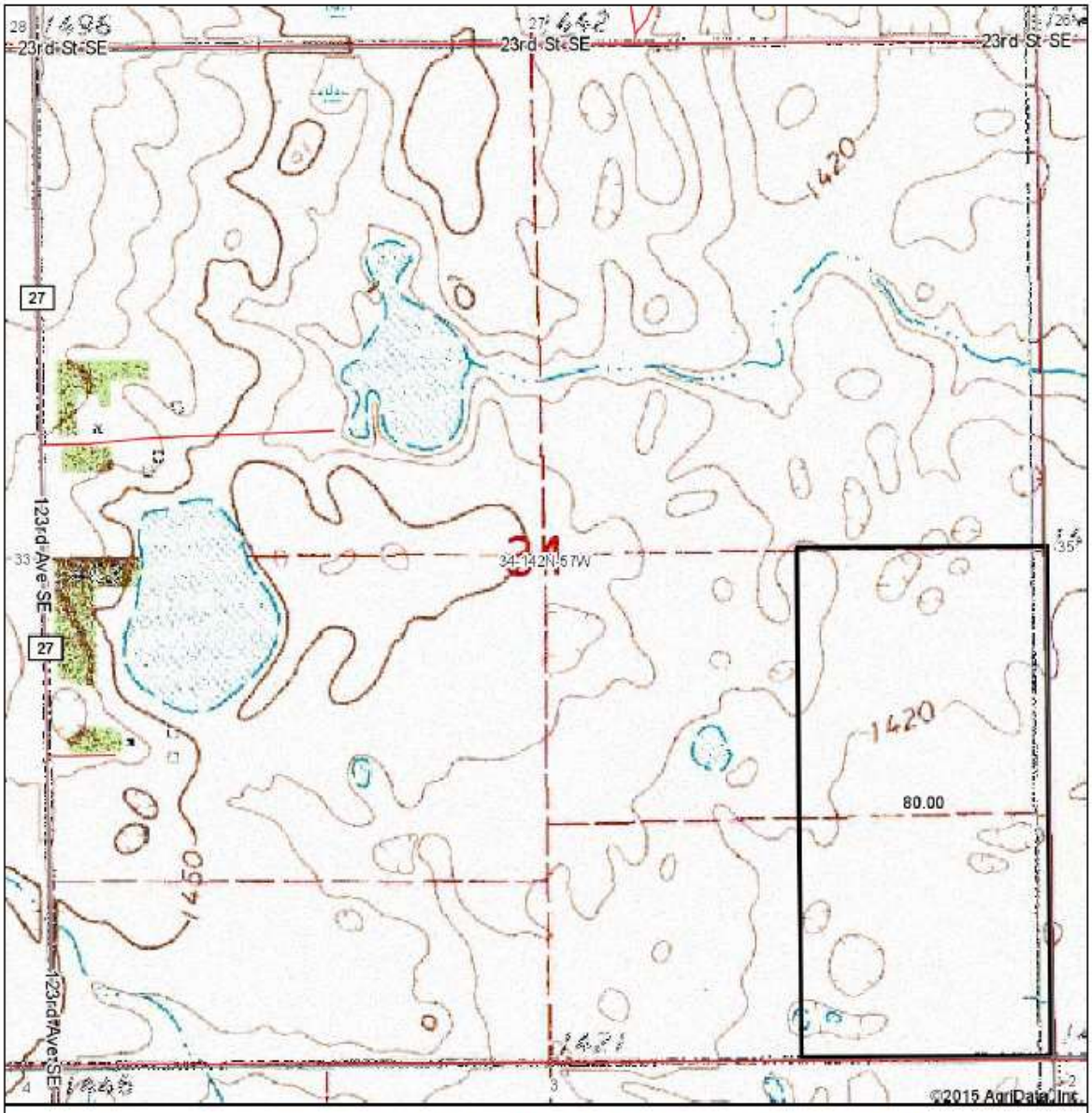
State: **North Dakota**
County: **Barnes**
Location: **34-142N-57W**
Township: **Grand Prairie**
Acres: **80**
Date: **12/1/2015**

Maps Provided By:
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Area Symbol: ND003, Soil Area Version: 20

Code	Soil Description	Acres	Percent of field	PI Legend	Water Table	Non-Irr Class *c	Range Production (lbs/acre/yr)	Productivity Index
G782B	Kranzburg-Lismore silty clay loams, 2 to 6 percent slopes	48.91	61.1%		4.9ft.	IIe	3031	81
G100A	Hamerly-Tonka complex, 0 to 3 percent slopes	14.38	18.0%		4.9ft.	IIe	4114	64
G144B	Barnes-Buse loams, 3 to 6 percent slopes	13.77	17.2%		4.9ft.	IIe	2988	69
G3A	Parnell silty clay loam, 0 to 1 percent slopes	2.86	3.6%		0ft.	Vw	5336	25
G143C	Barnes-Buse-Langhei loams, 6 to 9 percent slopes	0.08	0.1%		> 6.5ft.	IVe	2763	56
						Weighted Average	**3300.4**	**73.9**

Topography Map



map center: 47° 4' 24.18, -97° 53' 8.52

0ft 817ft 1634ft

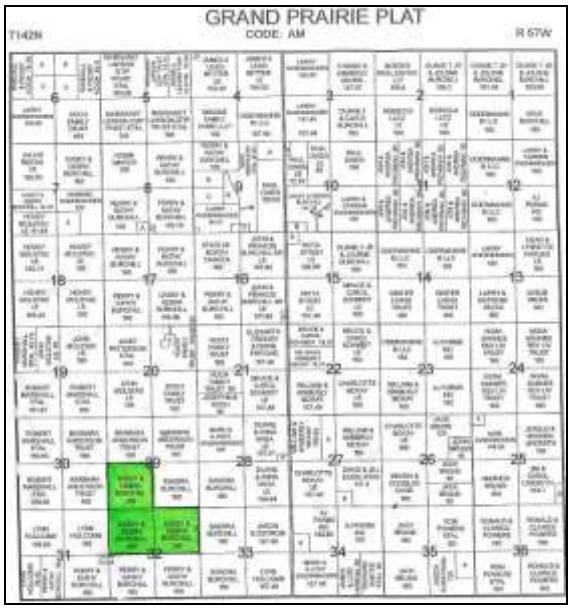
34-142N-57W
Barnes County
North Dakota

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N W E S

12/1/2015

Land Sale No. 6



Property Identification

Record ID	5975
Property Type	Vacant Land
Address	23rd Street SE and 122nd Avenue SE, Barnes County, North Dakota
Location	Grand Prairie Township
Tax ID	13-2930300; 13-3210100; 13-3220200
Legal Description	N2 Section 32; SE Section 29, T142N R57W, Barnes County, North Dakota

Sale Data

Grantor	Joyce S. Larson Revocable Living Trust U/T/A
Grantee	Casey J. and Debra L. Burchill
Sale Date	December 22, 2012
Deed Book/Page	TD 274327
Property Rights	Leased fee; fractional interest; seller retained wind royalties
Conditions of Sale	Assemblage to existing farming operation
Financing	Cash to seller
Sale History	Records were searched for a 3 year period; no transfer was found.
Verification	Deb Burchill, Grantee; (701) 845-0726, 11/19/2015; County records
Sale Price	$1,920,000

Land Data

Zoning	AG, Agricultural
Topography	Level to rolling hills; slopes 0 – 15%
Utilities	Assumed telephone and electricity available
Shape	Irregular
Roads	Gravel
Access	23rd Street SE
Productivity Index	58.4 (no adjustment required)
Wind Farm	Wind Farms on tract and to east; southeast
Wind Turbines on Tract	Four

Land Size Information

Gross Acres	480.00 Acres
Tillable Acres	384.00 Acres, 80.00%
Sloughs and Waste	96.00 Acres, 20.00%

Indicators

Sale Price/Gross Acre	$4,000
Sale Price/ Acre	$5,000

Remarks

The sale was confirmed by Deb Burchill, Grantee, who stated they were approached by the Grantor to purchase the land due to the fact they were leasing it at the time for $75.00/acre. Mrs. Burchill purchased the land to continue their farm operation. The land is 80% tillable and 20% water / wasteland. Four wind turbines were located on the N2 of Section 32 at the time of the sale. Mrs. Burchill would have liked to have purchased the wind royalty rights for the turbines, but the Grantor retained them. Mrs. Burchill believes the price was premium and stated that the turbines did not impact the sale price.

The primary soils include Hamerly-Tonka complex, Barnes-Svea loams, and Barnes-Buse loams. The slopes range from 0-15%. The non-irrigated soil classifications are II, IV, V, VI, and VIII, with various susceptibility to erosion, stones, and water. The PI for this subject ranges from 9 to 75, with an overall weighted average of 58.4 for the entire tract. Of the total acreage 36.0% is Prime Farmland, 35.7% is Not Prime Farmland, 25% is Prime Farmland if Drained, with the remaining 3.3% being Farmland of Statewide Importance. The soils are a range of predominantly non-hydric (60.6%), partially hydric (25%), predominantly hydric (11.1%), and non-hydric (3.3%). 11.90 acres are saline, which impacts plant growth and sale price.



Aerial Map



map center: 47° 4' 49.76, -97° 55' 40.3

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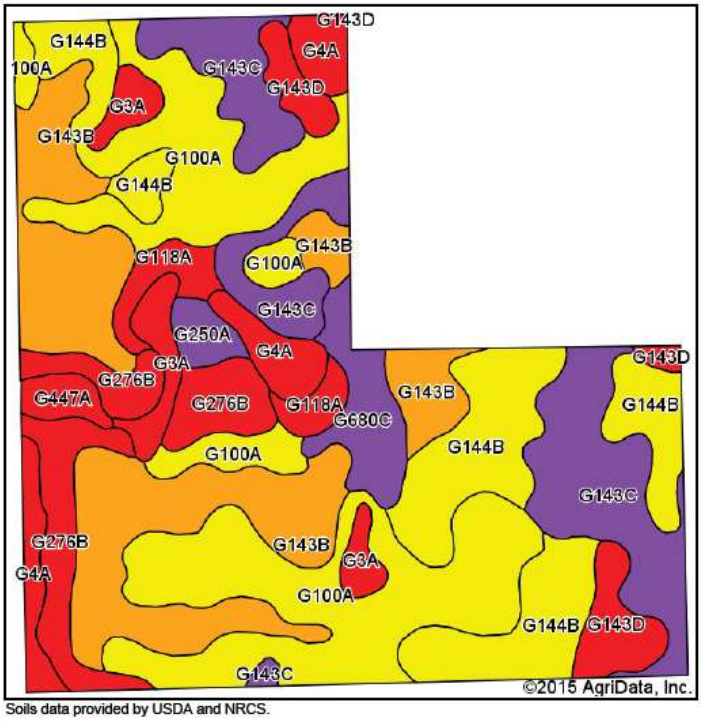
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32-142N-57W
Barnes County
North Dakota

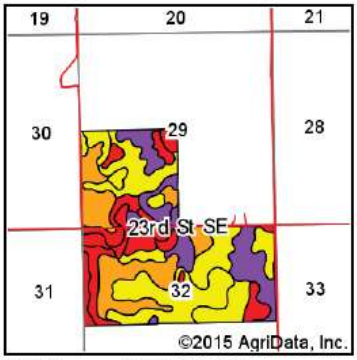
N W E S

12/1/2015

Soil Map



Soils data provided by USDA and NRCS.



State: **North Dakota**
County: **Barnes**
Location: **32-142N-57W**
Township: **Grand Prairie**
Acres: **480**
Date: **12/1/2015**

Maps Provided By: surety CUSTOMIZED ONLINE MAPPING
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Area Symbol: ND003, Soil Area Version: 20

Code	Soil Description	Acres	Percent of field	PI Legend	Water Table	Non-Irr Class *c	Range Production (lbs/acre/yr)	Productivity Index
G100A	Hamerly-Tonka complex, 0 to 3 percent slopes	120.06	25.0%		4.9ft.	IIe	4114	64
G143B	Barnes-Svea loams, 3 to 6 percent slopes	93.51	19.5%		4.9ft.	IIe	3034	75
G144B	Barnes-Buse loams, 3 to 6 percent slopes	73.88	15.4%		4.9ft.	IIe	2988	69
G143C	Barnes-Buse-Langhei loams, 6 to 9 percent slopes	65.97	13.7%		> 6.5ft.	IVe	2763	56
G276B	Renshaw-Sioux complex, 2 to 6 percent slopes	34.56	7.2%		> 6.5ft.	IVs	2002	40
G4A	Southam silty clay loam, 0 to 1 percent slopes	20.96	4.4%		0ft.	VIIIw	1217	9
G143D	Barnes-Buse-Langhei loams, 9 to 15 percent slopes	17.51	3.6%		> 6.5ft.	VIe	2650	41
G3A	Parnell silty clay loam, 0 to 1 percent slopes	15.88	3.3%		0ft.	Vw	5336	25
G680C	Barnes-Sioux complex, 3 to 9 percent slopes	15.33	3.2%		4.9ft.	IIe	2302	55
G118A	Vallers loam, saline, 0 to 1 percent slopes	11.90	2.5%		0.7ft.	IVw	3892	42
G250A	Divide loam, 0 to 2 percent slopes	5.32	1.1%		2.5ft.	IIs	3729	58
G447A	Colvin-Borup complex, saline, 0 to 1 percent slopes	5.12	1.1%		0.7ft.	IVw	3801	37
						Weighted Average	**3182.1**	**58.4**

Topography Map



map center: 47° 4' 49.76, 97° 55' 40.3

0ft 843ft 1686ft

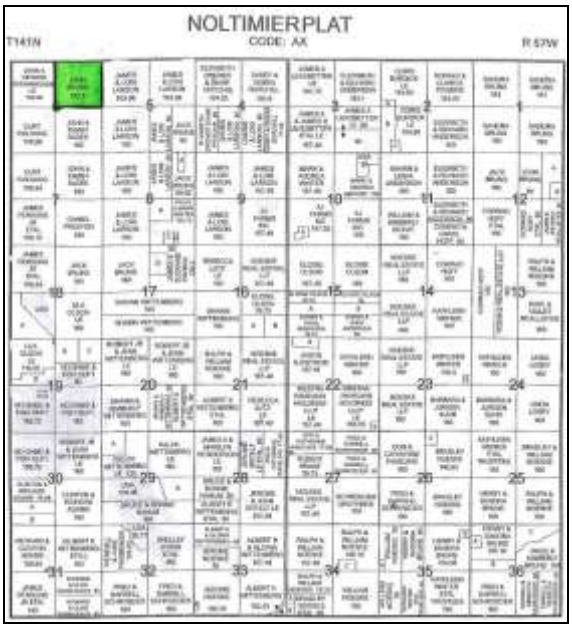
32-142N-57W
Barnes County
North Dakota

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N W E S

12/1/2015

Land Sale No. 7



Property Identification

Record ID	5972
Property Type	Vacant Land
Address	24th Street SE and 120th Avenue SE, Barnes County, North Dakota
Location	Noltimier Township
Tax ID	24-0610100
Legal Description	NE4 Section 6, T141N R57W, Barnes County, North Dakota.

Sale Data

Grantor	Sandra J. Burchill
Grantee	John T. Bruns
Sale Date	December 21, 2012
Deed Book/Page	WD 274276
Property Rights	Leased Fee
Conditions of Sale	Assemblage
Financing	Cash to seller
Verification	John Bruns, Grantee; (701) 845-3346, 11/20/2015; County records
Sale Price / Land	$275,000 or $1,689 per gross acre
Sale Price/Turbines	$100,000 representing wind right to turbines ($50,000 per turbine)
Cumulative Sale Price	$375,000

Land Data

Zoning	AG, Agricultural
Topography	Nearly level, slopes 0-6%
Utilities	Assumed telephone and electricity available
Shape	Square
Roads	Gravel
Access	24th St SE
Productivity Index	65.0
Adjusted Productivity Index	68.4

Land Sale No. 7 (Cont.)

Wind Farm	Wind Farms on tract; to the east and ½ mile north and 1 mile northeast
Wind Turbines on Tract	Two

Land Size Information

Gross Acres	162.800 Acres; 55.04 acres have saline present (33.8%)
Tillable Acres	140.000 Acres, 86.00%
Sloughs and Waste	22.800 Acres, 14.00%

Indicators

Sale Price/Gross Acre	$1,689 excluding wind royalties; $2,303 including wind royalties
Sale Price/ Tillable Acre	$1,964 excluding wind royalties; $2,679 including wind royalties

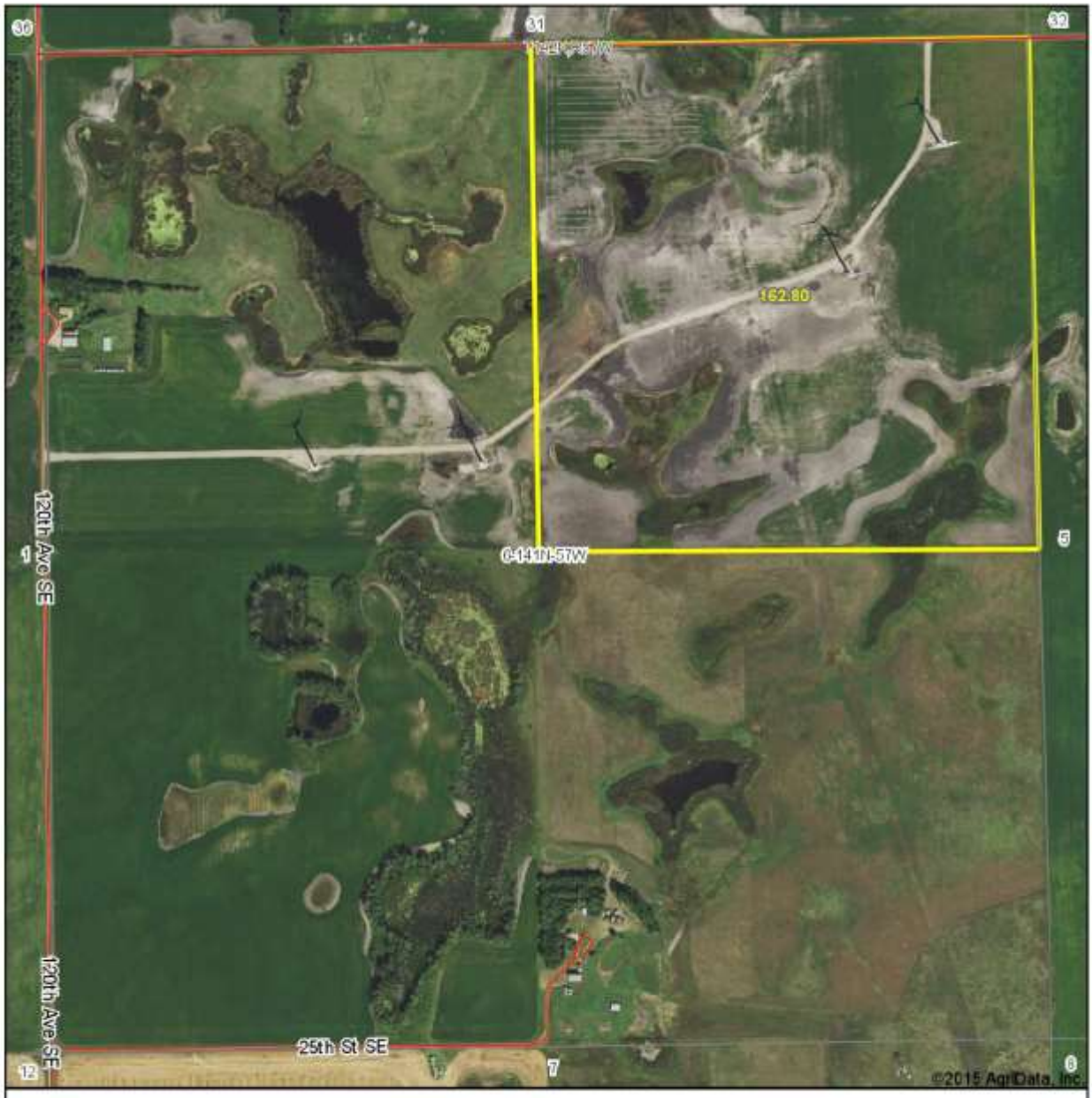
Remarks

The sale was confirmed by John Bruns, Grantee, who stated that the seller approached him to buy the land since he was leasing it. The land is very flat and has about 80 good tillable acres, 60 marginal acres and 22.8 in waste and sloughs. He stated that the Grantor, Sandra Burchill is a substantial land owner in the area and he and his sons would like to acquire more land from her, so bought this land to keep her happy. The transaction was comprised of two transactions, rolled into one. The land was purchased at $1,689 per acre or $275,000 total. The wind royalties for the two turbines on the land were purchased at $100,000 or $50,000 per turbine. Mr. Bruns used Ag County to assist in establishing the price paid for the air rights. He viewed the deal as a "public relations" transaction to keep the doors open for future transactions with Ms. Burchill.

The primary soils include Overly-Bearden silty clay loams, Bearden silty clay loam, Vallers loam, and Colvin-Borup complex. The slopes range from 0-6%. The non-irrigated soil classifications are II, IV, and V, with various susceptibility to erosion, water, stones, and climate. The PI for this subject ranges from 25 to 88, with an overall weighted average of 65 for the entire tract. Of the total acreage, 55.8% is Prime Farmland, with the remaining 44.2% being Not Prime Farmland. The soils are a range of predominantly non-hydric (55.8%), predominantly hydric (36.9%), and non-hydric (7.3%). This tract has 55.04 acres of saline soils, which negatively affect plant growth and price paid.



Aerial Map



map center: 47° 3' 32.1", 97° 56' 56.93

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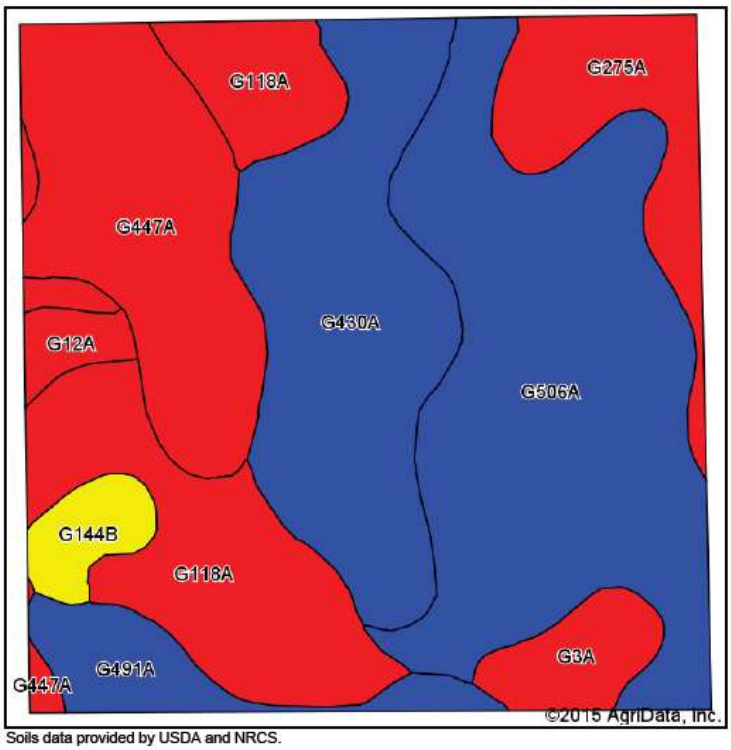
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6-141N-57W
Barnes County
North Dakota

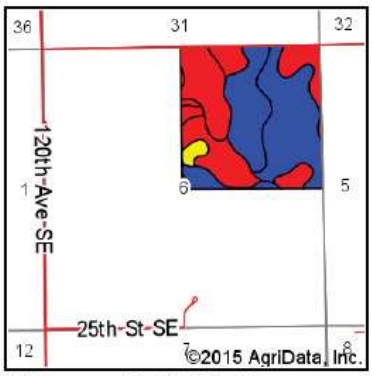
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11/30/2015

Soil Map



Soils data provided by USDA and NRCS.



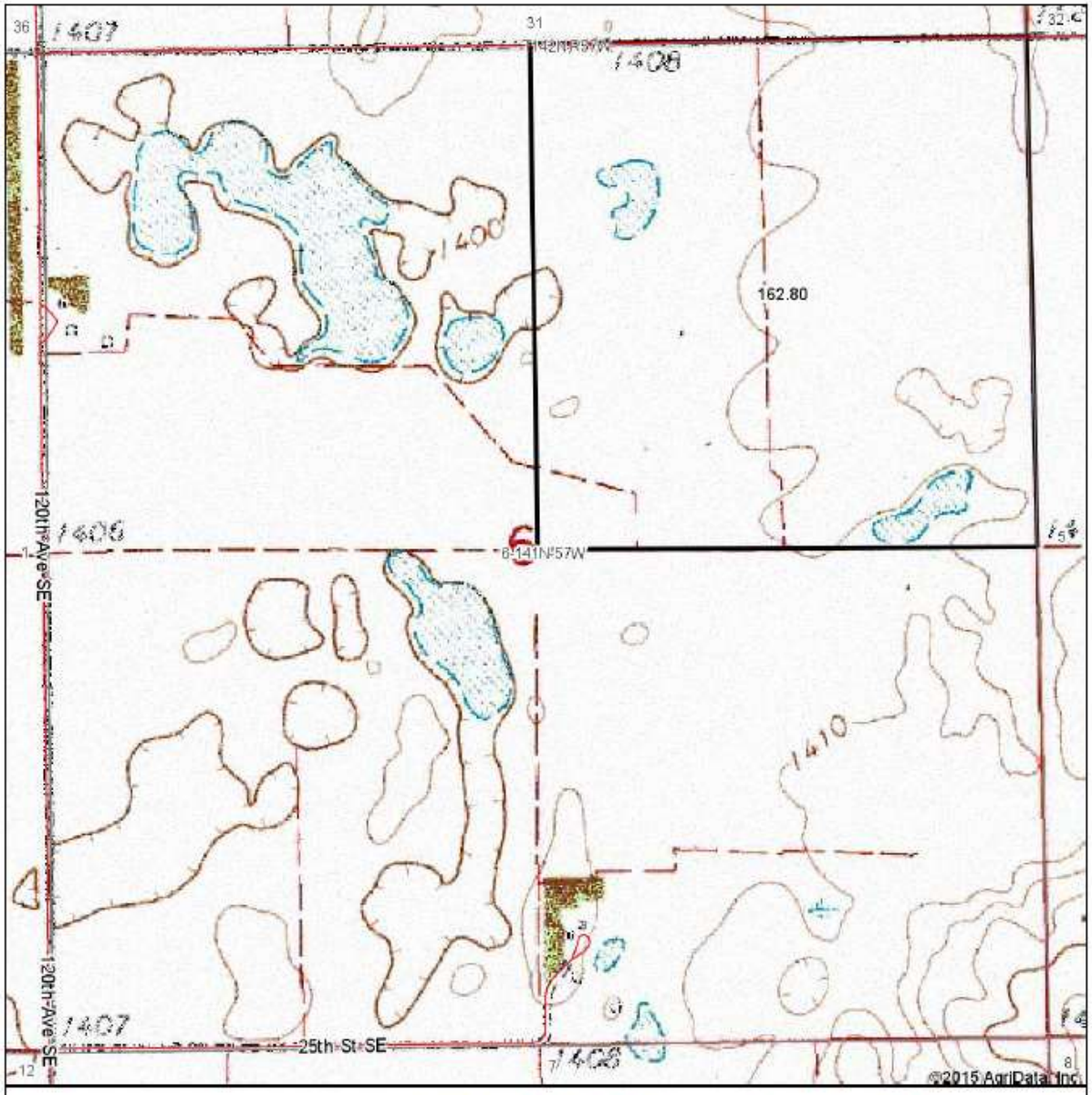
State: **North Dakota**
County: **Barnes**
Location: **6-141N-57W**
Township: **Noltimier**
Acres: **162.8**
Date: **11/30/2015**

Maps Provided By surety CUSTOMIZED ONLINE MAPPING
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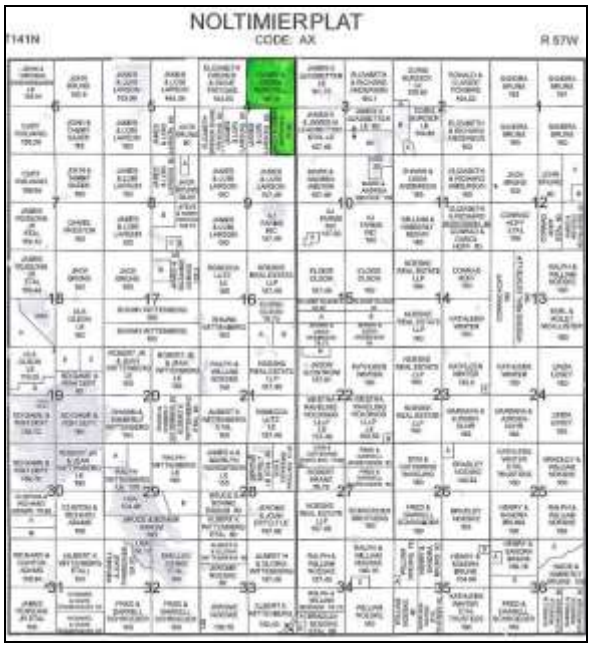
Area Symbol: ND003, Soil Area Version: 20

Code	Soil Description	Acres	Percent of field	PI Legend	Water Table	Non-Irr Class *c	Range Production (lbs/acre/yr)	Productivity Index
G506A	Overly-Bearden silty clay loams, 0 to 2 percent slopes	49.07	30.1%		4.9ft.	IIc	3548	88
G430A	Bearden silty clay loam, 0 to 2 percent slopes	30.63	18.8%		2.5ft.	IIe	3933	84
G118A	Vallers loam, saline, 0 to 1 percent slopes	27.50	16.9%		0.7ft.	IVw	3892	42
G447A	Colvin-Borup complex, saline, 0 to 1 percent slopes	25.18	15.5%		0.7ft.	IVw	3801	37
G275A	Renshaw loam, 0 to 2 percent slopes	11.90	7.3%		> 6.5ft.	IVs	1969	44
G491A	Gardena-Glyndon loams, 0 to 2 percent slopes	7.18	4.4%		4.9ft.	IIc	3371	87
G3A	Parnell silty clay loam, 0 to 1 percent slopes	5.21	3.2%		0ft.	Vw	5336	25
G144B	Barnes-Buse loams, 3 to 6 percent slopes	3.77	2.3%		4.9ft.	IIe	2988	69
G12A	Vallers, saline-Parnell complex, 0 to 1 percent slopes	2.36	1.4%		0.7ft.	IVw	4453	31
						Weighted Average	**3651.8**	**65**

Topography Map



Land Sale No. 8



Property Identification

Record ID	5971
Property Type	Vacant Land
Address	123rd Avenue SE and 24th Street SE , Barnes County, North Dakota
Location	Noltimier Township
Tax ID	24-0410100; 24-0440400
Legal Description	NE4; E2SW4 Section 4, T141N R57W, Barnes County, North Dakota.

Sale Data

Grantor	Bruce L. Schmidt et al
Grantee	Casey J. and Debra L. Burchill
Sale Date	October 31, 2012
Deed Book/Page	WD 273843, 273844, 273845
Property Rights	Surface rights / fractional interest; reservation of mineral rights and life estate in existing wind project (wind royalties)
Conditions of Sale	Assemblage
Financing	Cash to seller
Sale History	Records were searched for a 3 year period; no transfer was found.
Verification	Casey Burchill, Grantee; (701) 845-0726, November 24, 2015; Other sources: County records
Sale Price	$889,999

Land Data

Zoning	AG, Agricultural
Topography	Level to undulating; slopes 0 to 9%
Utilities	Assumed telephone and electricity available
Shape	Square
Roads	Gravel
Access	123rd Ave SE
Productivity Index	71.6

Land Sale No. 8 (Cont.)

Wind Farm	Wind Farms adjacent to the NW
Wind Turbines on Tract	Two

Land Size Information

Gross Acres	239.390 Acres
Tillable Acres	239.39 Acres

Indicators

Sale Price/Gross Acre	$3,718

Remarks

The sale was confirmed by Casey Burchill, Grantee, who stated they purchased the land via an auction that was advertised in the newspaper. Mr. Burchill believes he paid market price for the vacant land and stated that the seller kept the wind royalties to the two turbines on the tract, it did not impact the sale price. Mr. Burchill purchased the land to expand his farm operation and described the land as mostly tillable with a tree clump on the north border and a row of trees near the south border.

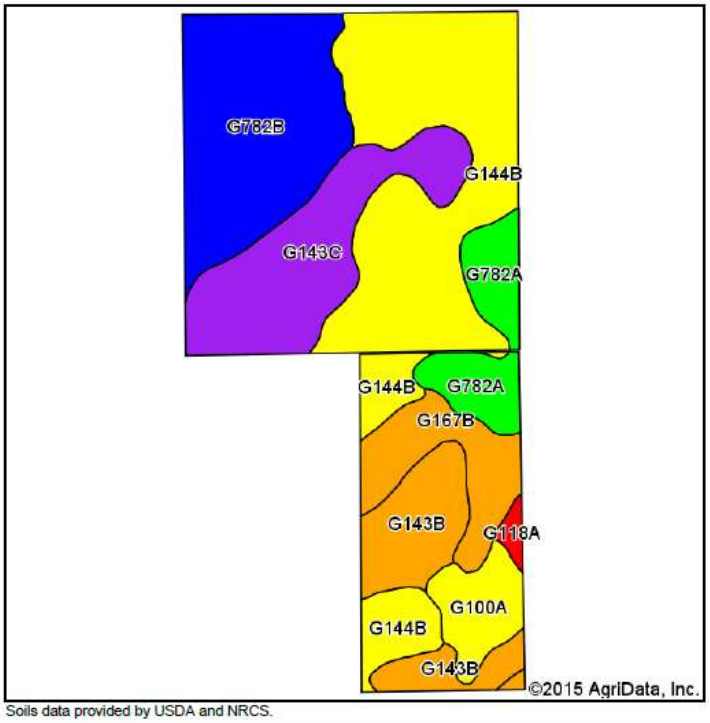
The primary soils include Barnes-Buse loams, Kranzburg-Lismore silty clay loams, and Barnes-Buse-Langhei loams. The slopes range from 0-9%. The non-irrigated soil classifications are II and IV, with various susceptibility to erosion, water, and climate. The PI for this subject ranges from 42 to 92, with an overall weighted average of 71.6 for the entire tract. Of the total acreage 78.6% is Prime Farmland, 16.4 is Not Prime Farmland, 4.8% is Prime Farmland if Drained, with the remaining 0.2% being Farmland of Statewide Importance. The soils are a range of predominantly non-hydric (94.6%), partially hydric (4.8%), and predominantly hydric (0.6%).



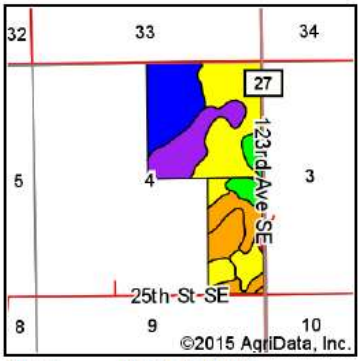
Aerial Map


32
33
34
123rd Ave SE
161.90
27
4-141N-57W
5
6
77.49
25th St SE
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10
©2015 AgriData, Inc.
map center: 47° 3' 31.8, 97° 54' 24.33
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Maps Provided By:
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4-141N-57W
Barnes County
North Dakota
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11/30/2015

Soil Map



Soils data provided by USDA and NRCS.



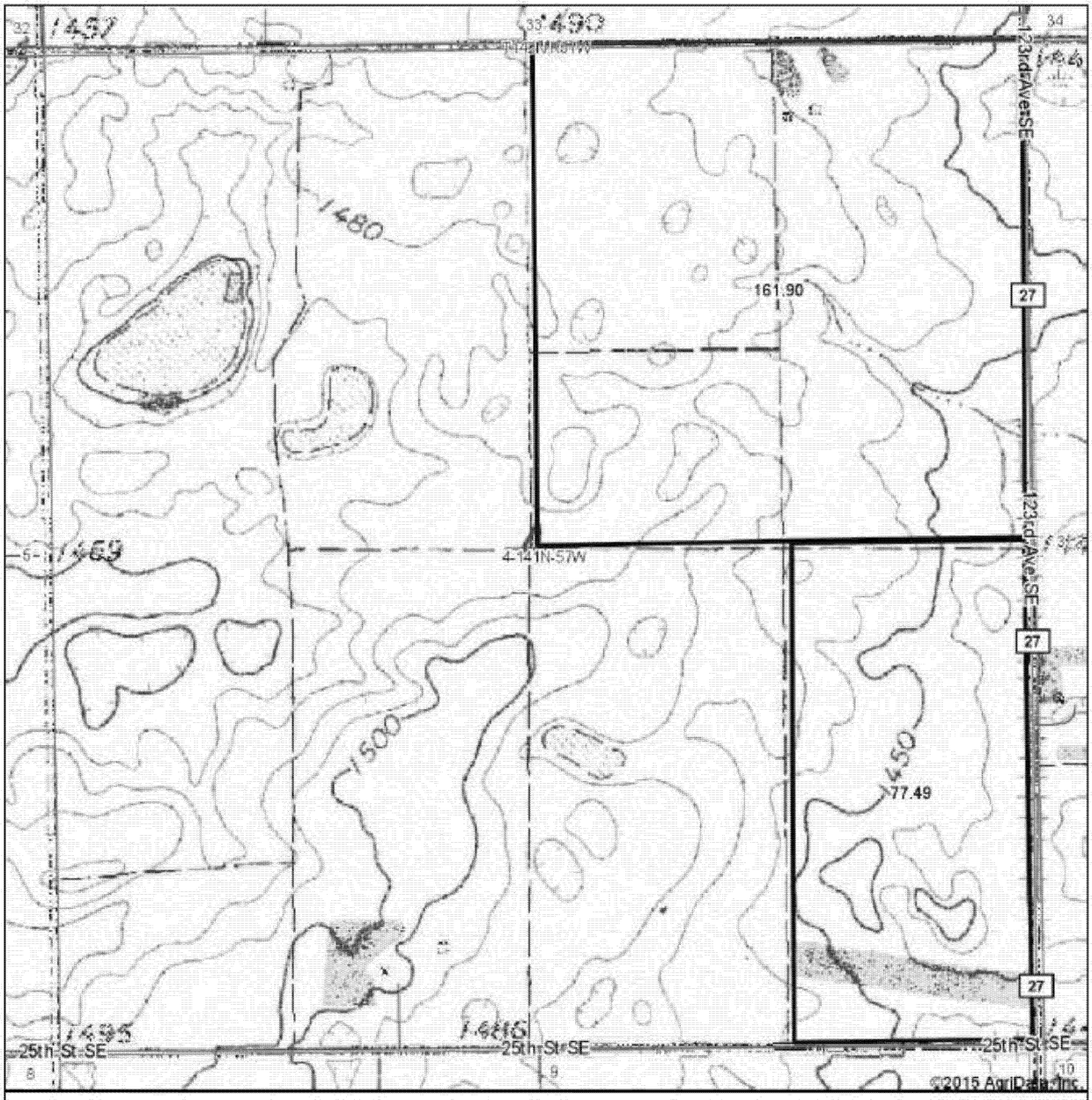
State: **North Dakota**
County: **Barnes**
Location: **4-141N-57W**
Township: **Noltimier**
Acres: **239.39**
Date: **11/30/2015**

Maps Provided By: surety CUSTOMIZED ONLINE MAPPING
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Area Symbol: ND003, Soil Area Version: 20

Code	Soil Description	Acres	Percent of field	PI Legend	Water Table	Non-Irr Class *c	Range Production (lbs/acre/yr)	Productivity Index
G144B	Barnes-Buse loams, 3 to 6 percent slopes	80.51	33.6%		4.9ft.	IIe	2988	69
G782B	Kranzburg-Lismore silty clay loams, 2 to 6 percent slopes	49.50	20.7%		4.9ft.	IIe	3031	81
G143C	Barnes-Buse-Langhei loams, 6 to 9 percent slopes	37.31	15.6%		> 6.5ft.	IVe	2763	56
G143B	Barnes-Svea loams, 3 to 6 percent slopes	23.34	9.7%		4.9ft.	IIe	3034	75
G167B	Balaton-Wyard loams, 0 to 6 percent slopes	18.19	7.6%		4.9ft.	IIe	3245	73
G782A	Lismore-Kranzburg silty clay loams, 0 to 2 percent slopes	16.88	7.1%		4.9ft.	IIc	3835	92
G100A	Hamerly-Tonka complex, 0 to 3 percent slopes	11.57	4.8%		2.5ft.	IIe	4114	64
G118A	Vallers loam, saline, 0 to 1 percent slopes	1.63	0.7%		0.7ft.	IVw	3892	42
G466A	Overly-Nahon silt loams, 0 to 2 percent slopes	0.46	0.2%		4.9ft.	IIc	2757	79
						Weighted Average	**3105.7**	**71.6**

Topography Map



map center: 47° 3' 31.8, 97° 54' 24.33

0ft 830ft 1660ft

4-141N-57W
Barnes County
North Dakota

Maps Provided By:
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N W E S

11/30/2015

Land Sale No. 9



Property Identification

Record ID	5973
Property Type	Vacant Land
Address	26th Street SE and 123rd Avenue SE, Barnes County, North Dakota
Location	Noltimier Township
Tax ID	24-0840400
Legal Description	E2SE4; SW4SW4 Section 8, T141N R57W, Barnes County, North Dakota, less and excepting a tract in the SE4 containing 4.25 acres and Auditor's Lot No. 1 of the SE4 containing 10 acres.

Sale Data

Grantor	Prairie Industries, LLC
Grantee	Steve Winter and Mark C. Winter
Sale Date	February 23, 2012
Deed Book/Page	WD 272189
Property Rights	Leased fee; fractional interest; excludes wind royalties – existing projects
Conditions of Sale	Assemblage
Financing	Cash to seller
Sale History	CFD 258568 dated 12/7/2006 from James L. and Lori K. Larson to Prairie Industries, LLC for $170,000, satisfied by WD 272188 dated 3/6/2012. This transfer did not include Auditor's Lot No. 1 which was the residential site (see FSA map).
Verification	Paul Reese, Grantor; (936) 346-2491, Other sources: County records
Sale Price	$275,000

Land Data

Zoning	AG, Agricultural
Topography	Level to undulating; slopes 0 – 15%
Utilities	Assumed telephone and electricity available
Shape	Irregular
Roads	Gravel

Land Sale No. 9 (Cont.)

Access	26th St SE
Productivity Index	47.4
Adjusted Productivity Index	51.5, less sloughs and waste
Wind Farm	Wind Farms adjacent to the NE
Wind Turbines on Tract	One turbine and one met tower

Land Size Information

Gross Acres	105.75 Acres
Tillable Acres	89.00 Acres ; 84.16%
Slough and Waste	16.75 Acres; 5.84%

Indicators

Sale Price/Gross Acre	$2,600
Sale Price/Tillable Acre	$3,090

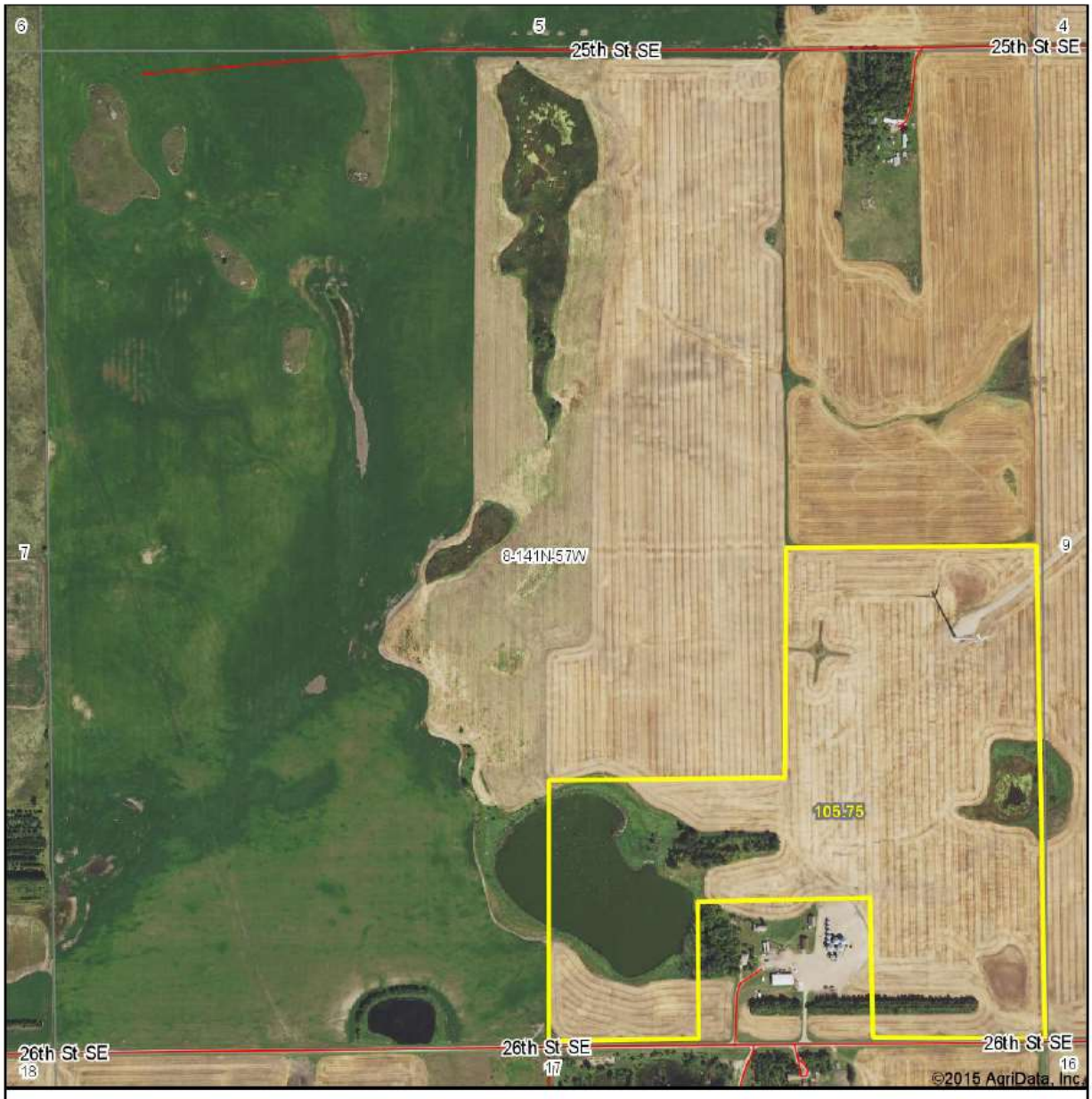
Remarks

The sale was confirmed by Paul Reese, Grantor, who stated the Grantee rented and farmed the land prior to purchase. Mr. Reese said the sale price was not discounted due to the lease or the turbine – since he kept the wind royalties, but that both he and the grantee were satisfied with the price which reflected the rapidly increasing prices of ag land in 2012. The tract has about 16.75 acres in slough and waste as measured by FSA maps. The seller indicated no negative impact on the residence (his homestead) which was excluded from this sale. (12/12/15)

The primary soils include Barnes-Sioux complex and Barnes-Buse-Langhei loams. The slopes range from 0-15%. The non-irrigated soil classifications are II, IV, VI, and VIII, with various susceptibility to erosion, stones, and water. The PI for this subject ranges from 9 to 75, with an overall weighted average of 47.4 for the entire tract. Of the total acreage 57.2% is Not Prime Farmland, 31.4% is Farmland of Statewide Importance, with the remaining 11.4% being Prime Farmland. The soils are a range of predominantly non-hydric (53.9%), non-hydric (35.7%), and predominantly hydric (10.4%).



Aerial Map



map center: 47° 2' 39.73, 97° 55' 40.65

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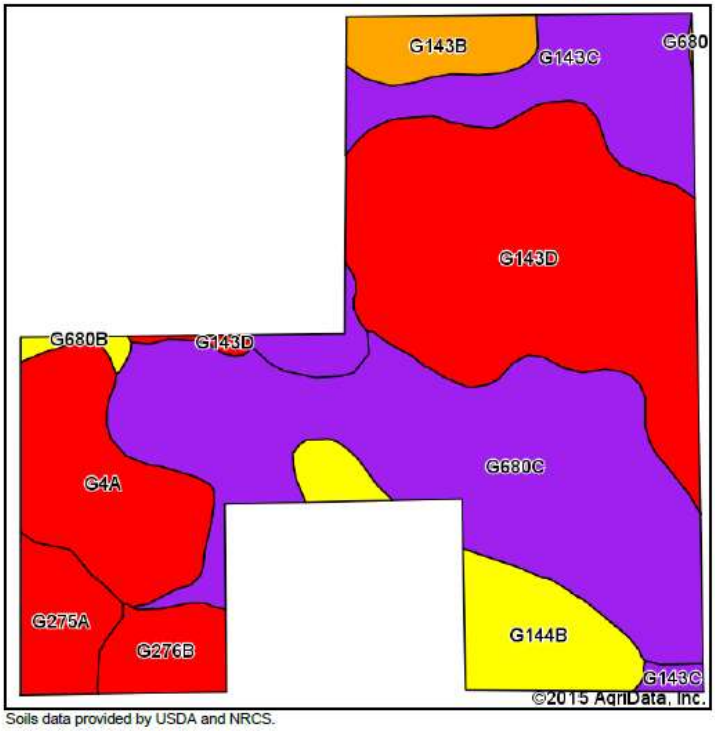
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8-141N-57W
Barnes County
North Dakota

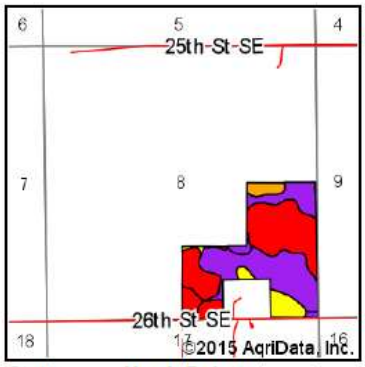
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11/30/2015

Soil Map



Soils data provided by USDA and NRCS.



State: **North Dakota**
County: **Barnes**
Location: **8-141N-57W**
Township: **Noltimier**
Acres: **105.75**
Date: **11/30/2015**

Maps Provided By: surety CUSTOMIZED ONLINE MAPPING
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Area Symbol: ND003, Soil Area Version: 20

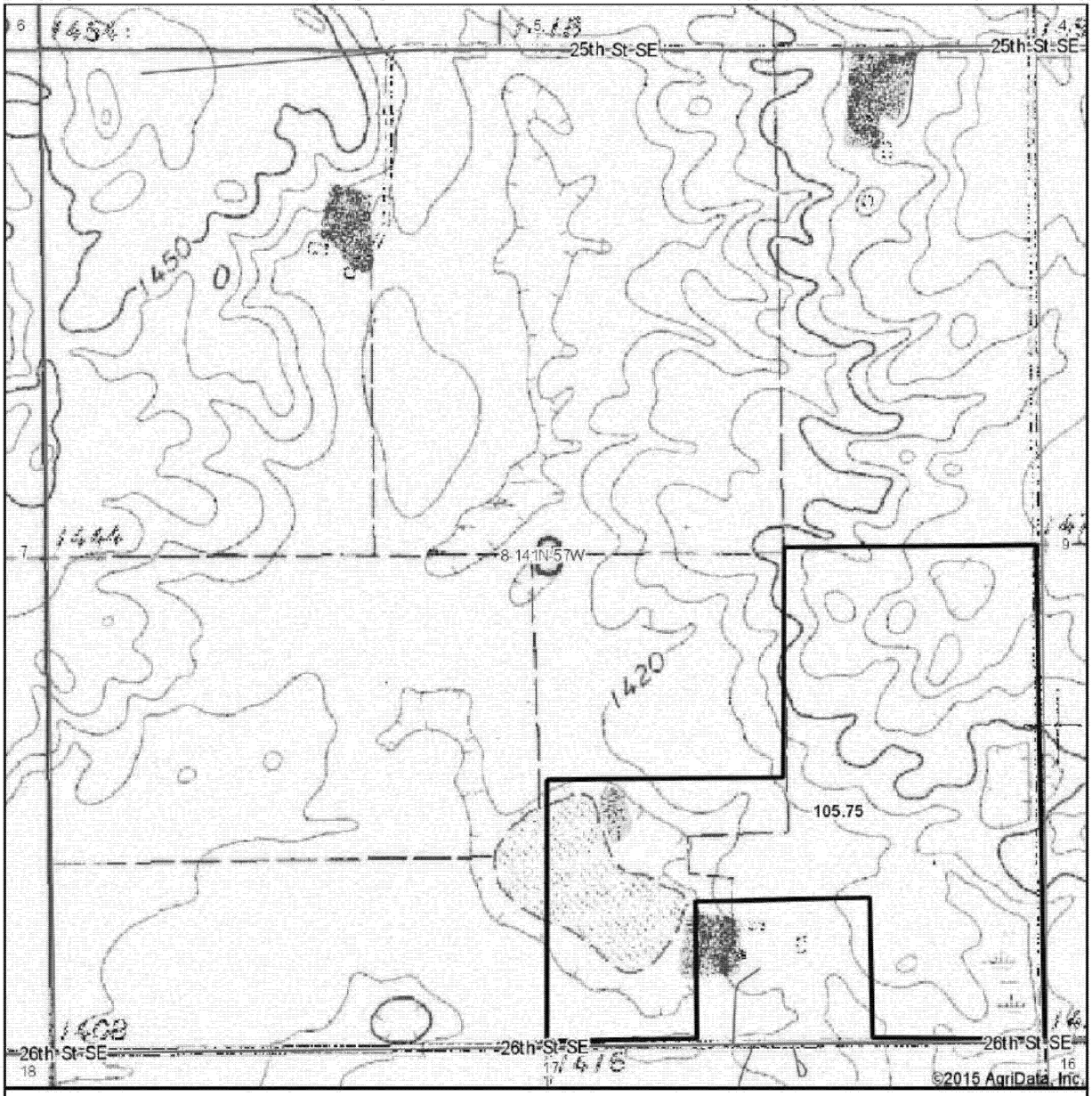
Code	Soil Description	Acres	Percent of field	PI Legend	Water Table	Non-Irr Class *c	Range Production (lbs/acre/yr)	Productivity Index
G680C	Barnes-Sioux complex, 3 to 9 percent slopes	32.89	31.1%		4.9ft.	IIe	2302	55
G143D	Barnes-Buse-Langhei loams, 9 to 15 percent slopes	29.72	28.1%		> 6.5ft.	VIe	2650	41
G143C	Barnes-Buse-Langhei loams, 6 to 9 percent slopes	12.46	11.8%		> 6.5ft.	IVe	2763	56
G4A	Southam silty clay loam, 0 to 1 percent slopes	10.72	10.1%		0ft.	VIIIw	1217	9
G144B	Barnes-Buse loams, 3 to 6 percent slopes	7.65	7.2%		4.9ft.	IIe	2988	69
G275A	Renshaw loam, 0 to 2 percent slopes	4.19	4.0%		> 6.5ft.	IVs	1969	44
G143B	Barnes-Svea loams, 3 to 6 percent slopes	3.92	3.7%		4.9ft.	IIe	3034	75
G276B	Renshaw-Sioux complex, 2 to 6 percent slopes	3.57	3.4%		> 6.5ft.	IVs	2002	40
G680B	Barnes-Sioux complex, 1 to 6 percent slopes	0.63	0.6%		4.9ft.	IIe	2416	63
						Weighted Average	**2398.2**	**47.4**

Area Symbol: ND003, Soil Area Version: 20

*c: Using Capabilities Class Dominant Condition Aggregation Method

Soils data provided by USDA and NRCS.

Topography Map



map center: 47° 2' 39.73, 97° 55' 40.65

0ft 820ft 1640ft

8-141N-57W
Barnes County
North Dakota

N W E S

11/30/2015

Maps Provided By:
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Land Sale No. 10



Property Identification

Record ID	5966
Property Type	Vacant Land
Address	125th Avenue SE and 23rd Street SE, Barnes County, North Dakota
Location	Grand Prairie Township
Tax ID	13-2530300
Legal Description	SW4 Section 25, T142N R57W, Barnes County, North Dakota.

Sale Data

Grantor	Nora B. Sannes
Grantee	Jack T. Bruns and John T. Bruns
Sale Date	November 18, 2010
Deed Book/Page	CFD 269323; (W/D 269450 January 6, 2011 satisfied C/D)
Property Rights	Fee simple
Conditions of Sale	Assemblage
Financing	Contract for Deed: $5,000 down payment and the remaining $210,000 to be paid in 2 installments of $110,000 on or before November 18, 2010 and $100,000 to be paid on or before January 5, 2011.
Sale History	Records were searched for 3 years prior to this sale; no transfer was found.
Verification	John Bruns, Grantee; (701) 840-2330, November 23, 2015; Other sources: County records
Sale Price	$215,000

Land Data

Zoning	AG, Agricultural
Topography	Nearly level; slopes 0 – 6%
Utilities	Assumed telephone and electricity available
Shape	Square
Roads	Gravel
Access	23rd St SE

Productivity Index	64.7
Adjusted Productivity Index	66.0, less sloughs and waste
Wind Farm	1 mile southwest
Wind Turbines on Tract	None

Land Size Information

Gross Acres	160.000 Acres; 19.41 acres have saline present
Tillable Acres	136.96 Acres; 85.6%
Sloughs, Waste	23.04 Acres; 14.4%

Indicators

Sale Price/ Acre	$1,344
Sale Price / Tillable Acre	$1,570

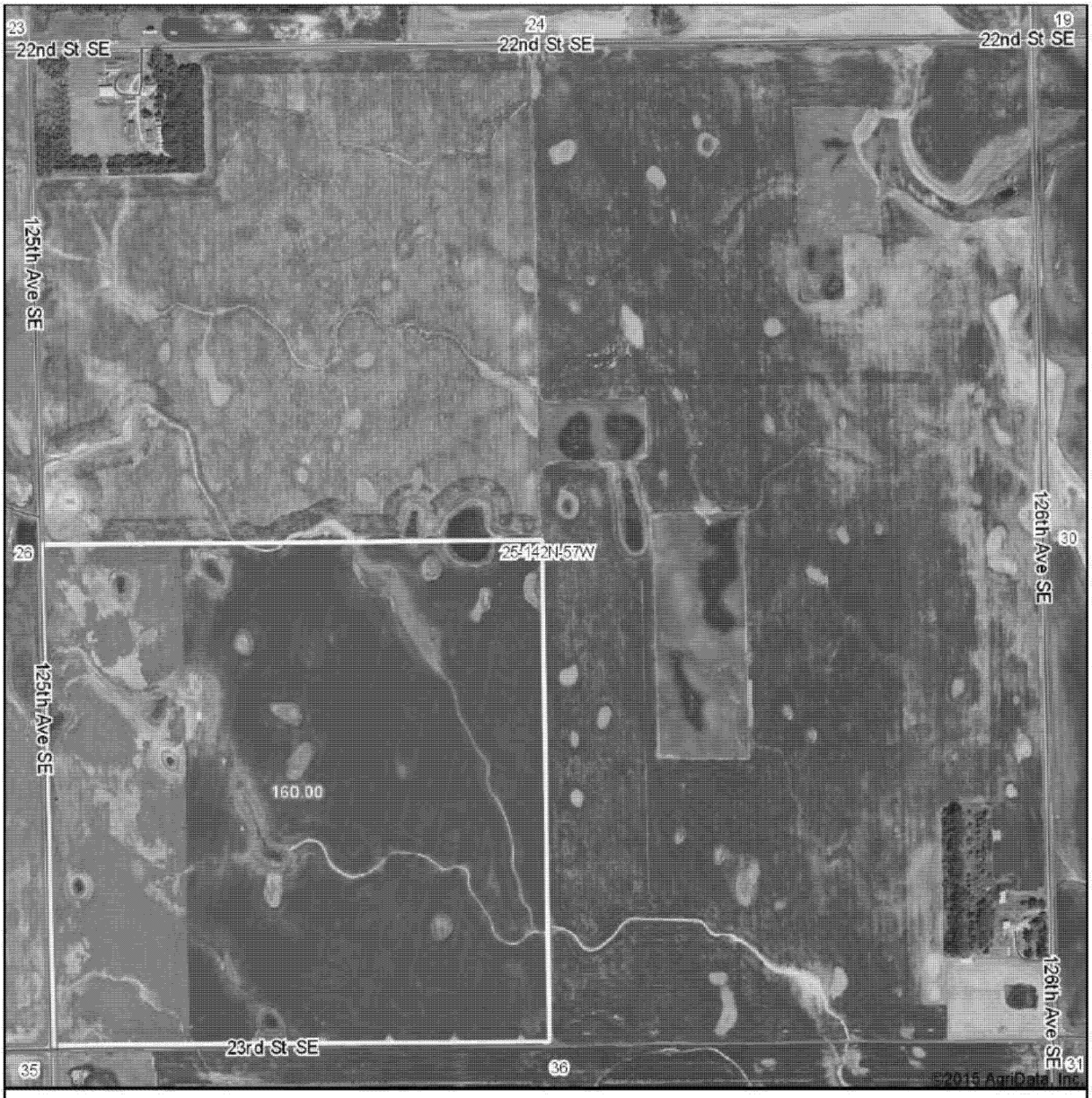
Remarks

The sale was confirmed by John Bruns, Grantee, who stated this was a private sale with his former father-in-law connecting him with the Grantor. The purchase was contract for deed for tax reasons and was satisfied via WD 269450 dated January 6, 2011. There are no wind turbines on the land, however, there are wind farms nearby. Mr. Bruns does not believe this had an impact on the purchase price. The land is 100% tillable. Mr. Bruns purchased the land to expand his farm business which is on the west side of 125th Avenue SE. Mr. Bruns has since deeded the land to his son via WD 277107 dated February 11, 2014, this transaction was exempt. The tract has many small potholes and sloughs.

The primary soils include Hamerly-Tonka complex, Hamerly-Wyard loams, and Balaton-Wyard loams. The slopes range from 0-6%. The non-irrigated soil classifications are II, IV, and V, with various susceptibility to erosion and water. The PI for this subject ranges from 25 to 77, with an overall weighted average of 64.7 for the entire tract. Of the total acreage 53.3% is Prime Farmland, 32.2% is Prime Farmland if Drained, with the remaining 14.5% being Not Prime Farmland. The soils are a range of predominantly non-hydric (53.3%), partially hydric (32.2%), and predominantly hydric (14.5%).



Aerial Map



map center: 47° 5' 15.93, 97° 50' 35.9

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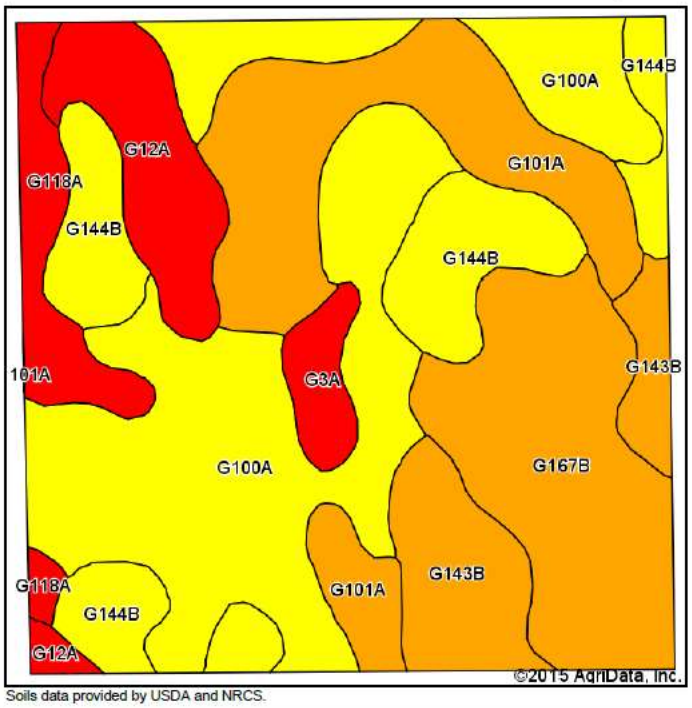
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25-142N-57W
Barnes County
North Dakota

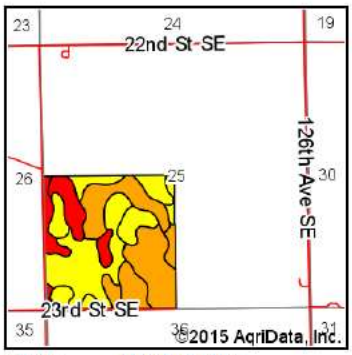
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11/25/2015

Soil Map



Soils data provided by USDA and NRCS.



State: **North Dakota**
County: **Barnes**
Location: **25-142N-57W**
Township: **Grand Prairie**
Acres: **160**
Date: **11/25/2015**

Maps Provided By:
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Area Symbol: ND003, Soil Area Version: 20

Code	Soil Description	Acres	Percent of field	PI Legend	Non-Irr Class *c	Productivity Index
G100A	Hamerly-Tonka complex, 0 to 3 percent slopes	51.15	32.0%		IIe	64
G101A	Hamerly-Wyard loams, 0 to 3 percent slopes	25.93	16.2%		IIe	77
G167B	Balaton-Wyard loams, 0 to 6 percent slopes	25.23	15.8%		IIe	73
G144B	Barnes-Buse loams, 3 to 6 percent slopes	21.92	13.7%		IIe	69
G143B	Barnes-Svea loams, 3 to 6 percent slopes	12.73	8.0%		IIe	75
G12A	Vallers, saline-Parnell complex, 0 to 1 percent slopes	11.57	7.2%		IVw	31
G118A	Vallers loam, saline, 0 to 1 percent slopes	7.84	4.9%		IVw	42
G3A	Parnell silty clay loam, 0 to 1 percent slopes	3.63	2.3%		Vw	25
					Weighted Average	**64.7**

Area Symbol: ND003, Soil Area Version: 20

*c: Using Capabilities Class Dominant Condition Aggregation Method

Soils data provided by USDA and NRCS.

Topography Map



map center: 47° 5' 15.93, 97° 50' 35.9

0ft 817ft 1634ft

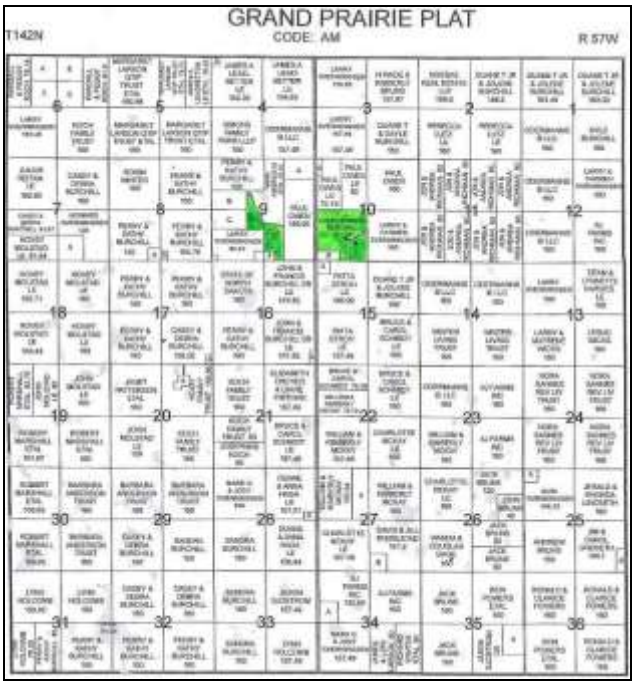
25-142N-57W
Barnes County
North Dakota

N W E S

11/25/2015

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Land Sale No. 11



Property Identification

Record ID	5976
Property Type	Vacant Land
Address	20th Street SE and 123rd Avenue SE, Barnes County, North Dakota
Location	Grand Prairie Township
Tax ID	13-1030300; 13-0930320; 13-0940430
Legal Description	SW4 Section 10, less tracts; and Auditor's Lot 3 of the W2 and a tract 100 rods x 60 rods in the SE4, Section 9, T142N R57W, Barnes County, North Dakota. Metes and bound on file in the office of the appraiser.

Sale Data

Grantor	Mark C. Askerooth et al
Grantee	Casey J. and Debra L. Burchill
Sale Date	September 09, 2010
Deed Book/Page	WD 268586; Amended October 27, 2010; W/D 269226
Property Rights	Lease fee; Surface rights / fractional interest; mineral rights reserved
Conditions of Sale	Assemblage
Financing	Cash to seller
Sale History	TD 259801 dated 22 May 2007, Ethel A. Askerooth Living Trust to Mark C. Askerooth et al for the SW4, this transaction was exempt.
Verification	Deb Burchill, Grantee; (701) 845-0726, November 19, 2015; Other sources: County records
Sale Price	$250,000

Land Data

Zoning	AG, Agricultural
Topography	Level to rolling hills; slopes 0 – 15%
Utilities	Assumed telephone and electricity available

Land Sale No. 11 (Cont.)

Shape	Irregular
Roads	Gravel
Access	20th St SE
Productivity Index	63.4
Wind Farm	Adjacent
Wind Turbines on Tract	None; pad sites are owned by Grantor

Land Size Information

Gross Acres	196.270 Acres; 13.83 acres have saline present
Tillable Acres	176.640 Acres, 90.00%
Wetlands Land Size	19.620 Acres, 10.00%

Indicators

Sale Price/Gross Acre	$1,274
Sale Price/ Tillable Acre	$1,415

Remarks

The sale was confirmed by Deb Burchill, Grantee, who stated they leased the land for $65.00/acre from the Grantor prior to purchase. She believes they paid market price and purchased the land to maintain their farm operation. The land is 90% tillable and 10% waste / wetland. There were 3 wind turbines on the land at the time of the sale which the Grantor kept, making the sale quite confusing as it was one of the first in the State. Since attorneys were not familiar with wind royalties, the land under the turbines was omitted from the sale, resulting in very complicated legal descriptions for the sold tracts. (See W/D Doc. #'s 268462, 268463, 268461, 268464). Mrs. Burchill believes the wind farm had no impact on the value of the land. A large substation is located in the SW corner of the SW4 Section 10. A farmstead that belongs to the grantor, is located just south-southwest of the turbines on the S2 of Section 9. The seller retained the farmstead.

The primary soils include Barnes-Buse loams and Barnes-Buse-Langhei loams. The slopes range from 0-15%. The non-irrigated soil classifications are II, III, IV, V, and VI, with various susceptibility to erosion, water, and climate. The PI for this subject ranges from 25 to 75, with an overall weighted average of 63.4 for the entire tract. Of the total acreage, approximately 71.5% is Prime Farmland, 17.3% is Not Prime Farmland, 10.7% is Farmland of Statewide Importance, 0.5% is Prime Farmland if Drained. The soils are a range of predominantly non-hydric (84.0%), predominantly hydric (7.8%), non-hydric (7.6%), and partially hydric (0.6%). 13.83 acres have saline present. Saline affects plant growth and prices.



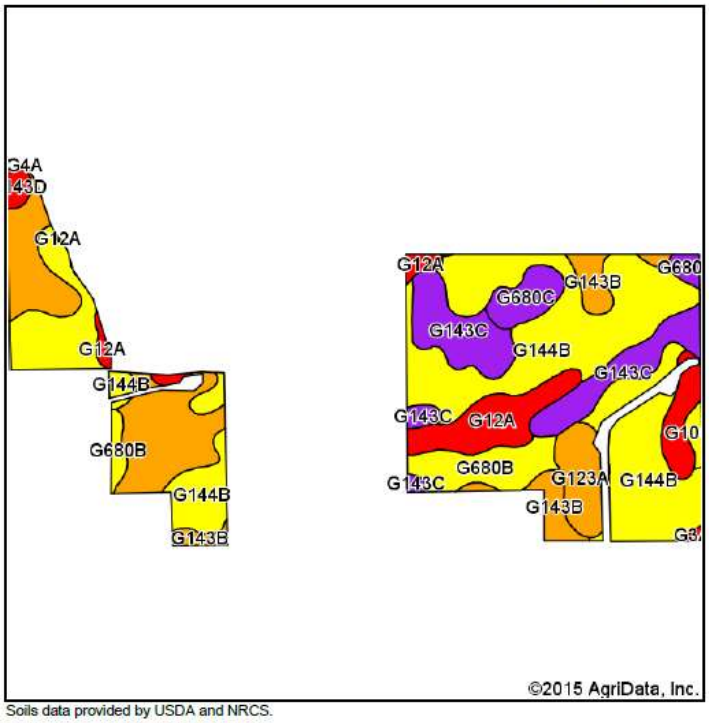




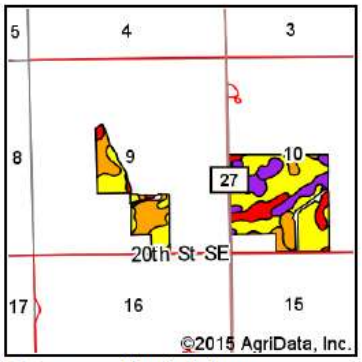
Aerial Map


4-142N-57W
123rd Ave SE
9-142N-57W
27
8-142N-57W
24.83
10-142N-57W
141.39
30.05
20th St SE
20th St SE
20th St SE
16-142N-57W
15-142N-57W
123rd Ave SE
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map center: 47° 7' 52.46, -97° 54' 3.42
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9-142N-57W
Barnes County
North Dakota
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12/1/2015

Soil Map



Soils data provided by USDA and NRCS.



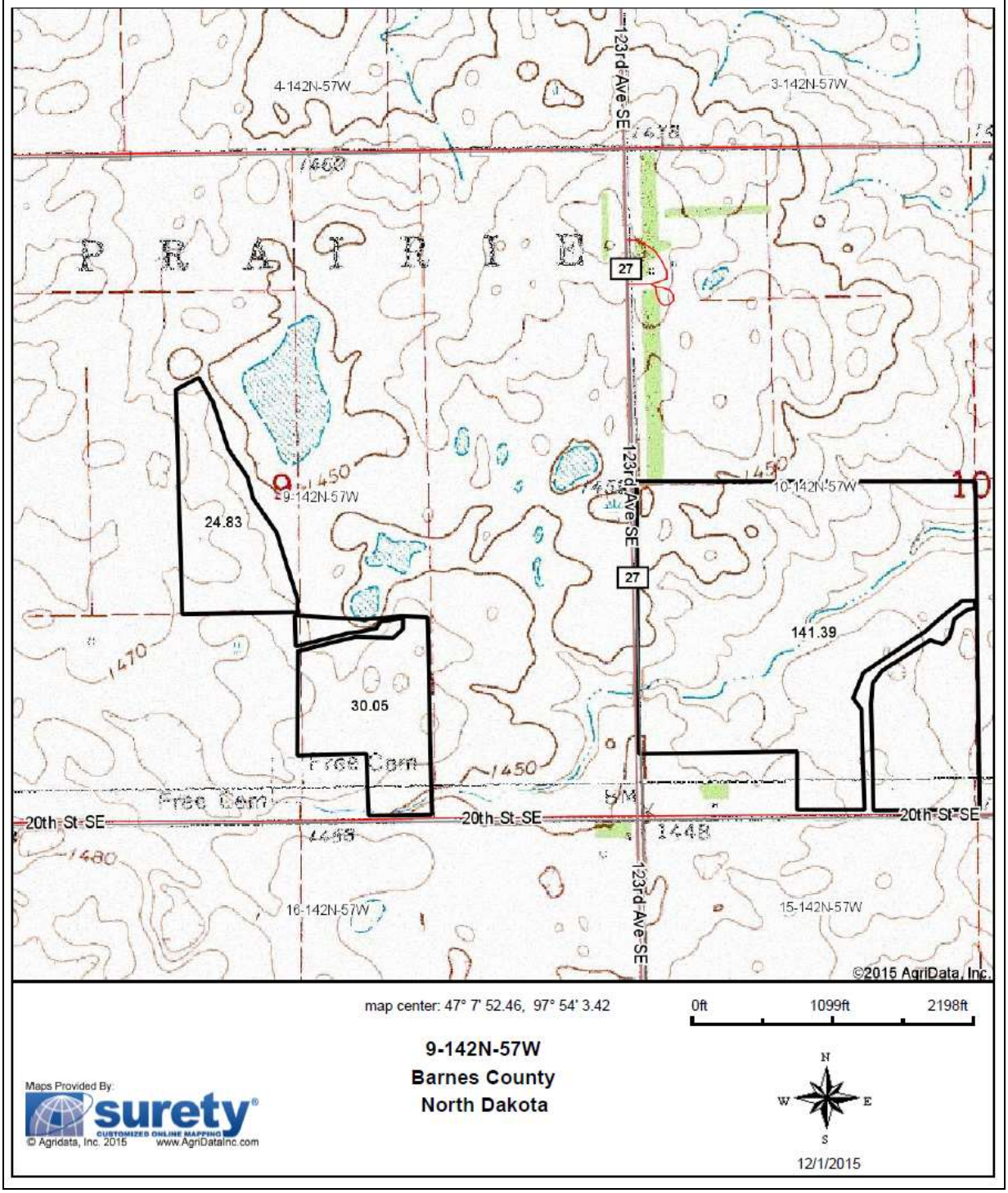
State: **North Dakota**
County: **Barnes**
Location: **9-142N-57W**
Township: **Grand Prairie**
Acres: **196.27**
Date: **12/1/2015**

Maps Provided By: surety® CUSTOMIZED ONLINE MAPPING © Agridata, Inc. 2015 www.AgriDataInc.com

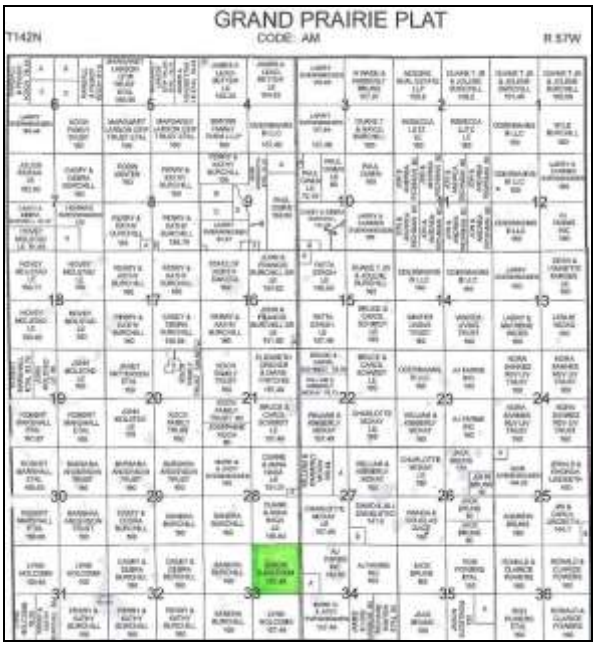
Area Symbol: ND003, Soil Area Version: 20

Code	Soil Description	Acres	Percent of field	PI Legend	Water Table	Non-Irr Class *c	Range Production (lbs/acre/yr)	Productivity Index
G144B	Barnes-Buse loams, 3 to 6 percent slopes	86.90	44.3%		4.9ft.	IIe	2988	69
G143C	Barnes-Buse-Langhei loams, 6 to 9 percent slopes	23.46	12.0%		> 6.5ft.	IVe	2763	56
G143B	Barnes-Svea loams, 3 to 6 percent slopes	19.52	9.9%		4.9ft.	IIe	3034	75
G732B	Swenoda-Barnes complex, 3 to 6 percent slopes	16.24	8.3%		4.9ft.	IIIe	3334	74
G12A	Vallers, saline-Parnell complex, 0 to 1 percent slopes	13.83	7.0%		0.7ft.	IVw	4453	31
G680B	Barnes-Sioux complex, 1 to 6 percent slopes	11.94	6.1%		4.9ft.	IIe	2416	63
G123A	Svea-Cavour loams, 0 to 3 percent slopes	7.82	4.0%		4ft.	IIc	2703	73
G680C	Barnes-Sioux complex, 3 to 9 percent slopes	7.19	3.7%		4.9ft.	IIe	2302	55
G3A	Parnell silty clay loam, 0 to 1 percent slopes	6.38	3.3%		0ft.	Vw	5336	25
G143D	Barnes-Buse-Langhei loams, 9 to 15 percent slopes	1.65	0.8%		> 6.5ft.	VIe	2650	41
G100A	Hamerly-Tonka complex, 0 to 3 percent slopes	1.34	0.7%		4.9ft.	IIe	4114	64
						Weighted Average	**3107.4**	**63.4**

Topography Map



Land Sale No. 12



Property Identification

Record ID	5964
Property Type	Vacant Land
Address	123rd Avenue SE and 23rd Street SE, Barnes County, North Dakota
Location	Grand Prairie Township
Tax ID	13-3310100
Legal Description	NE4 Section 33, T142N R57W, Barnes County, North Dakota.

Sale Data

Grantor	Sandra Burchill
Grantee	Jason Sjostrom
Sale Date	March 30, 2010
Deed Book/Page	WD 267592
Property Rights	Fee simple
Conditions of Sale	Normal
Financing	Cash to seller
Sale History	Records were searched for 3 years prior to the sale; no transfer was found.
Verification	Jason Sjostrom, Grantee; (701) 367-4548, November 23, 2015; Other sources: County records
Sale Price /Land Only	$170,200 land only
Premium for Air Rights	$ 47,300 air rights at $300 per acre
Sale Price inc Air Rights	$217,500

Land Data

Zoning	AG, Agricultural
Topography	Level to undulating; slopes 1 – 9%
Utilities	Assumed telephone and electricity available
Shape	Square
Roads	Gravel
Access	123rd Ave SE
Productivity Index	66.8

Land Size Information

Gross Acres	157.490 Acres
Tillable Acres	149.490 Acres, 94.92%
Sloughs Land Size	8.000 Acres, 5.08%

Indicators

Sale Price/Gross Acre	$1,381
Sale Price/ Acre	$1,455

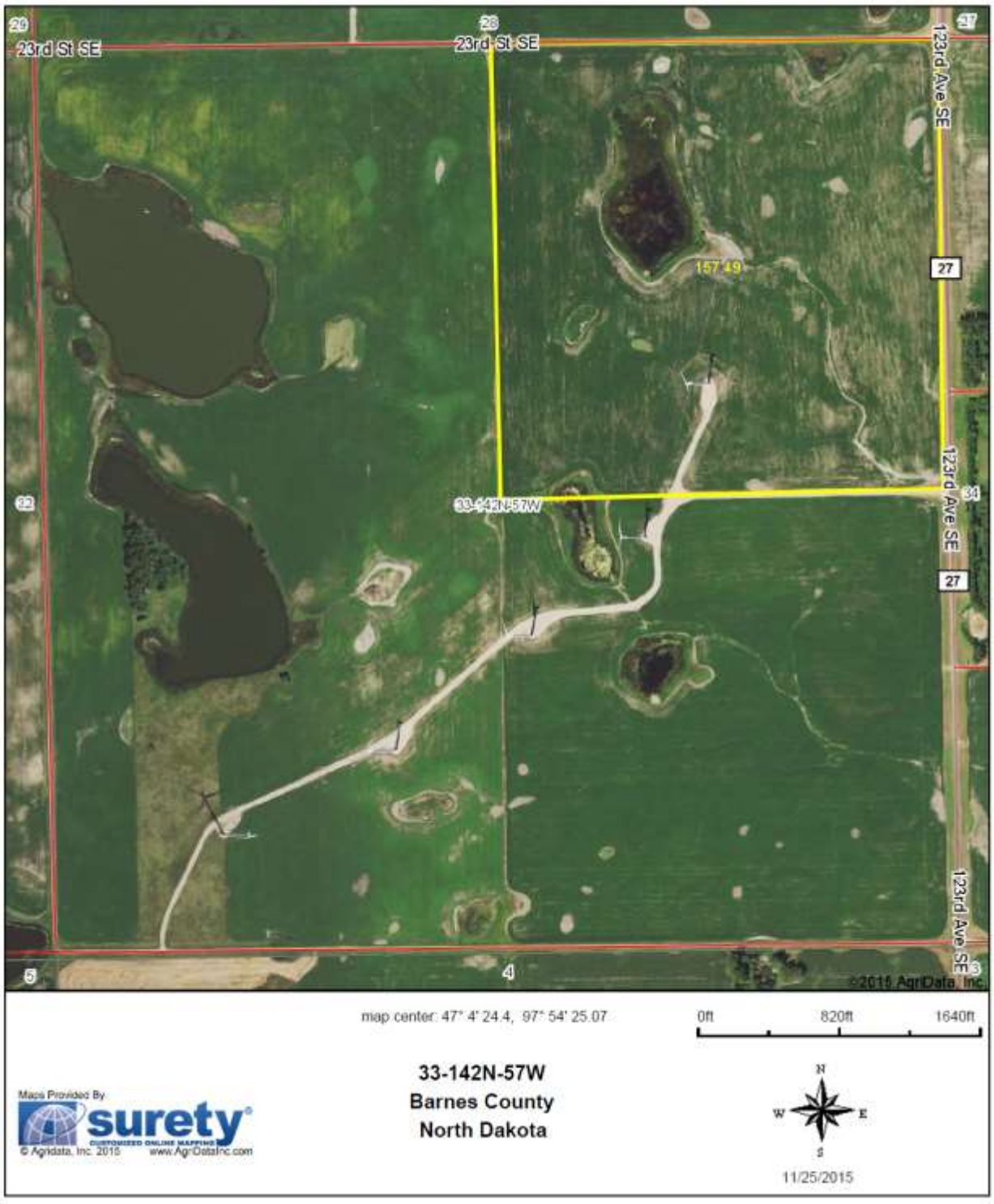
Remarks

The sale was confirmed by Jason Sjostrom, Grantee. He purchased the land from the Grantor as an investment, and now rents it back to her nephew. Of the total, 149.49 acres are tillable; 8 acres are waste or slough. There was 1 wind turbine on the land at the time of the sale. Mr. Sjostrom said he paid $300.00+ more per acre for the land to secure the royalty rights, or $47,300 for the royalty rights of the single turbine. This is comparable to Sale 16 in which the buyer paid $50,000 per turbine for the royalty rights. That sale took place in December 2012 or roughly 2.5 years later, which would explain the increase.

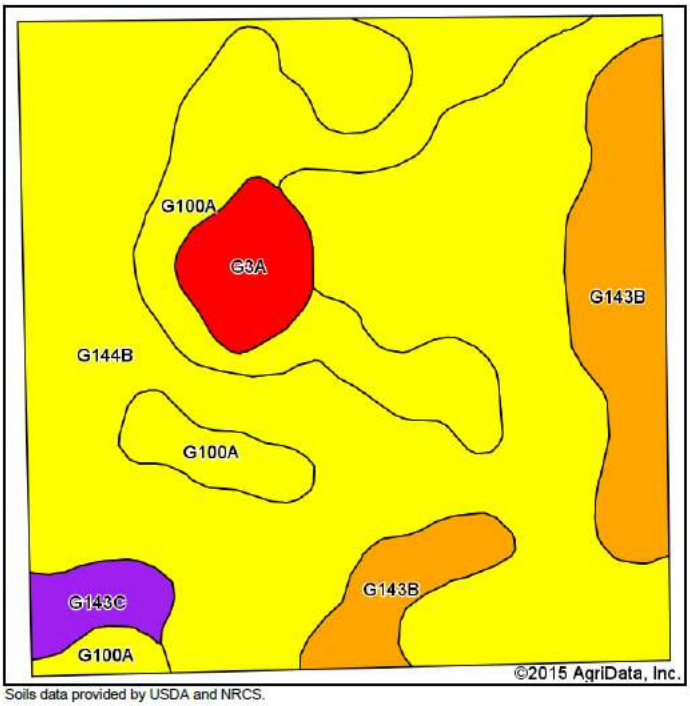
The primary soils include Barnes-Buse loams, Hamerly-Tonka complex, and Barnes-Svea loams. The slopes range from 0-9%. The non-irrigated soil classifications are II, IV, and V, with various susceptibility to erosion and water. The PI for this subject ranges from 25 to 75, with an overall weighted average of 66.8 for the entire tract. Of the total acreage 75.3% is Prime Farmland, 18.1% is Prime Farmland if Drained, with the remaining 6.6% being Not Prime Farmland. The soils are a range of predominantly non-hydric (77.9%), partially hydric (18.1%), and predominantly hydric (4.0%).



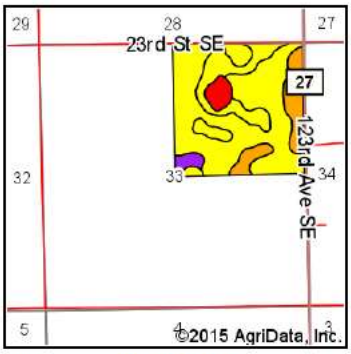
Aerial Map


29
28
27
23rd St SE
23rd St SE
123rd Ave SE
157.49
27
32
33-142N-57W
34
123rd Ave SE
27
5
4
3
©2015 AgriData, Inc
map center: 47° 4' 24.4, 97° 54' 25.07
0ft
820ft
1640ft
Maps Provided By
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33-142N-57W
Barnes County
North Dakota
N
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11/25/2015

Soil Map



Soils data provided by USDA and NRCS.



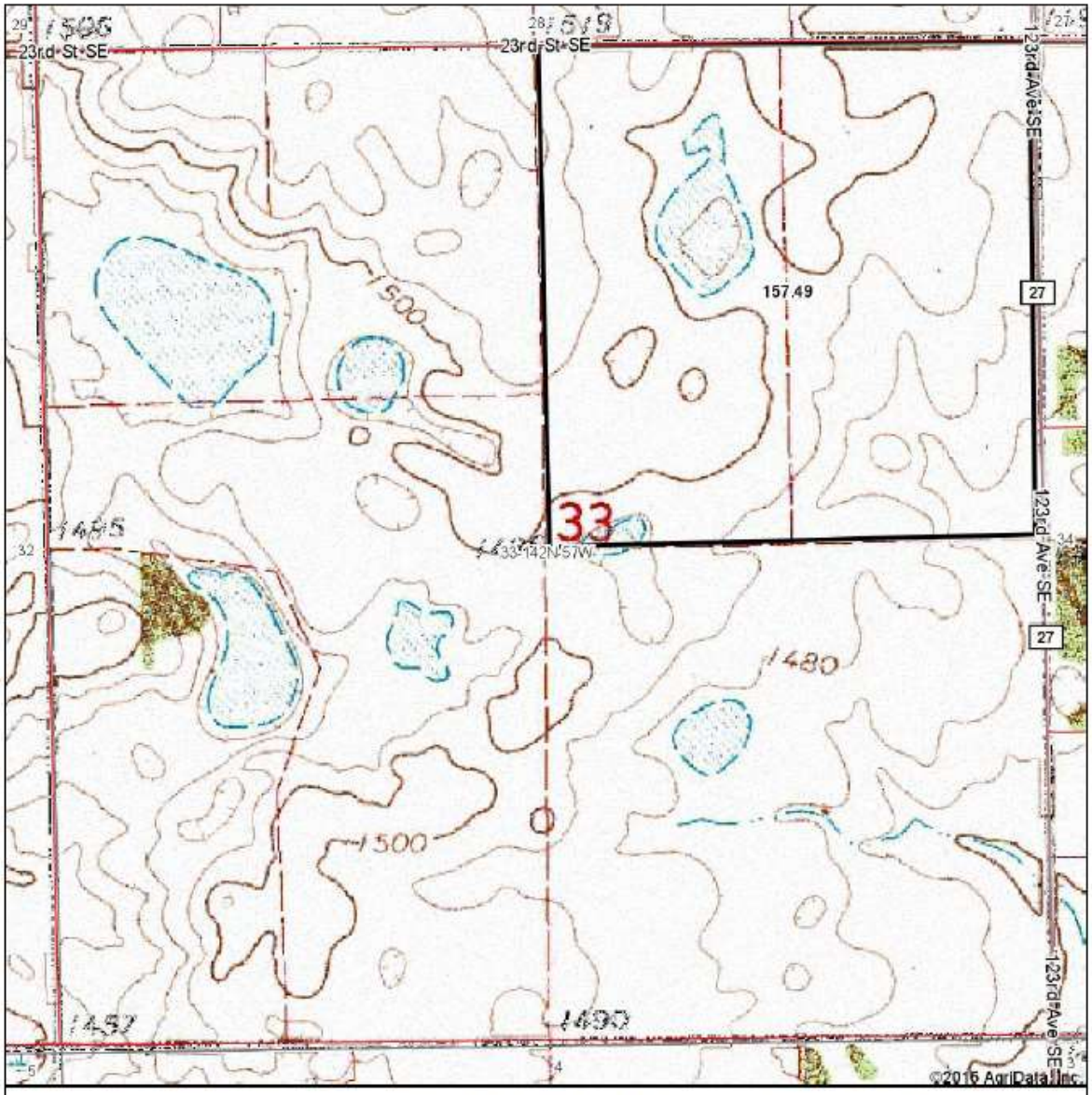
State: **North Dakota**
County: **Barnes**
Location: **33-142N-57W**
Township: **Grand Prairie**
Acres: **157.49**
Date: **11/25/2015**

Maps Provided By:
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Area Symbol: ND003, Soil Area Version: 20

Code	Soil Description	Acres	Percent of field	PI Legend	Non-Irr Class *c	Productivity Index
G144B	Barnes-Buse loams, 3 to 6 percent slopes	97.67	62.0%		IIe	69
G100A	Hamerly-Tonka complex, 0 to 3 percent slopes	28.79	18.3%		IIe	64
G143B	Barnes-Svea loams, 3 to 6 percent slopes	20.97	13.3%		IIe	75
G3A	Parnell silty clay loam, 0 to 1 percent slopes	6.30	4.0%		Vw	25
G143C	Barnes-Buse-Langhei loams, 6 to 9 percent slopes	3.76	2.4%		IVe	56
					Weighted Average	**66.8**

Topography Map



STEELE COUNTY, NORTH DAKOTA

The surveyed area is located north of Luverne, North Dakota, adjacent to and east of Lake Ashtabula or the upper reserve of the Baldhill Dam. The area is primarily rural in nature, with farmsteads located at one to two mile increments, and Lake Ashtabula lying about ½ to three miles west. Barnes County lies to the south. The topography is comprised of rolling hills with some steep ravines. The area is generally treeless, with the exception of sporadic mature tree claims or wooded swales. The soils are glacial till, and range from level to undulating with drainage varying from poor to well drained. Agricultural uses include crop and hay production as well as pasture for livestock.

Overall, the wind farms suggest little physical impact to the land other than the area used for turbine placement and access. Typically, the access roads appeared to use a minimal amount of land to access the turbines.

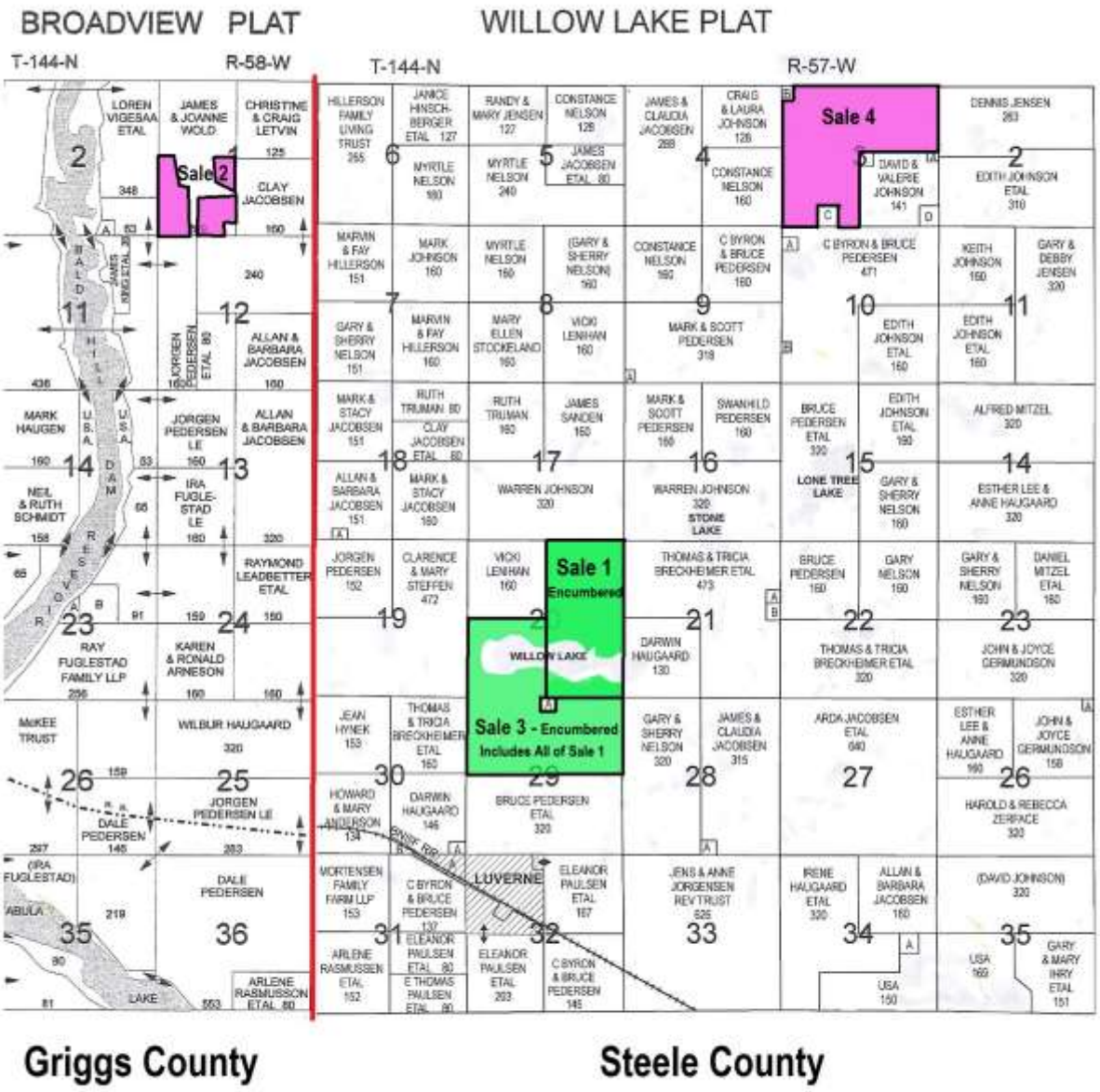
Sales were not as plentiful as Barnes County. Only two sales (1 and 3), which represent a sale and partial resale of the same tract, were improved with wind turbines. Sales 2 and 4 were not. All of the data are situated adjacent to or near wind farms.

No	Legal Description					Date	Sale Price	Deeded Acres	PI	Sale Price/ Deeded Acre	Turbines on Sale Tract	Adjacent Wind Farm	Negative Influence	Premium Paid
1	NE4; Lots 1&2	20	144	57	Steele	2/26/2013	$ 668,043	262.27	66.8	$ 2,547	two	yes	no	no
2	A,B,C SW4	1	144	58	Griggs	12/31/2012	$ 205,000	108.21	66.7	$ 1,894	none	yes	no	no
3	Parts NE, S2 N2	20 29	144	57	Steele	12/23/2012	$1,737,563	662.23	69.0	$ 2,624	three	yes	no	yes
4	W2, NE4, less tracts	3	144	57	Steele	12/12/2012	$1,239,000	413.00	68.7	$ 3,000	none	yes	no	yes

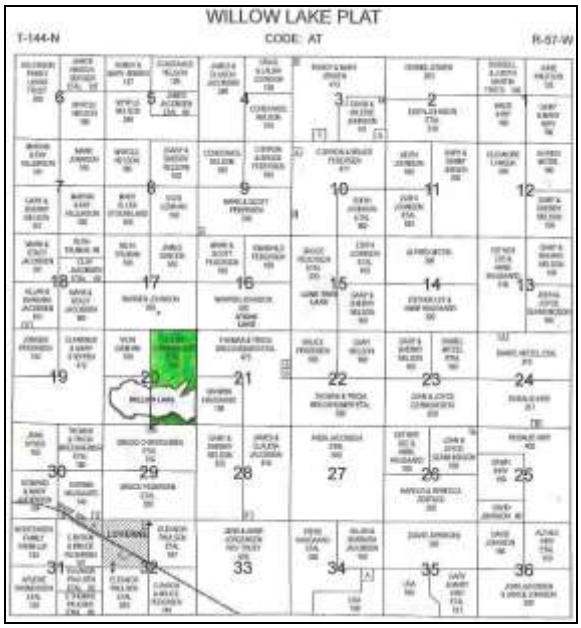
The sales were then grouped according to their productivity index as follows.

No	Legal Description					Date	Sale Price	Deeded Acres	PI	Sale Price/ Deeded Acre	Turbines on Sale Tract	Adjacent Wind Farm	Negative Influence	Premium Paid	Comments
3	Parts NE, S2 N2	20 29	144	57	Steele	12/23/2012	$1,737,563	662.23	69.0	$ 2,624	three	yes	no	yes	Wind royalties were retained by previous grantor; 27.97% waste
4	W2, NE4, less tracts	3	144	57	Steele	12/12/2012	$1,239,000	413.00	68.7	$ 3,000	none	yes	no	yes	Premium paid for land due to increasing prices
1	NE4; Lots 1&2	20	144	57	Steele	2/26/2013	$ 668,043	262.27	66.8	$ 2,547	two	yes	no	no	Wind royalties were retained by previous grantor. Partial resale of part of Sale 4; 33.8% waste
2	A,B,C SW4	1	144	58	Griggs	12/31/2012	$ 205,000	108.21	66.7	$ 1,894	none	yes	no	no	Parcel consists of three individual tracts; diminution in functional utility noted

Again, these sales occurred during the rapidly increasing market of 2012. The data notes the rapidly increasing agricultural prices from 2011 to 2013 due to high commodity prices and to the construction of an ethanol plant at Casselton, North Dakota, which was driving up the price of corn. Sale 1 is a part of Sale 3. The buyer of Sale 3 indicated that neither the turbines nor the lack of wind royalties made a difference in the price he paid. The land was purchased for agricultural and recreational uses. The difference in sale prices between the two tracts (1 and 3) is due to the amount of waste, which becomes readily apparent when the Sales are compared to Sale 4 which is entirely tillable. The buyer of Sale 4 stated he paid a premium for the tract because he wanted it to expand his farming operation. Finally, Sale 2 suffers from functional inutility as it is comprised of three tracts of irregularly shaped land located in the same section. The variances within each data set are attributable to differences in physical condition. None of the Sales evidence market resistance.


BROADVIEW PLAT
WILLOW LAKE PLAT
T-144-N
R-58-W
T-144-N
R-57-W
Sale 2
Sale 4
Sale 1
Encumbered
Sale 3 - Encumbered
Includes All of Sale 1
WILLOW LAKE
LUVERNE
LONE TREE LAKE
STONE LAKE
Griggs County
Steele County

Land Sale No. 1



Property Identification

Record ID	5999
Property Type	Vacant Land
Address	9th Street SE; east of County Hwy 25, Steele County, North Dakota
Location	Willow Lake Township
Tax ID	20-0000-04280-000; 20-0000-04282-000
Legal Description	NE4; Lots 1–4, Section 20, T144N R57W, Steele County, North Dakota

Sale Data

Grantor	Trevor L. Jacobson et al
Grantee	Darwin L. and Denora M. Haugaard
Sale Date	February 26, 2013
Deed Book/Page	WD 102716
Property Rights	Surface rights / fractional interest, less wind royalties
Conditions of Sale	Normal
Financing	Cash to seller
Sale History	WD 102715 dated 2/21/2013, from Gregg W. Christensen et al to Trevor L. Jacobson et al, for this land and other land see DC 5998.
Verification	Trevor Jacobson, Grantor; (701) 371-9233, 12/1/2015; Judy Brosz, Office of the State Tax Commissioner, (701) 328-3142, County records
Sale Price	$668,043

Land Data

Zoning	AG, Agricultural
Topography	Level to undulating; 0 to 15% slopes
Utilities	Assumed telephone and electricity available
Shape	Irregular
Roads	Paved and gravel
Access	9th St SE and part landlocked

Land Sale No. 1 (Cont.)

Productivity Index	66.8
Adjusted Productivity Index	71.7 less sloughs and waste
Wind Farm	Adjacent to the northwest and northeast
Wind Turbines on Tract	Two

Land Size Information

Gross Acres	262.27 Acres
Tillable Acres	173.71 Acres, 66.23%
Sloughs and Waste	88.56 Acres. 33.77%

Indicators

Sale Price/Gross Acre	$2,547
Sale Price/Tillable Acre	$3,846

Remarks

The sale was confirmed by Trevor Jacobson, Grantor, who stated he sold the land privately and believes he got a market rate. Mr. Jacobson did not think the wind turbines impacted the price but he does not own the royalty rights to the turbines and therefore could not sell the rights with the land. The land is vacant with a large tree grove; the sale does not include Willow Lake. The NE4 is mostly tillable whereas there is little land in the SE4 as it is mostly lake.

The primary soils include Barnes-Svea loams, Barnes-Buse loams, and Hamerly-Tonka complex. The slopes range from 0-15%. The non-irrigated soil classifications are II, IV, V, and VI, with various susceptibility to erosion, water, and climate. The PI for this subject ranges from 2 to 85, with an overall weighted average of 66.8 for the entire tract. Of the total average acreage 62.2% is Prime Farmland, 21.4% is Prime Farmland if Drained, with the remaining 16.4% being Not Prime Farmland. The soils are a range of predominantly non-hydric (76.7%), partially hydric (20.1%), and predominantly hydric (3.2%).



Aerial Map



map center: 47° 16' 37.2, 97° 55' 45.97

0ft 846ft 1693ft

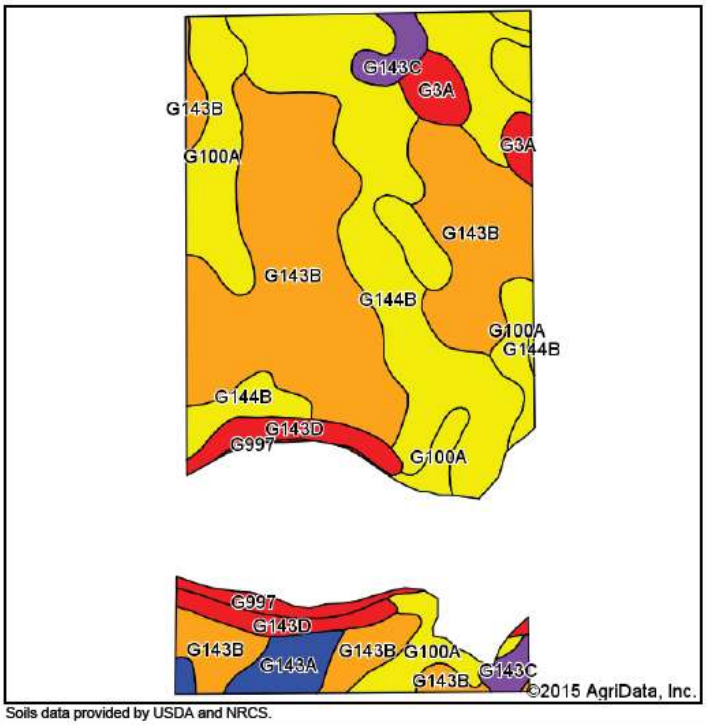
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20-144N-57W
Steele County
North Dakota

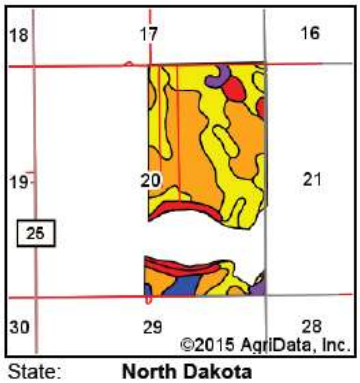
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12/4/2015

Soil Map



Soils data provided by USDA and NRCS.



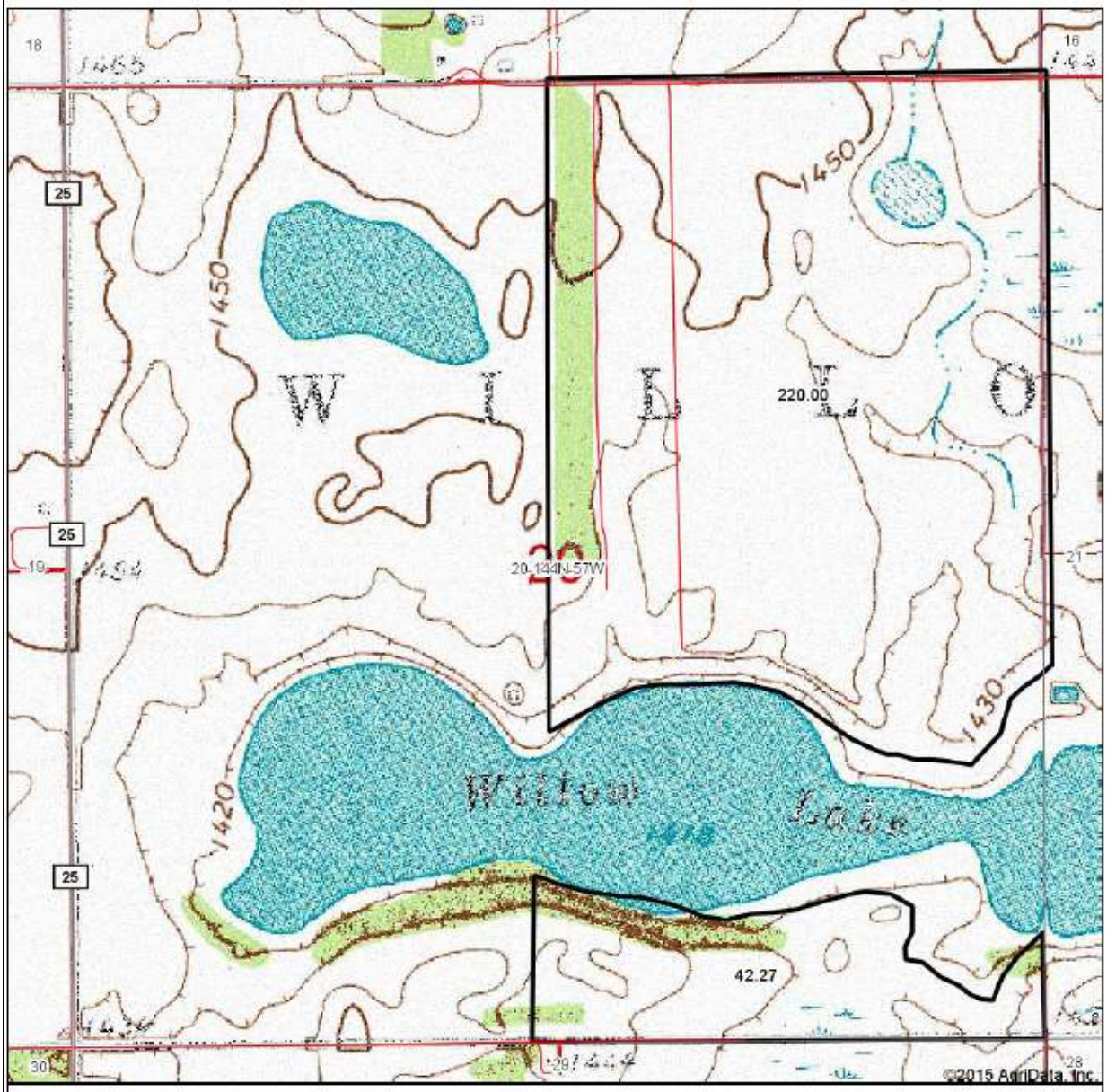
State: **North Dakota**
County: **Steele**
Location: **20-144N-57W**
Township: **Willow Lake**
Acres: **262.27**
Date: **12/4/2015**

Maps Provided By:
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Area Symbol: ND091, Soil Area Version: 20

Code	Soil Description	Acres	Percent of field	PI Legend	Water Table	Non-Irr Class *c	Range Production (lbs/acre/yr)	Productivity Index
G143B	Barnes-Svea loams, 3 to 6 percent slopes	107.83	41.1%		4.9ft.	IIe	3034	75
G144B	Barnes-Buse loams, 3 to 6 percent slopes	64.31	24.5%		4.9ft.	IIe	2988	69
G100A	Hamerly-Tonka complex, 0 to 3 percent slopes	50.55	19.3%		4.9ft.	IIe	4114	64
G143D	Barnes-Buse-Langhei loams, 9 to 15 percent slopes	12.77	4.9%		> 6.5ft.	VIe	2650	41
G143A	Barnes-Svea loams, 0 to 3 percent slopes	7.75	3.0%		4.9ft.	IIc	3405	85
G3A	Parnell silty clay loam, 0 to 1 percent slopes	7.48	2.9%		0ft.	Vw	5336	25
G143C	Barnes-Buse-Langhei loams, 6 to 9 percent slopes	6.91	2.6%		> 6.5ft.	IVe	2763	56
G997	Water, intermittent	4.67	1.8%		0ft.		415	2
						Weighted Average	**3235**	**66.8**

Topography Map



map center: 47° 16' 37.2, 97° 55' 45.97

0ft 846ft 1693ft

20-144N-57W
Steele County
North Dakota

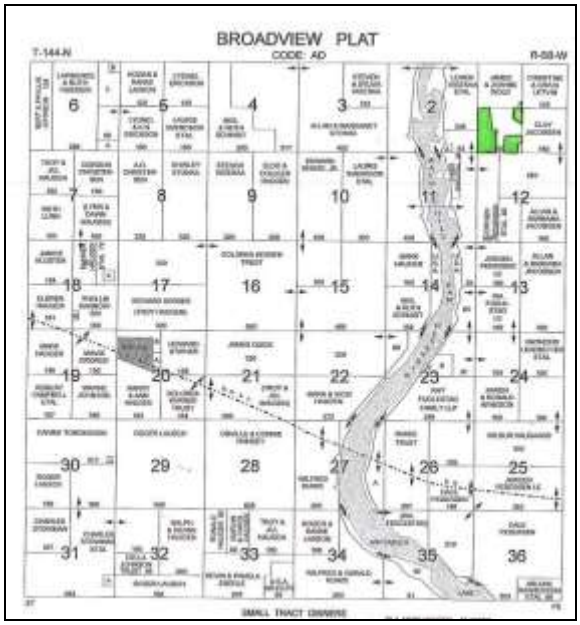
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N W E S

12/4/2015

Land Sale No. 2





Property Identification

Record ID	6000
Property Type	Agricultural
Address	7th Street SE, Prairie Road, Griggs County, North Dakota
Location	Broadview Township
Legal Description	Tracts A, B and C in SW4 Section 1, T144N R58W, Griggs County, North Dakota

Sale Data

Grantor	James and JoAnne Wold Trust
Grantee	George Berger
Sale Date	December 31, 2012
Deed Book/Page	CFD 102864; amended 2/15/2013 Doc #102958
Property Rights	Fee Simple to pass when warranty deed is issued
Conditions of Sale	Assemblage
Financing	Cash to Seller
Verification	George Berger, Grantee; (701) 490-1222, December 04, 2015
Sale Price	$205,000

Land Data

Topography	Undulating, 3 to 15% slopes
Utilities	Assumed water and electricity
Shape	Irregular
Access	7th Street SE
Productivity Index	66.7
Wind Farm	To the S-SE, N-NE and ½ mile east
Turbines on Tract	None

Land Sale No. 2 (Cont.)

Land Size Information
Gross Land Size 108.21 Acres

Indicators
Sale Price/Gross Acre $1,894

Remarks
The grantee and the grantor were neighbors. The grantee believes he paid a market price for the vacant subject. The property was an assemblage to the grantee's land. The tract includes 8 acres of native prairie grass. The grantee believes there was no impact on the price due to wind towers being located adjacent to the tract.

The primary soils include Barnes-Svea loams, and Barnes-Buse loams. The slopes range from 0-15%. The non-irrigated soil classifications are II, IV, and VI, with various susceptibility to erosion. The PI for this subject ranges from 46 to 75, with an overall weighted average of 66.7 for the entire tract. Of the total acreage 16.6% is Not Prime Farmland, 6.8% is Farmland of Statewide Importance, and 76.6% is Prime Farmland. The soils are 100% predominantly non-hydric.



Aerial Map



map center: 47° 19' 0.55, 97° 58' 34.31

0ft 449ft 899ft

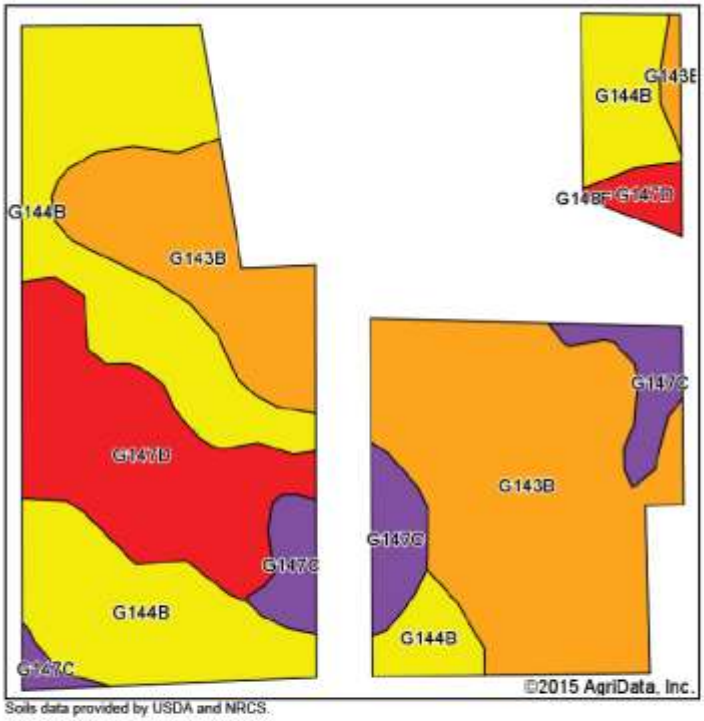
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1-144N-58W
Griggs County
North Dakota

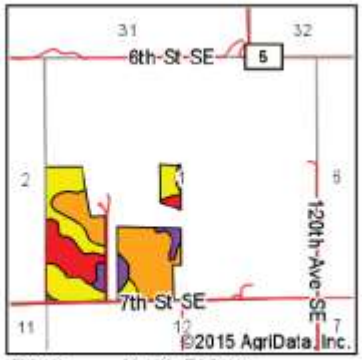
N W E S

12/4/2015

Soil Map



Soils data provided by USDA and NRCS.



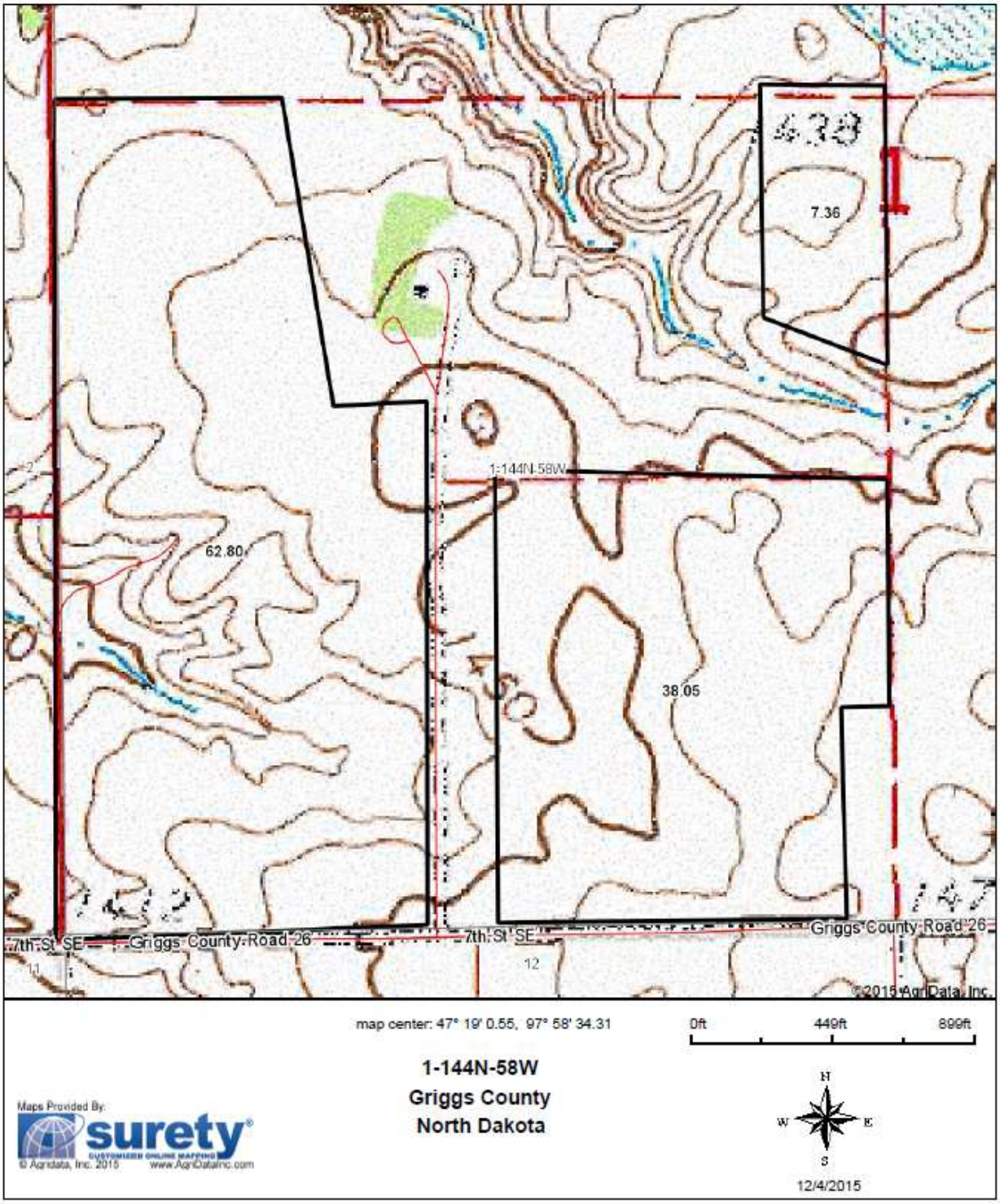
State: North Dakota
County: Griggs
Location: 1-144N-58W
Township: Broadview
Acres: 108.21
Date: 12/4/2015

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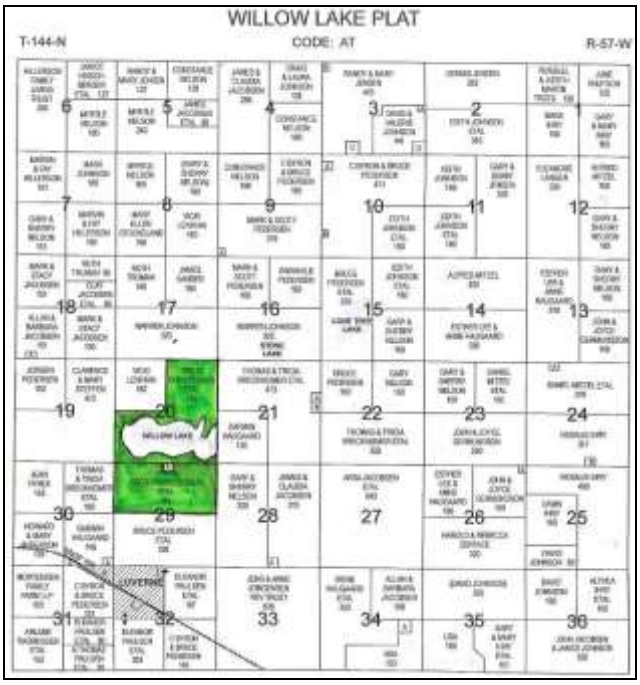
Area Symbol: ND039, Soil Area Version: 20

Code	Soil Description	Acres	Percent of field	PI Legend	Non-Irr Class *c	Productivity Index
G143B	Barnes-Svea loams, 3 to 6 percent slopes	42.70	39.5%		IIe	75
G144B	Barnes-Buse loams, 3 to 6 percent slopes	38.11	35.2%		IIe	69
G147D	Buse-Barnes-Darnen loams, 6 to 15 percent slopes	18.45	17.1%		VIe	46
G147C	Buse-Barnes-Darnen loams, 3 to 9 percent slopes	8.95	8.3%		IVe	60
					Weighted Average	**66.7**

Topography Map



Land Sale No. 3



Property Identification

Record ID	5998
Property Type	Vacant Land
Property Name	3 wind turbines
Address	County Hwy 25 and 9th Street SE, North Dakota
Location	Willow Lake Township
Tax ID	Various parcel numbers
Legal Description	Lots 1 – 8; NE4 Section 20; N2 Section 29; T144N R57W, Less 4.03 acres for homestead. See WD for metes and bounds.

Sale Data

Grantor	Gregg W. Christensen et al
Grantee	Trevor L. Jacobson et al
Sale Date	December 23, 2012
Deed Book/Page	C/D 102571; satisfied W/D Doc #102715 / 2/21/2013
Property Rights	Leased fee; fractional interest, less mineral rights and wind royalties
Conditions of Sale	Assemblage
Financing	Cash to seller
Sale History	Records were searched for a 3 year period; no transfer was found.
Verification	Trevor Jacobson, Grantee; (701) 371-9233, December 01, 2015; Other sources: County records
Sale Price	$1,737,563

Land Data

Zoning	AG, Agricultural
Topography	Level to rolling hills, 0 to 15% slopes
Utilities	Assumed telephone and electricity available
Shape	Irregular

Land Sale No. 3 (Cont.)

Roads	Paved and gravel
Access	County Hwy 25 and 9th St SE
Productivity Index	69
Tree Farm	Adjacent, NE and NW
Turbines on Tract	Three

Land Size Information

Gross Land Size	662.230 Acres
Tillable Land Size	477.000 Acres, 72.03%
Unusable Land Size	185.330 Acres, 27.99%

Indicators

Sale Price/Gross Acre	$2,624
Sale Price/ Acre	$3,643

Remarks

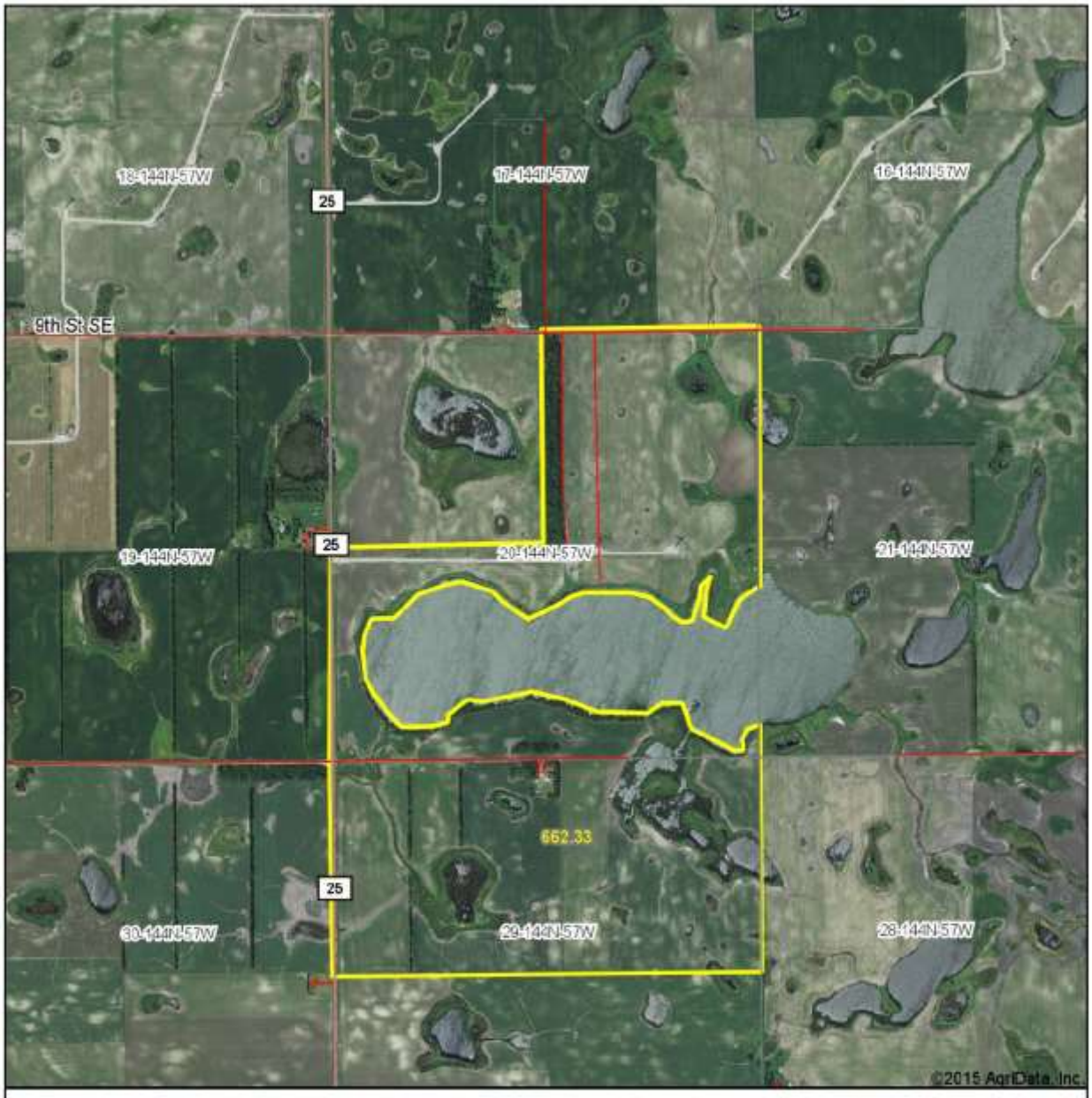
The sale was confirmed by Trevor Jacobson, Grantee, who stated he was approached by the Grantor to purchase the land. The price was negotiated and Mr. Jacobson felt the price was market. Although the Grantor retained the royalty rights to the three turbines located on the tract, Mr. Jacobsen stated that neither the turbines nor the lack of royalty rights influenced the price paid. Mr. Jacobson He had been leasing it for $57.00 per acres prior to sale, and purchased it to maintain his farm operation as well as to have some private hunting ground. Willow Lake acts as a safe haven for water and ground fowl. The primary soils include Barnes-Svea loams and Barnes-Buse loams. The slopes range from 0-15%. The County does not include the lake area as taxable area as the State of North Dakota maintains control over lakes.

The non-irrigated soil classifications are II, IV, V, and VI, with various susceptibility to erosion, water, and climate. The PI for this subject ranges from 2 to 85, with an overall weighted average of 69 for the entire tract. Of the total acreage 72.4% is Prime Farmland, 14.5% is Not Prime Farmland, with the remaining 13.1% being Farmland of Statewide Importance. The soils are a range of predominantly non-hydric (82.9%), partially hydric (13.1%), and predominantly hydric (4.0%).





Aerial Map



map center: 47° 16' 36.24, 97° 55' 45.6

0ft 1913ft 3825ft

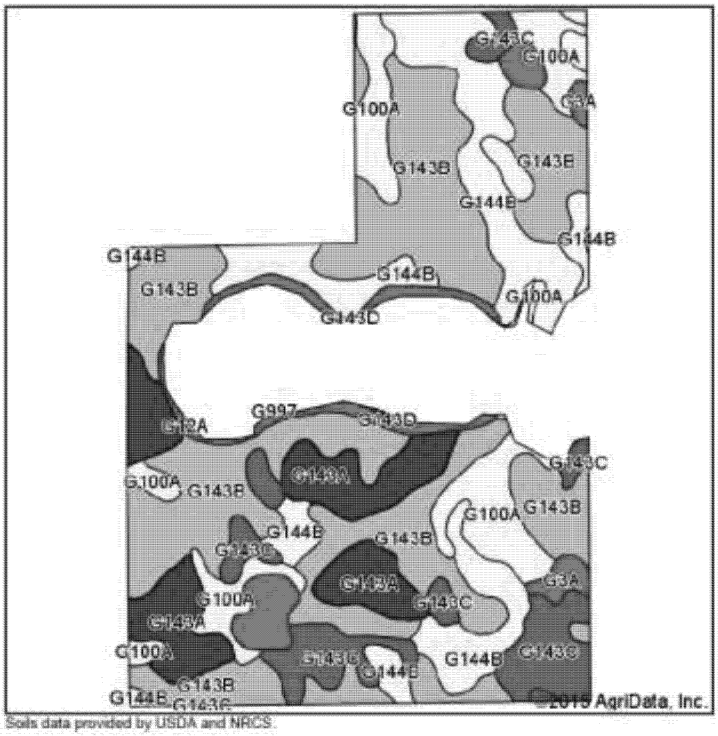
Maps Provided By surety CUSTOMIZED ONLINE MAPPING © Agridata, Inc. 2015 www.AgriDataInc.com

20-144N-57W
Steele County
North Dakota

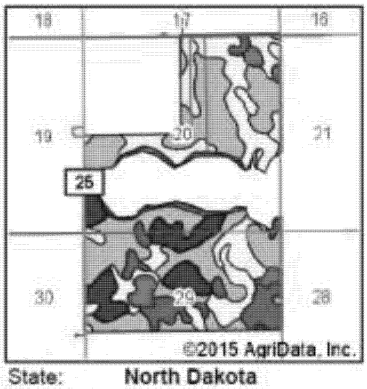
N W E S

12/4/2015

Soil Map



Soils data provided by USDA and NRCS.



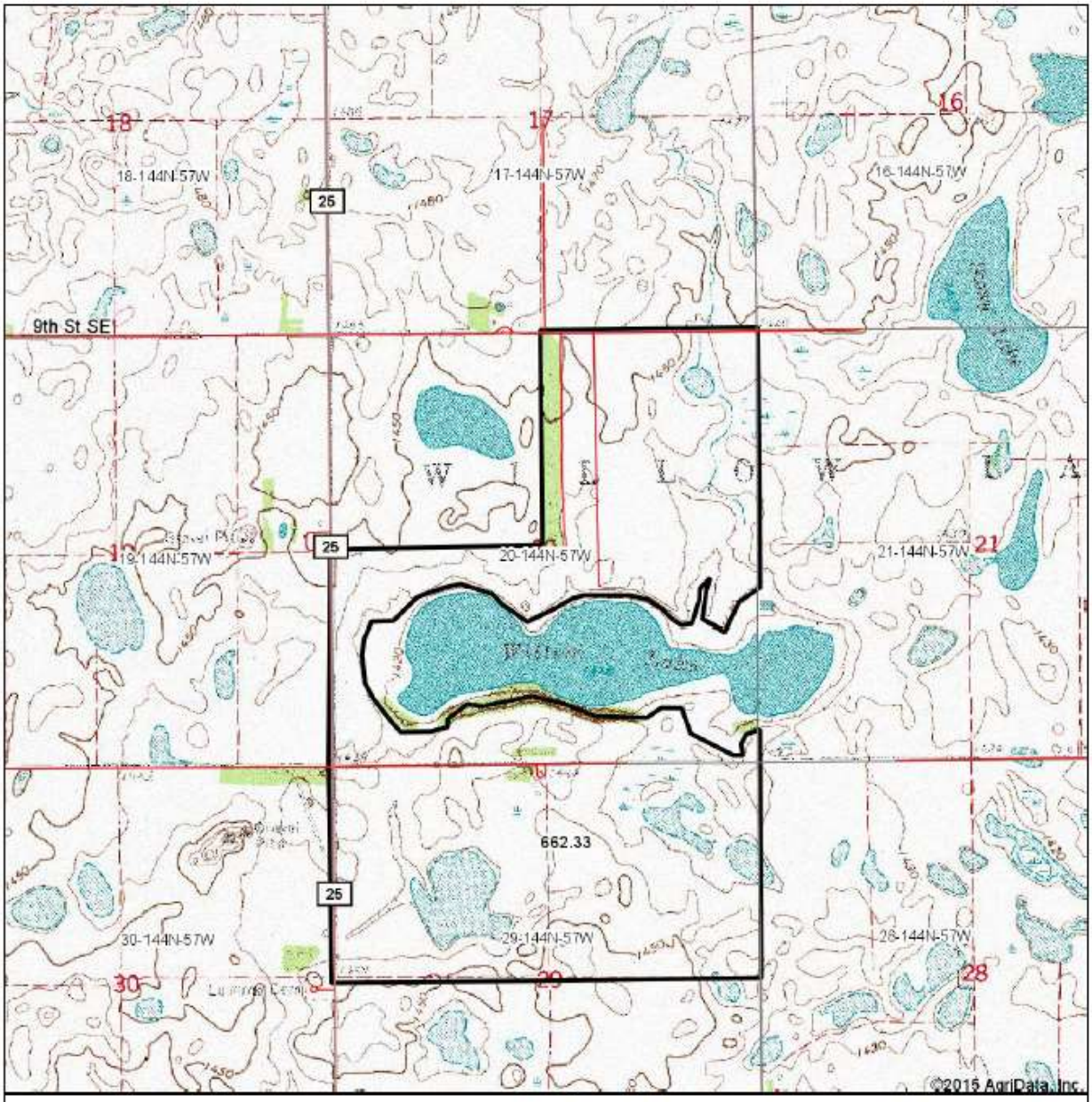
State: North Dakota
County: Steele
Location: 20-144N-57W
Township: Willow Lake
Acres: 662.33
Date: 12/4/2015

Maps Provided By:
surety
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Area Symbol: ND091, Soil Area Version: 20

Code	Soil Description	Acres	Percent of field	PI Legend	Water Table	Non-Irr Class *c	Range Production (lbs/acre/yr)	Productivity Index
G143B	Barnes-Svea loams, 3 to 6 percent slopes	276.46	41.7%		4.9ft.	IIe	3034	75
G144B	Barnes-Buse loams, 3 to 6 percent slopes	117.16	17.7%		4.9ft.	IIe	2988	69
G100A	Hamerly-Tonka complex, 0 to 3 percent slopes	84.50	12.8%		4.9ft.	IIe	4114	64
G143A	Barnes-Svea loams, 0 to 3 percent slopes	78.36	11.8%		4.9ft.	IIc	3405	85
G143C	Barnes-Buse-Langhei loams, 6 to 9 percent slopes	61.69	9.3%		> 6.5ft.	IVe	2763	56
G3A	Parnell silty clay loam, 0 to 1 percent slopes	25.49	3.8%		0ft.	Vw	5336	25
G143D	Barnes-Buse-Langhei loams, 9 to 15 percent slopes	15.95	2.4%		> 6.5ft.	VIe	2650	41
G12A	Vallers, saline-Parnell complex, 0 to 1 percent slopes	2.48	0.4%		0.7ft.	IVw	4453	31
G997	Water, intermittent	0.24	0.0%		0ft.		415	2
						Weighted Average	3296	69

Topography Map



map center: 47° 16' 36.24, 97° 55' 45.6

0ft 1913ft 3825ft

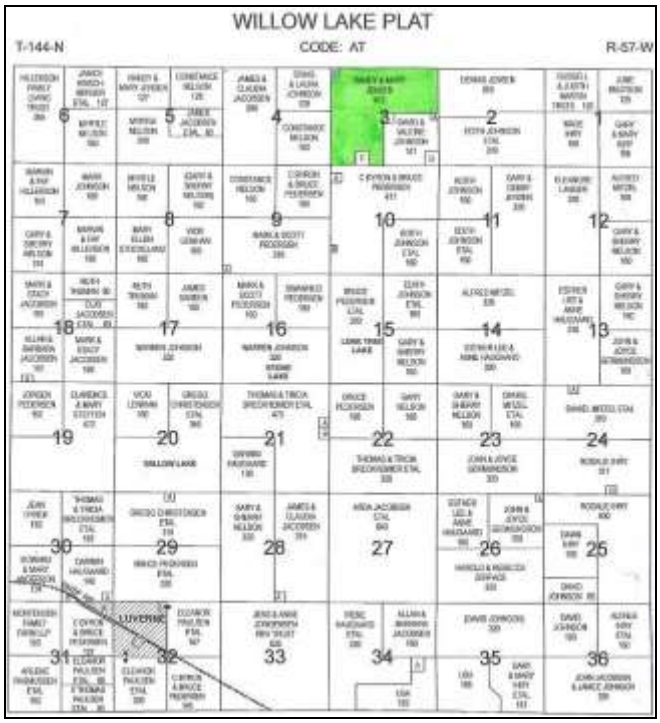
20-144N-57W
Steele County
North Dakota

Maps Provided By surety CUSTOMIZED ONLINE MAPPING © Agridata, Inc. 2015 www.AgriDataInc.com

N W E S

12/4/2015

Land Sale No. 4



Property Identification

Record ID	6003
Property Type	Vacant Land
Address	County Hwy 5 and 124th Avenue SE
Location	Willow Lake
Tax ID	020-0000-04212-010 & 20-0000-04210-000
Legal Description	W2 less tract, and the NE4 Section 3, T144N R57W, Steele County, North Dakota. See WD for full legal description.

Sale Data

Grantor	Randy C. and Mary Jensen
Grantee	David A. and Valerie Johnson
Sale Date	December 12, 2012
Deed Book/Page	WD 102505
Property Rights	Fee Simple
Conditions of Sale	Assemblage
Financing	Cash to Seller
Sale History	Numerous Warranty Deeds in the 1990s transferring ownership to Randy and Mary Jensen.
Verification	Dave Johnson, Grantee; (701) 945-2881, 12/4/2015; Judy Brosz, Office of the State Tax Commissioner, (701) 328-3142, County records
Sale Price	$1,239,000

Land Data

Zoning	AG, Agricultural
Topography	Level to undulating; slopes 0 – 9%

Land Sale No. 4 (Cont.)

Shape	Irregular
Utilities	Electricity and Phone
Roads	Gravel
Access	County Hwy 5
Productivity Index	68.7
Wind Farm	Adjacent
Turbines on Tract	None

Land Size Information

Gross Land Size	413.000 Acres

Indicators

Sale Price/Gross Acre	$3,000

Remarks

The sale was confirmed by Dave Johnson, Grantee, who stated he was the Grantor's neighbor for the last 50 years, and that the grantor knew he wanted to buy the land. Mr. Johnson believes the price was high, but he purchased the tract to expand his farm operation. The land was 100% tillable. Mr. Johnson stated he had no comment regarding the impact of the wind turbine.

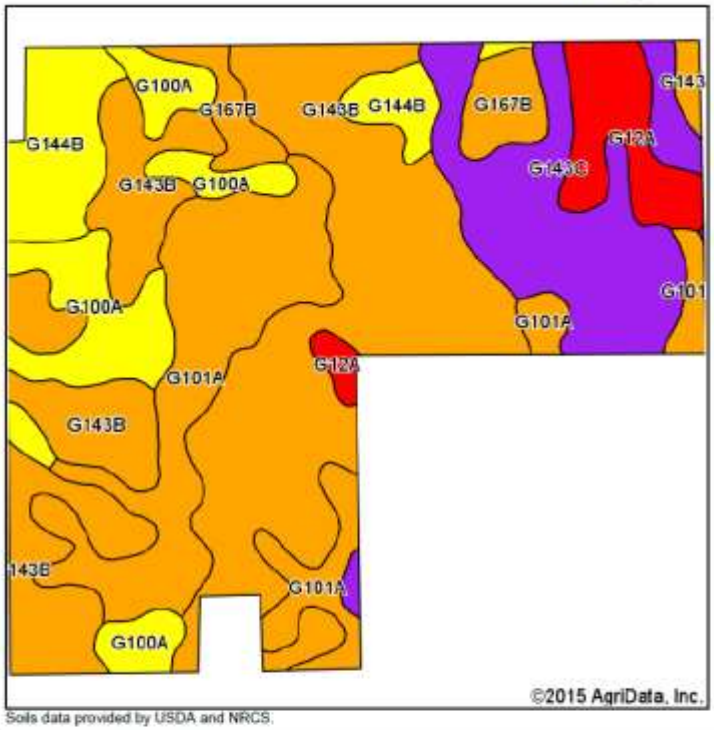
The primary soils include Barnes-Svea loams and Hamerly-Wyard loams. The slopes range from 0-9%. The non-irrigated soil classifications are II and IV, with various susceptibility to erosion and water. The PI for this subject ranges from 31 to 77, with an overall weighted average of 68.7 for the entire tract. Of the total acreage 71.1% is Prime Farmland, 19% is Not Prime Farmland, with the remaining 9.9% being Prime Farmland if Drained. The soils are a range of predominantly non-hydric (84.7%), partially hydric (9.9%), and predominantly hydric (5.4%).



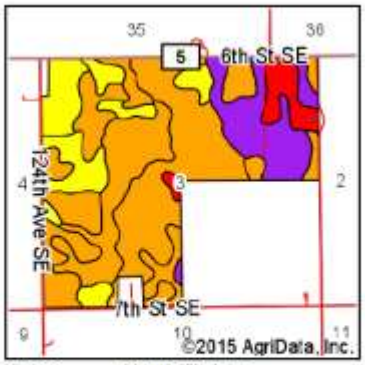
Aerial Map


6th St SE
124th Ave SE
413.00
7th St SE
map center: 47° 19' 11.15, -97° 53' 13.41
0ft
869ft
1739ft
3-144N-57W
Steele County
North Dakota
Maps Provided By:
surety
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12/9/2015

Soil Map



Soils data provided by USDA and NRCS.



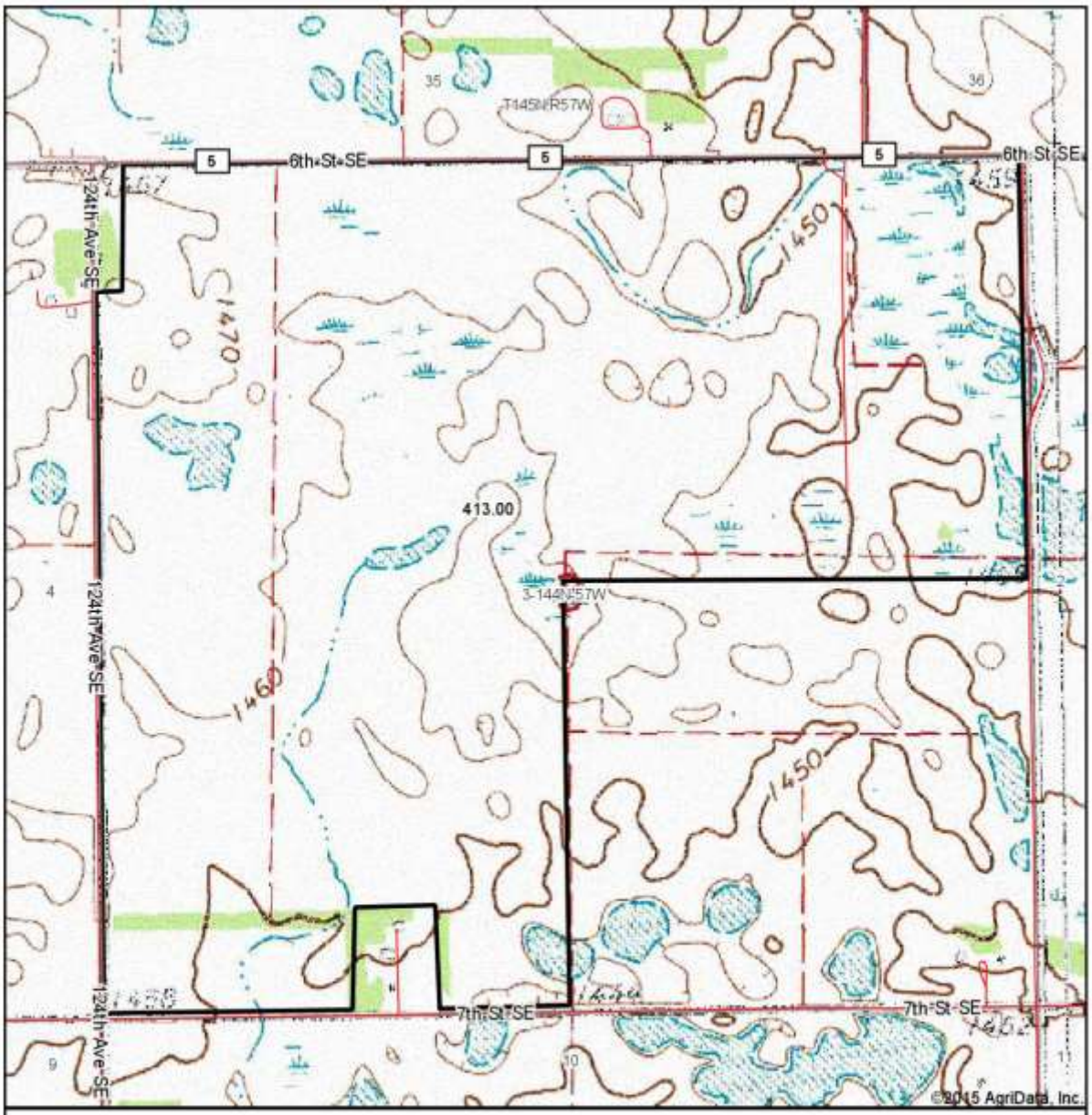
State: North Dakota
County: Steele
Location: 3-144N-57W
Township: Willow Lake
Acres: 413
Date: 12/9/2015

Maps Provided By:
surety
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Area Symbol: ND091, Soil Area Version: 20

Code	Soil Description	Acres	Percent of field	PI Legend	Water Table	Non-Irr Class *c	Range Production (lbs/acre/yr)	Productivity Index
G143B	Barnes-Svea loams, 3 to 6 percent slopes	168.79	40.9%		4.9ft.	IIe	3034	75
G101A	Hamerly-Wyard loams, 0 to 3 percent slopes	77.52	18.8%		2.5ft.	IIe	4014	77
G143C	Barnes-Buse-Langhei loams, 6 to 9 percent slopes	56.97	13.8%		> 6.5ft.	IVe	2763	56
G100A	Hamerly-Tonka complex, 0 to 3 percent slopes	40.39	9.8%		2.5ft.	IIe	4114	64
G144B	Barnes-Buse loams, 3 to 6 percent slopes	29.84	7.2%		4.9ft.	IIe	2988	69
G12A	Vallers, saline-Parnell complex, 0 to 1 percent slopes	22.87	5.5%		0.7ft.	IVw	4453	31
G167B	Balaton-Wyard loams, 0 to 6 percent slopes	16.62	4.0%		4.9ft.	IIe	3245	73
						Weighted Average	**3369.9**	**68.7**

Topography Map



CAVALIER COUNTY, NORTH DAKOTA

The surveyed area is located in Cavalier County, about 6 miles south of Langdon. Langdon is situated approximately 68 miles northwest of I-29 at Drayton and 15 miles south of the Canadian border. The area is primarily rural in nature, with farmsteads interspersed at one to two mile increments. The topography is gently rolling to undulating, being a part of the drift plain deposited by glaciers. Drainage is typically poor and is the major concern of most farming operations. The Pembina River flows through the County, east of the Pembina Gorge, which marks the end of the drift plain. Tributaries of the Pembina River flow through the study area. The majority of the County sits on the Pierre Aquifer, which is slightly saline; the water is generally not suitable for irrigation purposes. The soils are used for crop and hay production as well as pasture for livestock.

Overall, the wind farms suggest little physical impact to the land other than the area used for turbine placement and access. Typically, the access roads appeared to use a minimal amount of land to access the turbines.

Again, sales were not plentiful as most farming operations are retained within families for generations. Only two sales were found. Sale 1, consisting of two separate tracts located one mile apart, was improved with a single turbine. Sale 2 located ¼ mile north of Sale 1 of Sections 25 and 26 T160N R60W is not improved.

No	Legal Description					Date	Sale Price	Deeded Acres	PI	Sale Price/ Deeded Acre	Turbines on Sale Tract	Adjacent Wind Farm	Negative Influence	Premium Paid
1	Parts 25, 26	34	160	60	Cavalier	7/28/2010	$356,000	320.00	68.2	$ 1,113	one	yes	no	no
2	NE	26	160	60	Cavalier	7/28/2010	$144,000	160.00	67.5	$ 900	none	yes	no	no

When arranged by the productivity index, the results are as follows:

No	Legal Description					Date	Sale Price	Deeded Acres	PI	Sale Price/ Deeded Acre	Turbines on Sale Tract	Adjacent Wind Farm	Negative Influence	Premium Paid
1	Parts 25, 26	34	160	60	Cavalier	7/28/2010	$356,000	320.00	68.2	$ 1,113	one	yes	no	no
2	NE	26	160	60	Cavalier	7/28/2010	$144,000	160.00	67.5	$ 900	none	yes	no	no

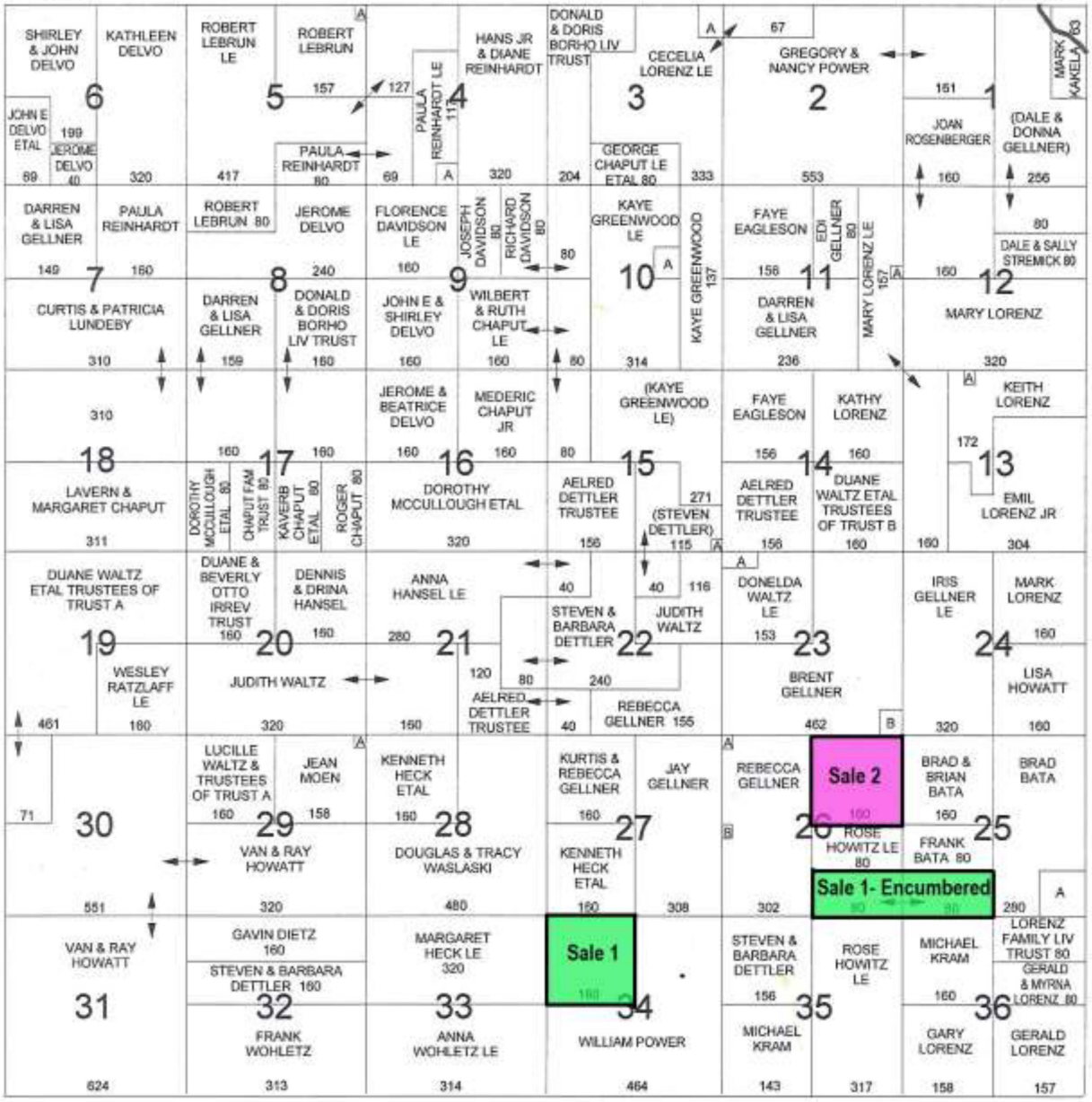
The sales closed in 2010, prior to the increasing markets of 2011 – 2013. Both sales were from relative to relative; however, Sale 1 was purchased at auction against five other bidders. Sale 2 was purchased privately. Once Sale 2 is adjusted for the acreage in CRP, which is marginal land at best, the sale prices are comparable. The variances within the data set are attributable to differences in physical condition. Neither sale evidenced market resistance.

Cavalier County

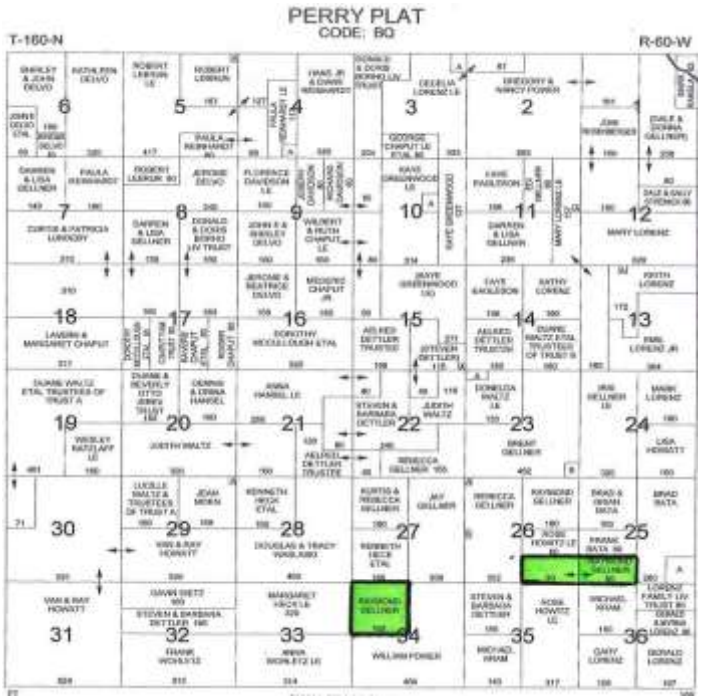
PERRY PLAT
CODE: BQ

T-160-N

R-60-W



Land Sale No. 1



Property Identification

Record ID	5993
Property Type	Vacant Land
Property Name	1 wind turbine
Address	County Highways 1 and 66, Cavalier County, North Dakota
Location	Perry Township
Tax ID	33176000; 33142000; 33135000
Legal Description	S2SW4 Section 25; S2SE4 Section 26; NW4 Section 34; T160N R60W Cavalier County, North Dakota.

Sale Data

Grantor	William Gellner et al
Grantee	Kenneth and Dianne Stremick
Sale Date	July 28, 2010
Deed Book/Page	SWD 232584
Property Rights	Leased fee; Fractional interest; reservation of wind royalties
Conditions of Sale	Assemblage
Financing	Cash to seller
Sale History	Records were searched for 3 years prior; no transfer was found.
Verification	Bill Gellner, Grantor; (701) 281-2180, 11/23/2015; Judy Brosz, Office of the State Tax Commissioner , (701) 328-3142, County records
Sale Price	$356,000

Land Data

Zoning	AG, Agricultural
Topography	Level to undulating; 0 to 65 slopes
Utilities	Assumed telephone and electricity available
Shape	Square and rectangular
Roads	Paved and gravel

Land Sale No. 1 (Cont.)

Access	107th Ave NE and prairie trail
Productivity Index	68.2
Wind Farm	Adjacent
Wind Turbine on Tract	One

Land Size Information

Gross Acres	320.000 Acres
Tillable Acres	272.000 Acres, 85.00%
Wetlands Acres	48.000 Acres, 15.00%

Indicators

Sale Price/Gross Acre	$1,113
Sale Price / Tillable Acre	$1,309

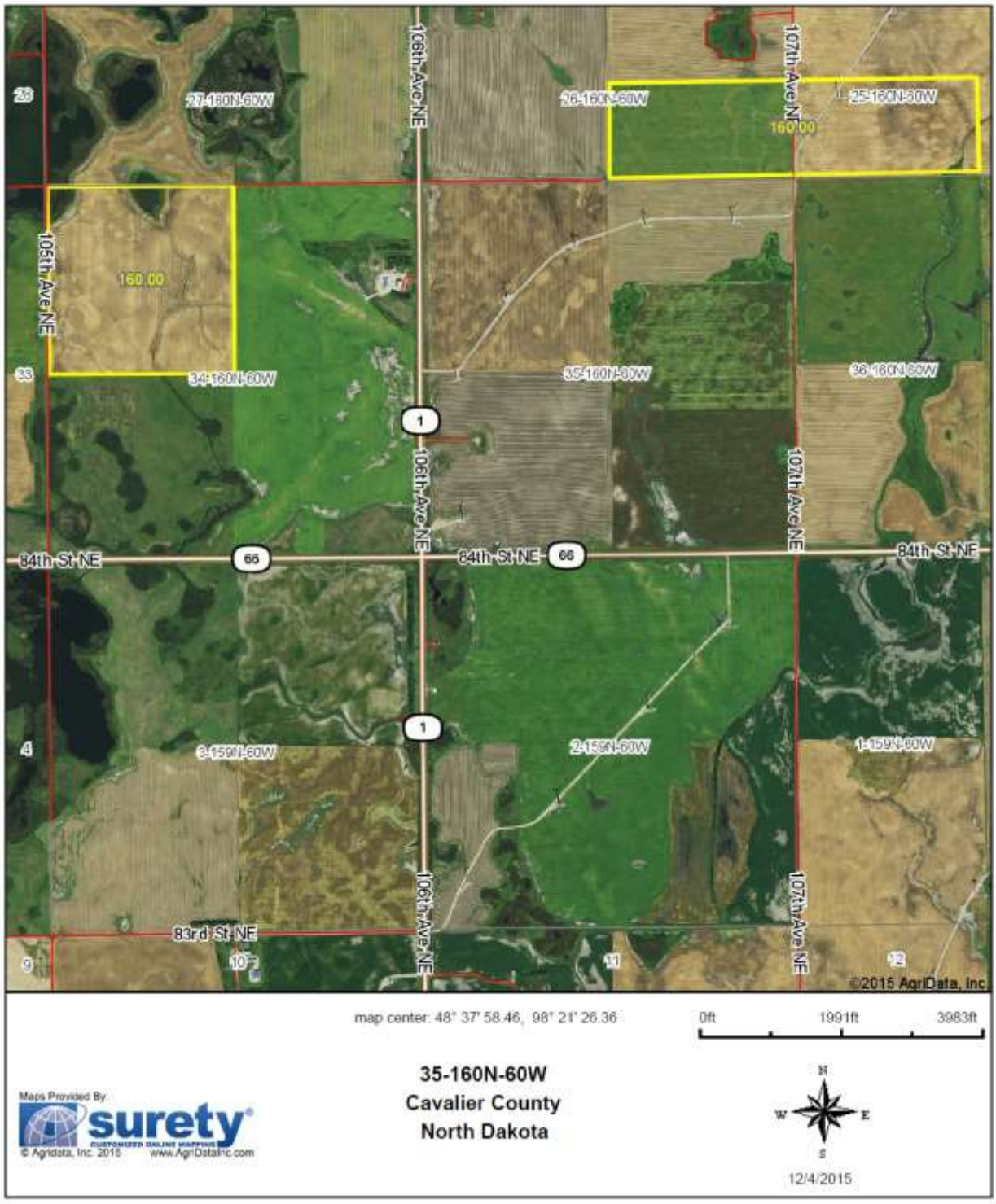
Remarks

The sale was confirmed by Bill Gellner, Grantor. The tract was sold through a local attorney office with a number of interested parties interested placing bids. Mr. Gellner is an uncle to the Grantee but this did not impact the price and Mr. Gellner believes he got market rate. The land is vacant with 85% tillable and 15% waste and sloughs. The Grantee leased 160 acres of the land prior to the sale at $42/acre. A wind turbine is located on the tract in Section 25. Per the deed, Mr. Gellner kept the royalty rights. He also stated that the adjacent turbines did not impact the sale price as wind farms are individual operations.

The primary soils include Hamerly-Tonka complex, Svea-Buse loams, and Barnes-Svea loams. The slopes range from 0-9%. The non-irrigated soil classifications are II, III, IV, and VIII, with various susceptibility to erosion, stones, water, and climate. The PI for this subject ranges from 9 to 85, with an overall weighted average of 68.2 for the entire tract. Of the total acreage approximately 46.7% is Prime Farmland, 46% is Farmland of Statewide Importance, 37.1% is Prime Farmland if Drained, with the remaining 11.6% being Not Prime Farmland. The soils are a range of predominantly non-hydric (51%), partially hydric (40.8), non-hydric (4.3%), and predominantly hydric (3.9%).



Aerial Map



map center: 48° 37' 58.46", 98° 21' 26.36"

0ft 1991ft 3983ft

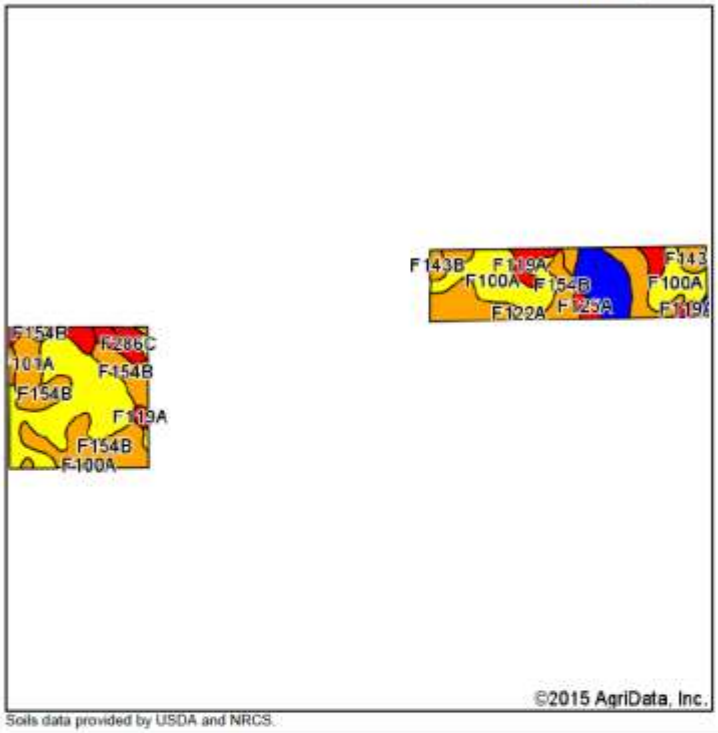
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35-160N-60W
Cavalier County
North Dakota

N W E S

12/4/2015

Soil Map



Soils data provided by USDA and NRCS.



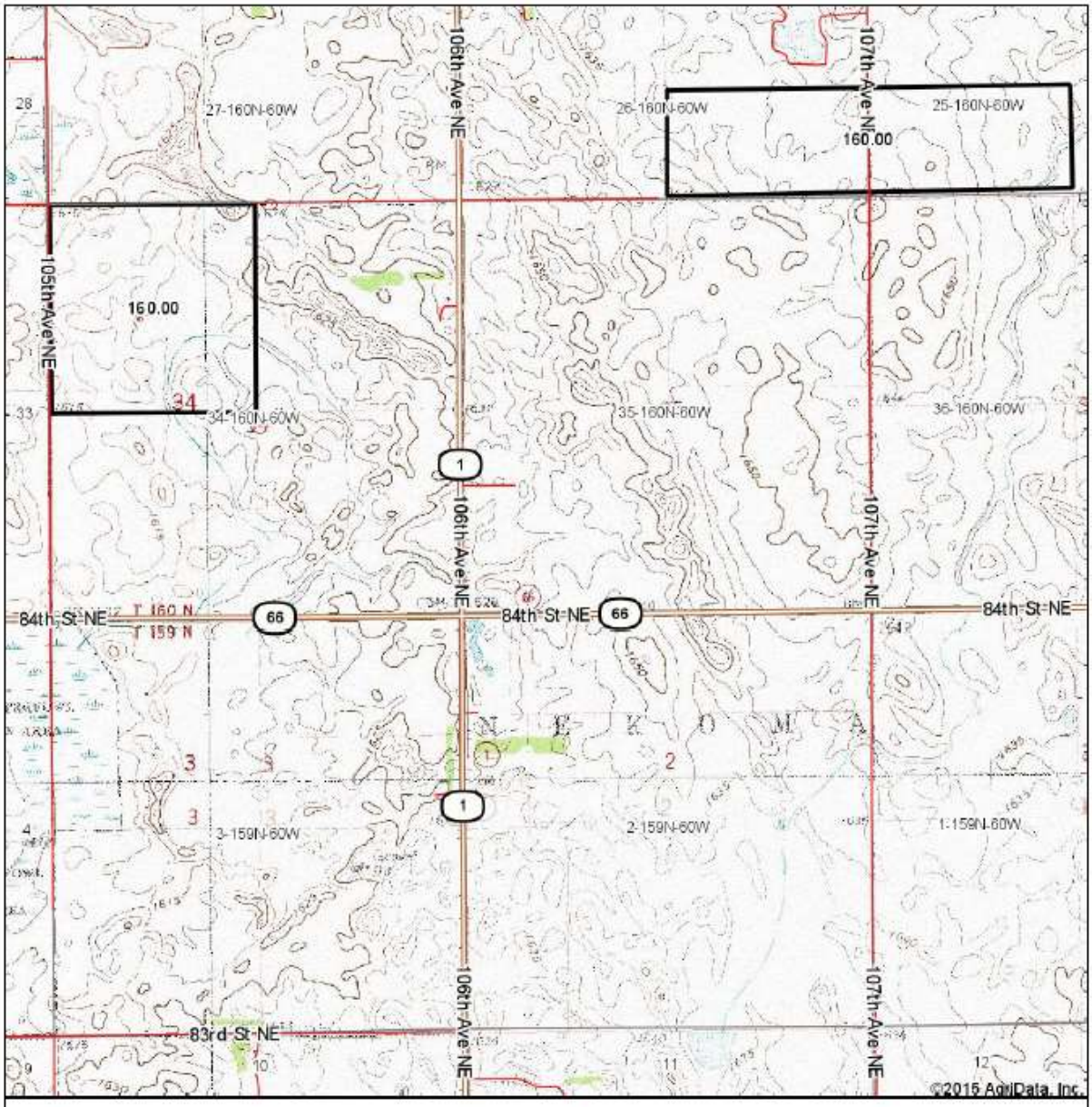
State: North Dakota
County: Cavalier
Location: 35-160N-60W
Township: Perry
Acres: 320
Date: 12/4/2015

Maps Provided By:
surety
CUSTOMIZED ONLINE MAPPING
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Area Symbol: ND019, Soil Area Version: 20

Code	Soil Description	Acres	Percent of field	PI Legend	Water Table	Non-Irr Class *c	Range Production (lbs/acre/yr)	Productivity Index
F100A	Hamerly-Tonka complex, 0 to 3 percent slopes	121.73	38.0%		0.5ft.	IIe	4023	64
F154B	Svea-Buse loams, 3 to 6 percent slopes	71.79	22.4%		4.9ft.	IIe	3045	77
F143B	Barnes-Svea loams, 3 to 6 percent slopes	43.33	13.5%		4.9ft.	IIe	3025	75
F143A	Barnes-Svea loams, 0 to 3 percent slopes	25.82	8.1%		4.9ft.	IIc	3381	85
F119A	Vallers-Hamerly loams, saline, 0 to 3 percent slopes	15.41	4.8%		2.5ft.	IVw	3665	45
F101A	Hamerly-Wyard loams, 0 to 3 percent slopes	11.56	3.6%		3.7ft.	IIe	3919	77
F122A	Svea-Cresbard loams, 0 to 3 percent slopes	7.96	2.5%		4.9ft.	IIc	2608	79
F286C	Fordville-Sioux complex, 2 to 9 percent slopes	7.03	2.2%		4.9ft.	IIIe	2199	49
F128A	Fernley-Cavour loams, 0 to 3 percent slopes	5.03	1.6%		4ft.	IVs	2059	30
F12A	Vallers, saline-Parnell complex, 0 to 1 percent slopes	4.71	1.5%		0ft.	IVw	4394	31
F125A	Cavour-Cresbard loams, 0 to 3 percent slopes	4.02	1.3%		4.9ft.	IVs	2311	50
F4A	Southam silty clay loam, 0 to 1 percent slopes	1.57	0.5%		0ft.	VIIIw	1205	9
						Weighted Average	**3459.6**	**68.2**

Topography Map



map center: 48° 37' 58.46, 98° 21' 26.36

0ft 1991ft 3983ft

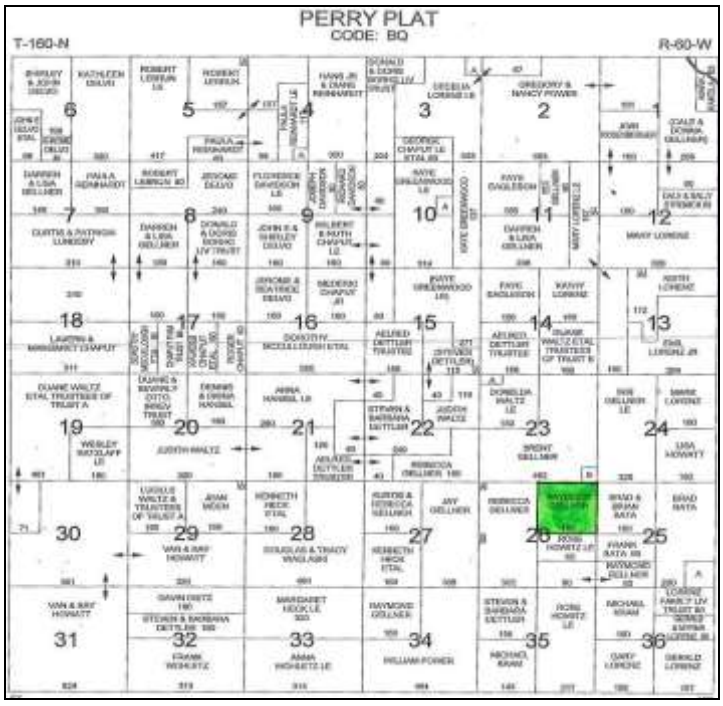
35-160N-60W
Cavalier County
North Dakota

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N W E S

12/4/2015

Land Sale No. 2



Property Identification

Record ID	5994
Property Type	Vacant Land
Address	86th Street NE and 107th Avenue NE , Cavalier County, North Dakota
Location	Perry Township
Tax ID	33138000
Legal Description	NE4 Section 26, T160N R60, Cavalier County, North Dakota.

Sale Data

Grantor	William Gellner et al
Grantee	Corey Stremick
Sale Date	July 28, 2010
Deed Book/Page	WD 232583
Property Rights	Fee simple
Conditions of Sale	Assemblage
Financing	Cash to seller
Sale History	Records were searched for a 3 year period; no transfer was found.
Verification	Corey Stremick, Grantee; (701) 256-5271, 11/30/2015; Judy Brosz, Office of the State Tax Commissioner, (701) 328-3142, County records
Sale Price	$144,000

Land Data

Zoning	AG, Agricultural
Topography	Nearly level
Utilities	Assumed telephone and electricity available
Shape	Square
Roads	Paved and gravel
Access	86th St NE
Productivity Index	67.5

Land Sale No. 2 (Cont.)

Wind Farm	Adjacent
Wind Turbine on Tract	None

Land Size Information

Gross Acres	160.000 Acres
Tillable Acres	110.88 Acres, 81.80%
Waste / Slough	29.12 Acres, 18.20%
CRP Acres	14.15 Acres

Indicators

Sale Price/Gross Acre	$900
Sale Price / Tillable Acre	$1,205
Sale Price CRP Acre	$736

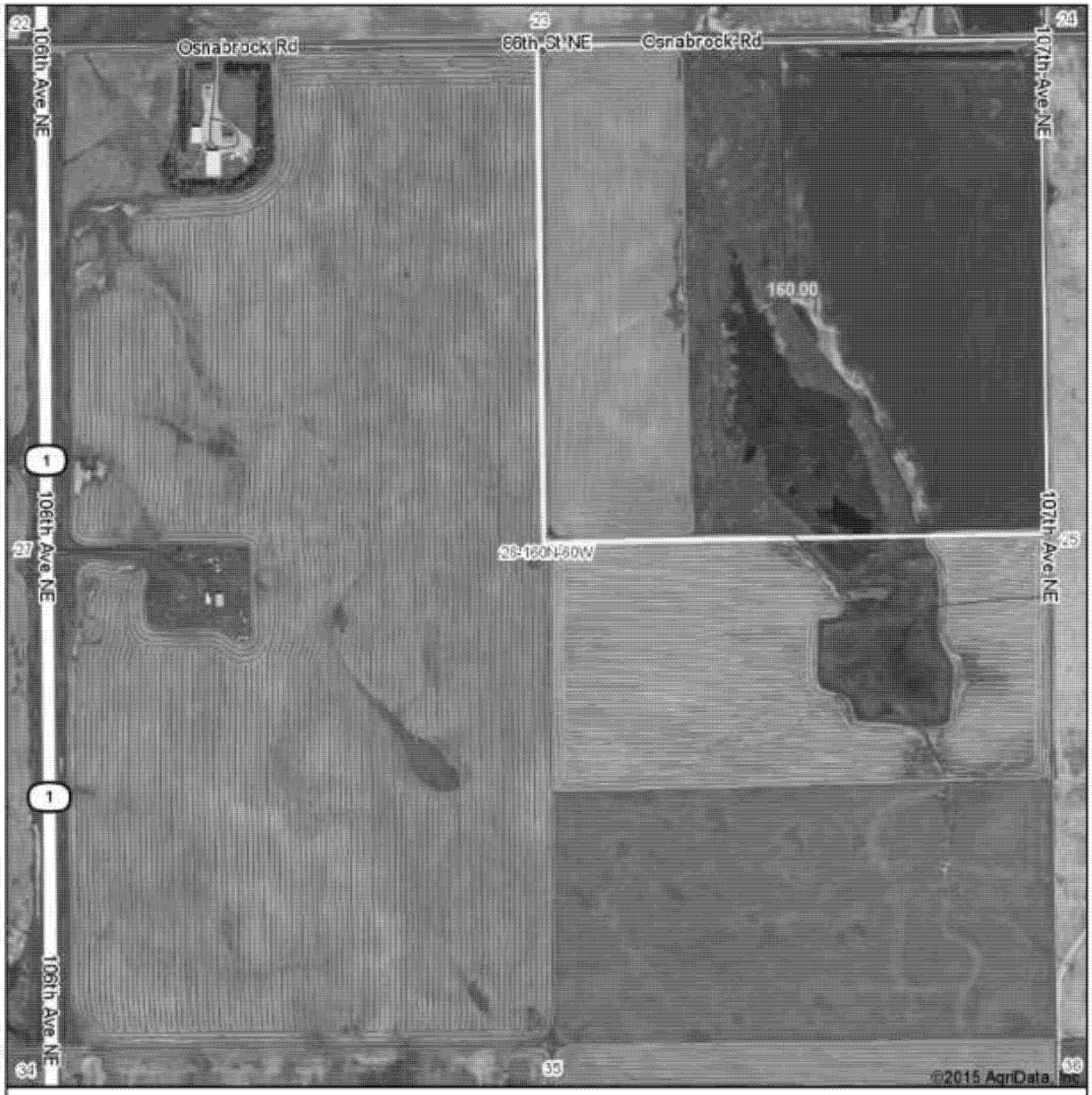
Remarks

The sale was confirmed by Corey Stremick, Grantee, who stated he was approached by the Grantor to purchase the land. Mr. Stremick had been leasing the land for $50/acre and purchased it to maintain his farm operation. The Grantee and Grantor are distant relatives and wanted the land to stay in the family. The vacant land has 110 tillable acres, and 14.5 acres in CRP with 10 years left on the contract. The CRP payment is $40/acre/year; at 90% net operating income and a 5% capitalization rate, the indicated value of the 14.15 acres is approximately $736 per acre, which capitalized. Mr. Stremick stated the nearby wind farm did not impact the sale price.

The primary soils include Svea-Cresbard loams, Barnes-Svea loams, and Hamerly-Tonka complex. The slopes range from 0-6%. The non-irrigated soil classifications are II, IV, and VIII, with various susceptibility to erosion, water, and climate. The PI for this subject ranges from 9 to 85, with an overall weighted average of 67.5 for the entire tract. Of the total acreage 33.9% is Farmland of Statewide Importance, 33.3% is Prime Farmland, 18.1% is Not Prime Farmland, with the remaining 14.7% being Prime Farmland if Drained. The soils are a range of predominantly non-hydric (67.2%), partially hydric (25.8%), and predominantly hydric (7.0%).



Aerial Map



map center: 48° 39' 8.72, 98° 21' 3.25

0ft 814ft 1627ft

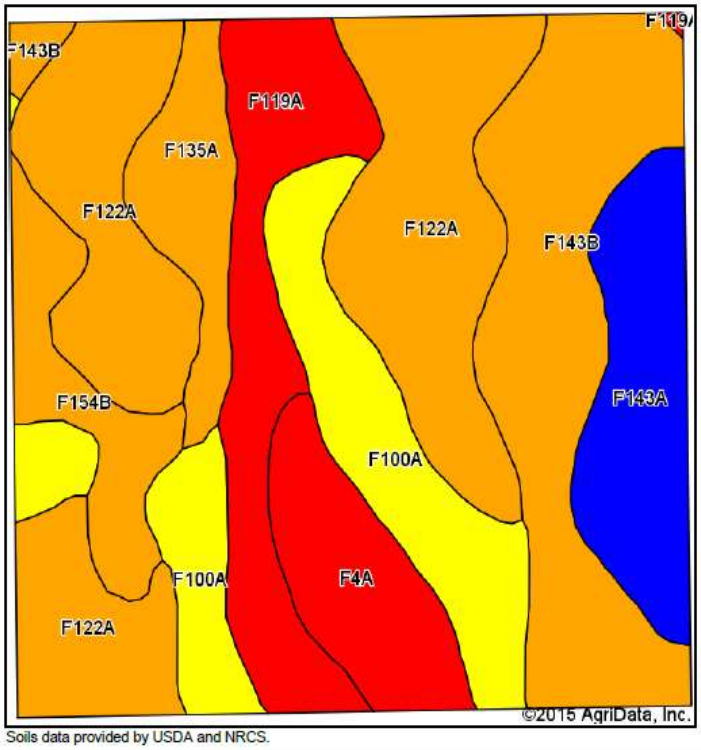
26-160N-60W
Cavalier County
North Dakota

N W E S

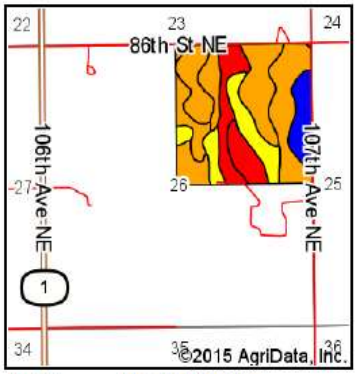
12/4/2015

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Soil Map



Soils data provided by USDA and NRCS.



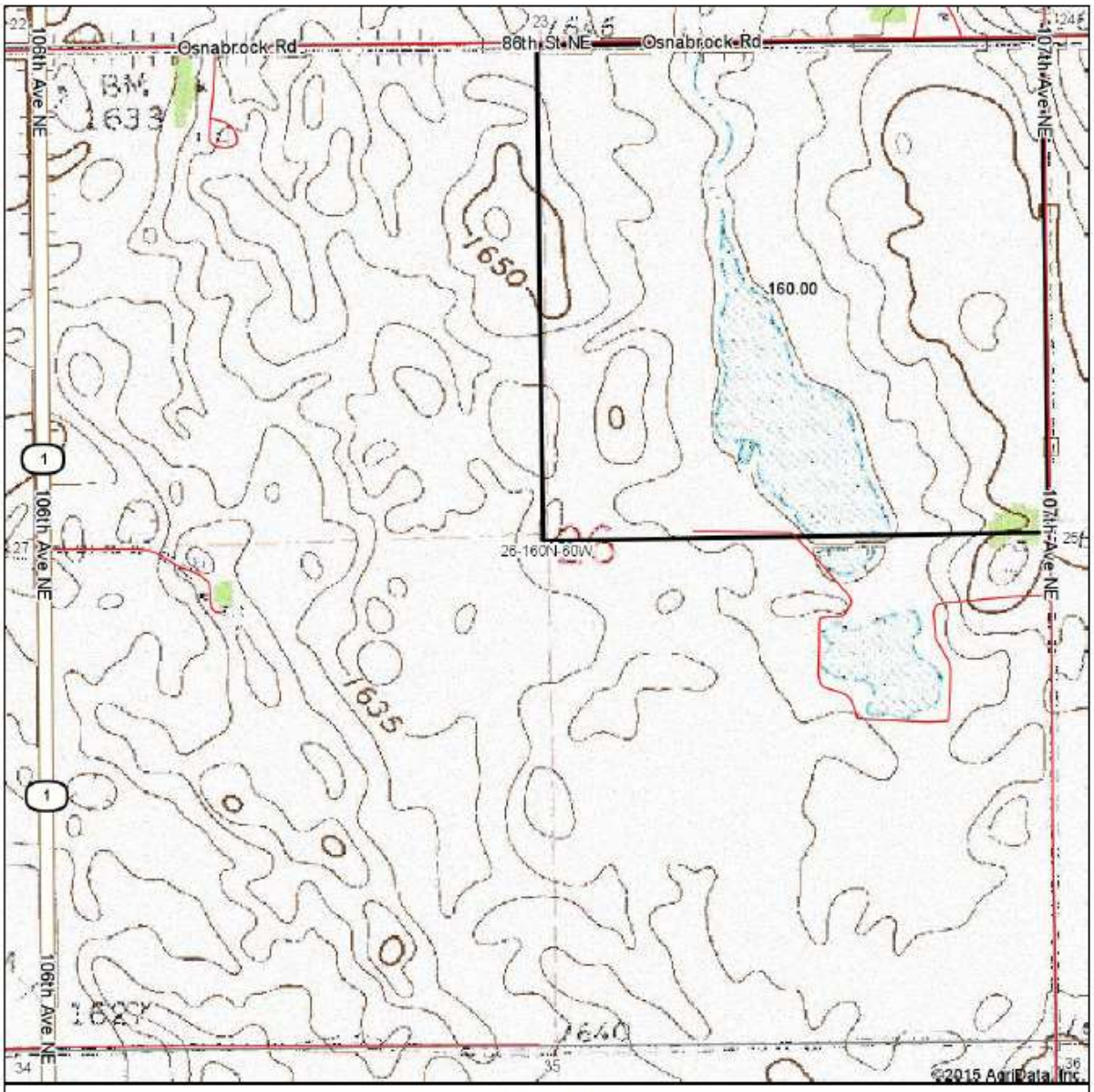
State: **North Dakota**
County: **Cavalier**
Location: **26-160N-60W**
Township: **Perry**
Acres: **160**
Date: **12/4/2015**

Maps Provided By:
surety® CUSTOMIZED ONLINE MAPPING
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Area Symbol: ND019, Soil Area Version: 20

Code	Soil Description	Acres	Percent of field	PI Legend	Water Table	Non-Irr Class *c	Range Production (lbs/acre/yr)	Productivity Index
F122A	Svea-Cresbard loams, 0 to 3 percent slopes	45.87	28.7%		4.9ft.	IIc	2608	79
F143B	Barnes-Svea loams, 3 to 6 percent slopes	29.21	18.3%		4.9ft.	IIe	3025	75
F100A	Hamerly-Tonka complex, 0 to 3 percent slopes	23.78	14.9%		0.5ft.	IIe	4023	64
F119A	Vallers-Hamerly loams, saline, 0 to 3 percent slopes	17.72	11.1%		2.5ft.	IVw	3665	45
F143A	Barnes-Svea loams, 0 to 3 percent slopes	14.42	9.0%		4.9ft.	IIc	3381	85
F4A	Southam silty clay loam, 0 to 1 percent slopes	11.31	7.1%		0ft.	VIIIw	1205	9
F154B	Svea-Buse loams, 3 to 6 percent slopes	9.20	5.8%		4.9ft.	IIe	3045	77
F135A	Hamerly-Cresbard loams, 0 to 3 percent slopes	8.49	5.3%		3.7ft.	IIe	3078	75
						Weighted Average	**3032.1**	**67.5**

Topography Map



DICKEY AND LAMOURE COUNTIES, NORTH DAKOTA

The surveyed area is located along the southwest border of LaMoure County and northwest corner of Dickey County, about 2.5 miles east of Kulm, 10 miles southwest of Edgeley, and 20 miles north of the South Dakota border. These counties are part of the Drift Plain (glaciated) with the surveyed area lying in the Coteau du Missouri. The area is rural with community size typically less 1,000 people. Farmsteads are located two to three miles apart. The topography is gently rolling to undulating then sharply increasing to rolling hills made up of glacial moraine. Gravel and sand deposits are present. The James, Elm and Maple Rivers cut through the area. Drainage is typically poor and is the major concern of most farming operations. Sloughs and potholes are present. The three major aquifers are the Spiritwood, which lies concurrent to the James River, Nortonville and Ellendale. They range in depth from about 10 to 300 feet below the surface. The water is sufficient for domestic use and is also used for irrigation. The soils are suitable for crop and hay production as well as pasture and rangeland. Livestock are raised primarily in the western portions of the counties.

Overall, the wind farms suggest little physical impact to the land other than the area used for turbine placement and access. Typically, the access roads appeared to use a minimal amount of land to access the turbines.

Five sales were found with one improved with turbines. The lack of data is attributable to the retention of land within families for generations. The four unimproved sales are located adjacent to one another about 1.0 to 1.5 miles east of the improved sale. As noted, the royalty rights went with the improved sale. The unimproved sales are located in Dickey County; the improved sale is located in LaMoure County.

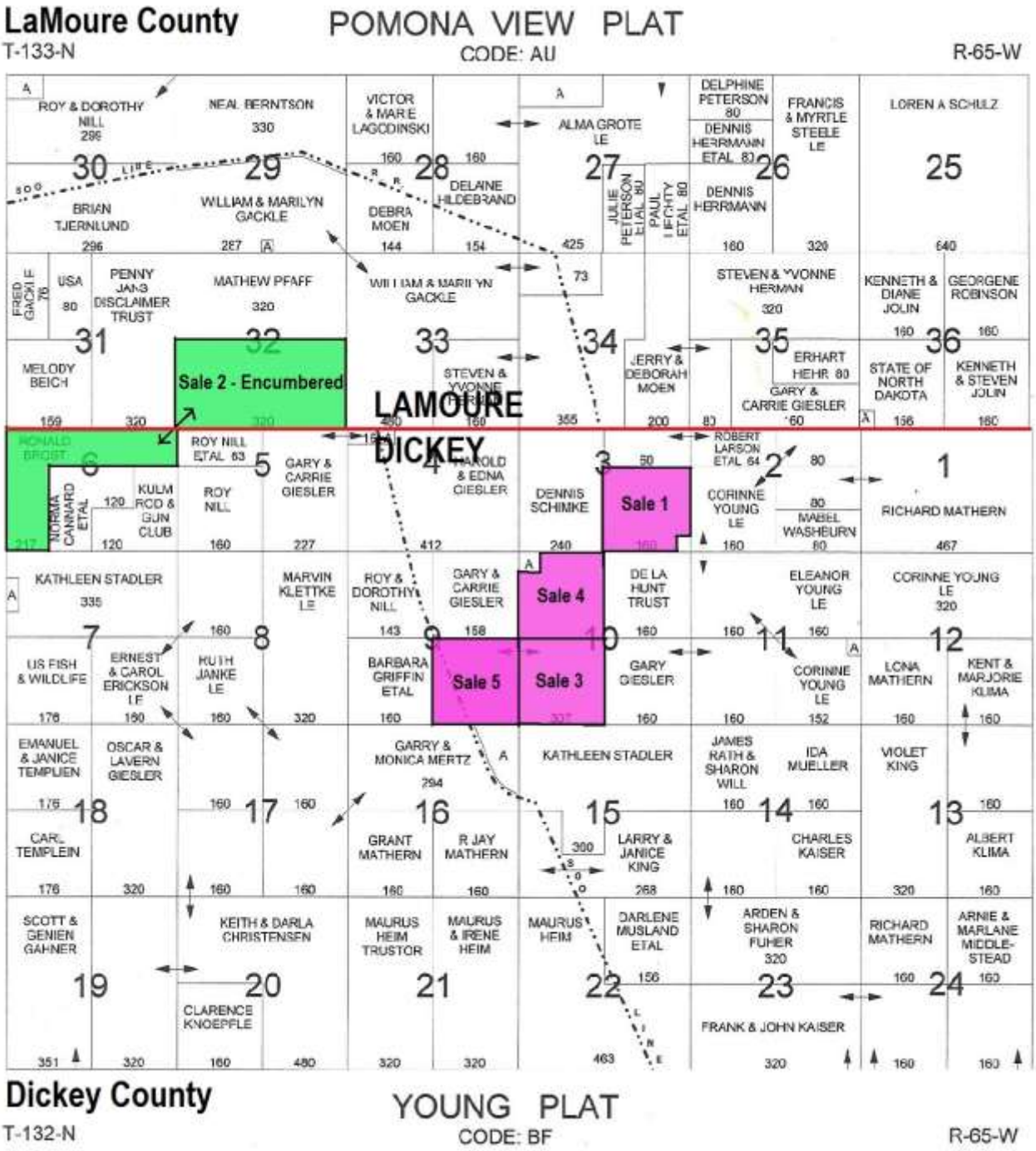
No	Legal Description					Date	Sale Price	Deeded Acres	PI	Sale Price/ Deeded Acre	Turbines on Sale Tract	Adjacent Wind Farm	Negative Influence	Premium Paid
1	part SE4	3	132	65	Dickey	6/27/2013	$ 105,000	150.00	35.2	$ 700	none	yes	no	no
2	Lots 1-6 S2	6 32	132 133	65 65	Dickey LaMoure	5/31/2012	$1,000,000	537.21	72.1	$ 1,861	three & met tower	yes	no	no
3	SW4	10	132	65	Dickey	10/24/2011	$ 240,000	160.00	70.7	$ 1,500	none	yes	no	no
4	NW less tract	10	132	65	Dickey	10/24/2011	$ 220,500	146.60	71.1	$ 1,504	none	yes	no	yes
5	SE, less ROW	9	132	65	Dickey	10/24/2011	$ 140,000	146.76	68.4	$ 954	none	yes	no	yes

The sales were then grouped according to their productivity index as follows.

No	Legal Description					Date	Sale Price	Deeded Acres	PI	Sale Price/ Deeded Acre	Turbines on Sale Tract	Adjacent Wind Farm	Negative Influence	Premium Paid	Comments
2	Lots 1-6 S2	6 32	132 133	65	Dickey LaMoure	5/31/2012	$1,000,000	537.21	72.1	$ 1,861	three & met tower	yes	no	no	Royalty Rights went with sale Note 16 month time difference in sales
4	NW less tract	10	132	65	Dickey	10/24/2011	$ 220,500	146.60	71.1	$ 1,504	none	yes	no	yes	Road Frontage; tillable and pasture
3	SW4	10	132	65	Dickey	10/24/2011	$ 240,000	160.00	70.7	$ 1,500	none	yes	no	no	Land locked ; tillable and waste
5	SE, less ROW	9	132	65	Dickey	10/24/2011	$ 140,000	146.76	68.4	$ 954	none	yes	no	yes	Land locked; tillable and pasture
1	part SE4	3	132	65	Dickey	6/27/2013	$ 105,000	150.00	35.2	$ 700	none	yes	no	no	Road frontage; all pasture

Sales 1, 3, and 5 were purchased by members of the same family of large land owners in the area. These multiple sales establish what buyers are willing to pay for assemblage of land with and without access. Mrs. Giesler stated that she can see the wind farm from her house, but that view does not create a negative impact. Both Sales 3 and 4 are assemblages to current farm/ranch operations. Although Sale 3 was tilled prior to purchase, it is now used to pasture buffalo.

With the exception of Sale 1, which had a PI of 35.2, the remaining sales demonstrated a very consistent range from 68.4 to 72.1. Once the sales are adjusted for use and landlocked status, the sales demonstrate no diminution in value.



Land Sale No. 1



Property Identification

Record ID	5986
Property Type	Vacant Land
Address	79th Street SE and 76th Avenue, Dickey County, North Dakota
Location	Young Township
Tax ID	07450000
Legal Description	SE Section 3, less SESESE; T132N R65W, Dickey County, North Dakota

Sale Data

Grantor	Judith E. Morgan
Grantee	Eric and Carol Giesler
Sale Date	June 27, 2012
Deed Book/Page	WD 180971
Property Rights	Leased Fee
Conditions of Sale	Assemblage
Financing	Cash to seller
Sale History	Records were searched for a 3 year period; no transfer was found.
Verification	Judy Morgan, Grantor; (701) 452-2395, 12/2/2015; County records
Sale Price	$105,000

Land Data

Zoning	AG, Agricultural
Topography	Level to steep hills; 0 to 25% steep slopes
Utilities	Assumed telephone and electricity available
Shape	Irregular
Roads	Gravel
Access	79th St SE
Productivity Index	35.2
Wind Farm	2.5 miles west, northwest
Turbines on Tract	None

Land Sale No. 1 (Cont.)

Land Size Information
Gross Land Size 150.00 Acres

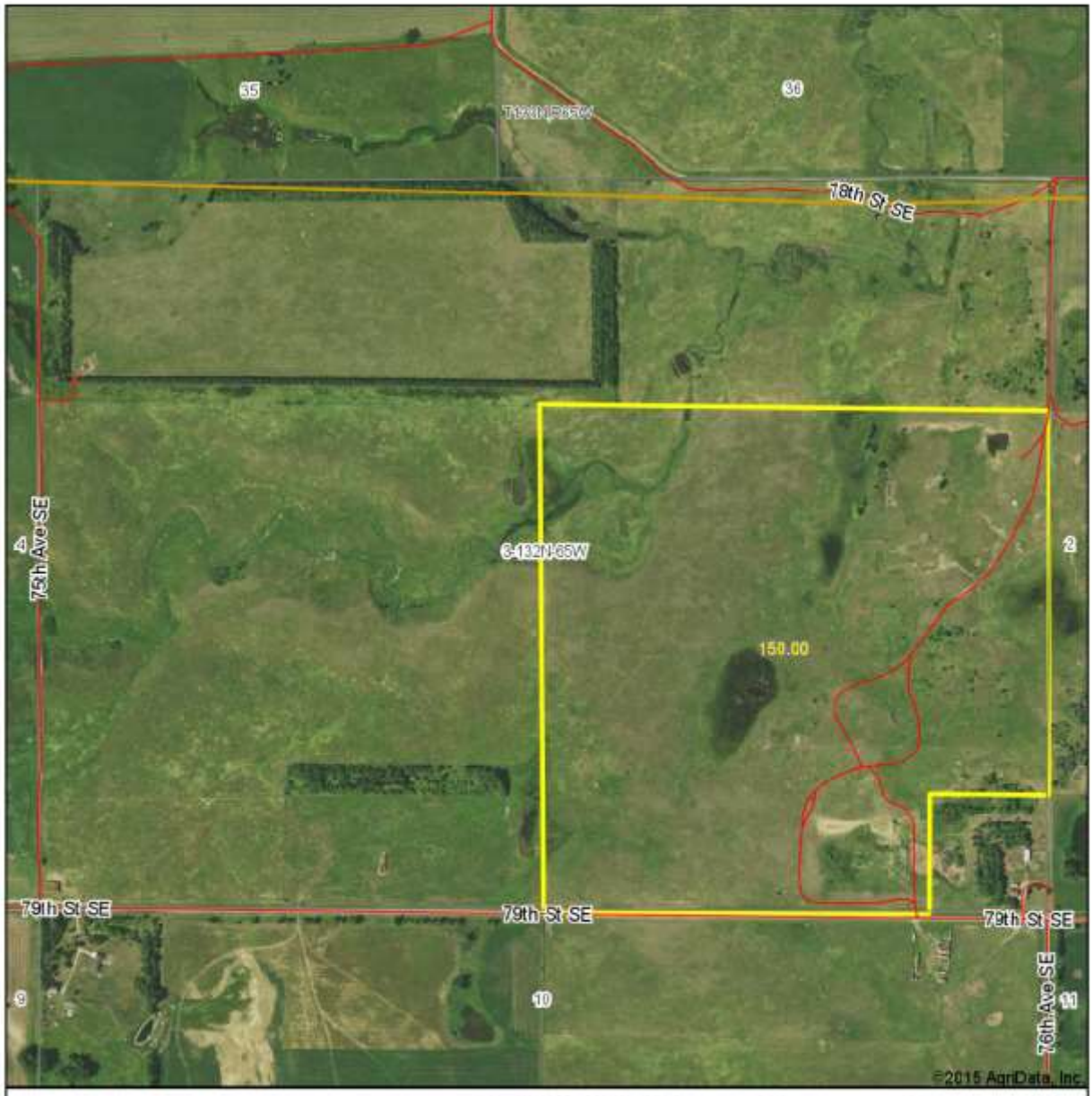
Indicators
Sale Price/Gross Acre $700

Remarks
The sale was confirmed by Judy Morgan who is a neighbor to the Grantee and was approached to purchase the land. The Grantee farms and ranches with his father who owns substantial adjacent land. They had been trying to purchase this tract for some time. Other parties had been interested but since Giesler's had been renting it, she decided to sell to them as they are her neighbors. The wind farms located near the subject had no impact on the price which Ms. Morgan believes was market. The sale is fenced pasture as is the majority of surrounding land. Ms. Morgan stated she had partially removed some of the gravel prior to sale.

The primary soils are Renshaw-Sioux complex. The slopes range from 0-25%. The non-irrigated soil classifications are II, IV, V, VI, and VIII, with various susceptibility to erosion, stones, and water. The PI for this subject ranges from 9 to 75, with an overall weighted average of 35.2 for the entire tract. Of the total acreage 89.2% is Not Prime Farmland, with the remaining 10.8% being Prime Farmland. The soils are a range of predominantly non-hydric (48.6, non-hydric (41.5%), predominantly hydric (5.3%), and partially hydric (4.6%).



Aerial Map



map center: 46° 16' 39.59, 98° 48' 24.42

0ft 801ft 1601ft

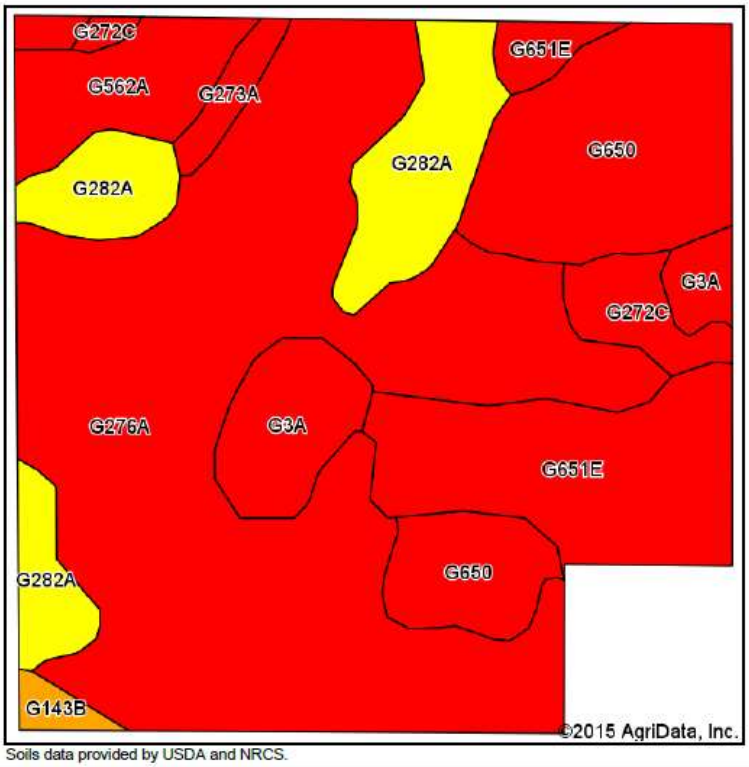
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3-132N-65W
Dickey County
North Dakota

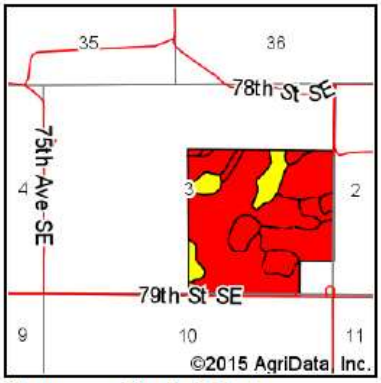
N W E S

12/3/2015

Soil Map



Soils data provided by USDA and NRCS.



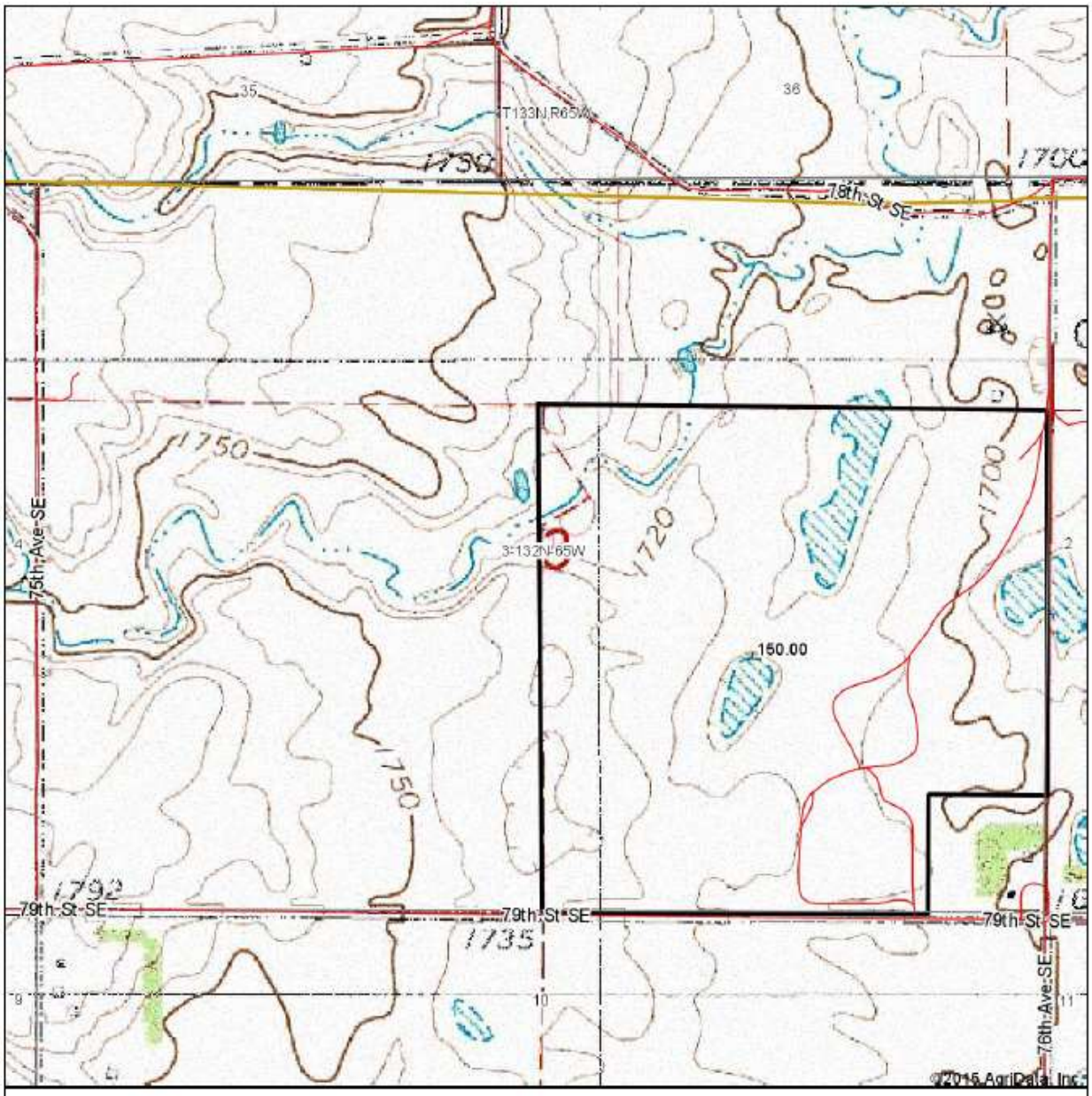
State: **North Dakota**
County: **Dickey**
Location: **3-132N-65W**
Township: **Young**
Acres: **150**
Date: **12/3/2015**

Maps Provided By:
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Area Symbol: ND021, Soil Area Version: 18

Code	Soil Description	Acres	Percent of field	PI Legend	Water Table	Non-Irr Class *c	Range Production (lbs/acre/yr)	Productivity Index	Barley	Oats	Sunflowers	Spring wheat	Winter wheat
G276A	Renshaw-Sioux complex, 0 to 2 percent slopes	71.82	47.9%		> 6.5ft.	IVs	2042	42					
G650	Pits, gravel and sand	21.63	14.4%		> 6.5ft.	VIIIs	212	9					
G651E	Udarents loamy, abandoned gravel pits, 0 to 25 percent slopes	18.05	12.0%		> 6.5ft.	VIIIs	332	14	1	1	11	1	1
G282A	Spottswood loam, dry, 0 to 2 percent slopes	15.60	10.4%		4.9ft.	IIs	2718	66					
G3A	Parnell silty clay loam, 0 to 1 percent slopes	7.93	5.3%		0ft.	Vw	5336	25					
G562A	La Prairie-Fluvaquents, channeled complex, 0 to 2 percent slopes, frequently flooded	7.10	4.7%		4.9ft.	VIw	2460	42					
G272C	Sioux-Arvilla-Renshaw complex, 6 to 9 percent slopes	4.16	2.8%		> 6.5ft.	VIs	1767	26					
G273A	Sioux-Arvilla complex, 0 to 2 percent slopes	1.87	1.2%		> 6.5ft.	VIs	1755	32					
G143B	Barnes-Svea loams, 3 to 6 percent slopes	1.13	0.8%		4.9ft.	IIe	3034	75					
G147D	Buse-Barnes-Darnen loams, 6 to 15 percent slopes	0.71	0.5%		> 6.5ft.	VIe	2534	46					
						Weighted Average	**1835.2**	**35.2**	**0.1**	**0.1**	**1.3**	**0.1**	**0.1**

Topography Map



map center: 46° 16' 39.59, 98° 48' 24.42

0ft 801ft 1601ft

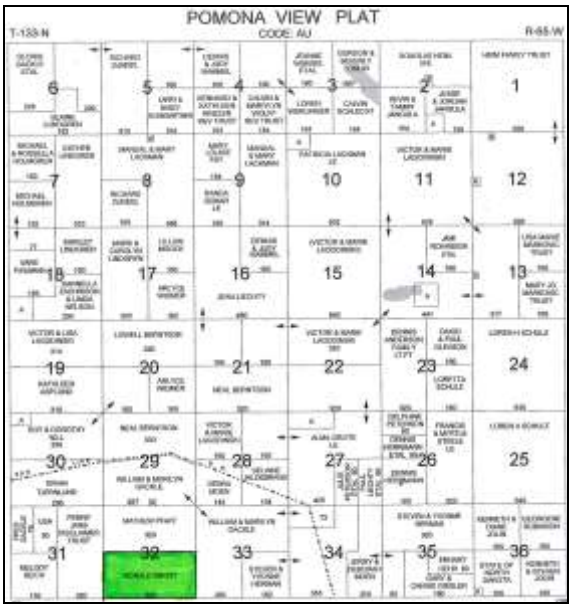
3-132N-65W
Dickey County
North Dakota

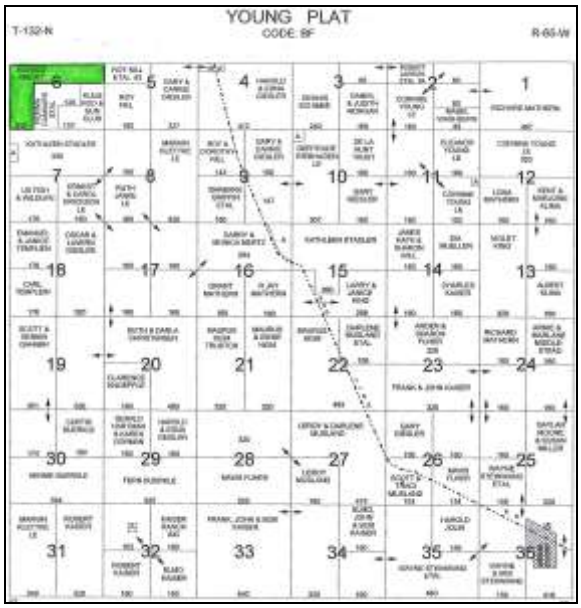
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H W E S

12/3/2015

Land Sale No. 2





Property Identification

Record ID	5991
Property Type	Vacant Land
Property Name	3 wind turbines
Address	74th Avenue SE and 78th Street SE , Dickey County, North Dakota
Location	Young Township and Pomona View Township
Tax ID	25-3203000; 25-3204000; 07459000; 07460000; 07461000
Legal Description	Lots 1 - 6 Section 6, T132N R65W, Dickey County; S2 Section 32, T133N R65W, LaMoure County, North Dakota.

Sale Data

Grantor	Ronald Brost
Grantee	Frederick and Linda Gackle
Sale Date	May 31, 2012
Deed Book/Page	CFD 168599; satisfied W/D 172303; 3/31/2015
Property Rights	Leased Fee;
Conditions of Sale	Assemblage.
Financing	A down payment of $60,000; balance at 4% interest per annum; three equal installments of $60,171.25; beginning June 1, 2013 and ending June 1, 2015. Balloon payment due June 1, 2016 of $904,323.25.
Sale History	WD; 7/21/1982 from Mathilda Brost to Ronald Brost, 1/3 interest, exempt
Verification	Jordan Gackle (701) 321-1041, Fred Gackle, (701) 647-2429, 11/20/2015; County records
Sale Price	$1,000,000

Land Data

Zoning	AG, Agricultural
Topography	Level to undulating, 0 to 35% slopes
Utilities	Assumed telephone and electricity available
Shape	Irregular
Roads	Paved and gravel

Land Sale No. 2 (Cont.)

Access	74th Ave SE and 78th St SE
Productivity Index	72.1
Wind Farm	Adjacent to the north
Wind Turbines on Tract	Three plus one meteorological tower

Land Size Information

Gross Land Size	537.21 Acres
Tillable Land Size	430.00 Acres, 80.04%
Pasture	107.21 Acres, 19.96%

Indicators

Sale Price/Gross Acre	$1,861
Sale Price / Tillable Acre	$2,151
Sale Price/ Pasture Acre	$700

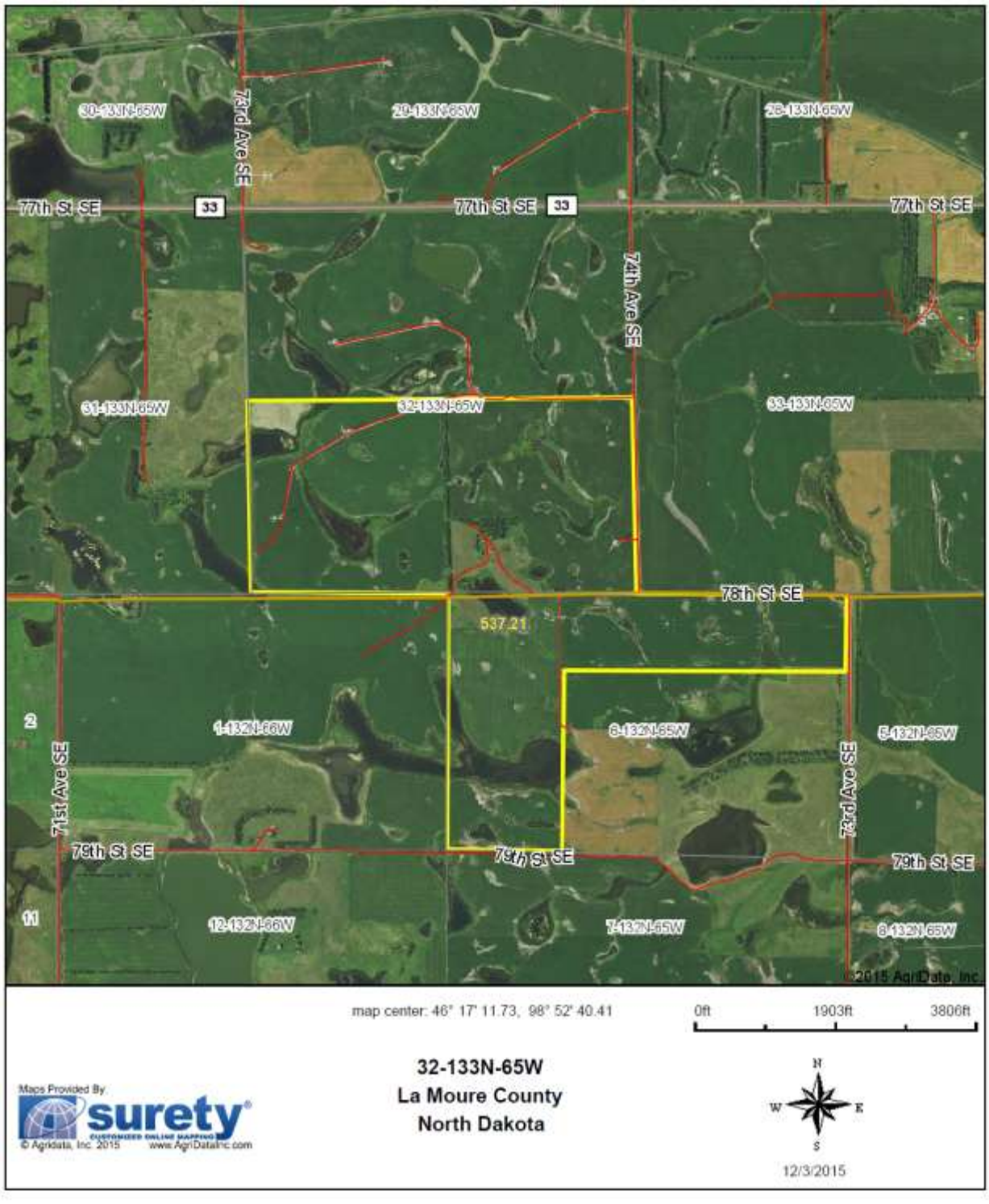
Remarks

The sale was confirmed by Fred Gackle, Grantee, who leased the land on a 1/3 – 2/3 split for 30 years prior to purchase, and was approached by the grantor. The land was vacant except for an old farmstead with no contributory value. It was purchased to maintain the farm operation but also as a start-up for his 2 sons. At the time of the sale, Section 32 was improved with 3 wind turbines and 1 meteorological tower, which were built in 2003 and leased for 25 years. The Grantor retained the royalty rights until the contract for deed was paid in full, at which time the rights passed to the buyer. Mr. Gackle feels the lease has a positive effect on the value of the land. Jordan Gackle, confirmed that he and his brother then purchased the land from their father. He feels the monetary benefit of the turbines outweighs the cost of the land.

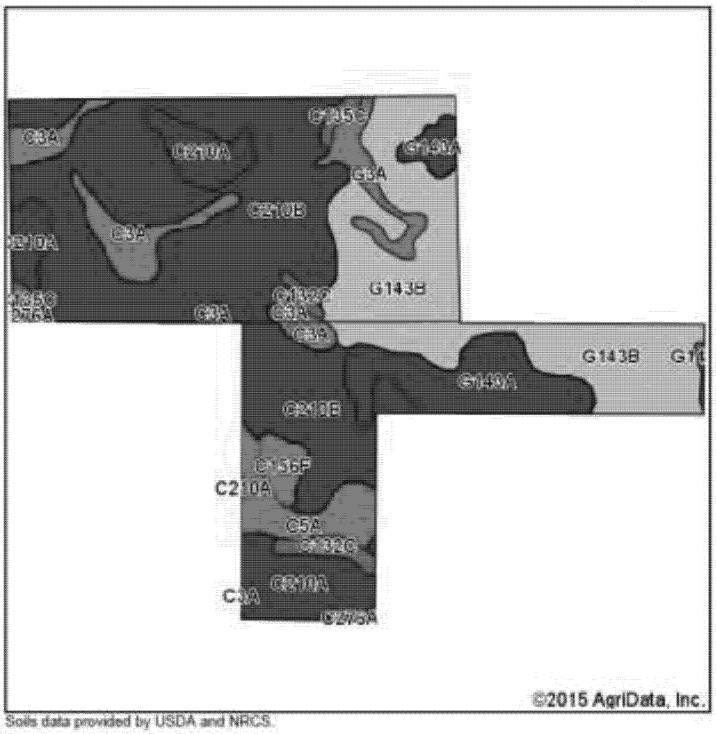
The primary soils include Williams-Bowbells loams and Barnes-Svea loams. The slopes range from 0-9%. The non-irrigated soil classifications are II, IV, V, VII, and VIII, with susceptibility to erosion, water, and climate. The PI for this subject ranges from 5 to 86, with an overall weighted average of 72.1 for the entire tract. Of the total acreage 51.6% is Farmland of Statewide Importance, 31.5% is Prime Farmland, with the remaining 16.9% being Not Prime Farmland. The soils are a range of predominantly non-hydric (87.5%), predominantly hydric (6.4%), hydric (5.8%), and partially hydric (0.3%).



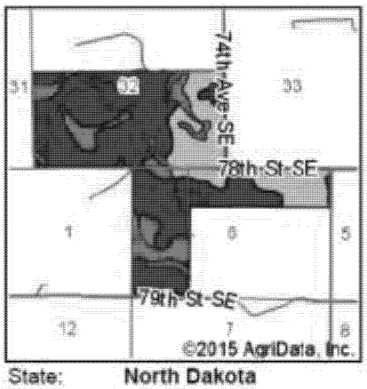
Aerial Map


30-133N-65W
29-133N-65W
28-133N-65W
73rd Ave SE
77th St SE
33
77th St SE
33
77th St SE
74th Ave SE
31-133N-65W
32-133N-65W
33-133N-65W
78th St SE
537.21
2
1-132N-66W
6-132N-65W
5-132N-65W
71st Ave SE
73rd Ave SE
79th St SE
79th St SE
79th St SE
11
12-132N-66W
7-132N-65W
8-132N-65W
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map center: 46° 17' 11.73, 98° 52' 40.41
0ft
1903ft
3806ft
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32-133N-65W
La Moure County
North Dakota
N
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12/3/2015

Soil Map



Soils data provided by USDA and NRCS.



State: North Dakota
County: La Moure
Location: 32-133N-65W
Township: Pomona View
Acres: 537.21
Date: 12/3/2015

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Area Symbol: ND021, Soil Area Version: 18
Area Symbol: ND045, Soil Area Version: 16

Code	Soil Description	Acres	Percent of field	PI Legend	Water Table	Non-Irr Class *c	Range Production (lbs/acre/yr)	Productivity Index
C210B	Williams-Bowbells loams, 3 to 6 percent slopes	171.71	32.0%		4.2ft.	IIe	2876	83
G143B	Barnes-Svea loams, 3 to 6 percent slopes	66.86	12.4%		4.9ft.	IIe	3034	75
G143B	Barnes-Svea loams, 3 to 6 percent slopes	56.79	10.6%		4.9ft.	IIe	3034	75
C210B	Williams-Bowbells loams, 3 to 6 percent slopes	52.89	9.8%		4.2ft.	IIe	2876	83
G143A	Barnes-Svea loams, 0 to 3 percent slopes	41.98	7.8%		4.9ft.	IIc	3405	85
C210A	Williams-Bowbells loams, 0 to 3 percent slopes	27.43	5.1%		4.2ft.	IIc	2711	86
C3A	Parnell silty clay loam, 0 to 1 percent slopes	26.94	5.0%		0ft.	Vw	5939	20
C210A	Williams-Bowbells loams, 0 to 3 percent slopes	23.90	4.4%		4.2ft.	IIc	2711	86
C5A	Southam silty clay loam, 0 to 1 percent slopes	20.91	3.9%		0.5ft.	VIIIw	919	5
G3A	Parnell silty clay loam, 0 to 1 percent slopes	13.59	2.5%		0.7ft.	Vw	5336	25
C156F	Zahl-Max-Bowbells loams, 6 to 35 percent slopes	8.06	1.5%		4.2ft.	VIIe	2422	36
G143A	Barnes-Svea loams, 0 to 3 percent slopes	7.25	1.3%		4.9ft.	IIc	3405	85
C132C	Williams-Zahl-Zahill complex, 6 to 9 percent slopes	5.90	1.1%		> 6.5ft.	IVe	2334	56
C135C	Zahl-Williams-Zahill complex, 6 to 9 percent slopes	4.53	0.8%		> 6.5ft.	IVe	2294	56
C3A	Parnell silty clay loam, 0 to 1 percent slopes	3.78	0.7%		0ft.	Vw	5939	20
C132C	Williams-Zahl-Zahill complex, 6 to 9 percent slopes	1.98	0.4%		> 6.5ft.	IVe	2334	56
C276A	Hamerly-Tonka-Parnell complex, 0 to 3 percent slopes	1.20	0.2%		2.5ft.	IIw	4209	58
G143C	Barnes-Buse-Langhei loams, 6 to 9 percent slopes	0.97	0.2%		> 6.5ft.	IVe	2763	56
C276A	Hamerly-Tonka-Parnell complex, 0 to 3 percent slopes	0.54	0.1%		2.3ft.	IIw	4209	58

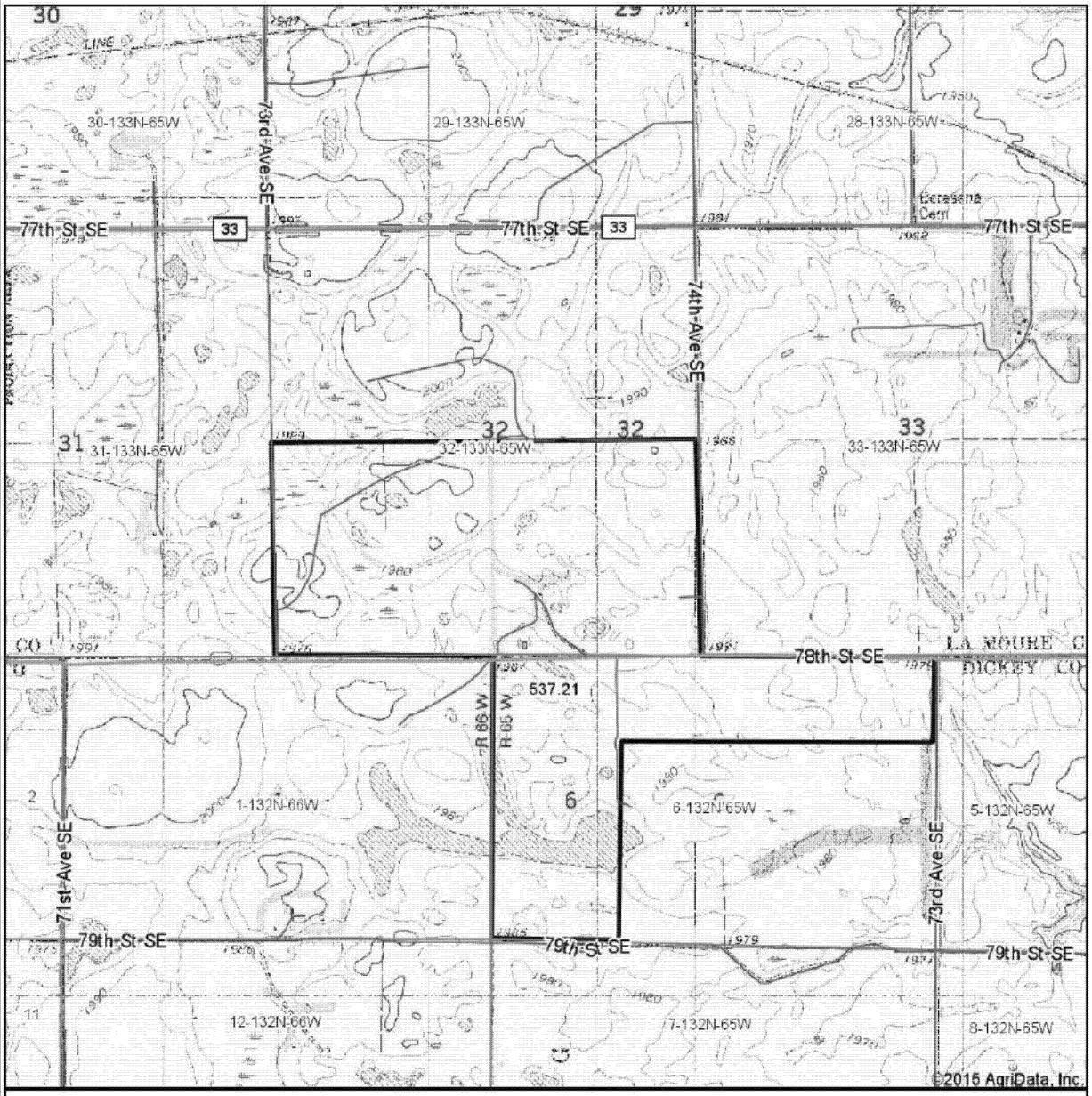
Weighted Average	3090.7	72.1

Area Symbol: ND021, Soil Area Version: 18
Area Symbol: ND045, Soil Area Version: 16

*c: Using Capabilities Class Dominant Condition Aggregation Method

Soils data provided by USDA and NRCS.

Topography Map



map center: 46° 17' 11.73, 98° 52' 40.41

0ft 1903ft 3806ft

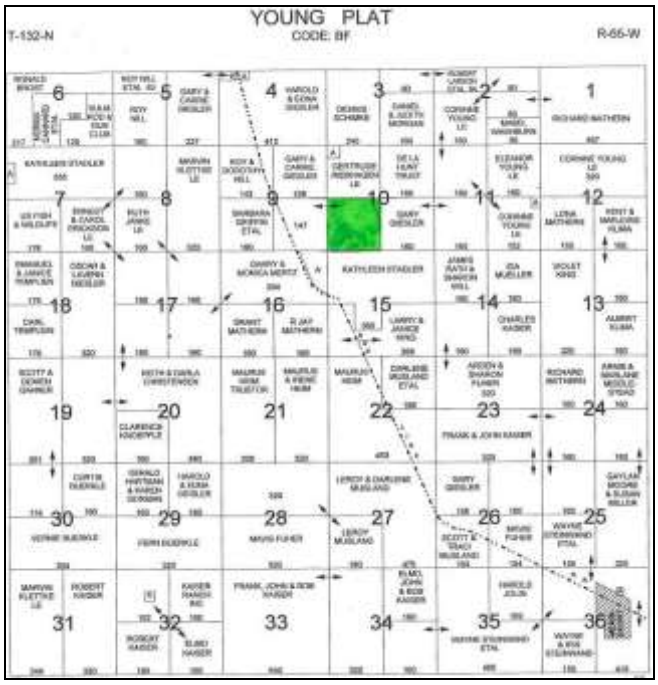
32-133N-65W
La Moure County
North Dakota

N W E S

12/3/2015

Maps Provided By: surety CUSTOMIZED ONLINE MAPPING © Agridata, Inc. 2015 www.AgriDataInc.com

Land Sale No. 3



Property Identification

Record ID	5990
Property Type	Vacant Land
Address	79th Street SE and 76th Avenue SE , Dickey County, North Dakota
Location	Young Township
Tax ID	07477000
Legal Description	SW4 of Section 10, T132N R65W, Dickey County, North Dakota.

Sale Data

Grantor	Melvin and Darlene Y. Herrmann
Grantee	Gary and Carrie Giesler
Sale Date	October 24, 2011
Deed Book/Page	WD 180164
Property Rights	Fee simple
Conditions of Sale	Assemblage
Financing	Cash to seller
Sale History	WD 173401; 11/14/2006 and WD 173745; 3/5/2007 from Betty Zimmerman to Melvin and Darlene Herrmann, exempt transactions.
Verification	Carrie Giesler, Grantee; (701) 647-2254, 12/1/2015; County records
Sale Price	$240,000

Land Data

Zoning	AG, Agricultural
Topography	Level to undulating; 0 to 9% slopes
Utilities	Assumed telephone and electricity available
Shape	Square
Roads	Gravel
Access	Land locked
Productivity Index	70.7

Land Sale No. 3 (Cont.)

Wind Farm	2 miles west, northwest
Turbines on Tract	None

Land Size Information

Gross Land Size	160.00 Acres
Tillable Land Size	120.00 Acres, 75.00%
Waste	40.00 Acres; 25%

Indicators

Sale Price/Gross Acre	$1,500
Sale Price/Tillable Acre	$2,000

Remarks

The sale was confirmed by Carrie Giesler, Grantee, who stated they purchased the land by private auction, limited to 6 parties. She states they paid market for the tract. The purchase is an assemblage to their existing farming operation. Mrs. Giesler added that she can see the wind farm from her house but that it does not create a negative impact.

The primary soils include Barnes-Svea loams and Barnes-Buse-Langhei loams. The slopes range from 0-9%. The non-irrigated soil classifications are II and IV, with various susceptibility to erosion and climate. The PI for this subject ranges from 56 to 85, with an overall weighted average of 70.7 for the entire tract. Of the total acreage 57.8% is Prime Farmland, 22.8% Not Prime Farmland, with the remaining 19.4% being Farmland of Statewide Importance. The soils are 100% predominantly non-hydric.



The land was not accessible; the photograph is looking south toward the sale and adjacent sale.

Aerial Map



map center: 46° 15' 54.79, 98° 48' 24.98

0ft 810ft 1621ft

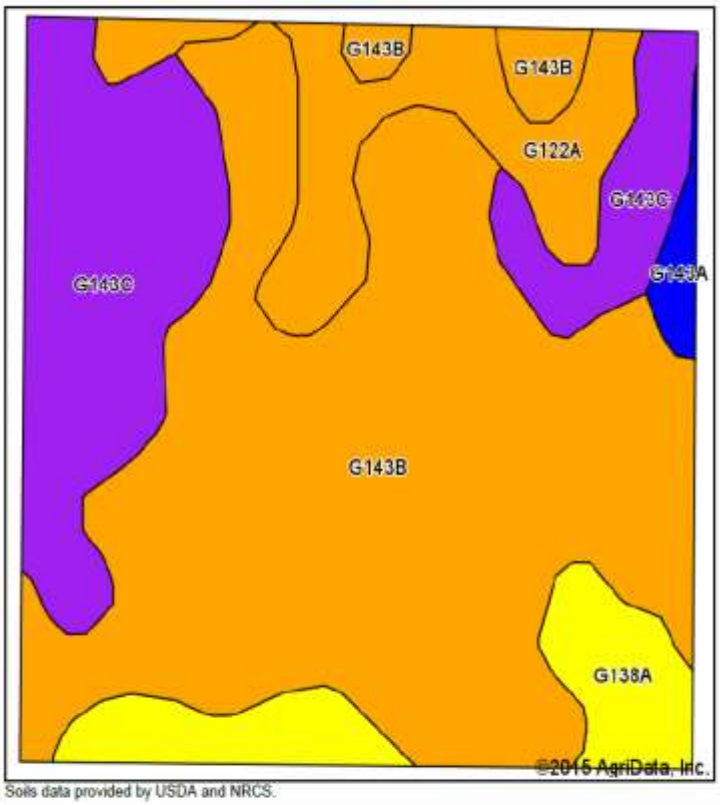
Maps Provided By surety CUSTOMIZED ONLINE MAPPING © Agridata, Inc. 2015 www.AgriDataInc.com

10-132N-65W
Dickey County
North Dakota

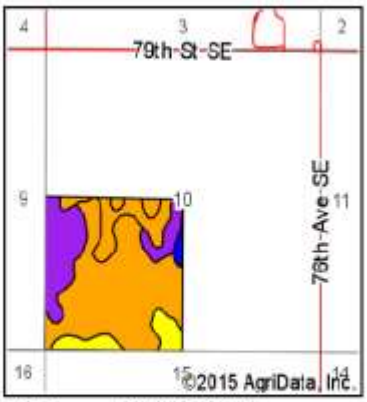
N W E S

12/3/2015

Soil Map



Soils data provided by USDA and NRCS.



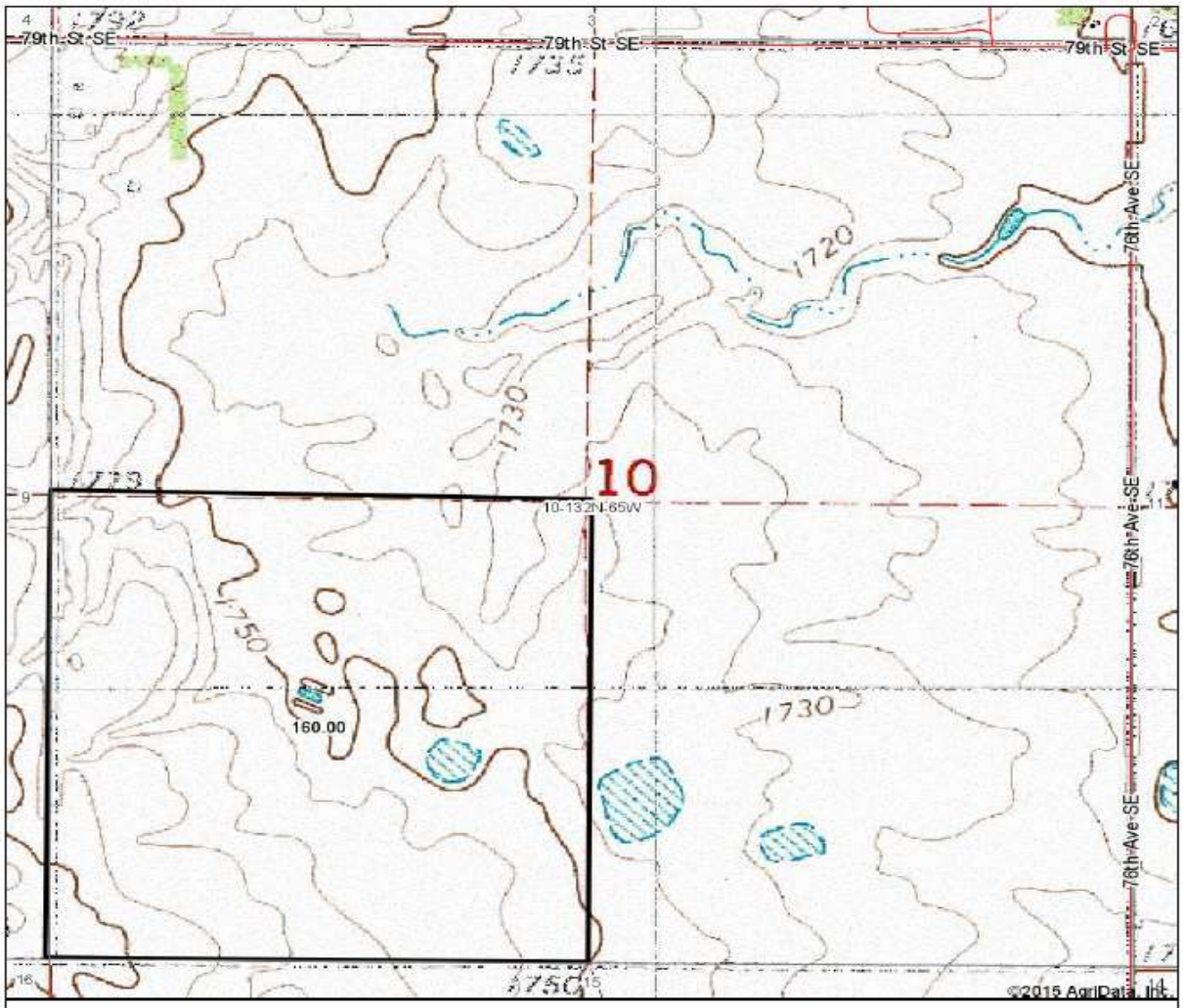
State: North Dakota
County: Dickey
Location: 10-132N-65W
Township: Young
Acres: 160
Date: 12/3/2015

Maps Provided By surety CUSTOMIZED ONLINE MAPPING © Agridata, Inc. 2015 www.AgriDataInc.com

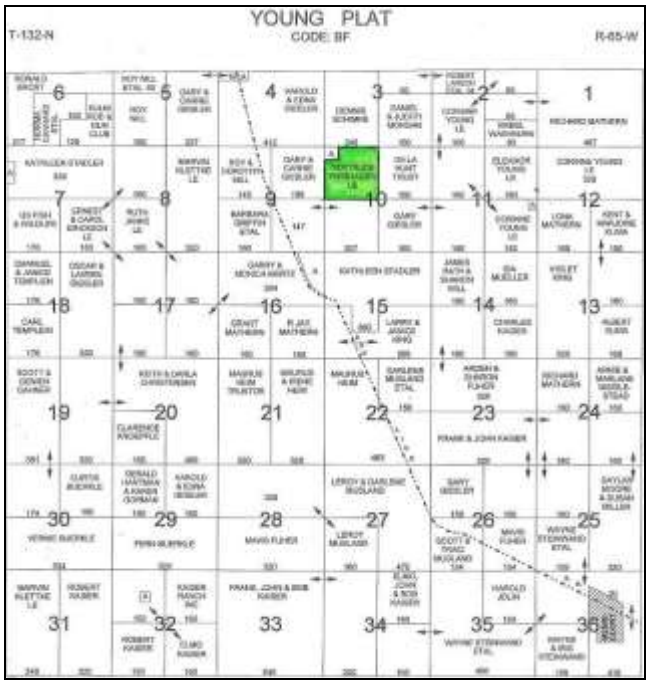
Area Symbol: ND021, Soil Area Version: 18

Code	Soil Description	Acres	Percent of field	PI Legend	Water Table	Non-Irr Class *c	Range Production (lbs/acre/yr)	Productivity Index
G143B	Barnes-Svea loams, 3 to 6 percent slopes	91.35	57.1%		4.9ft.	IIe	3034	75
G143C	Barnes-Buse-Langhei loams, 6 to 9 percent slopes	35.14	22.0%		> 6.5ft.	IVe	2763	56
G122A	Svea-Cresbard loams, 0 to 3 percent slopes	17.95	11.2%		4.9ft.	IIc	2788	79
G138A	Forman-Cavour loams, 0 to 3 percent slopes	13.50	8.4%		4.9ft.	IIc	2671	67
G143A	Barnes-Svea loams, 0 to 3 percent slopes	2.06	1.3%		4.9ft.	IIc	3405	85
						Weighted Average	**2921**	**70.7**

Topography Map



Land Sale No. 4



Property Identification

Record ID	5988
Property Type	Vacant Land
Address	79th Street SE and 76th Avenue SE , Dickey County, North Dakota
Location	Young Township
Tax ID	07476000
Legal Description	NW4 Section 10, T132N R65W, Dickey County North Dakota, Less 630 x 930 parcel containing 13.4 acres more or less.

Sale Data

Grantor	Melvin and Darlene Y. Herrmann
Grantee	Dennis J. Schimke
Sale Date	October 24, 2011
Deed Book/Page	WD 180123
Property Rights	Fee simple
Conditions of Sale	Assemblage
Financing	Cash to seller
Sale History	WD 173401; 11/14/2006 from Betty Lou D. Zimmerman to Darlene Y. Herrmann and including N2SW4 Section 10. Exempt transaction
Verification	Dennis Schimke; (701) 298-3625, 12/1/2015: County records
Sale Price	$220,500

Land Data

Zoning	AG, Agricultural
Topography	Level to rolling hills; 0 to 15% slopes
Utilities	Assumed telephone and electricity available
Shape	Irregular
Roads	Gravel

Land Sale No. 4 (Cont.)

Access	79th St SE
Productivity Index	71.1
Wind Farm	2 miles northwest
Turbines on Tract	None

Land Size Information

Gross Land Size	146.600 Acres

Indicators

Sale Price/Gross Acre	$1,504

Remarks

The sale was confirmed by Dennis Schimke, Grantee, who stated he was invited by the Grantor's attorney to attend an auction with 5 other parties. Mr. Schimke believes he paid a market price and stated the wind farms 2+ miles away had no impact on the price. He purchased the land as assemblage to his ranch operation in Section 3, as he raises buffalo. This tract will be used for pasture.

The primary soils include Svea Cresbard loams, Barnes-Svea loams, and Barnes-Buse-Langhei loams. The slopes range from 0-15%. The non-irrigated soil classifications are II, IV, V, and VI, with various susceptibility to erosion, water, and climate. The PI for this subject ranges from 25 to 93, with an overall weighted average of 71.1 for the entire tract. Of the total acreage 39.4% is Prime Farmland, 31.3% is Not Prime Farmland, with the remaining 29.3% being Farmland of Statewide Importance. The soils are a range of predominantly non-hydric (97.9%) and predominantly hydric (2.1%).



Aerial Map



map center: 46° 15' 54.79", 98° 48' 24.98

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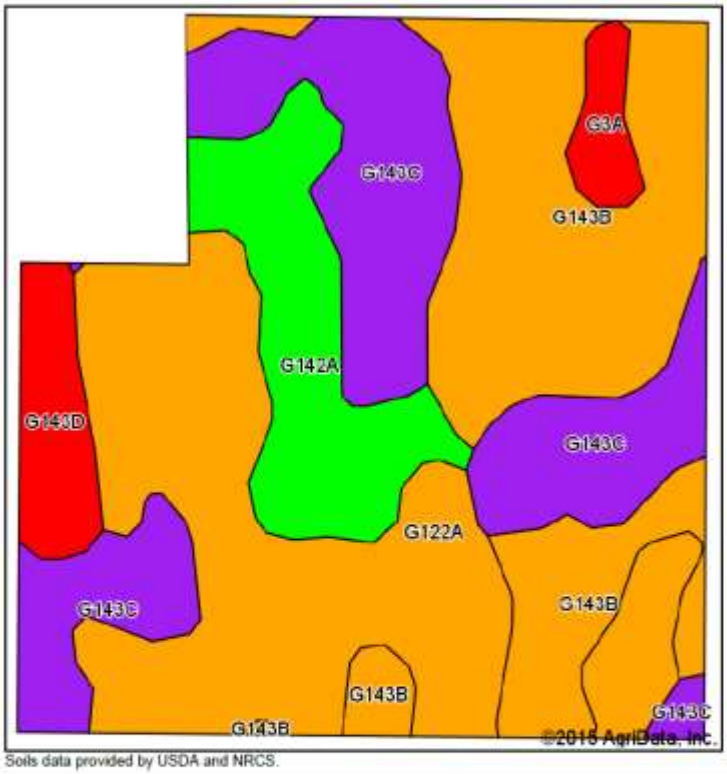
Maps Provided By:
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10-132N-65W
Dickey County
North Dakota

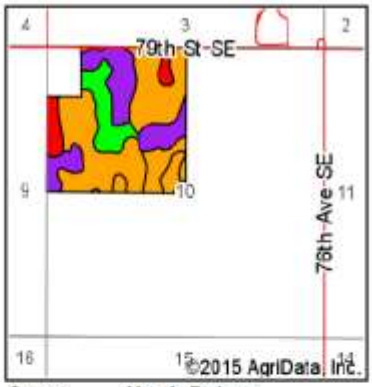
N W E S

12/3/2015

Soil Map



Soils data provided by USDA and NRCS.



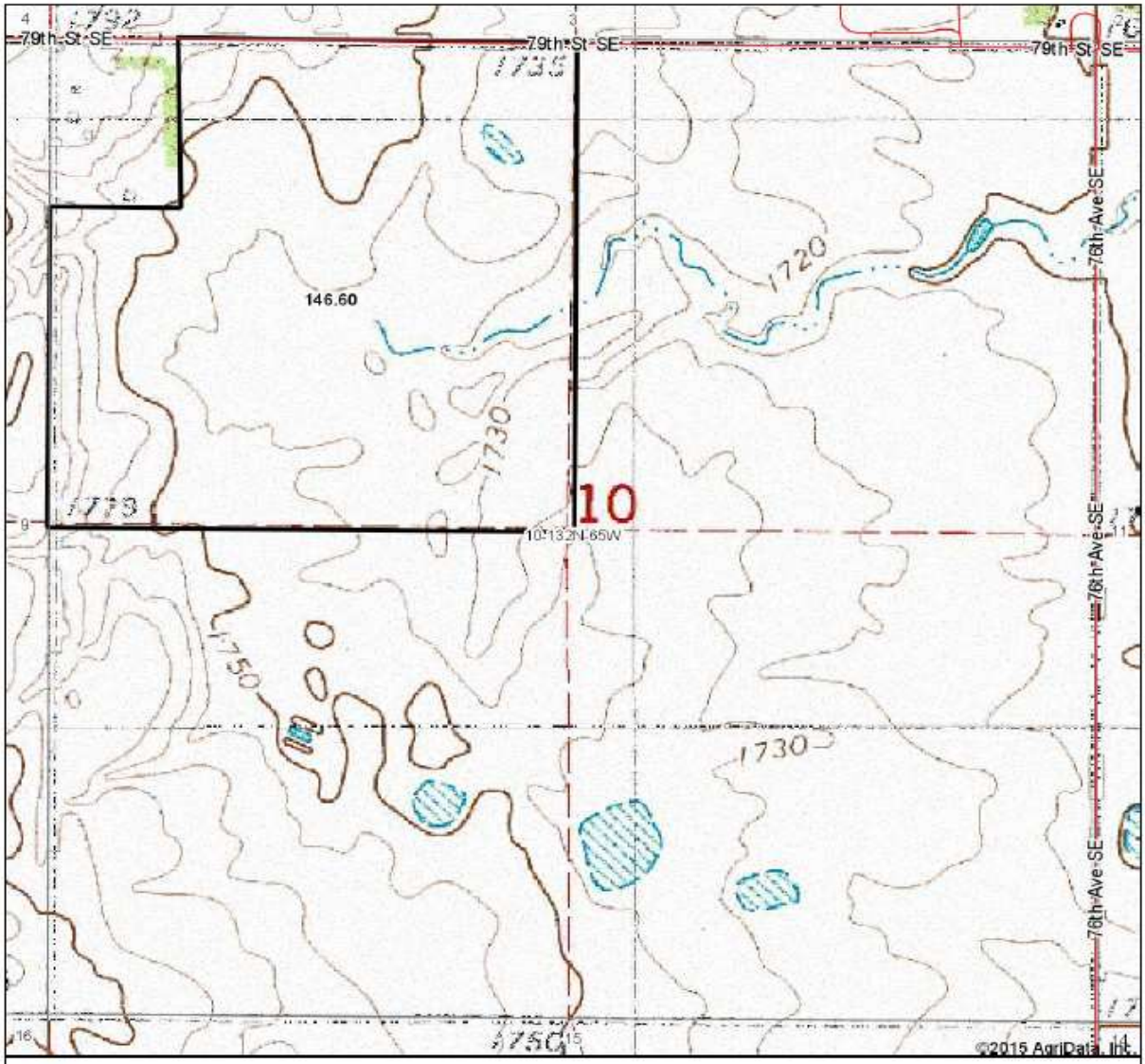
State: North Dakota
County: Dickey
Location: 10-132N-65W
Township: Young
Acres: 146.6
Date: 12/3/2015

Maps Provided By surety CUSTOMIZED ONLINE MAPPING © Agridata, Inc. 2015 www.AgriDataInc.com

Area Symbol: ND021, Soil Area Version: 18

Code	Soil Description	Acres	Percent of field	PI Legend	Water Table	Non-Irr Class *c	Range Production (lbs/acre/yr)	Productivity Index
G122A	Svea-Cresbard loams, 0 to 3 percent slopes	43.17	29.4%		4.9ft.	IIc	2788	79
G143B	Barnes-Svea loams, 3 to 6 percent slopes	41.13	28.1%		4.9ft.	IIe	3034	75
G143C	Barnes-Buse-Langhei loams, 6 to 9 percent slopes	35.80	24.4%		> 6.5ft.	IVe	2763	56
G142A	Svea loam, 0 to 3 percent slopes	17.13	11.7%		4ft.	IIc	2988	93
G143D	Barnes-Buse-Langhei loams, 9 to 15 percent slopes	6.36	4.3%		> 6.5ft.	VIe	2650	41
G3A	Parnell silty clay loam, 0 to 1 percent slopes	3.01	2.1%		0.7ft.	Vw	5336	25
						Weighted Average	**2920.6**	**71.1**

Topography Map



map center: 46° 15' 54.79, 98° 48' 24.98

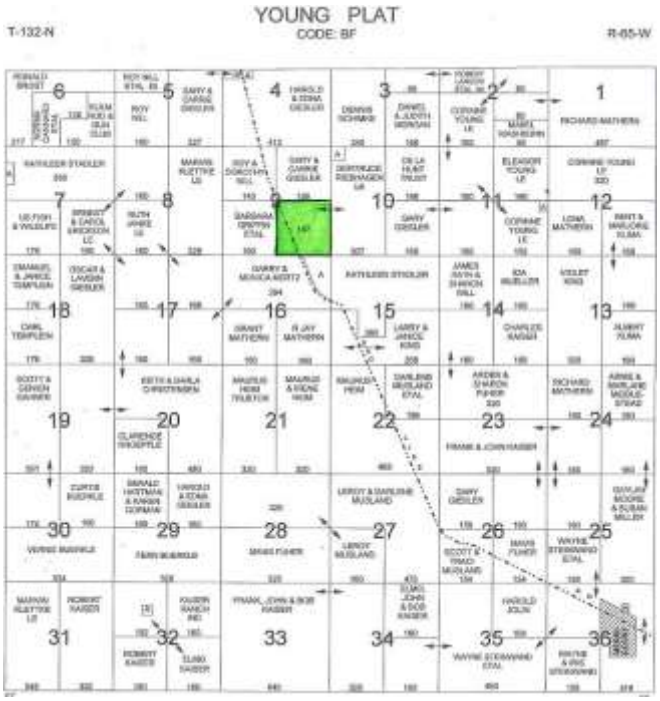
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10-132N-65W
Dickey County
North Dakota

Maps Provided By:
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12/3/2015

Land Sale No. 5



Property Identification

Record ID	5987
Property Type	Vacant Land
Address	79th Street SE and 76th Avenue SW, Dickey County, North Dakota
Location	Young Township
Tax ID	07474000
Legal Description	SE4 Section 9 less ROW, T132N R65W, Dickey County, North Dakota

Sale Data

Grantor	Betty L. Zimmerman Revocable Living Trust
Grantee	Gary and Carrie Giesler
Sale Date	October 24, 2011
Deed Book/Page	WD 180165
Property Rights	Fee simple
Conditions of Sale	Assemblage
Financing	Cash to seller
Sale History	WD 173400; 11/14/2006 from Darlene Y. Herrmann to Betty Lou D. Zimmerman, includes SW4 Section 10. Exempt transaction.
Verification	Carrie Giesler, Grantee; (701) 647-2254, 12/1/2015; County records
Sale Price	$140,000

Land Data

Zoning	AG, Agricultural
Topography	Level to undulating
Utilities	Assumed telephone and electricity available
Shape	Square
Roads	Gravel roads
Access	Land locked

Productivity Index	68.4
Wind Farm	2.5 miles northwest
Turbines on Tract	None

Land Size Information

Gross Acres	146.760 Acres
Tillable Acres	88.056 Acres, 60.00%
Pasture Acres	58.704 Acres, 40.00%

Indicators

Sale Price/Gross Acre	$954
Sale Price/ Tillable Acre	$1,123
Sale Price / Pasture Acre	$700

Remarks

The sale was confirmed by Carrie Giesler, Grantee. The tract was purchased by private auction with five other parties attending. Giesler believes they paid less than market as the tract is land locked. Additionally, the tract is severed by railroad tracks. The land was purchased to expand the current farming operation. It is 60% tillable (the acreage lying to the east of the railroad) and 40% pasture which lies west of the railroad tracks. Mrs. Giesler added that she can see the wind farm from her house but that it does not create a negative impact.

The primary soils include Barnes-Svea loams and Barnes-Buse-Langhei loams. The slopes range from 0-9%. The non-irrigated soil classifications are II and IV, with various susceptibility to erosion, water, and climate. The PI for this subject ranges from 42 to 93, with an overall weighted average of 68.4 for the entire tract. Of the total acreage 64.8% is Prime Farmland, 34.7% is Not Prime Farmland, with the remaining 0.5% being Prime Farmland if Drained. The soils are a range of predominantly non-hydric (99.5%) and predominantly hydric (0.5%).

The land was not accessible; the photograph is looking south toward the sale and adjacent sale.



Aerial Map



map center: 46° 15' 55.21, -98° 49' 39.93

0ft 810ft 1621ft

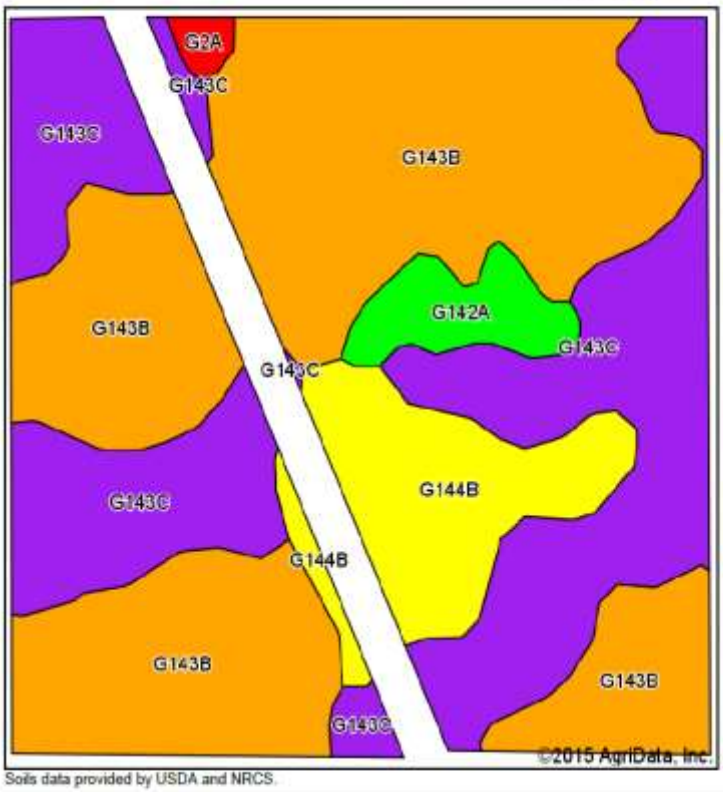
Maps Provided By surety
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9-132N-65W
Dickey County
North Dakota

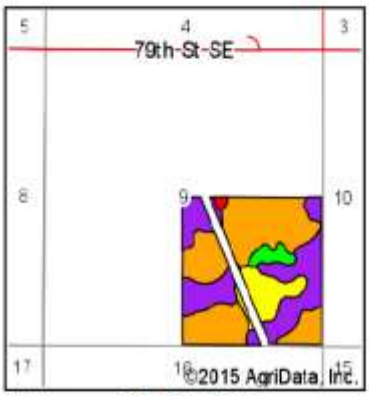
N W E S

12/3/2015

Soil Map



Soils data provided by USDA and NRCS.



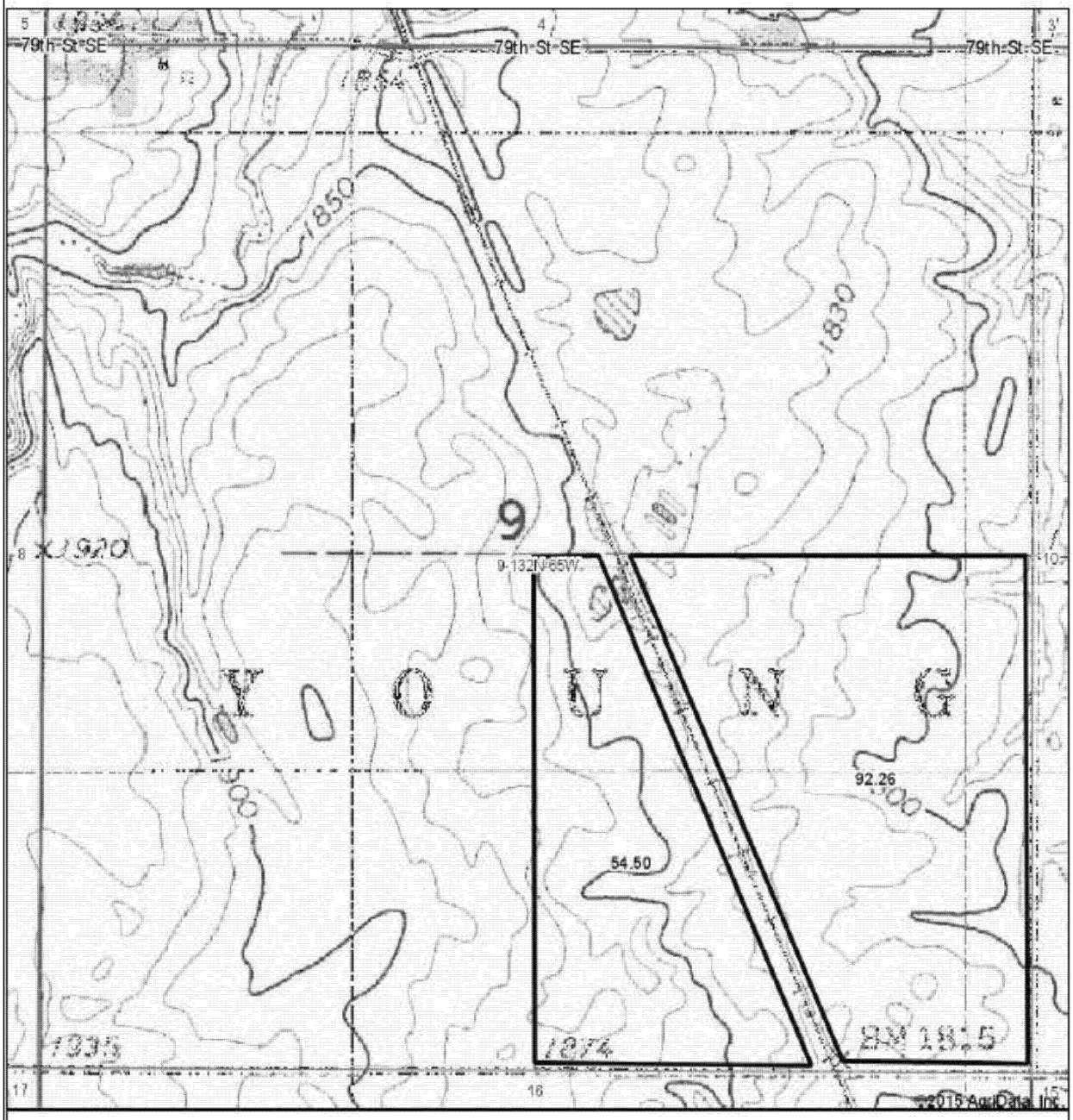
State: North Dakota
County: Dickey
Location: 9-132N-65W
Township: Young
Acres: 146.76
Date: 12/3/2015

Maps Provided By surety
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Area Symbol: ND021, Soil Area Version: 18

Code	Soil Description	Acres	Percent of field	PI Legend	Water Table	Non-Irr Class *c	Range Production (lbs/acre/yr)	Productivity Index
G143B	Barnes-Svea loams, 3 to 6 percent slopes	75.53	51.5%		4.9ft.	IIe	3034	75
G143C	Barnes-Buse-Langhei loams, 6 to 9 percent slopes	49.44	33.7%		> 6.5ft.	IVe	2763	56
G144B	Barnes-Buse loams, 3 to 6 percent slopes	15.58	10.6%		4.9ft.	IIe	2968	69
G142A	Svea loam, 0 to 3 percent slopes	5.28	3.6%		4ft.	IIc	2968	93
G2A	Tonka silt loam, 0 to 1 percent slopes	0.93	0.6%		0.5ft.	IVw	4606	42
						Weighted Average	**2946.1**	**68.4**

Topography Map



map center: 46° 15' 55.21, -98° 49' 39.93

0ft 810ft 1621ft

9-132N-65W
Dickey County
North Dakota

Maps Provided By:
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N W E S

12/3/2015

BURLEIGH COUNTY, NORTH DAKOTA

The surveyed area is located approximately 19 miles north of Bismarck, the State Capital and roughly 7 miles east of U. S. Highway 83. The area is rural, with farmsteads placed at ½ mile to one mile intervals. The topography is gently rolling to undulating then sharply increasing to rolling hills made up of glacial land formations with rocky soils and alluvial bottom lands. The county lies in the Missouri River Trench, Coteau Slope and Missouri Coteau. The county is drained by the Missouri River, Apple Creek and Burnt Creek. Drainage is typically collected in pot holes or sloughs. Erosion is the major concern of most farming operations. The soils are suitable for crop and hay production as well as pasture and rangeland. Livestock are raised throughout the county.

Overall, the wind farms suggest little physical impact to the land other than the area used for turbine placement and access. Typically, the access roads appeared to use a minimal amount of land to access the turbines.

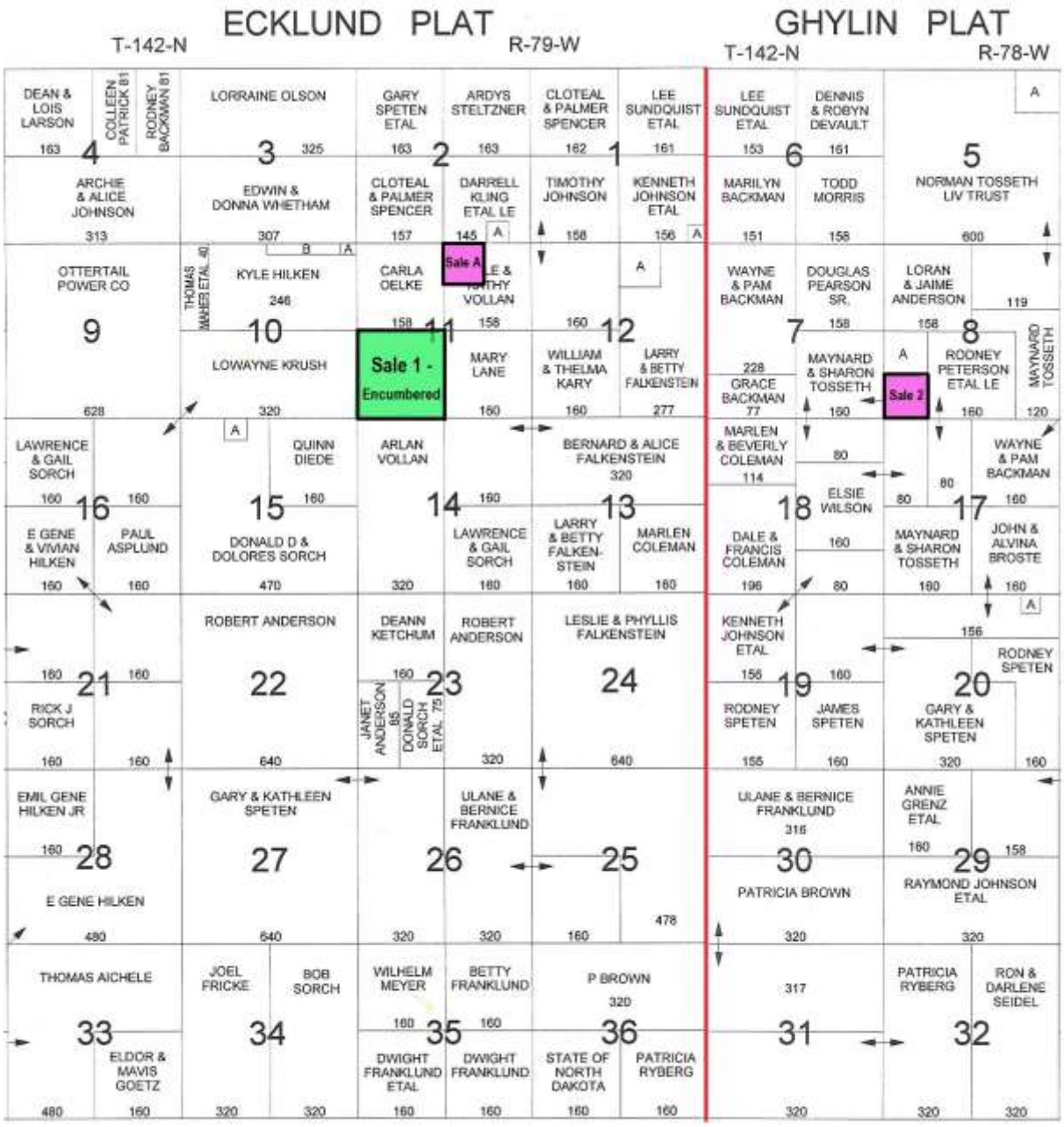
Three sales were found; one improved with a turbine, noted as Sale 1; one without a turbine noted as Sale 2; and one of a farmstead, noted as Sale A. Again, the lack of data is attributable to the retention of land within families for generations. As noted, the royalty rights went with the improved sale.

No.	Legal Description					Date	Sale Price	Deeded Acres	PI	Sale Price/ Deeded Acre	Turbines on Sale Tract	Adjacent Wind Farm	Negative Influence	Premium Paid
1	SW4	11	142	79	Burleigh	10/27/2013	$ 170,000	160.00	60.6	$ 1,063	yes	no	no	no
2	SW4SW4	8	142	78	Burleigh	8/30/2013	$ 40,000.00	40.00	71.20	$ 1,000	none	yes	no	no
A	NW4NE4	11	142	79	Burleigh	5/27/2014	$ 289,900	37.62		$ 7,706	none	yes	no	yes

The sales were then grouped according to their productivity index as follows.

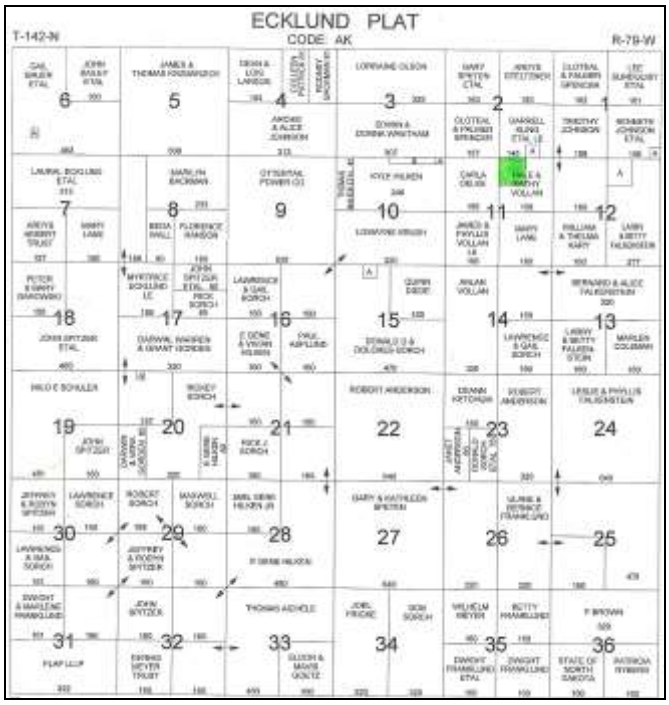
No.	Legal Description					Date	Sale Price	Deeded Acres	PI	Sale Price/ Deeded Acre	Turbines on Sale Tract	Adjacent Wind Farm	Negative Influence	Premium Paid	Comments
2	SW4SW4	8	142	78	Burleigh	8/30/2013	$ 40,000.00	40.00	71.20	$ 1,000	none	yes	no	no	100% tillable land
1	SW4	11	142	79	Burleigh	10/27/2013	$ 170,000	160.00	60.60	$ 1,063	yes	no	no	no	Grantor retained the royalty rights
A	NW4NE4	11	142	79	Burleigh	5/27/2014	$ 289,900	37.62		$ 7,706	none	yes	no	yes	Improved at time of sale; no market resistance to adjacent wind farm

Sales 1 and 2 closed in 2013 two months apart. Both were purchased as assemblages to existing farming operations. The differences are nominal. Neither sale evidenced market resistance. Sale A was improved with a mobile home, a barn and other out buildings at the time of sale. The buyer indicated he purchased the property as the site of his new home, which he intends to construct. The mobile home was sold off after purchase. He stated that the proximity of the wind turbines located nearby did not impact the price paid.



Burleigh County

Land Sale No. A



Property Identification

Record ID	6015
Property Type	Vacant Land
Address	County Road 36 and 93rd Street NE , Burleigh County, North Dakota
Location	Ecklund Township
Tax ID	10-142-79-00-11-220
Legal Description	NW4NE4 Section 11, T142N R79W, Burleigh County, North Dakota, less the N100' of said NW4NE4 as conveyed in Document No. 213880.

Sale Data

Grantor	Dale Vollan
Grantee	Rudolph D. Anderson
Sale Date	May 27, 2014
Deed Book/Page	WD 806592
Property Rights	Surface rights / fractional interest
Conditions of Sale	Normal
Financing	Cash to seller
Sale History	Records were searched for a 3 year period; no transfer was found.
Verification	Rudy Anderson, Grantee; (701) 220-4584, 12/15/2015 County records
Sale Price	$289,900

Land Data

Zoning	AG, Agricultural
Utilities	Assumed telephone and electricity available
Shape	Square
Roads	Paved and gravel
Access	County Road 36

Land Size Information

Gross Land Size	37.620 Acres
Tillable Land Size	25.000 Acres, 66.45%
Unusable Land Size	12.620 Acres, 33.55%

Indicators

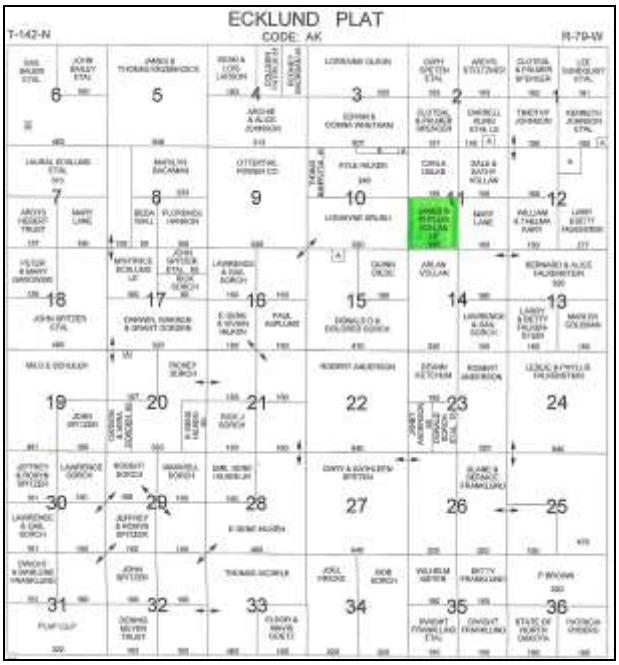
Sale Price/Gross Acre	$7,706

Remarks

The sale was confirmed by Rudy Anderson, Grantee, who stated that he bought this tract the day it went up for sale, offering the full list price of $289,900, which was accepted. He believes this may have been a premium price. The subject had been on the market a few years earlier for $300,000 but did not sell. The land consists of 25 tillable acres, a small slough and the farmstead which was improved with a double wide mobile home, barn and miscellaneous out buildings. Mr. Anderson stated the wind turbines located nearby did not impact the price he paid, and did not diminish the view. He sold off the mobile home for $40,000 and will be constructing a new stick built house on the property. He valued the barn, which was in good condition at $70,000 and gave no value to the outbuildings. Burleigh County purchased the adjacent NE4NE4 to build a shop. The Grantor retained ownership of the balance of the NE4.



Land Sale No. 1



Property Identification

Record ID	6013
Property Type	Vacant Land
Property Name	1 wind turbine
Address	County Road 36 and 80th Street NE , Burleigh County, North Dakota
Location	Ecklund Township
Tax ID	10-142-79-00-11-600
Legal Description	SW4 Section 11, T142N R79W, Burleigh County, North Dakota.

Sale Data

Grantor	Phyllis Vollan et al
Grantee	Donald D. and Doreen Sorch
Sale Date	October 27, 2013
Deed Book/Page	WD 798067
Property Rights	Surface rights / fractional interest
Conditions of Sale	Leased fee
Financing	Cash to seller
Sale History	WD 666587 dated 29 December 2006 from James and Phillis Vollan to James Vollan et al, this transfer was exempt.
Verification	Renee Kunz, Grantor; (206) 948-8155, 12/14/2015; Judy Brosz, Office of the State Tax Commissioner, (701) 328-3142, County records
Sale Price	$170,000

Land Data

Zoning	AG, Agricultural
Topography	Level to steep hills

Utilities	Assumed telephone and electricity available
Shape	Square
Roads	Paved and gravel
Access	80th St NE
Productivity Index	60.6

Land Size Information

Gross Land Size	160.000 Acres
Tillable Land Size	106.000 Acres, 66.25%
Pasture Land Size	54.000 Acres, 33.75%

Indicators

Sale Price/Gross Acre	$1,063

Remarks

The sale was confirmed by Renee Kunz, Grantor. She stated that her family approached the grantee who had been leasing the land. He purchased it as an assemblage to the current farming operation. The land was approximately 2/3 cropland and 1/3 hay land / pasture. Ms. Kunz believed the sale price was market and that the wind turbine did not negatively impact the sale price. The royalty rights were retained.

The primary soils include Williams-Zahl-Zahill complex and Sen silt loam. The topography ranges from level to steep hills at 0-60%. The non-irrigated soil classifications are II, IV, VI, and VIII, with various susceptibility to erosion, stones, and climate. The PI for this subject ranges from 10 to 98, with an overall weighted average of 60.6 for the entire tract. Of the total acreage 55.9% is Not Prime Farmland, 31.5% is Farmland of Statewide Importance, with the remaining 12.6% being Prime Farmland. The soils are a range of predominantly non-hydric (58.3%) and non-hydric (41.7%).

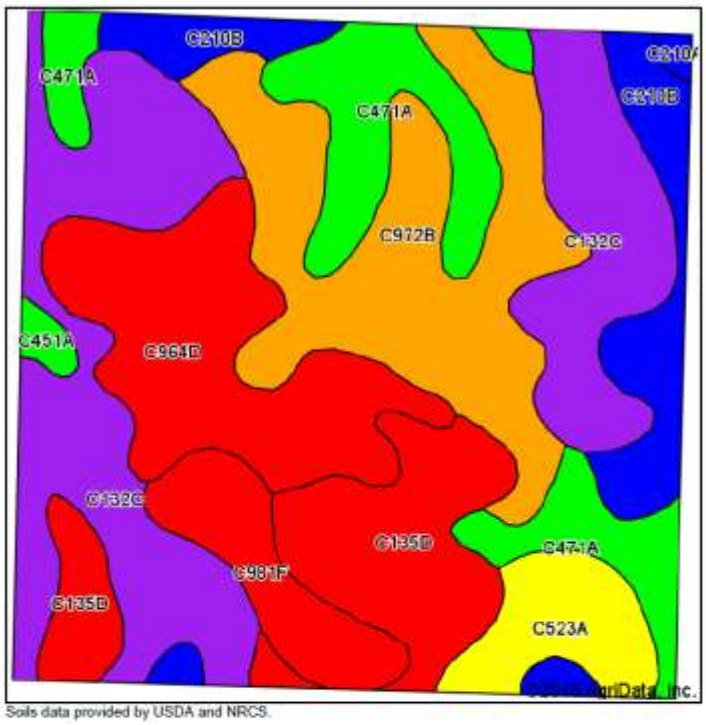


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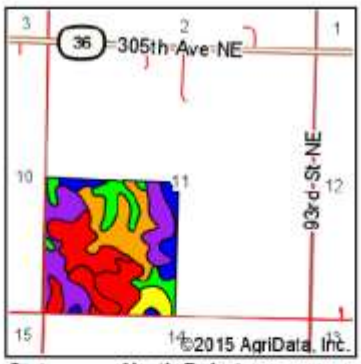
Aerial Map


36
305th Ave NE
93rd St NE
11-142N-79W
160.00
map center: 47° 8' 6.8, 100° 39' 14.68
0ft
823ft
1647ft
11-142N-79W
Burleigh County
North Dakota
Maps Provided By
surety
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12/14/2015

Soil Map



Soils data provided by USDA and NRCS.



State: **North Dakota**
County: **Burleigh**
Location: **11-142N-79W**
Township: **Ecklund**
Acres: **160**
Date: **12/14/2015**

Maps Provided By:
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Area Symbol: ND015, Soil Area Version: 16

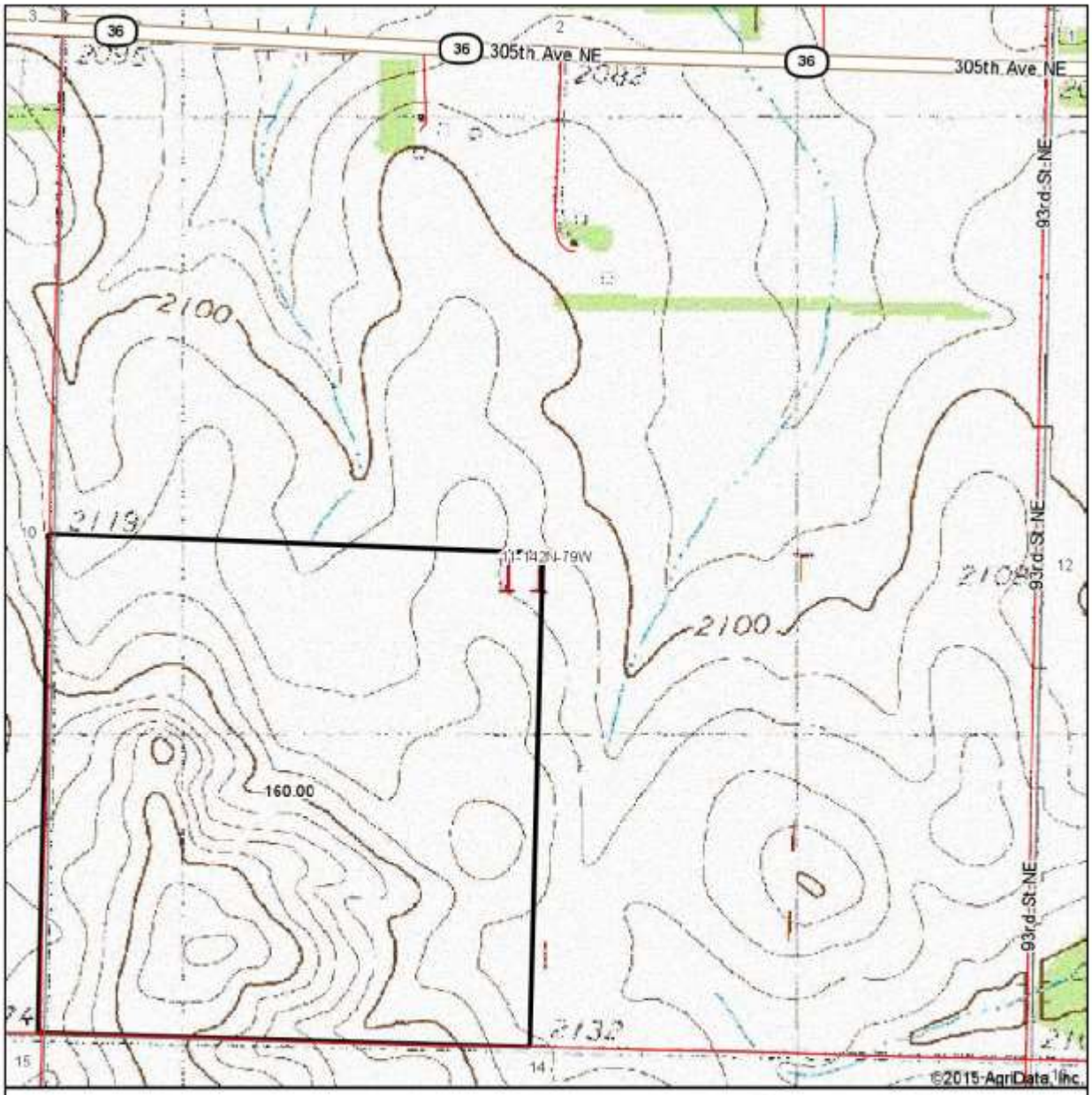
Code	Soil Description	Acres	Percent of field	PI Legend	Non-Irr Class *c	Productivity Index
C132C	Williams-Zahl-Zahill complex, 6 to 9 percent slopes	40.59	25.4%		IVe	56
C972B	Sen silt loam, 3 to 6 percent slopes	29.11	18.2%		IIe	74
C964D	Sen-Werner complex, 9 to 15 percent slopes	21.87	13.7%		VIe	37
C471A	Grail silty clay loam, 0 to 2 percent slopes	19.42	12.1%		IIc	95
C135D	Zahl-Williams loams, 9 to 15 percent slopes	18.43	11.5%		VIe	43
C210B	Williams-Bowbells loams, 3 to 6 percent slopes	13.39	8.4%		IIe	83
C981F	Ustarents loamy, mineland, 0 to 60 percent slopes	8.20	5.1%		VIIIs	10
C523A	Belfield-Rhoades-Grail silty clay loams, 0 to 2 percent slopes	7.47	4.7%		IIs	66
C451A	Arnegard loam, 0 to 2 percent slopes	1.04	0.6%		IIc	98
C210A	Williams-Bowbells loams, 0 to 3 percent slopes	0.48	0.3%		IIc	86
					Weighted Average	**60.6**

Area Symbol: ND015, Soil Area Version: 16

*c: Using Capabilities Class Dominant Condition Aggregation Method

Soils data provided by USDA and NRCS.

Topography Map



map center: 47° 8' 6.8, 100° 39' 14.68

0ft 823ft 1647ft

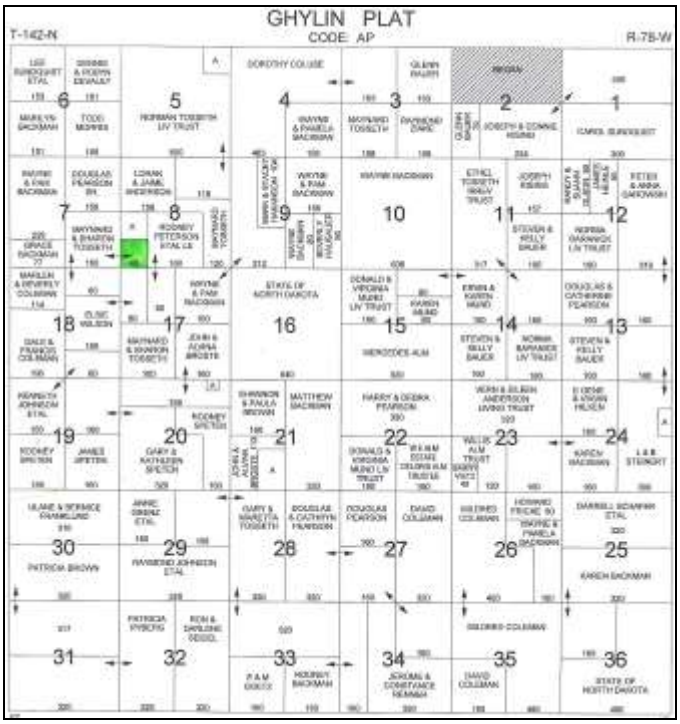
11-142N-79W
Burleigh County
North Dakota

Maps Provided By surety
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N W E S

12/14/2015

Land Sale No. 2



Property Identification

Record ID	6011
Property Type	Vacant Land
Address	119th Street NE and 292nd Avenue NE, Burleigh County, North Dakota
Location	Ghylin Township
Tax ID	11-142-78-00-08-600
Legal Description	SW4SW4 Section 8, T142N R78W, Burleigh County, North Dakota.

Sale Data

Grantor	Maynard and Sharon Tosseth
Grantee	Steven and Kelly Bauer
Sale Date	August 30, 2013
Deed Book/Page	WD 794269
Property Rights	Surface rights / fractional interest
Conditions of Sale	Leased fee
Financing	Cash to seller
Sale History	Records were searched for a 3 year period; no transfer was found.
Verification	Maynard Tosseth, Grantor (701)734-6420, 12/14/2015; County records
Sale Price	$40,000

Land Data

Zoning	AG, Agricultural
Topography	Level to undulating
Utilities	Assumed telephone and electricity available
Shape	Square

Land Sale No. 2 (Cont.)

Roads	Paved and gravel
Access	119th St NE
Productivity Index	71.2

Land Size Information

Gross Land Size	40.000 Acres; 100% tillable

Indicators

Sale Price/Gross Acre	$1,000

Remarks

The sale was confirmed by Maynard Tosseth, Grantor, who stated he was approached by the Grantee. The Grantee had been leasing the land for $40/acre prior to purchase. Mr. Tosseth believes he got a market rate and the price was not impacted by the nearby wind farms. The land was improved with an old building of no value.

The primary soils include Williams-Bowbells loams and Williams-Zahl-Zahill complex. The topography range is undulating at 0-9%. The non-irrigated soil classifications are II and IV, with various susceptibility to erosion and climate. The PI for this subject ranges from 56 to 86, with an overall weighted average of 71.2 for the entire tract. Of the total acreage 55.9% is Farmland of Statewide Importance, with the remaining 44.1% being Not Prime Farmland. The soils are 100% predominantly non-hydric.



Aerial Map



map center: 47° 8' 6.07, 100° 35' 27.52

0ft 820ft 1640ft

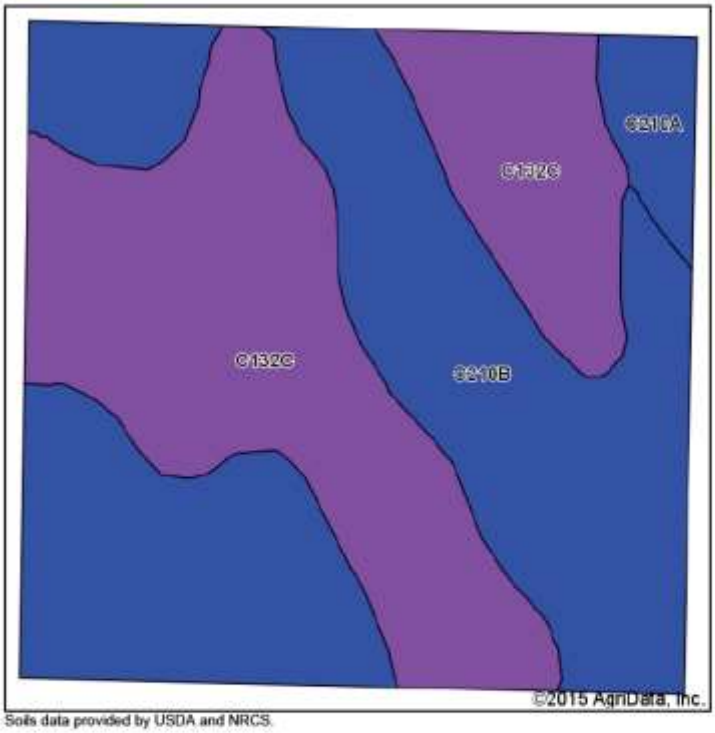
Maps Provided By surety
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8-142N-78W
Burleigh County
North Dakota

N W E S

12/14/2015

Soil Map



Soils data provided by USDA and NRCS.



State: **North Dakota**
County: **Burleigh**
Location: **8-142N-78W**
Township: **Ghylin**
Acres: **40**
Date: **12/14/2015**

Maps Provided By surety® CUSTOMIZED ONLINE MAPPING © Agridata, Inc. 2015 www.AgriDataInc.com

N W E S

Area Symbol: ND015, Soil Area Version: 16

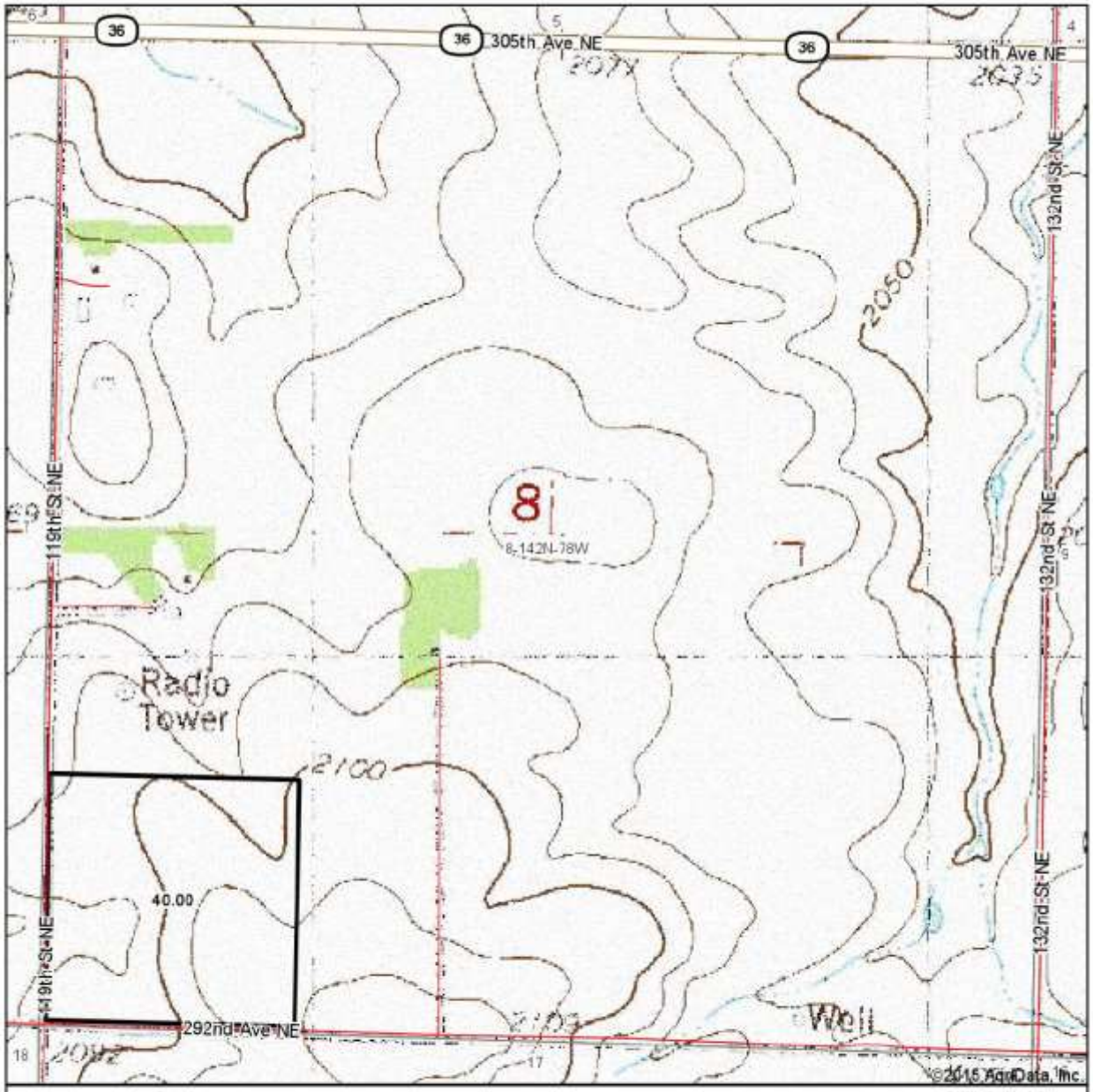
Code	Soil Description	Acres	Percent of field	PI Legend	Water Table	Non-Irr Class *c	Range Production (lbs/acre/yr)	Productivity Index
C210B	Williams-Bowbells loams, 3 to 6 percent slopes	20.83	52.1%		4.2ft.	IIe	2876	83
C132C	Williams-Zahl-Zahill complex, 6 to 9 percent slopes	17.71	44.3%		> 6.5ft.	IVe	2334	56
C210A	Williams-Bowbells loams, 0 to 3 percent slopes	1.46	3.6%		4.2ft.	IIc	2711	86
						Weighted Average	**2630**	**71.2**

Area Symbol: ND015, Soil Area Version: 16

*c: Using Capabilities Class Dominant Condition Aggregation Method

Soils data provided by USDA and NRCS.

Topography Map



ADDENDA



CONSULTING SERVICES AGREEMENT

This Consulting Services Agreement ("**Agreement**") dated October 8, 2015, is by and between RM Hoefs & Associates, Inc., a North Dakota corporation ("**Consultant**"), and Brady Wind, LLC, a Delaware limited liability company ("**Wind Operator**").

1. Retention of Consultant. Subject to the terms and conditions set forth in this Agreement, Wind Operator hereby retains Consultant to perform the services set forth in this Agreement and Consultant accepts this retention on the terms and conditions set forth in this Agreement.

2. Term. The term of this Agreement shall commence as of the date set forth above and shall terminate on January 31, 2017, subject to the earlier termination provisions contained herein ("**Term**"). The Term may be extended as mutually agreed upon in writing by the parties.

3. Consulting Services. The services to be performed by Consultant under this Agreement ("**Consulting Services**") shall be as set forth and described in **Exhibit A**.

4. Compensation and Payment. Consultant's compensation, payment and rates for Consulting Services ("**Fee**") shall be as set forth in **Exhibit B** to this Agreement.

5. Insurance. Consultant shall procure and maintain at its expense, the following minimum insurance coverage, unless otherwise specified in the Agreement, covering all operations required to complete the Consulting Services. Consultant shall provide evidence of the following minimum insurance coverage by providing an ACORD or other Certificate of Insurance in forms and with insurance companies acceptable to the Risk Management Department of Wind Operator (rated "A-, VII" or higher by A.M. Best's Key Rating Guide are deemed acceptable, before any Consulting Services under the Agreement begins: (i) all insurance requirements required by law, including but not limited to, workers' compensation insurance for statutory obligations imposed by workers' compensation or occupational disease laws; (ii) Employers' Liability Insurance, including Occupational Disease, shall be provided with a limit of One Million Dollars ($1,000,000) per occurrence; (iii) General Liability Insurance, written on Insurances Services Office form CG 00 01 1204 (or equivalent) covering liability arising out of premises, operations, bodily injury, property damage, products and completed operations and liability insured under and insured contract (contractual liability), with minimum limits of One Million Dollars ($1,000,000) per occurrence, which shall insure the performance of the contractual obligations assumed by the Consultant under the Agreement. The coverage shall insure the performance of the contractual obligations assumed by Consultant under the Agreement; and (iv) Professional Liability, Errors and Omissions Coverage, with the minimum limits of liability, per claim, of One Million Dollars ($1,000,000). Except for the Workers' Compensation and Professional Liability, Errors and Omissions Coverage, Wind Operator, its parent, subsidiaries and affiliated companies, along with their respective officers, directors, agents and employees (collectively, "**Wind Operator Entities**") shall be designated as an additional insured on Consultant's insurance policy required to be maintained under the Agreement, and such policy shall be endorsed to be primary to any insurance that may be maintained by or on behalf of the Wind Operator Entities. All policies of insurance required to be maintained by the Consultant hereunder shall: (i) provide a severability of interests or cross liability clause; (ii) provide that Wind Operator Entities be provided thirty (30) business days prior written notice of any non-renewals or cancellations; and (iii) waive any right of subrogation against Wind Operator Entities and waive any other right of the insurers to any off-set or counterclaim or any other deduction, whether by attachment or otherwise, in respect of any liability of Wind Operator Entities. Neither the Consultant's failure to provide evidence of minimum coverage of insurance following Wind

1

Operator's request, nor Wind Operator's decision to not make such request, shall release Consultant from its obligation to maintain the minimum coverage provided for in this Section 5.

6. Independent Contractor. Consultant agrees to perform Consulting Services as an independent contractor and not as a subcontractor, agent or employee of Wind Operator, its parent, subsidiaries or affiliates. Wind Operator retains no control or direction over Consultant, its employees or over the detail, manner or methods of performance of Consulting Services. Consultant is not granted any right or authority or responsibility expressed, implied or apparent on behalf of or in the name of Wind Operator to bind or act on behalf of Wind Operator.

7. Taxes. Consultant, and not Wind Operator, shall be solely responsible for all taxes incurred by Consultant in connection with its performance of Consulting Services, including, but not limited to, (i) all withholding, social security and other taxes of Consultant's employees and (ii) all taxes with respect to Consultant's compensation.

8. Business Records. Consultant shall maintain books and records supporting all costs for Consulting Services performed under this Agreement. During Consultant's normal business hours for the duration of this Agreement, and for a period of two years thereafter, Wind Operator shall have access to such books and to all other records of Consultant as required to verify reimbursable costs and to otherwise ensure compliance with the terms of this Agreement.

9. Confidentiality.

(a) Consultant agrees to hold Confidential Information in strict confidence and agrees that it shall not disclose Confidential Information without prior written consent of Wind Operator. For purposes of this Agreement, **"Confidential Information"** shall mean all information, regardless of the form in which it is communicated or maintained (whether oral, written, or visual) and whether prepared by Wind Operator or otherwise which is disclosed to Consultant in connection with the this Agreement and including all reports, analyses, notes or other information that are based on, contain or reflect any such Confidential Information. Confidential Information may only be disclosed to employees with a need to know the Confidential Information for the sole purpose of performing Consulting Services under this Agreement and Consultant is responsible for any breach of this provision by its employees.

(b) This provision does not apply to information that is presently a matter of public knowledge, which is or becomes available on a nonconfidential basis from a source which is not known to be prohibited from disclosing such information or which was legally in Consultant's possession without obligation of confidentiality prior to disclosure by Wind Operator.

(c) In the event that Consultant is requested or required by legal or regulatory authority to disclose any Confidential Information, Consultant shall promptly notify Wind Operator of such request or requirement prior to disclosure so that Wind Operator may seek an appropriate protective order and/or waive compliance with the terms of this Agreement.

(d) Wind Operator and Consultant acknowledge that Wind Operator would not have an adequate remedy at law for money damages if the covenants contained in this provision were breached. Accordingly, Wind Operator shall be entitled to an injunction restraining Consultant from violating this provision.

(e) Upon the termination of this Agreement or at any time upon written request of Wind Operator, Consultant shall promptly deliver to Wind Operator all drawings, manuals, letters, notes, notebooks, reports, and copies thereof and all other materials, including those of a secret or confidential nature, relating to Wind Operator's business that are in Consultant's and its contractors' or consultants' possession or control. The obligations of confidentiality contained in this provision 9 shall survive the termination of this Agreement and shall remain in effect for a period of two years following such termination.

(f) Wind Operator makes no representation or warranty as to the accuracy or completeness of the Confidential Information. Neither Wind Operator nor any of the other Wind Operator Entities shall be subject to liability resulting from any use of the Confidential Information by Consultant.

10. Publicity. The Consultant shall not make any public disclosures regarding Wind Operator or the project for which it is performing the Consulting Services without the prior approval of Wind Operator.

11. Work Product. Subject to the next sentence, the Consultant and Wind Operator agree that Wind Operator, not the Consultant, shall own all rights (including all intellectual property rights), title and interest to any and all work products resulting from Consulting Services performed under this Agreement. The Consultant shall retain all right, title and interest in and to Consultant Preexisting IP, provided that to the extent that any of Consultant Preexisting IP is embedded in the work product provided to Wind Operator under this Agreement, the Consultant hereby grants to Wind Operator and each Wind Operator Entity a non-exclusive, irrevocable, perpetual, and royalty-free license to use such Consultant Preexisting IP as Wind Operator may deem necessary to utilize the work product for Wind Operator's business purposes. **"Consultant Preexisting IP"** means individually and collectively, all inventions, improvements and/or discoveries, patentable or unpatentable, copyrightable or uncopyrightable, including but not limited to, computer software databases, methodologies and works of authorship, which were in existence, prior to the Consultant's performance of the Consulting Services under this Agreement. The Consultant hereby assigns all rights (including all intellectual property rights), title and interest in work products resulting from this Agreement. At the request of Wind Operator, the Consultant shall, without further consideration, execute all papers and documents and perform all other acts necessary or appropriate to evidence or further document Wind Operator's ownership of the work product.

12. Standard of Performance. The Consultant shall perform the Consulting Services in accordance with (i) the standards of care, diligence, skill and judgement normally exercised by professional firms and individuals with respect to services of a similar nature; (ii) recognized and sound consulting practices, procedures and techniques; (iii) all applicable laws and regulations; and (iv) the terms of **Exhibit A**.

13. Termination. Wind Operator or Consultant shall have the right to terminate this Agreement for its convenience in whole or in part at any time, upon thirty (30) days' written notice to the other party. In the event of such termination, Consultant shall be paid for services provided to the termination date.

14. Modifications. No amendment or modification to this Agreement shall be effective unless made in writing.

15. Assignment. This Agreement and all of the Consultant's rights, duties and obligations under this Agreement are personal in nature and shall not be subcontracted, assigned, delegated or otherwise disposed of by the Consultant without the prior written consent of Wind Operator. Wind Operator may assign this Agreement upon prior written notice to the Consultant.

16. Liability Limitation. In no event shall either party be liable to the other party whether in contract, tort or otherwise for payment of any special, indirect, incidental, consequential or similar damages.

17. Indemnification. The Consultant shall protect, defend, indemnify and hold Wind Operator, its affiliates, officers, employees, partners, members, successors and assigns free and unharmed from and against any and all claims, liabilities, loss, costs, or damages, including court costs and attorneys' fees which shall arise in connection with (i) anything done or omitted to be done by the Consultant with respect to the Consulting Services if caused by the negligence or willful misconduct of the Consultant, (ii) any breach by the Consultant of a covenant, warranty or representation contained herein, or (iii) any claim by Consultant's employees.

18. Notice. All notices required under this Agreement shall be deemed given when sent by overnight courier or registered or certified mail, or when sent by telecopy, telegraph or other graphic, electronic means and confirmed by overnight courier or registered or certified mail addressed as follows:

Hoefs & Associates, Inc.,	Brady Wind, LLC
PO Box 3102	700 Universe Blvd., FEW/JB
Fargo, ND 58103	Juno Beach, FL 33408
(701) 298-3066 Office	Attn: Project Manager
(701) 799-3347 Cell	(561) 694-4638

Either party shall have the right to change the address or name of the person to whom such notices are to be delivered by notice in accordance with this paragraph to the other party.

19. Law and Venue. This Agreement shall be governed in all respects by and construed in accordance with the laws of the State of Florida without regard to conflicts of law provisions. Any litigation between the parties shall be conducted in the state or federal courts of the State of Florida.

20. Headings. The headings in this Agreement are provided for convenience of reference only and shall not affect the construction of the text of this Agreement.

21. Non-Waiver. No waiver of any provision of this agreement shall be deemed to be nor shall constitute a waiver of any other provision whether or not similar, nor shall any waiver constitute a continuing waiver. No waiver shall be binding unless executed in writing by the party making the waiver.

22. Cumulative Remedies. All rights and remedies of the parties under this Agreement shall be cumulative and the exercise of any one right or remedy shall not bar the exercise of any other right or remedy.

23. Severability. If any provision of this Agreement shall be held or deemed to be invalid, inoperative or unenforceable, such circumstances shall not affect the validity of any other provision of this Agreement.

24. Survival. The obligations of the parties hereunder which by their nature survive the termination of this Agreement and / or the completion of the Consulting Services hereunder shall survive and inure to the benefit of the parties. Those provisions of this Agreement which provide for the limitation of or protection against liability shall apply to the full extent permitted by law and shall survive termination of this Agreement and / or completion of the Consulting Services.

25. Complete Agreement. This Agreement is composed of this document and all exhibits hereto. This Agreement constitutes the entire and final agreement and supersedes all prior and contemporaneous agreements, representations, warranties and understandings of the parties, whether oral, written or implied.

26. Counterparts. This Agreement may be signed in counterparts, each of which may be deemed an original and all of which together constitute one and the same agreement.

27. Waiver of Trial by Jury. Wind Operator and Consultant hereby knowingly, voluntarily and intentionally waive the right to a trial by jury with respect to any litigation based hereon or arising out of, under or in connection with this Agreement. This provision is a material inducement for the parties entering into this Agreement.

28. Authorization and Binding Obligations. Each party hereto represents to the other party that the execution, delivery and performance of this Agreement have been duly authorized, and this Agreement has been duly executed and delivered by the signatory so authorized, and the obligations contained herein constitute the valid and binding obligations of such party.

(The remainder of this page is intentionally blank. The next page is the signature page.)

The parties have executed this Consulting Agreement effective as of the day and year first above written.

Consultant

RM Hoefs & Associates, Inc.,
a North Dakota corporation

By: _____
Rose M. Hoefs, President

Wind Operator:

Brady Wind, LLC
a Delaware limited liability company

By: _____
John DiDonato, Vice President

EXHIBIT A

Consulting Services

Provide labor, material, equipment, transportation and office calculations to perform a study on the impact of NextEra Energy Resources, LLC's wind farms (if any) on property improved with wind turbines and related structures, as well as surrounding properties. Consultant shall use paired sales by using the sale of the Wind Operator's encumbered tracts and tracts adjacent to the encumbered tracts as a basis.

EXHIBIT B

Compensation

Upon completion of the analysis set forth in **Exhibit A**, the Consultant shall submit an invoice summarizing the Consulting Services performed, the number of hours worked and the expenses incurred with accompanying receipts. Consultant's rate shall be $175.00 per hour and expenses include a straight per diem of $40.00 per day plus $0.567 per mile, plus lodging costs. The only receipts submitted will be for lodging. This is done in accordance with invoices submitted to the ND DOT and similar institutions. If it appears the cost of the analysis set forth in **Exhibit A** will exceed $25,000.00 then Consultant shall immediately contact Wind Operator so that Wind Operator can restrict the scope of the analysis, if necessary. Payments for undisputed amounts shall be made within forty-five (45) days from the receipt of an invoice.

Any modifications to the Scope of Work, respective modifications to compensation, if any, shall be agreed upon by both parties in a mutual writing.

QUALIFICATIONS OF ROSE M. HOEFS

AFFILIATION

The Appraisal Institute, Chicago, Illinois, 1986; Associate Member
The International Right of Way Association
DUNS available on request

MEMBER OF

Greater Minnesota Chapter of the Appraisal Institute
Greater North Dakota Chapter of the Appraisal Institute
Fargo-Moorhead Board of Realtors

LICENSES AND DESIGNATIONS

North Dakota Certified General Appraiser, 1992; #1063
Minnesota Certified General Appraiser, 1992; #4002095
South Dakota Certified General Appraiser, 2014; #1333CG
North Dakota Real Estate Broker, 1976; lapsed 2005
GRI (Graduate Realtors Institute) 1976; CRS (Certified Residential Specialist) 1977

EDUCATIONAL INSTITUTIONS

Dickinson Branch NDSU, Dickinson, North Dakota
Moorhead State University, Moorhead, Minnesota
North Dakota State University, Fargo, North Dakota
University of Colorado, Boulder, Colorado
University of Minnesota, Minneapolis, Minnesota
University of St. Thomas, Minneapolis, Minnesota

EDUCATION – APPRAISAL INSTITUTE COURSES

Advanced Applications
2000 University of St. Thomas, Minneapolis, Minnesota

Advanced Sales Comparison and Cost Approaches
2000 University of St. Thomas, Minneapolis, Minnesota

Basic Valuation Procedures
1989 University of Minnesota, Minneapolis, Minnesota

Business Practices and Ethics
2013 Appraisal Institute
2009 Appraisal Institute

Capitalization Theory and Technique, Parts A and B
1989 University of Colorado, Boulder, Colorado

Case Studies
1992 University of St. Thomas, Minneapolis, Minnesota
1991 Appraisal Institute, Houston, TX

Commercial Cost Approach Training
2009 Appraisal Institute

Condemnation Appraising / Advanced Topics and Applications
1999 University of Colorado, Boulder, Colorado

Condemnation Appraising / Basic Principles and Applications
1999 University of Colorado, Boulder, Colorado

Demonstration Report Writing
1999 Appraisal Institute, Chicago, Illinois

Eminent Domain and Condemnation
2006 Appraisal Institute

FHA and the Appraisal Process
1999 Appraisal Institute, Bismarck, ND

Introduction to Green Buildings: Principles & Concepts
2013 Appraisal Institute

Real Estate Principles
1988 University of Colorado, Boulder, Colorado

Report Writing and Valuation
1991 Houston Chapter, Appraisal Institute; Houston, Texas

Residential Cost Approach Training
2009 Appraisal Institute

Residential Market Analysis and Highest & Best Use
2011 Appraisal Institute

Small Hotel/Motel Valuation
2006 Appraisal Institute

Subdivision Valuation
2013 Appraisal Institute

Supervising Appraisal Trainees
2013 Appraisal Institute

Valuation of Detrimental Conditions in Real Estate
2006 Appraisal Institute

Uniform Standards for Federal Land Acquisitions
2014 Chamberlain, SD
2007 St. Paul, Minnesota
2002 Sheridan, Wyoming

Uniform Standards of Professional Appraisal Practice, Parts A, B & C
2013 North Dakota Chapter, Appraisal Institute; update
2012 State of Minnesota, Department of Commerce; update
2010 North Dakota Chapter, Appraisal Institute; update
2008 North Dakota Chapter, Appraisal Institute; update
2006 North Dakota Chapter, Appraisal Institute; update
2005 North Dakota Chapter, Appraisal Institute; update
1999 Houston Chapter, Appraisal Institute; Houston, Texas
1994 University of Minnesota, Minneapolis, Minnesota
1988 University of Minnesota, Minneapolis, Minnesota

EDUCATION – OTHER

Enbridge Safety Course 2014; Grand Forks, North Dakota

REAL ESTATE AND APPRAISAL EXPERIENCE

1996-present	RM Hoefs & Associates, Inc.; Fargo, North Dakota; Fee Appraiser
1995-1998	Parsons Brinkerhoff; Herndon, Virginia; FEMA Inspector
1990-1996	TW Sapa & Associates; Fargo, North Dakota; Fee Appraiser
1989-1990	Fargo Planning Commission; Fargo, North Dakota; Board Member
1984-1990	H.R. Arneson & Associates; Fargo, North Dakota; Fee Appraiser
1983-1984	Bagan Real Estate; Jamestown, North Dakota; Broker – Owner
1975-1981	Bagan Real Estate; Jamestown, North Dakota; Real Estate Sales
1974-1975	Rueben Liechty & Company; Jamestown, North Dakota; Real Estate Sales

Appraisal Experience includes over 5,600 self-contained, summary, or restricted appraisals of vacant land, mixed residential, commercial, industrial, and special purpose properties. Primary focus is litigation and eminent domain issues.

Purpose of the Appraisals includes purchase, sale, refinance, government acquisition, easements, contamination, insurance, litigation, and damaged properties. Appraisal area includes all of North Dakota, Western Minnesota, and northeastern South Dakota.

Court Experience: Qualified expert witness; appraisal and reviewer; decision North Dakota Supreme Court/review/ {*City of Grand Forks v. Hendon, No. 20050197*}.

PARTIAL LIST OF CLIENTS

Government

Bismarck Airport Authority, Bismarck, North Dakota
Cass County, North Dakota
City of Breckenridge, Minnesota
City of Detroit Lakes, Becker County, Minnesota
City of Dickinson, North Dakota
City of East Grand Forks, Minnesota
City of Fargo, North Dakota
City of Grand Forks, North Dakota
City of Moorhead, Minnesota
City of West Fargo, North Dakota
Clay County, Minnesota
Fargo Airport Authority, Fargo, North Dakota
Federal Aviation Administration (FAA)
Federal Housing Administration (FHA)
General Services Administration (GSA)
Grand Forks Airport Authority, Grand Forks, North Dakota
Homeland Security, North Dakota / Army Corps Engineers – Rock Island, Illinois
Mayville Airport Authority, Mayville, North Dakota
Minnesota Department of Transportation (MNDOT)
Mountrail County, North Dakota
North Dakota Department of Transportation (NDDOT)
North Dakota State Water Commission
U.S. Department of the Army / Corps of Engineers – St. Paul, Minnesota
Wahpeton Airport Authority, Wahpeton, North Dakota

Engineering Firms

Apex Engineering Group, Inc
Bartlett and West - AECOM Engineers, Inc
DOWL HKM, Inc.
HDR Engineering, Inc.
Houston Engineering, Inc
Interstate Engineering, Inc
Kadrmas, Lee, and Jackson
Moore Engineering, Inc
SRF Consulting, Inc
Tait & Associates, Inc.
Ultieg Engineers, Inc

Corporations and Other Entities

American Society for Environmental Education
AT&T
Burlington Northern and Santa Fe Railroad
Cargill, Inc
Cass County Electric
Coca Cola
Concordia College
Consolidated Beef
Enbridge Oil Corporation
General Motors
Great Plains Supply
John Deere
Minnesota Mining and Manufacturing
Minnkota Power Cooperative, Inc.
Northwestern Bell
Pamida, Inc.
Pepsi Cola
Ramada Inns
Regency Inns
Roadway Express
Steiger Tractor
SuperValu Stores
Surplus Tractor, Inc.

REFERENCES

Garylle Stewart, Attorney at Law; Solberg, Stewart, & Miller; Fargo, North Dakota 701-237-3166
Howard Swanson, City Attorney and Special Assistant to the Attorney General of North Dakota; Grand Forks, North Dakota 701-772-3407
Richard Stoppelmoor, Vice President, PE; HDR Inc.; 4503 Coleman Street, Suite 105, Bismarck, North Dakota 58503-2007; 701-557-9602

MAJOR PROJECTS (1996 – Present)

AIRPORT NEW CONSTRUCTION OR EXPANSION

Fargo, ND
Grand Forks, ND
Gwinner, ND
Jamestown, ND
Kindred, ND
Lisbon, ND
Stanley, ND
Wahpeton, ND

AIRPORT REVIEW

Bismarck, ND
Gen Ulen, ND
Grand Forks, ND
Kindred, ND
Lakota, ND
Linton, ND
Oaks, ND
Washburn, ND

STREETS, HIGHWAYS, AND UTILITIES

- ***North Dakota Department of Transportation***

Construction / Reconstruction of I-29 & Main Avenue Railroad Shoofly, Fargo, ND
Construction of Dickinson Bypass, Dickinson, ND (2 of 3 phases completed)
Construction of Highway 85/2 North, Williams County, North Dakota
Construction of I-94 sound wall; Fargo, ND
Construction of U.S. Highway 281 Bypass, (approximately 12 miles) Jamestown, ND
Construction of Williston Bypass, Williston, ND (3 phases completed)
Construction of Williston Temporary Bypass, Williston, ND
Construction of Williston Underpass, Williston, ND
Reconstruction of 12th Avenue North and University Drive, Fargo, ND
Reconstruction of County Road 3A, Mountrail County, ND
Reconstruction of County Road 7, Mountrail County, ND
Reconstruction of Dakota Avenue, City limits to Red /Ottertail/Bois de Sioux River; Wahpeton, ND
Reconstruction of Highway 1804 interchange, Williams County, ND
Reconstruction of Highway 20, Devils Lake, ND
Reconstruction of Highway 23, Mountrail County, ND
Reconstruction of Highway 281 South, Mill Hill to City limits, Jamestown ND
Reconstruction of Highway 83; Max, ND
Reconstruction of Highway19, Devils Lake, ND
Reconstruction of I-29 and 52nd Avenue Overpass; Fargo, North Dakota
Reconstruction of Intersection of Highways 1804 and 58, Buford, ND
Reconstruction of Main Ave & 25th Street Underpass/Shoofly, Fargo, ND
Reconstruction of Main Ave & University Drive Underpass/Shoofly, Fargo, ND
Reconstruction of Main Street, 1st Ave to 6th Ave, Williston, ND
Reconstruction of North Broadway, Minot, North Dakota, total takings
Reconstruction of Palermo Road, Mountrail County, ND
Reconstruction of roads and bridges; Ward County and FEMA; Ward County, ND

Reconstruction of Shell Creek Bridge, Mountrail County, ND
Reconstruction of South University Drive, north of 52nd Avenue; Fargo, ND
Reconstruction of State Highway 200, Killdeer, North Dakota
Reconstruction of State Highway 46, Gackle, North Dakota
Reconstruction of West Main Avenue, West Fargo, ND

- ***City of Fargo, North Dakota***

Construction / Reconstruction of 32nd Avenue S - 45th Street to 38th Street, Fargo, ND
Construction / Reconstruction of 45th Street - I-94 to 52nd Avenue, Fargo, ND
Construction of 17th Avenue Underpass / I-29, Fargo, ND
Construction of 42nd Avenue South Underpass / I-29, Fargo, ND
Construction of 64th Avenue South and 25th Street, Fargo, ND
Reconstruction of 13th Avenue South - 25th Street to I-29, Fargo, ND
Reconstruction of 25th Street - 17th Avenue S to 23rd Avenue S, Fargo, ND
Reconstruction of 42nd Street - 9th Avenue S to 32nd Avenue S, Fargo, ND
Reconstruction of 45th Street - 9th Avenue South to I-94
Reconstruction of Main Avenue - 45th Street to 25th Street, Fargo, ND
Utility Project, Major Thoroughfares, Fargo, ND

- ***Cass County, North Dakota***

Cass County Highway 32, Alice, North Dakota
Cass County Highway 4, Argusville ND to CC Highway 18
Construction of County Road 14, Horace, ND to I-29
Reconstruction of Cass County 17 from County Road 6 to Horace, ND
Reconstruction of County Highway 15, Mapleton, ND
Reconstruction of County Road 32 / Rush River, Amenia, ND

- ***Transmission Lines / Oil Pipelines***

Construction of Big Stone Transmission Line – Dickey County, ND
Construction of Minnkota Power transmission line, various counties, ND
Construction of Sandpiper Pipeline, Enbridge Corporation - Tioga, ND to Grand Forks, ND

- ***US Border Control – Homeland Security / Army Corps of Engineers***

Construction of Maida Border Control Station, Maida, ND
Construction of Pembina Border Control Station, Pembina, ND
Construction of Portal Border Control Station, Portal, ND

WATER PROJECTS

- ***Total and Partial Takings / Government Participation (2000 – present)***

Baldhill Dam / Lake Ashtabula, 5' Pool Raise – Corps of Engineers
Becker County, MN; Becker County Dam / South Branch of Wild Rice River
Breckenridge, MN, floodwall and levee construction; Corps of Engineers
Devils Lake East End Outlet – North Dakota Water Commission
Devils Lake West End Outlet; Property Owners versus State of North Dakota Water Commission
East Grand Forks, MN; floodwall and levee construction; Corps of Engineers
Fargo and Cass County, ND; south/north side flood project
Fargo, ND; levee construction; City of Fargo (on going)
Fargo-Moorhead Red River Diversion (on going)
Grand Forks, ND; floodwall and levee construction; Corps of Engineers
Hendrum, Minnesota, ring dike; Wild Rice Water District
Little Missouri pipeline break, Medora, ND; North Dakota State Water Commission
Neva, Minnesota, ring dike; Wild Rice Water District
Norman County Minnesota; Wild Rice Water District; levee construction
Oxbow, North Dakota Emergency Buyouts – Corps of Engineers & FM Metro Area Diversion

Perley, Minnesota ring dike; Wild Rice Water District
Shelly, Minnesota, ring dike; Wild Rice Water District

- ***Voluntary Buyouts / Government Participation (2000 – present)***

Breckenridge, MN
Cass County, ND
City of Fargo, ND
Clay County, MN
Norman County, MN
Wild Rice Water District, MN

- ***Flood Damaged Properties (1997 – present)***

Cass County, ND
Clay County, MN
East Grand Forks, MN
Fargo, ND
Grand Forks, ND
Lisbon, ND
Moorhead, MN
Norman County, MN

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END OF REPORT

NEXTera® ENERGY RESOURCES

Fact Sheet

What impact will a wind farm have on my property value?

Multiple studies have found wind farms have **no significant long-term impacts** on property values.

- Wind energy projects drive **economic development**, job growth and tax revenue to their host communities, which benefits landowners and land values in the area.
- Landowners who host a wind turbine on their property earn regular lease payments that transfer with the sale of the property, **adding to its value**.
- While some potential property purchasers may be hesitant to purchase land near wind turbines, academic studies show that the **positive impacts** of a wind energy project either balance or **outweigh any negative impacts**.
- A study of more than 50,000 home sales among 27 counties in nine states found no statistical evidence that home prices near wind farms were affected by the wind farm.[1]
- A 2010 study conducted in Chatham-Kent, Ontario, found there was no statistically relevant relationship between the presence of a wind project and negative effects on property values.[2]



CASE STUDY



"There is a lot of real estate sales activity and many properties in the area of the NextEra Windfarm project are selling for substantially higher prices than what is reflected on the current assessment rolls. For the 2015 calendar year Assessor's Office data shows 712 single family residential properties sold in the areas around the Windfarm and transmission line corridor. The total value of those sales was just under $181.1 million dollars. This represents an increase of $42.9 million over the current Assessor's Market Value on those same properties. An even greater increase in value is indicated by the sales of 30 parcels of grazing land for $5.4 million representing a $3.7 million dollar increase over Assessor's Market Value on those properties."

– Steve Schlieker, El Paso County Assessor, *El Paso County, CO*[3]

Sources:

[1] Wind Farm Proximity and Property Values: A Pooled Hedonistic Regression Analysis of Property Values in Central Illinois. Jennifer L. Hinman, (May 2010).

[2] A Spatial Hedonic Analysis of the Effects of Wind Energy Facilities on Surrounding Property Values in the United States. Hoen, B., Brown, J., Jackson, T., Wiser, R., Thayer, M. and Cappers, P. (2013). Lawrence Berkeley National Laboratory, Berkeley, CA. 151 pages.

[3] County Assessor Reports Spike in Home and Property Values Near Calhan Wind Farm, 02/18/2016, The Gazette [Colorado], Ryan Maye Handy.

Additional research:

The Impact of Wind Power Projects on Residential Property Values in the United States: A Multi-Site Hedonic Analysis. Hoen, B., Wiser, R., Cappers, P., Thayer, M. and Sethi, G. (2009). Lawrence Berkeley National Laboratory, Berkeley, CA. December, 2009. 146 pages. LBNL-2829E.

Decommissioning Plan
Crowned Ridge Wind
Energy Facility

January 29, 2019

Decommissioning Plan for the Crowned Ridge Wind Energy Facility

1.0 Introduction

1.1 Background

Crowned Ridge Wind, LLC (CRW or Applicant) an indirect, wholly-owned subsidiary of NextEra Energy Resources, LLC (NEER) has prepared this Decommissioning Plan (Plan) to provide documentation of activities necessary to decommission the proposed Crowned Ridge Wind (CRW) Facility (Wind Facility or Project) located in Codington County and Grant County, South Dakota. The Project would be situated within an approximately 53,200-acre Project Area and would consist of 130 three bladed, upwind, horizontal axis wind turbines which originate from the GE 2MW-116 model series. The proposed Project would utilize 117 GE 2.3MW turbines with 116-meter (381-feet) rotor diameter and 90-meter (295-feet) hub height as the Project's primary turbine technology, and 13 GE 2.3MW turbines with 116-meter (381-feet) rotor diameter and an 80- meter (262-feet) hub height as the Project's secondary technology which will be utilized in select locations. The 130 turbines to be constructed would result in a total installed capacity of approximately 300 MW.

The decommissioning plan assumes the removal of 130 wind turbine generators as well as other associated Project facilities. This Plan is intended to provide an overview of the industry-standard approach to decommissioning and restoring the project site, as well as the local requirements of Codington County and Grant County concerning the decommissioning of the Project.

In preparing this Decommissioning Plan, CRW submitted the following local land use permit applications:

- A combined application for a Conditional Use Permit (CUP) to Codington County dated June 8, 2018. CRW received CUP approval on July 16, 2018; and
- A combined application for a Conditional Use Permit (CUP) to Grant County dated September 17, 2018. CRW received CUP approval on December 17, 2018.

1.2 Objective and Goals

The goal of this Decommissioning Plan is to establish the approach to:

1. Disassembly and removal of existing turbines;
2. Abandonment or removal of existing infrastructure associated with the turbines;
3. Scarification and reseeding of disturbed areas, where applicable;
4. Revegetation of newly-disturbed ground; and
5. Mitigation for potential impacts on sensitive environmental features.

1.3 Decommissioning Plan Schedule of Key Tasks

Key schedule tasks pertaining to the decommissioning plan are summarized in the following table.

Task	Supporting Information
Submittal of Decommission Plan	At least thirty 30-days prior to construction, CRW is required to file a decommissioning plan for Board approval (Grant County); and Within 120-days of completion of construction, the CRW shall submit to the County a decommissioning plan describing the manner in which the permittees anticipate decommissioning the project (Codington County).
Commencement of Decommissioning	Decommissioning of the Project shall begin within 8-months of the expiration of this permit, or earlier termination of operation of the Project (Codington County & Grant County).
Completion of Decommissioning	Decommissioning of the Project shall be completed within 18-months of the expiration of this permit or earlier termination of operation of the Project.
Completion of Restoration	Decommissioning of the Project shall be completed within 18-months of the expiration of this permit or earlier termination of operation of the Project.

The Project possesses an initial Power Purchase Agreement contract term of 25 years, which is also the estimated life of the facility or when termination of operations of the Project may occur. The estimated life of the Project can be increased through repowering of the Project.

2.0 Project Decommissioning

The Project shall be decommissioned in accordance with the local requirements of Codington County (Appendix A) and Grant County (Appendix B).

2.1 Decommissioning Preparation Activities

Prior to the physical decommissioning of the existing facilities, the following activities will be conducted:

- CRW will provide a 1-year notice to both Codington and Grant County in advance of the anticipated timing of the Project's decommissioning;
- CRW will identify locations of Project infrastructure that are to be removed per local decommissioning requirements;
- CRW will identify the locations of Project infrastructure that are to remain in place if per preference of Project's lease holders;
- CRW will identify work areas to enable the decommissioning of equipment;
- Transportation planning for conveyance of oversize turbine components will be reviewed to address traffic considerations by CRW; and
- CRW will receive applicable permits, approvals, and agreements that need to be obtained prior to physical removal of infrastructure.

2.2 Decommissioning of Facilities

The goal of Project decommissioning is to remove the Project infrastructure in accordance with local requirements of Codington County and Grant County and to return the site to a condition as close to a pre-construction state as feasible. The major activities required for the decommissioning may be as follows:

- Removal of 130 wind turbine generators and all existing above ground facilities;
- Removal of underground facilities such as turbine foundations up to a depth of four- feet; and
- Removal of roads and staging areas that are not desired by land owners to remain in place.

Turbines:

The decommissioning activity most notable to the general public will be the removal of the wind turbines. The disassembly and removal of this equipment will essentially be the same as its installation, but in reverse order. The large components that make up a wind turbine will be disassembled in the reverse order they were assembled.

The rotor (hub and blades) are removed from the nacelle and, with the help of a smaller crane, turned horizontally and set on the ground. Next, the nacelle will be removed from the top of the tower, followed by each portion of the tower. Once the turbine rotor has been removed, a crew and small crane will disassemble it into the hub and three loose turbine blades. The most efficient manner for component removal will be for each large component (other than the rotor) to be placed directly onto a truck bed when it is removed from the turbine. These trucks could then immediately take the component off the site. This approach will limit the need for clearing an area around the turbine base to just enough area to set down the rotor. When the rotor is disassembled, the blades will be placed into a carrying frame, which can then be loaded onto a truck for removal from the site. The hub can also be removed once it is disassembled from the blades.

Turbine tower sections will be dismantled utilizing cranes. A single large crane is typically used to disassemble the turbines, and smaller cranes would lift the parts onto trucks to be hauled away. Meteorological towers will also be similarly removed noted later in Section 2.3. After dismantling and excavating the facility, high value components will be removed for scrap value. The remaining materials will be reduced to transportable size and removed from the site for disposal. Materials will be disposed where disposal is permitted and where there is capacity for the disposal. Generally, turbines, transformers, electrical components, and towers are refurbished and resold or are recycled for scrap. All unsalvageable materials will be disposed of at authorized sites in accordance with applicable regulations. Decommissioning of the existing turbines will include removal and transport of generators and towers offsite to disposal facilities and/or sale of towers and generators. Some wind turbine generator components may be stored onsite within the existing laydown areas. Inert materials, such as foundations, will be decommissioned in place to avoid potential adverse environmental impacts.

Met Tower:

The meteorological tower will similarly be disassembled by a crane, starting with the upper tower section and moving downward.

Access Roads:

It is anticipated that several existing access roads will remain where preferred with landowners. CRW will work with landowners regarding whether the landowner prefers to keep the access

road in place. In the event landowners do not want the access road, or portions thereof, the access roads will be removed.

Substation:

Once the Project is de-energized, the substation will be disassembled. Major components will be removed from their foundations and placed onto trucks using a small crane. Fences and fence posts will be taken down and removed. The aggregate base and concrete foundations at the collection substation will be removed, and native soils will be spread on-site to return it to its prior condition and to assist in preventing erosion. The Project owners will review if the substation grounding grid is to be removed or left in place.

O&M Facility:

The O&M facility will be sold or disassembled. For disassembly, the roofing, siding and structural members will be removed and placed onto trucks using a small crane or forklift. Fences and fence posts will be taken down and removed. The aggregate base and concrete foundations at the facility will be removed, and native soils will be spread on-site to return it to its prior condition and to assist in preventing erosion.

Collector System:

Between each of the turbine locations will be a buried electrical cable and fiber optic cable. The respective Project owners will consult with the landowners at the time of decommissioning to determine if the landowners desire the Project owners to remove the cables or to leave to them in place.

Removing the cables will cause some environmental impact that would need to be mitigated. If the cables are to be removed, a trench will be opened and the cables pulled out. The cables will be cut into manageable sections and removed from the site. The trenches will then be filled with native soil, compacted, tilled and returned to a condition suitable for growing crops.

It is anticipated that some sections of underground cables will remain in place to avoid environmental impacts in sensitive areas. Underground cables will be identified for removal generally to a depth of four feet; however, in some cases, and in coordination with appropriate entities such as Northern States Power Company, county and state agencies, the landowner, and other applicable entities, underground cables may be identified to remain in place to avoid surficial disturbance of sensitive features, such as prairies, wetlands, other natural habitat, or cultural, tribal, and archaeological resources.

Transmission Line:

Initially, the wires will be removed from the tower hangers and collected for recycling. The tower structures will then be disassembled and removed, including grounding rods to 4 feet

below grade unless a lesser depth is otherwise agreed to by the landowner. The areas around the poles, along with any access roads that were necessary, will be reclaimed.

3.0 Restoration and Reclamation

3.1 Restoration Area

The areas subject to the provisions of this Plan are those areas that will be impacted during decommissioning activities, including all areas where decommissioning activities occur, as discussed in Section 3.2.

3.2 Restoration

Restoration activities will include, but not be limited to, the following:

- Restore property or properties to pre-construction conditions to the extent feasible.
- Restore property or properties with site specific characteristics such as topography, vegetation, drainage and other unique environmental features.
- Repair county roads impacted by movement of oversized loads or heavy haul vehicles and frequent vehicle trips.
- Remove graveled access roads and restore to pre-construction conditions to the extent feasible.
- Unexcavated areas compacted by equipment used in the decommissioning, including crane path areas, may be tilled in a manner adequate to restore the topsoil and subgrade material to a density consistent with the surrounding areas and then will be reseeded.
- Existing roadways will remain in place when desired by the landowner. Those roadways to be removed will be removed will be removed, scarified and reseeded to return the roadbed to pre-construction conditions to the extent feasible.
- Appropriate levels of soil compaction for earthwork required to bury turbine foundations will consider burrow establishment. Decommissioned surfaces identified for reclamation will be scarified, tilled, or harrowed, as appropriate. The depth of compaction relief will depend on site-specific conditions. The site will be left adequately rough after surface soil placement to provide micro sites for seed germination and to reduce soil movement.
- CRW will coordinate to revegetate non-cropland and pasture areas disturbed during decommissioning with native seed mixes appropriate to the region. Topsoil removed during decommissioning activities will be separated from other excavated material and will be reused as topsoil during reseeding and restoring plant communities. Reseeding with native seed mixtures will be used on restoration areas except in cropland areas and in areas where landowners indicate preference for other seeding plans. Reseeding of cropland areas will be conducted in coordination with the landowner.

- In areas where native seed mixes are applied, seed will be broadcast using manually operated, cyclone-type bucket spreaders, mechanical seed spreaders, blowers, hydroseeders, or rubber-tired all-terrain vehicles equipped with mechanical broadcast spreaders. Seed in the spreader hoppers will be mixed to discourage separation of the component seed types. Soils will be protected from wind erosion, if necessary, using biodegradable erosion control blankets or appropriate mulch cover until vegetation is established.

- Where applicable, restoration areas will be designated as areas for all onsite construction and operation and maintenance personnel to avoid and allow for timely seed germination and soil stabilization. Avoidance areas may be marked using temporary signage and/or fencing (for example, orange snow fence attached to t-posts), as determined necessary by CRW.

- When the wind turbines and substation components are removed from their foundations, the concrete and steel within the deeper wind turbine foundations will be broken-up and removed to a depth of four (4) feet below grade unless a lesser depth is otherwise agreed to by the landowner. Fully removing the wind turbine foundations would require major excavation/disturbance at each tower site, as well as additional truck haul-away traffic. The foundation sections below 4 feet that are proposed to remain are composed of non-leaching elements, concrete and steel, that should not present a hazard to the environment.

- The landowners will have the choice, when the Project is decommissioned, as to whether the Project access roads are to be removed. To facilitate the various uses for the property, the owner may choose to leave the roads in place. If the roads are left, maintenance of the roads will become the responsibility of the respective landowner. If the landowner does not want to leave the road in place, it will be removed once all the necessary equipment and materials have been removed from an area and the road to that area is no longer needed. The road surface and bed materials will be removed down to grade. Any materials native to the site will be scattered across the site, and foreign materials will be removed.

- For areas where equipment or materials are removed, those areas will be re-graded back to near pre-construction contours to the extent feasible. Removed roads will be regraded to original contours if cuts and fills make such re-grading practical. Crane pads will also be regraded. All disturbed areas will be seeded and mulched.

- Restoration areas shall be filled and covered with topsoil and restored to a state compatible with the surrounding land and will be completed within 18 months after expiration of the site permit.

3.3 Roadway and Facilities Repair and Reclamation

- County roadways will be repaired from damage that may result from the hauling away of materials, movement of oversized loading or heavy-haul vehicles, and traffic management. In addition, County roads used during the decommissioning process may be damaged due to use of heavy equipment used to off-haul turbine components. County roads used will be restored to their pre-decommissioning state as verified and approved by Codington County and Grant County.

- CRW will coordinate with landowners to identify property features, such as drain tiles, that need to be avoided during decommissioning activities and will avoid these features where practicable. Where identified features, such as drain tiles cannot be avoided, the drain tile or other features will be repaired following decommissioning and landowners will be compensated for crop damages or losses related to the damage.

- Livestock in pastureland may be temporarily disrupted during decommissioning due to temporary activities, but appropriate measures will be made to ensure fenced pastureland is secure. Temporary fencing may be put in place if fencing is impacted and will be repaired or replaced after decommissioning.

4.0 Cost Estimate

The cost to decommission the existing facility as described in this Plan is estimated to range between $10 million and $15 million. CRW will be responsible for all decommissioning costs. The funding for the decommissioning of the Project will be provided in a form of financial assurance that is acceptable to each county to cover the anticipated costs of the decommissioning of the Project.

Within 5-years from the date of issuance of a conditional use permit in Codington County, the Board may require such financial assurance while in Grant County a decommissioning account is to be funded by the turbine owner annually for a period of 30-years. Beginning in year ten following the beginning of operation and each fifth year thereafter, the turbine owner shall submit to Grant County the Project's estimated decommissioning costs and salvage values. Based on the verification of the information filed in the Grant County conditional use permit application, the County may change the annual financial assurance funding rate to more closely match the estimated amount needed for decommissioning.

Appendix A:

Codington County: Section 5.22.03.09 - Decommissioning, Restoration and Abandonment

Subject	Requirements
a) Decommissioning Plan	Within 120 days of completion of construction, the permittees shall submit to the County a decommissioning plan describing the manner in which the permittees anticipate decommissioning the project in accordance with the requirements of paragraph (b) below. The plan shall include a description of the manner in which the permittees will ensure that it has the financial capability to carry out these restoration requirements when they go into effect. The permittees shall ensure that it carries out its obligation to provide for the resources necessary to fulfill these requirements. The County may at any time request the permittees to file a report with the County describing how the permittees are fulfilling this obligation.
b) Site Restoration	The decommissioning of the WES shall begin within eight (8) months of the expiration of this permit, or earlier termination of operation of the WES, and be completed within eighteen (18) months of the expiration of this permit or earlier termination of operation of the WES. The permittees shall have the obligation to dismantle and remove from the site all towers, turbine generators, transformers, overhead and underground cables, foundations, buildings and ancillary equipment to a depth of four (4) feet. To the extent possible the permittees shall restore and reclaim the site to its pre-project topography and topsoil quality. All access roads shall be removed unless written approval is given by the affected landowner requesting that one or more roads, or portions thereof, be retained. Any agreement for removal to a lesser depth or for no removal shall be recorded with the County and shall show the locations of all such foundations. All such agreements between the permittees and the affected landowner shall be submitted to the County prior to completion of restoration activities. The site shall be restored in accordance with the requirements of this condition within eighteen (18) months after expiration.
c) Abandoned Turbines	The permittees shall advise the County of any turbines that are abandoned prior to termination of operation of the WES. The County may require the permittees to decommission any abandoned turbine.
d) Cost Responsibility	The owner or operator of a WES is responsible for decommissioning that facility and for all costs associated with decommissioning that facility and associated facilities.
e) Financial Assurance	Five (5) years from the date of issuance of a conditional use permit, the Board may require a performance bond, surety bond, letter of credit, corporate guarantee or other form of financial assurance that is acceptable to the Board to cover the anticipated costs of decommissioning the WES facility.
f) Failure to Decommission	If the WES facility owner or operator does not complete decommissioning, the Board may take such action as may be necessary to complete decommissioning, including requiring forfeiture of the above referenced financial assurance. The entry into a participating landowner agreement shall constitute agreement and consent of the parties to the agreement, their respective heirs, successors, and assigns, that the Board may take such action as may be necessary to decommission a WES facility.

Appendix B:

Grant County: Section 1211.04.10 – Decommissioning, Restoration and Abandonment

Subject	Requirements
a) Cost Responsibility	The owner or operator of a WES is responsible for decommissioning that facility and for all costs associated with decommissioning that facility and associated facilities.
b) Decommissioning Plan	At least thirty (30) days prior to construction, the applicant shall file a decommissioning plan for Board approval in accordance with the requirements of paragraphs (b), (c) and (d) below. The plan shall include an acceptable financial assurance plan which estimates the decommissioning cost per turbine and a description of the manner in which the permittees will ensure that it has the financial capability to carry out these restoration requirements when they go into effect. The permittees shall ensure that it carries out its obligation to provide for the resources necessary to fulfill these requirements. The County may at any time request the permittees to file a report with the County describing how the permittees are fulfilling this obligation
c) Financial Assurance	The Board shall require a performance bond, surety bond, escrow account, letter of credit, corporate guarantee or other form of financial assurance that is acceptable to the Board to cover the anticipated costs of decommissioning the WES facility. The financial assurance plan is subject to the following provisions: i. A decommissioning account is to be funded by the turbine owner annually at a rate of five thousand dollars ($5,000) per turbine for a period of thirty (30) years. ii. The Board may allow a decreased annual payment, if the Board determines the full rate as identified in the financial assurance plan is not necessary to cover costs of decommissioning. iii. All interest earned by any financial assurance account remains in the account. iv. A financial assurances statement is to be provided upon request to the administrative official. v. The financial assurance plan follows ownership of the wind turbines. vi. The financial assurances are not subject to foreclosure, lien, judgment, or bankruptcy. vii. Beginning in year ten (10) following the beginning of operation and each fifth year thereafter, the turbine owner shall submit to the Board an estimated decommissioning date, if established, and estimated decommissioning costs and salvage values. Based on the verification of the information in this filing the Board may change the annual financial assurance funding rate to more closely match the estimated amount needed for decommissioning. viii. Funds from the financial assurances are to be paid to the turbine owner at the time of decommissioning. Said funds are to be paid as decommissioning costs are incurred and paid for by the turbine owner. ix. If the turbine owner fails to execute the decommissioning requirement, the funds are payable to the landowner as the landowner incurs and pays decommissioning costs.
d) Site Restoration	The decommissioning of the WES shall begin within eight (8) months of the expiration of this permit, or earlier termination of operation of the WES and be completed within eighteen (18) months of the expiration of this permit or earlier termination of operation of the WES. The permittees shall have the obligation to dismantle and remove from the site all towers, turbine generators, transformers, overhead and underground collector and feeder lines, foundations, buildings and ancillary equipment to a depth of four (4) feet. To the extent possible the permittees shall restore and reclaim the site to its pre-project topography and topsoil quality. All access roads shall be removed unless written approval is given by the affected landowner requesting that one or more roads, or portions thereof, be retained. Any agreement for removal to a lesser depth or for no removal shall be recorded with the County and shall show the locations of all such foundations. All such agreements between the permittees and the affected landowner shall be submitted to the County prior to completion of restoration activities. The site shall be restored in accordance with the requirements of this condition within eighteen (18) months after expiration.
e) Failure to	If the WES facility owner or operator does not complete decommissioning, the Board may take

Decommission	such action as may be necessary to complete decommissioning, including requiring forfeiture of the bond. The entry into a participating landowner agreement shall constitute agreement and consent of the parties to the agreement, their respective heirs, successors, and assigns, that the Board may take such action as may be necessary to decommission a WES facility.
f) Abandoned Turbines	The permittees shall advise the County of any turbines that are abandoned prior to termination of operation of the WES. The County may require the permittees to decommission any abandoned turbine.

Crowned Ridge I and II, SD
Electromagnetic Interference Analysis

Crowned Ridge Wind LLC

The following document was prepared by WindLogics Inc. (WindLogics), an indirect wholly-owned subsidiary of NextEra Energy Resources, LLC (NEER) for the use of Crowned Ridge Wind, LLC, as an indirect wholly-owned subsidiary of NEER. WindLogics Inc. has prepared this report based on available government information by the Federal Communications Commission (FCC) and internal analysis methods. We cannot guarantee the accuracy of the data collected by the FCC. Microwave tower and link information may be inaccurate or incomplete due to FCC applicant error.

Executive Summary

WindLogics, an affiliate of Crowned Ridge Wind LLC (Crowned Ridge) assessed the potential for interference of licensed communication links in close proximity to the proposed Crowned Ridge Wind Project area for the purposes of determining exclusion zones to aid the design of a proposed wind energy generation project. This report summarizes the microwave links and towers along with local cellular towers, media towers (AM and FM), television, and aviation towers, identified within and near the assessment area.

A review of the Federal Communications Commission (FCC) national database and the Universal Licensing System was conducted to identify these possible constraints. Wind turbine offset distances were taken in consideration for the design of the wind turbine array.

Electromagnetic analysis results show that interference is not expected to impact nearby microwave, AM, FM, cellular, TV, and aviation towers based on the array design.

The analysis is current as of August 20th, 2018. WindLogics recommends a refresh of this analysis if the proposed wind energy generation project has not been constructed after two years.

This report only provides analysis for licensed radio towers and links found within the FCC database. Many local municipalities (police, fire, etc.) do not license microwave links, WindLogics recommends that Crowned Ridge LLC coordinate with the appropriate local municipality officials. Also not included within the database are microwave towers and links utilized by the Federal government (Dept. of Defense, Dept. of Commerce, etc.), again for public safety concerns. A letter stating “No Harmful Interference Anticipated” has been received from the National Telecommunications and Information Agency (NTIA) concerning the DOA (Agriculture), DOC (Commerce), and DON (Navy). The DOE (Energy) had considerable issues with turbine placement in the area and the developer is currently working with the agency to mitigate their concerns at the site.

Crowned Ridge Wind, SD – Electromagnetic Interference

WindLogics, an affiliate of Crowned Ridge Wind LLC (Crowned Ridge) assessed the potential for interference of licensed communication links in close proximity to the proposed Crowned Ridge Wind Project area for the purposes of determining exclusion zones to aid the design of a proposed wind energy generation project. This report summarizes the microwave links and towers along with local cellular towers, media towers (AM and FM), television, and aviation towers, identified within and near the assessment area.

A review of the FCC national database and the Universal Licensing System was conducted to identify these possible constraints. Wind turbine offset distances were taken into consideration for the design of the wind turbine array.

The site is located in Codington, Grant and Deuel Counties, South Dakota, roughly 15 kilometers east of the city of Watertown, South Dakota. Figure 1 below, depicts the project location of Crowned Ridge Wind.

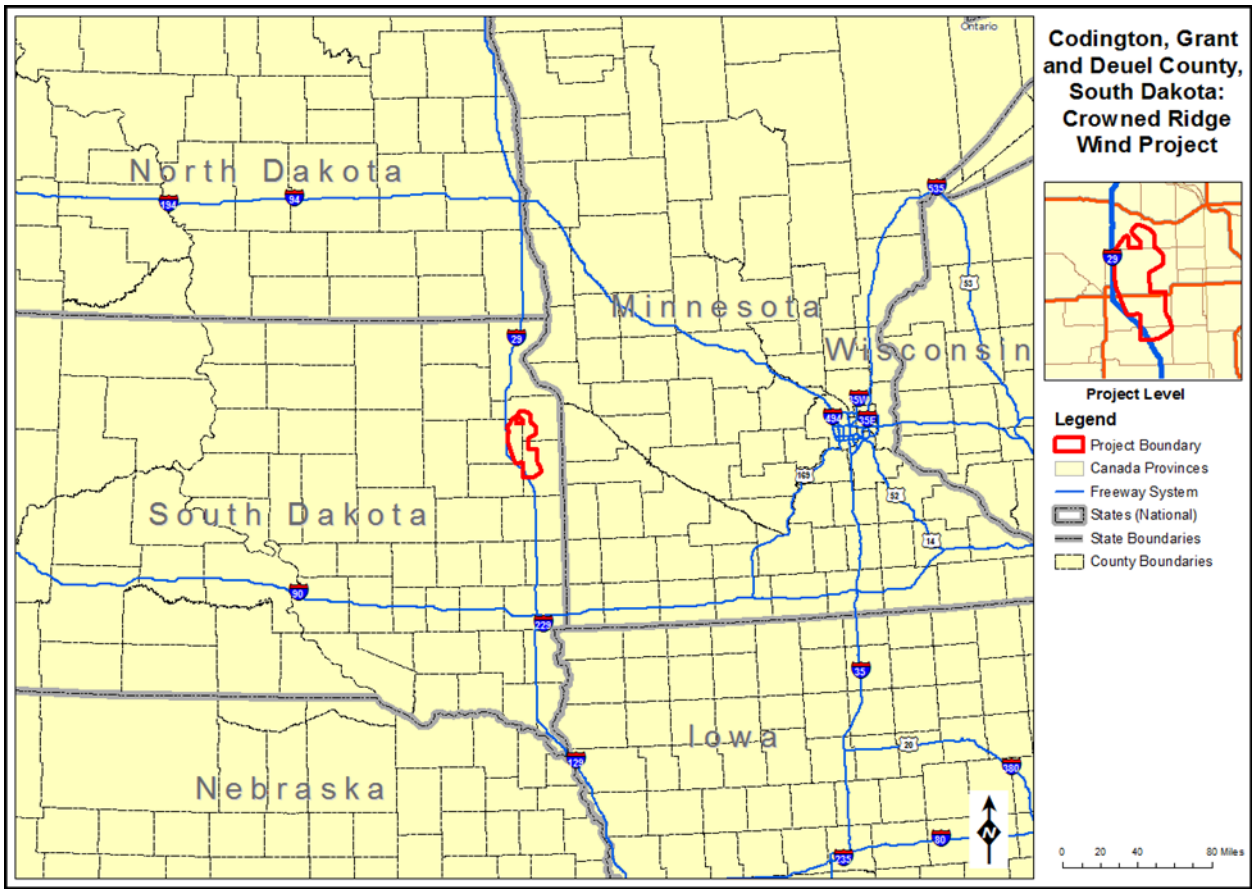


Figure 1: Crowned Ridge Wind Project Location

Turbine Technology

Crowned Ridge Wind is a proposed hybrid wind energy generation site that consists of 266 turbine locations. The layout is composed of 256 (238 primary and 18 alternate) GE2.3-116 turbines (2.3MW rated capacity, 116m rotor diameter (RD)), 15 GE2.1-116 turbines (2.1MW rated capacity, 116m rotor diameter (RD)) and 13 GE1.715-103 turbines (1.715MW rated capacity, 103m RD) for a total capacity of 601.2 MW. Turbine layout details are included in Table 1 and Figure 2

Turbine Technology	GE2.3-116 / GE2.1-116 GE1.715-103
Turbine Count	238(18) / 15 / 13
Hub Height (m)	90 / 80 / 80
Rotor Diameter (m)	116 / 116 / 103
Turbine Rated Power (MW)	2.3 / 2.1 / 1.715
Total Capacity (MW)	601.2

Table 1: Crowned Ridge Layout Summary

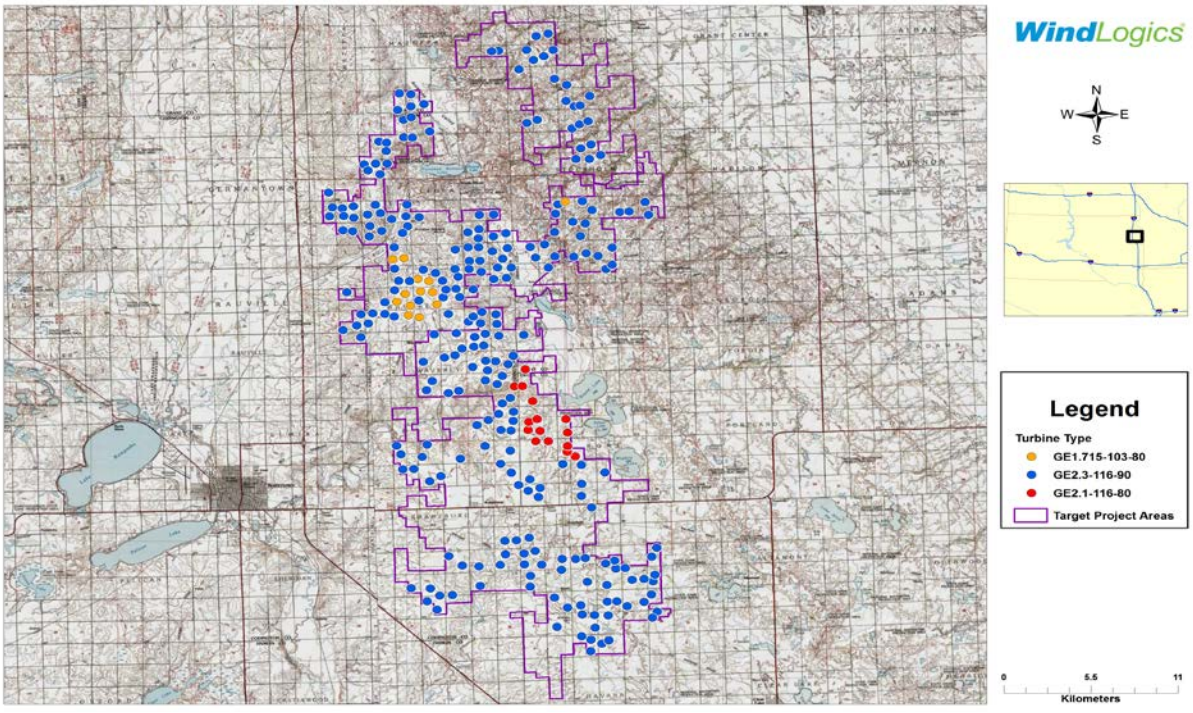


Figure 2: Crowned Ridge Wind Turbine Technology Allocation

Data Sources

Within the United States, the location of industrial and commercial telecommunication systems, including microwave links, are collected and maintained by the Wireless Telecommunications Bureau (WTB), a division of the FCC. This data is made publicly available through the ULS database, which contains licensing information on both current and permit pending facilities for microwave, cellular, media, and several radio services utilized by private industry (non-Federal telecommunication systems). License information supplied within the ULS database is updated daily, and is dependent upon information provided by each individual applicant.

WindLogics used several data sources (ESRI satellite imagery, Google Earth, etc.) of high resolution imagery to aid in assessing the accuracy of the geographic locations of each microwave tower with links intersecting the project boundary or area of interest (AOI).

Methodology

The ULS database, described earlier, was used to identify the microwave towers, microwave links, cellular, AM, FM, and aviation towers within a 25-kilometer radius that may impact the Crowned Ridge Wind Farm. Television towers were identified within a 100-kilometer radius. The database provides detailed information for each radio tower and link, which was used to calculate turbine exclusion zones to ensure interference compliance.

Exclusion zones for wind turbines near microwave links are calculated using a theory proposed by Bacon (2002), which identifies the radius of the 2nd Fresnel zone, a theoretical sphere representative of a propagating radio wave, as an appropriate offset distance. Calculations of the 2nd Fresnel zone can be determined by:

$$2nd\ Fresnel\ zone\ Radius = \sqrt{\frac{2\lambda d_1 d_2}{d_1 + d_2}} \qquad (1)$$

Where:
d_1, d_2 = distances from each end of the radio path.
λ= wavelength of the corresponding radio frequency.

To account for precision errors within the ULS database, and to further reduce the potential for interference from a wind turbine, a Worst Case Fresnel Zone (WCFZ) was calculated for each microwave link. The WCFZ provides the maximum offset distance required, and is determined by the 2nd Fresnel zone radius obtained at the midpoint of the link, where $d_1 = d_2$. Adjusting Eq. 1 to calculate the WCFZ in meters yields the following:

$$WCFZ = 17.32\sqrt{\frac{nD}{4(F)}} \qquad (2)$$

Where:
D = distance between the transmitter and receiver towers.
F = frequency in GHz.
n = Fresnel zone, which for the 2nd Fresnel Zone n = 2.

The calculated radius distance from Eq. 2 provides a three-dimensional turbine exclusion zone around each microwave link that can be used to guide wind turbine array design.

In addition to the WCFZ calculated for each microwave link, WindLogics applies an offset of one-half RD plus 10 meter to account for turbine blade overhang. A turbine overhang offset using a 116 m turbine technology is included within this analysis to represent the GE2.5-116 wind turbine generator.

The WTB cannot provide quality assurance for every license within the ULS database, so accuracy of the data relies on applicant certifications, and, in extreme cases, license audits. It has been WindLogics' experience that most inaccuracies occur with regard to the location of the radio towers, where approximation or lack of precision of the geographic coordinates can result in a difference in the position of the tower by as much as 500 meters.

To fully account for these location errors, WindLogics recommends on-site verification to identify the exact location of the transmitter and receiver towers. However, for this analysis, WindLogics used high-resolution satellite imagery to identify possible tower location errors. Most microwave, media, and cellular towers extend well over 80m above ground level, and can be clearly viewed within high resolution satellite imagery. Each tower that may impact the project boundary was investigated for potential location error. Adjustments to the location of the microwave, media, and cellular towers are only made if clear evidence from the satellite imagery shows an inaccuracy.

Microwave Links and Microwave Towers

Five microwave towers were identified within the Project area. In addition, twelve microwave links have been identified near the project area and ten have been found to intersect the AOI. The WCFZ for all of these links have been calculated, and the appropriate turbine offset has been used to minimize any harmful impact from the proposed turbine layout.

Figure 3 below illustrates the position of each microwave link with respect to the project boundary and turbine locations.

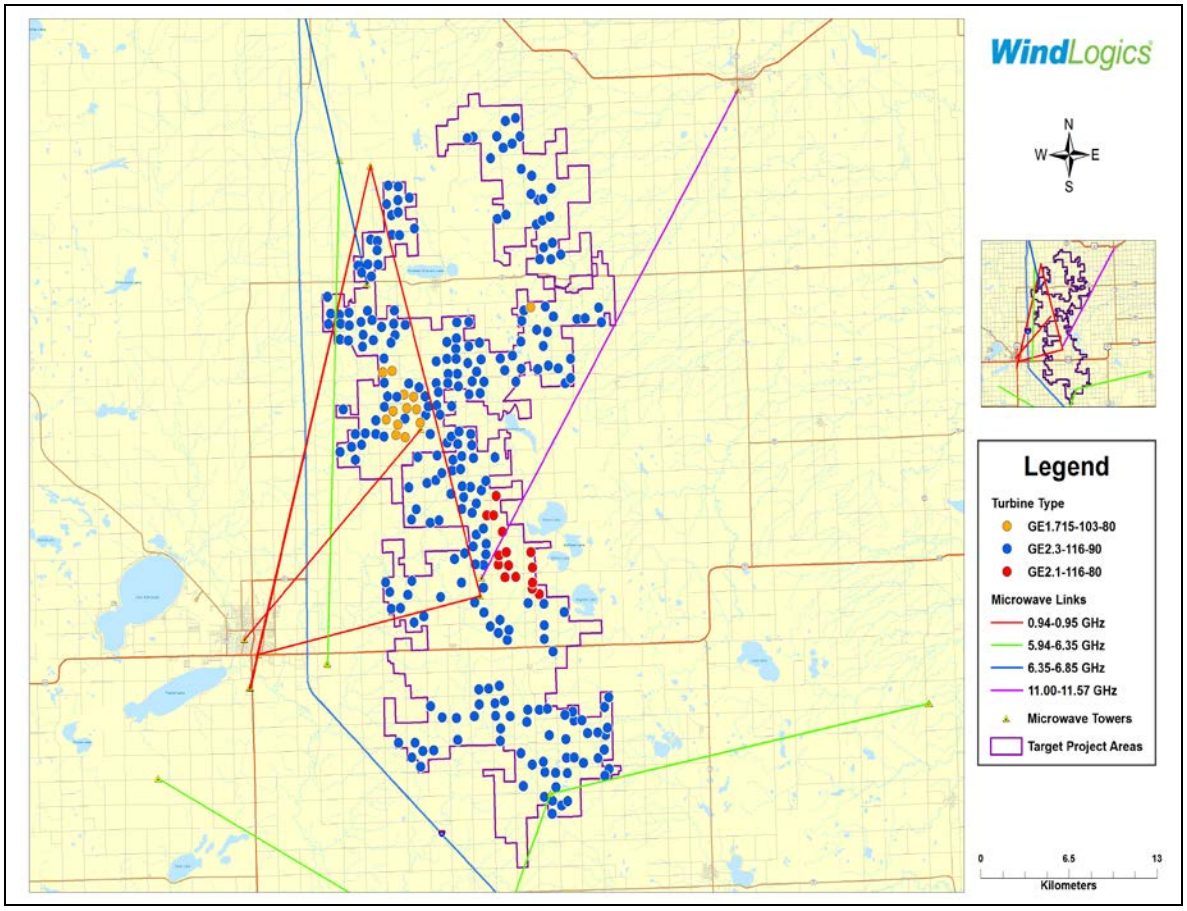


Figure 3: Crowned Ridge Wind With Microwave Links

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Table 2 provides more detailed information on each microwave link in proximity to the area with the calculated WCFZ.

ID	STATUS	TRANSMITTER CALLSIGN	MICROWAVE NAME	BAND FREQ (GHz)	WCFZ (m)	BEAM LENGTH (Km)
1	Active	WHI958	EAST RIVER ELECTRIC POWER COOP	6.12	30.04	36.84
2	Active	WHI958	EAST RIVER ELECTRIC POWER COOP	6.12	30.04	36.84
3	Active	WIA856	EAST RIVER ELECTRIC POWER COOP	6.26	26.19	28.60
4	Active	WIA856	EAST RIVER ELECTRIC POWER COOP	6.26	29.72	36.84
5	Active	WIA856	EAST RIVER ELECTRIC POWER COOP	6.26	26.16	28.54
6	Active	WIA856	EAST RIVER ELECTRIC POWER COOP	6.26	29.72	36.84
7	Active	WIA858	EAST RIVER ELECTRIC POWER COOP	6.09	28.44	32.86
8	Active	WIA858	EAST RIVER ELECTRIC POWER COOP	6.09	28.41	32.78
9	Active	WIA895	EAST RIVER ELECTRIC POWER COOP	5.95	26.83	28.54
10	Active	WIA895	EAST RIVER ELECTRIC POWER COOP	5.95	26.83	28.54
11	Active	WLP539	ALPHA 3E LICENSEE LLC	0.95	74.44	35.13
12	Active	WLP540	ALPHA 3E LICENSEE LLC	0.95	74.52	35.13
13	Active	WMG235	ALPHA 3E LICENSEE LLC	0.94	68.07	29.19
14	Active	WMG236	ALPHA 3E LICENSEE LLC	0.95	51.55	16.82
15	Active	WMN496	New Cingular Wireless PCS, LLC	6.63	24.58	26.68
16	Active	WPOR475	EAST RIVER ELECTRIC POWER COOP	6.35	27.84	32.78
17	Active	WPOR475	EAST RIVER ELECTRIC POWER COOP	6.35	27.84	32.78
18	Active	WPVJ218	New Cingular Wireless PCS, LLC	6.85	24.18	26.68
19	Active	WQDT286	Northern Border Pipeline Company	5.95	29.85	35.32
20	Active	WQDT287	Northern Border Pipeline Company	6.20	29.24	35.32
21	Active	WQDT287	Northern Border Pipeline Company	6.20	30.67	38.85
22	Active	WQDT287	Northern Border Pipeline Company	6.20	30.22	37.74
23	Active	WQDT288	Northern Border Pipeline Company	5.95	30.86	37.74
24	Active	WQDT289	Northern Border Pipeline Company	5.97	31.23	38.85
25	Active	WQME671	TMRG BROADCASTING, LLC	0.95	54.56	18.89
26	Active	WQYT404	RC Technologies	11.00	22.48	37.04
27	Active	WQYT405	RC Technologies	11.57	21.92	37.04

Table 2: Detailed Information on Microwave Links That Intersect the Project Boundary

There are a number of links that are within relatively close proximity to turbines. The Worst Case Fresnel Zone was calculated for each microwave link and a conservative offset of 68 meters was used to reduce the probability of harmful interference. Figures 4-6 provide aerial imagery of the turbine layout relative to the Fresnel zones and their offsets that intersect the project boundary.

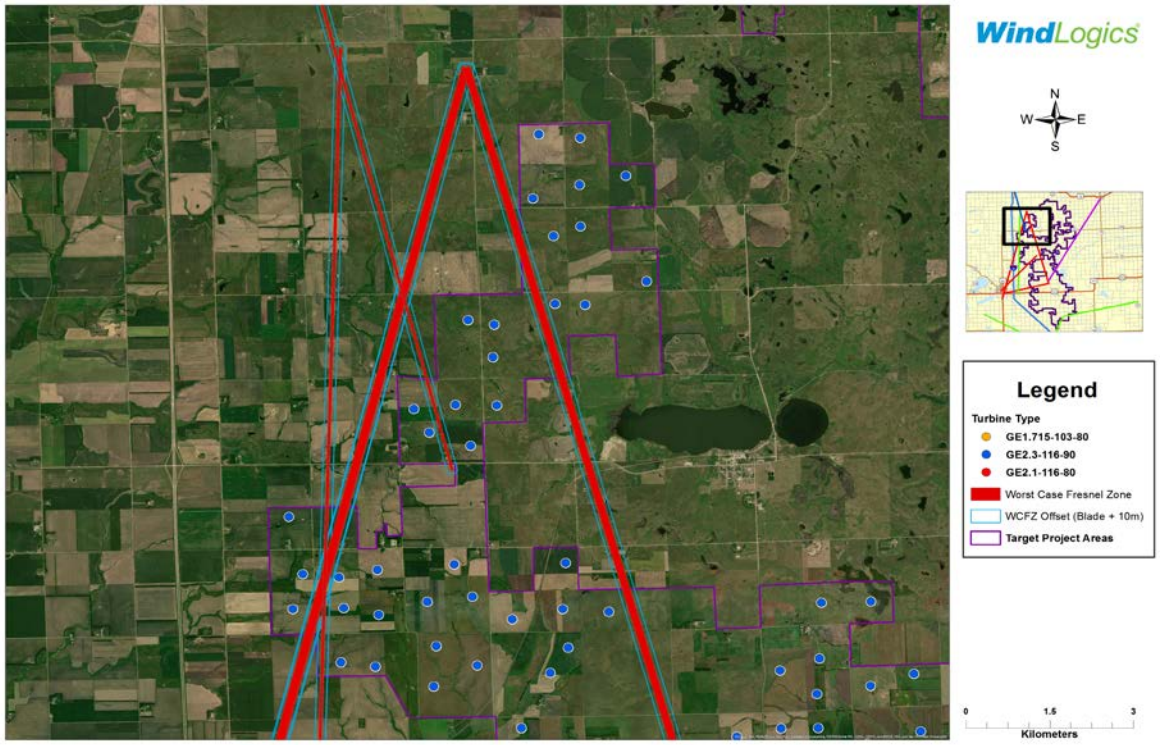


Figure 4: Crowned Ridge Wind Fresnel Zone Northwest

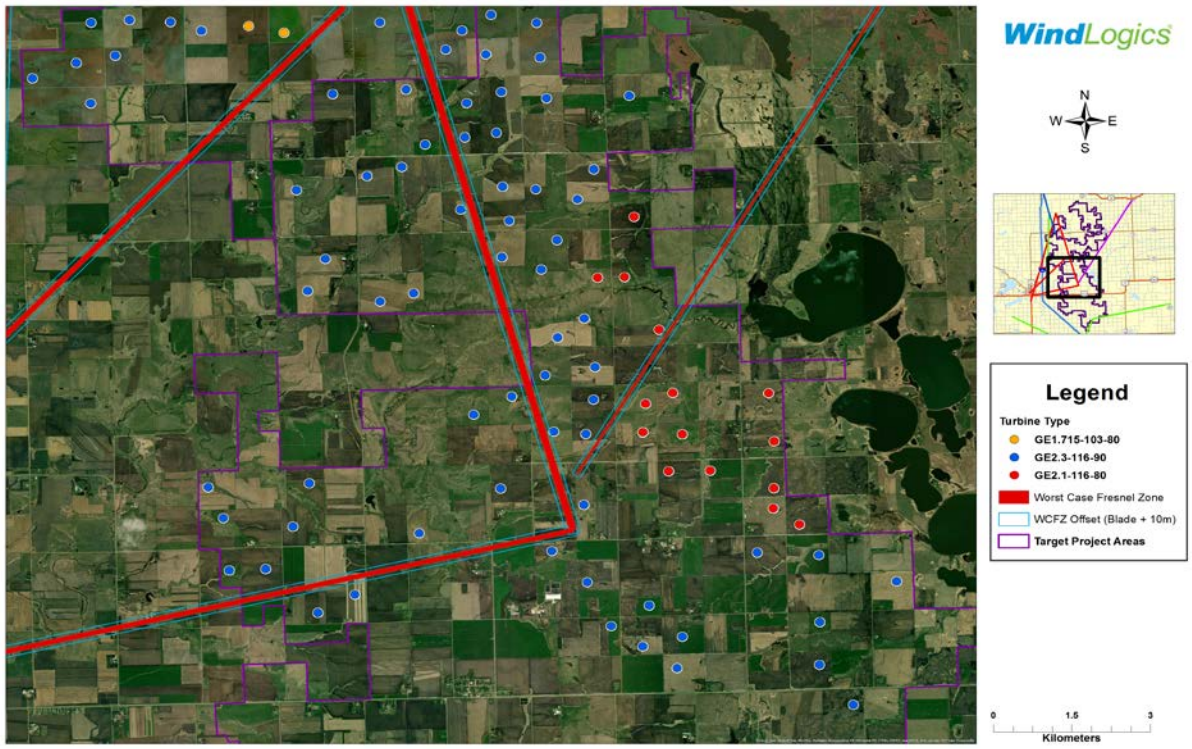


Figure 5: Crowned Ridge Wind Fresnel Zone Central

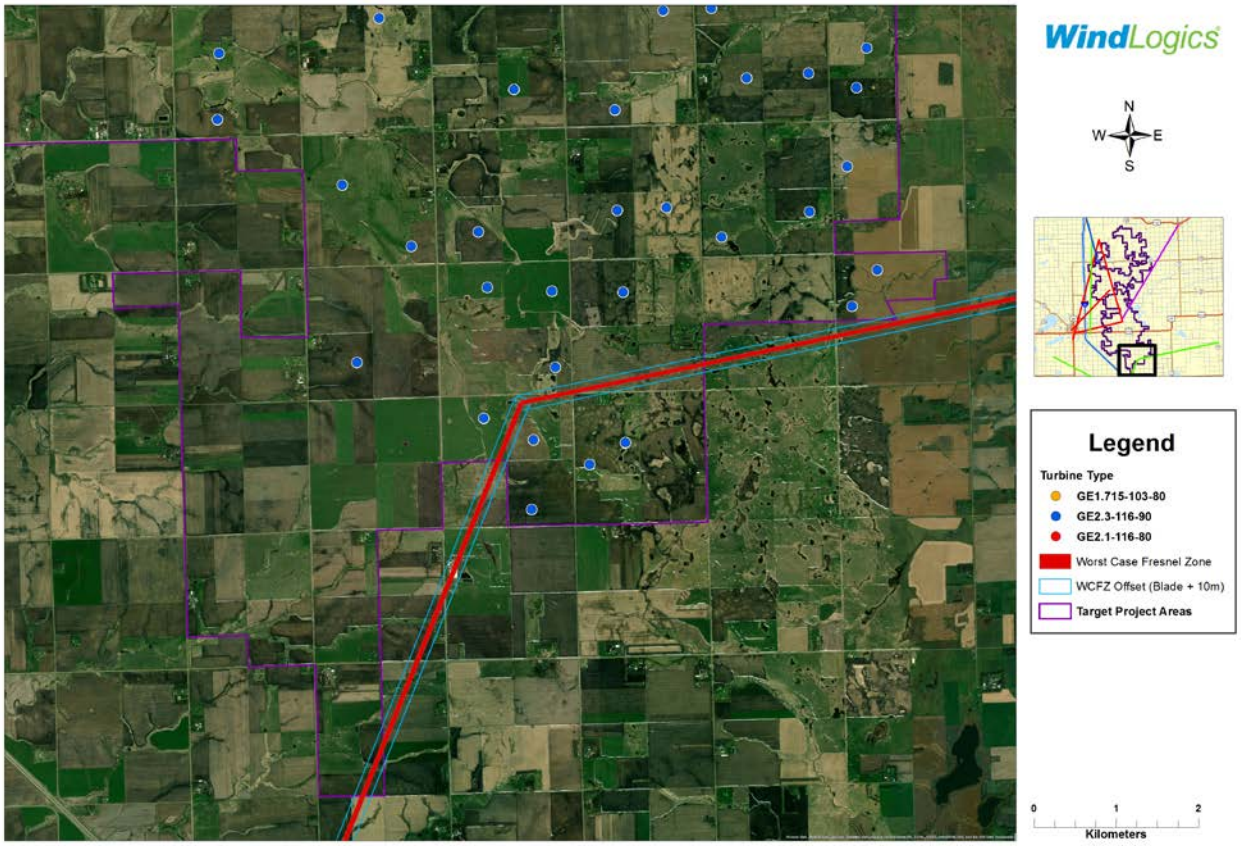


Figure 6: Crowned Ridge Wind Fresnel Zone South

Cellular Towers

One cellular tower was identified within the project boundary. Four additional cellular towers were discovered within 25 km of the project boundary and are identified in Table 3 and figure 7.

Harmful interference associated with cellular towers is not likely as cellular transitions or packet switching occurs when a cellular link becomes unavailable.

ID	STATUS	CALLSIGN	LICENSEE	LATITUDE	LONGITUDE	DISTANCE TO AOI(km)
1	Active	KNKN368	Rural Cellular Corporation	44.91581	-96.96506	0.00
2	Active	KNKN368	Rural Cellular Corporation	44.66469	-96.80867	13.95
3	Active	KNKN368	Rural Cellular Corporation	45.11611	-97.04653	2.04
4	Active	KNKN368	Rural Cellular Corporation	44.90667	-96.70056	6.35
5	Active	KNKN368	Rural Cellular Corporation	44.73344	-96.68386	11.27

Table 3: Cellular Towers within 25 km of the Project Boundary

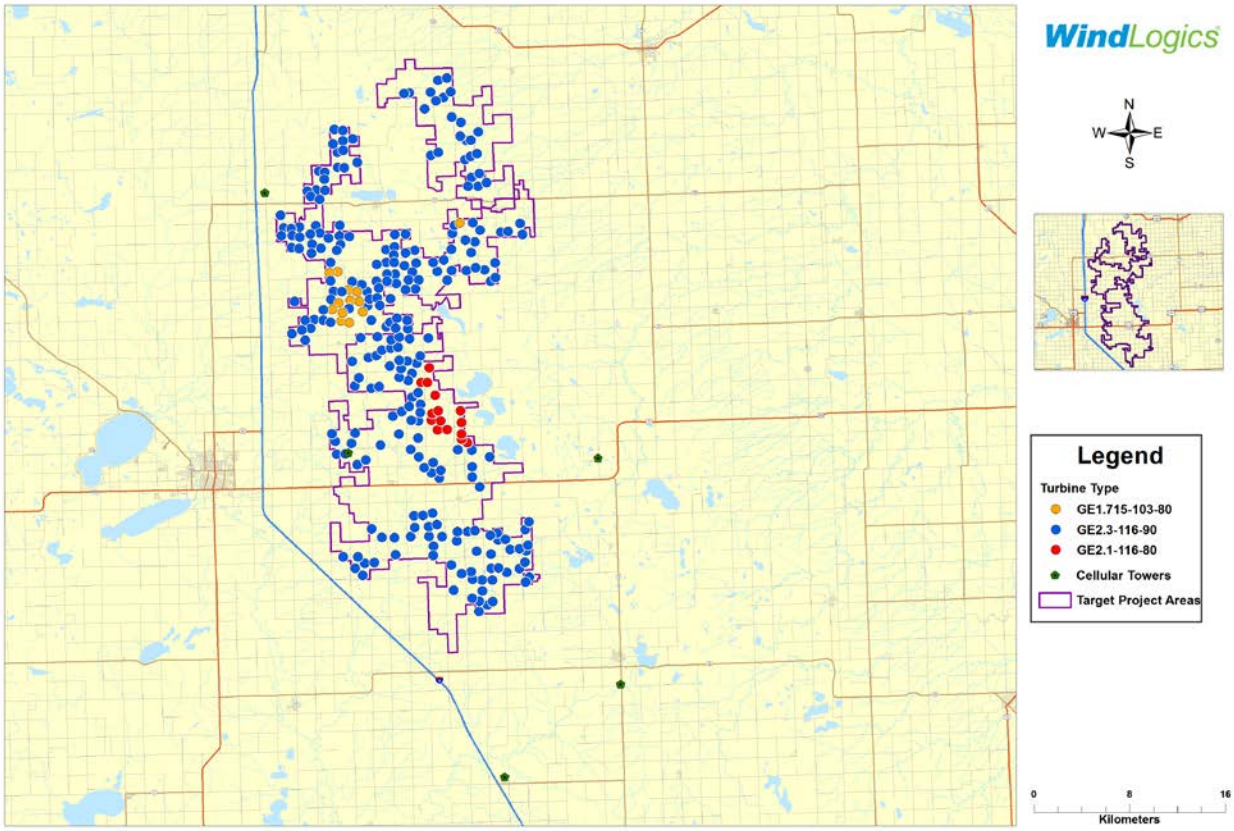


Figure 7: Cellular Towers within 25 km of the Project Boundary

Media Towers

No active AM radio towers were identified within the project boundary or within 25 km of the project boundary.

The KJSD and KXLG radio towers within the boundary are 435m from the nearest turbine. For frequencies near 100 MHz, it has been shown that wind turbines have minimal effect on the radiation pattern at distances greater than 100m from the FM transmitter (Salema, 1999). With a blade length of 51.5m, the closest wind turbine will be 383.5m from the KBTE tower and we expect minimal interference.

In addition the KPHR radio tower is 605m away from the nearest turbine. With a blade length of 58m, the closest turbine would be 547m away and minimum interference is also expected due to the previous assumptions

While minimal harmful interference to the FM towers is expected, reception of FM radio stations near each individual turbine may be impacted, especially for areas on the edge of FM radio coverage. FM stations that are closer than 4 kilometers to wind turbines have the potential to experience interference (Marlowe, 2015).

Given most FM radio receptors will be nearby dwellings, which should have a sufficient offset from each turbine, any interruption to reception from the installation of wind turbines is expected to be minimal. 3 additional FM towers are located less than 4 km from the AOI.

ID	CALLSIGN	LICENSEE	FREQUENCY (MHz)	LATITUDE	LONGITUDE	DISTANCE TO AOI(km)
1	KIXX	ALPHA 3E LICENSEE LLC	96.1	45.17528	-96.98750	1.48
2	KJSD	SOUTH DAKOTA BOARD OF DIRECTORS FOR EDUCATIONAL TELECOM	90.3	45.01939	-96.94519	0.00
3	KKSD	ALPHA 3E LICENSEE LLC	104.3	45.17500	-96.98722	1.43
4	KPHR	ARMADA MEDIA - WATERTOWN, INC.	106.3	45.10472	-96.98806	0.00
5	KSDR-FM	ALPHA 3E LICENSEE LLC	92.9	45.17528	-96.98750	1.43
6	KXLG	TMRG BROADCASTING, LLC	99.1	45.01944	-96.94528	0

Table 4: FM Transmitter Towers within 25 km of the Project Boundary

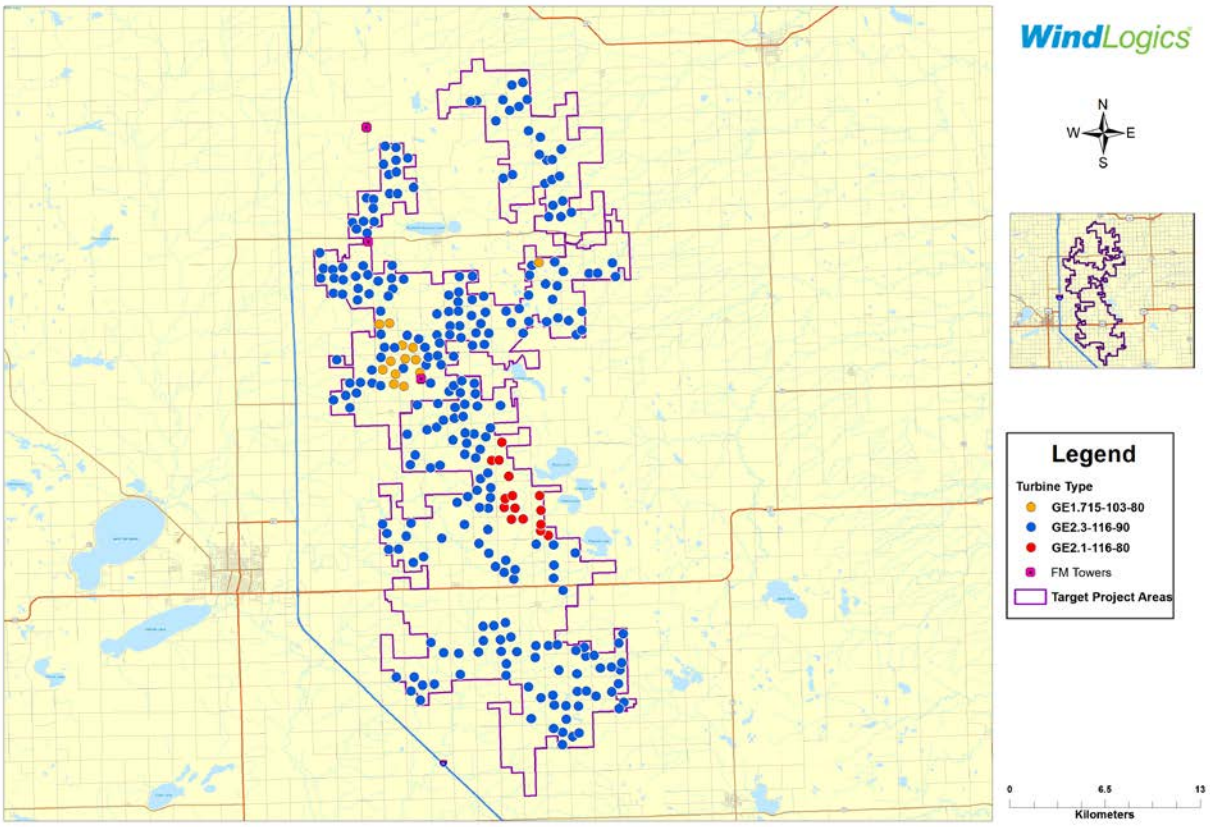


Figure 8: FM Transmitter Towers within 25 km of the Project Boundary

Television Stations

No digital or analog television stations were identified within the project boundary. Table 5 and figure 9 identifies licensed television stations within 100 km of the project boundary as determined by the FCC. There are 5 stations less than 50 km from the project boundary which are likely to be broadcasting to the region.

ID	CALLSIGN	LICENSEE	SERVICE	CHANNEL	ERP	Latitude	Longitude	DISTANCE TO AOI(km)
1	KABY-TV	HOAK MEDIA OF DAKOTA LICENSE, LLC	DT	28	54. kW	45.10640	-97.89959	68.09
2	KDLO-TV	YOUNG B/CING OF SIOUX FALLS, INC., DEBTOR-IN-POSSESSION	DT	3	14.4 kW	44.96561	-97.58978	44.94
3	KDSD-TV	SOUTH DAKOTA BOARD OF DIRECTORS FOR EDUCATIONAL TELECOMMU	DT	17	19. kW	45.49830	-97.67479	66.70
4	KESD-TV	SOUTH DAKOTA BOARD OF DIRECTORS FOR EDUCATIONAL TELECOMMU	DT	8	15. kW	44.33781	-97.22867	56.83
5	KWCM-TV	WEST CENTRAL MINNESOTA EDUCATIONAL TELEVISION COMPANY	DT	31	288. kW	45.16751	-96.00093	60.72
6	K16CP	MINNESOTA VALLEY TV IMPROVEMENT	TX	16	1.67 kW	44.80471	-95.58061	96.21
7	K18DI	MINNESOTA VALLEY TV IMPROVEMENT	TX	18	1.67 kW	44.80471	-95.58061	96.21
8	K22DO	MINNESOTA VALLEY TV IMPROVEMENT	TX	22	1.65 kW	44.80471	-95.58061	96.21
9	K24CS	MINNESOTA VALLEY TV IMPROVEMENT	TX	24	1.65 kW	44.8047	-95.58061	96.21
10	K26DG	MINNESOTA VALLEY TV IMPROVEMENT	TX	26	1.65 kW	44.80471	-95.58061	96.21
11	K32DK	INDEPENDENT COMMUNICATIONS, INC.	TX	32	11.4 kW	44.87001	-97.11397	10.75
12	K32DR	MINNESOTA VALLEY TV IMPROVEMENT	TX	32	1.45 kW	44.80471	-95.58061	96.21
13	K35DK	MINNESOTA VALLEY TV IMPROVEMENT	TX	35	1.45 kW	44.8047	-95.58061	96.21
14	K35GR	RED RIVER BROADCAST CO., LLC	TX	35	11.9 kW	44.4875	-97.23927	43.21
15	K40FZ	RED RIVER BROADCAST CO., LLC	TX	40	13.5 kW	44.33941	-96.76895	50.13
16	K42FI	RED RIVER BROADCAST CO., LLC	TX	42	10. kW	44.87111	-97.10977	10.75
17	K45DJ	MINNESOTA VALLEY TV IMPROVEMENT	TX	45	1.45 kW	44.8047	-95.58061	96.21
18	K47EA	MINNESOTA VALLEY TV IMPROVEMENT	TX	47	1.45 kW	44.8047	-95.58061	96.21
19	K47IC	RED RIVER BROADCAST CO., LLC	TX	47	7.8 kW	45.1753	-96.98756	1.48
20	K50DG	INDEPENDENT COMMUNICATIONS, INC.	TX	50	0.45 kW	44.3008	-96.76705	54.57
21	K61AU	MINNESOTA VALLEY TV IMPROVEMENT CORP	TX	61	1.13 kW	44.8047	-95.58061	96.21
22	K63AU	MINNESOTA VALLEY TV IMPROVEMENT CORP	TX	63	1.13 kW	44.8047	-95.58061	96.21
23	K65BA	MINNESOTA VALLEY TV IMPROVEMENT CORP	TX	65	1.13 kW	44.80471	-95.58061	96.21
24	K67AN	MINNESOTA VALLEY TV IMPROVEMENT CORP	TX	67	0.707 kW	44.80471	-95.58061	96.21
25	K69DP	MINNESOTA VALLEY TV IMPROVEMENT CORP	TX	69	0.734 kW	44.80471	-95.58061	96.21

Table 5: Television Stations within 100 km of the Project Boundary

http://www.thebestpageintheuniverse.net/c.cgi?u=irule

Figure 9: Television Stations within 100 km of the Project Boundary

While the impact of wind turbines on digital television reception is not well known due to limited cases and testing, any interference is expected to be limited to areas near the edge of station reception, areas near a turbine that is within the line-of-sight between the transmit tower and receptor, and areas of complex topography (OfCom, 2009). Most of the stations within 100km are low power stations or translator stations and have limited range and are not anticipated to experience reception degradation. There are five full power stations KABY-TV, KDLO-TV, KDSD-TV, KESD-TV, and KWCM-TV which have a possibility of experiencing reception degradation if the proposed wind farm is located in the line-of-sight.

It is important to note that this assessment is based on broad assumptions, as it is difficult to accurately pinpoint the impact a large wind farm may have on each individual household due to a large number of external variables (topography, weather, antennae, etc.) which affect the propagation of the television radio signal.

Aviation Towers

No active Aviation towers were identified within the project boundary or within 25 kilometers of the area of interest.

While no harmful interference is expected for the aviation towers; Crowned Ridge Wind is subject to a Federal Aviation Agency (FAA) to determine any exclusion zones. Proposed turbine locations will maintain the standard appropriate offset distances in addition to any setbacks set by the agency to minimize harmful impact.

Conclusion and Recommendations

WindLogics analyzed the potential for wind turbine interference on licensed microwave links located within the proposed Crowned Ridge Wind Project energy generation site. This report summarizes the microwave towers, microwave links, cellular towers, media towers, television towers, and aviation towers within and near the project boundary.

Eight microwave links were found to intersect the project boundary, and an appropriate offset to the WCFZ has been utilized to mitigate harmful interference from the proposed turbine layout. No interference from the proposed turbine layout is expected near microwave, AM, FM, cellular, aviation, and TV towers. This analysis is current as of August 20th, 2018. WindLogics recommends a refresh of this analysis if the proposed wind energy generation project has not been constructed after two years.

It is important to note that this report only provides analysis for licensed radio towers and links found within the FCC-ULS database. Many local municipalities (police, fire, etc.) do not license microwave links, WindLogics recommends Crowned Ridge Wind LLC coordinate with the appropriate local municipality officials. Also not included within the database are microwave towers and links utilized by the Federal government (Dept. of Defense, Dept. of Commerce, etc.),

again for public safety concerns. A Federal communications study by the National Telecommunications and Information Agency (NTIA) has been conducted stating no harmful interference is expected in the project area.

References

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Ofcom, "Tall structures and their impact on broadcast and other wireless services." http://www.ofcom.org.uk/radiocomms/ifi/licensing/classes/fixed/Windfarms/tallstructures/tall structures.pdf, August 2009.

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BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF SOUTH DAKOTA

IN THE MATTER OF THE APPLICATION OF CROWNED RIDGE, LLC FOR A FACILITIES PERMIT TO CONSTRUCTION 300 MEGAWATT WIND FACILITY

Docket No. EL19-

DIRECT TESTIMONY

OF JAY HALEY

January 28, 2019

INTRODUCTION AND QUALIFICATIONS

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is Jay Haley. My business address is 3100 DeMers Ave., Grand Forks, ND, 58201.

Q. BY WHOM ARE YOU EMPLOYED AND IN WHAT CAPACITY?

A. I am a Partner in EAPC Wind Energy and work as a Wind Engineer.

Q. WHAT ARE YOUR RESPONSIBILITIES?

A. My responsibility was to conduct the sound and shadow flicker studies for Crowned Ridge Wind, LLC ("CRW").

Q. PLEASE DESCRIBE YOUR BACKGROUND AND QUALIFICATIONS

A. I have more than 30 years of experience in wind farm design. My experience includes financial feasibility studies, technical due diligence, wind farm design, energy assessments, visual simulations, ice throw studies, noise studies, and shadow flicker studies. I have performed more than 60 noise impact assessments and shadow flicker studies in over 15 states across the U.S. I have also worked on wind energy projects in Australia, Puerto Rico, Argentina, Chile, Uruguay and Venezuela. I am also the North and South American sales and support representative for windPRO, which is the world's leading software tool used for the design of wind farms including noise and shadow flicker studies. I have trained hundreds of engineers and environmental consultants on the proper use of windPRO with regard to wind farm design, energy assessments, visual simulations, and noise and shadow flicker studies. I have provided expert witness testimony on noise impacts, shadow flicker issues, ice throw and visual impacts in adjudicatory hearings front of local boards and in judicial proceedings.

I have a Bachelor of Science degree in Mechanical Engineering from the University of North Dakota. I am a participating member of the International Electrotechnical Commission (IEC) Technical Committee TC88, Working Group 15 as a Technical Advisor for the U.S. National Committee. The purpose of this group is to develop an International Standard for the

assessment of wind resource, energy yield, and site suitability input conditions for wind power plants.

Q. HAS THIS TESTIMONY BEEN PREPARED BY YOU OR UNDER YOUR DIRECT SUPERVISION?

A. Yes.

Q. HAVE YOU PREVIOUSLY TESTIFIED BEFORE THE SOUTH DAKOTA PUBLIC UTILITIES COMMISSION?

A. No.

PURPOSE OF TESTIMONY

Q. PLEASE DESCRIBE THE PURPOSE OF YOUR TESTIMONY.

A. The purpose is to provide a description of the sound and shadow/flicker studies conducted for CRW and to set forth the results of the studies.

SOUND STUDY

Q. PLEASE DESCRIBE THE SOUND STUDY THAT WAS CONDUCTED FOR CRW.

A. Wind turbine noise can originate from a number of sources, but primarily from mechanical sound from the interaction of turbine components, and aerodynamic sound produced by the airflow over the rotor blades. In addition to the turbines, the transformer located at a wind project's substation will also emit sound.

Wind turbine sound pressure levels are measured using a sound level meter and a microphone. Sound level meters used for monitoring can pick up sounds perfectly, but the human ear is not as precise. The human ear cannot hear very low or very high frequencies. The sensitivity range of the human ear is approximately 20 to 20,000 Hz. Weighting networks are used in noise monitors in order to adjust specific frequencies in the audio spectrum to attempt to duplicate the response of the human ear.

The C-weighting network represents the actual sound pressure level that is received by the sound level meter, and does not noticeably vary in its amount of compensation throughout the audio spectrum. C-weighting is used during the calibration of sound level meters to ensure that the sound level displayed on the meter is accurate and the same as the frequency of the calibrator. The A-weighting network is then used to duplicate the sensitivity of the human ear (20-20,000 Hz).

Sounds in the environment vary with time. The two sound level metrics that are commonly reported in community noise monitoring are:

- L_{90}, which is the sound level in dBA that is exceeded 90 percent of the time during a measurement period. The L_{90} is close to the lowest sound level observed. It is essentially the same as the "residual", or ambient sound level, which is the sound level observed when there are no obvious nearby intermittent noise sources.
- L_{eq}, the equivalent level, is the level of a hypothetical steady sound that would have the same energy as the actual fluctuating sound observed. The equivalent level is designated L_{eq} and is commonly A-weighted. The equivalent level represents the time average of the fluctuating sound pressure, but because sound is represented on a logarithmic scale and the averaging is done with time-averaged mean square sound pressure values, the L_{eq} is mostly determined by occasional loud noises.

The sound levels at the base of a modern utility-scale wind turbine typically range between 55 to 60 dBA when the wind turbine is operating at full power. By comparison, a normal conversation between two people is typically 55-65 dBA when they are three feet apart. Sound levels decrease with distance. At 50 dBA it would be approximately half as loud as conversational speech, and between 30 and 40 dBA it is comparable to the ambient sound levels in a quiet rural area. A conservative prediction of sound levels associated with the Project was made using windPRO, the world's leading software tool for wind farm design, which is commonly used in the industry world-wide for sound modeling. This software incorporates the International Standard ISO 9613-2 for sound propagation (Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation).

In addition to the turbine model specifications, proposed Project layout, and the receptor locations discussed above, inputs and significant parameters employed in the model included:

- Project Layout: 284 locations were modeled (150 for Crowned Ridge and 134 for Crowned Ridge II).
- Receptor Locations: For Codington County, sound receptors were modeled as areas representing the land parcels and sound levels were calculated at the parcel boundaries. For Grant County, sound levels at receptors were modeled as discrete points at a height of 1.5 meters ("m") above ground level and 50 feet from the perimeter of the structures. Sound levels were also calculated on a 25 m x 25 m receptor grid in order to generate the sound level isolines, which are lines on a map depicting sound levels.
- Terrain Elevation: The terrain height contour elevations for the area modeled were generated from elevation information derived from the 3 m National Elevation Dataset ("NED"), developed by the U.S. Geological Survey.
- Wind Turbine Sound Levels: The expected sound power levels associated with the GE wind turbines were obtained from GE technical reports. The 1/3 octave-band sound power levels calculated for the GE 2.3-116-90 and GE 2.3-116-80 wind turbines represent the highest operational sound level emissions. In addition, all turbines were assumed to be operating simultaneously and at the design wind speed corresponding to the greatest sound level impacts, and upwind from all receptors, with an additional 2.0 dBA added to the maximum sound power level for each wind turbine.
- Ground Attenuation: Spectral ground absorption was calculated using a G-factor of 0.5, which corresponds to "mixed ground" consisting of both hard and porous ground cover. No additional attenuation due to tree shielding, air turbulence, or wind shadow effects was considered.
- Meteorological Assumptions: Meteorological conditions were selected to minimize atmospheric attenuation. The model also assumed favorable conditions for sound propagation, corresponding to a moderate, well-developed ground-based temperature inversion, as might occur on a calm, clear night.

Q. WHAT WAS THE SOUND STANDARD YOU APPLIED?

A. For Grant County, per Section 1211.04, paragraph 14 of the Grant County Zoning Ordinance 2016-01C, Grant County imposes the following requirement for wind energy facilities:

"14.) Noise. Noise level shall not exceed 45 dBA, average A-weighted Sound pressure including constructive interference effects measured twenty-five (25) feet from the perimeter of existing off-site non-participating residences, businesses, buildings owned and/or maintained by a governmental entity."

"Noise level shall not exceed 50 dBA, average A-weighted Sound pressure including constructive interference effects measured twenty-five (25) feet from the perimeter of participating residences, businesses, and buildings owned and/or maintained by a governmental entity."

For Codington County, per Section 5.22.03 paragraph 12 of the *Comprehensive Zoning Regulations for Codington County*, Codington County requires the following:

"Noise level shall not exceed 50 dBA, average A-weighted Sound pressure level effects at the property line of existing non-participating residences, businesses, and buildings owned and/or maintained by a governmental entity."

Q. WHAT WERE THE RESULTS OF YOUR SOUND STUDY?

A. The results of the study indicate that there were no sound pressure levels in exceedance of either of the two respective county's noise ordinances. Sound pressure levels at all non-participating occupied structures were 45 dBA or less, and 50 dBA or less at all participating occupied structures for both counties. Codington County's ordinance only requires 50 dBA or less at non-participating property lines and the highest sound pressure level was 48.8 dBA at the property line.

SHADOW/FLICKER STUDY

Q. WHAT IS SHADOW AND FLICKER AS IT RELATES TO WIND TURBINES?

A. Shadow flicker from wind turbines occurs when rotating wind turbine blades move between the sun and the observer. Shadow flicker is generally experienced in areas near wind turbines where the distance between the observer and wind turbine blade is short enough that sunlight has not been significantly diffused by the atmosphere. When the blades rotate, this shadow creates a pulsating effect, known as shadow flicker. If the blade's shadow is passing over the window of a building, it will have the effect of increasing and decreasing the light intensity in the room at a low frequency in the range of 0.5 to 1.2 Hz, hence the term "flicker." In this case, with a maximum rotational speed of 15.6 rpm for the GE 2.3-116, the frequency would be 0.78 Hz. This flickering effect can also be experienced outdoors, but the effect is typically less intense, and becomes less intense when farther from the wind turbine causing the flicker.

Q. PLEASE DESCRIBE THE SHADOW AND FLICKER STUDY THAT WAS CONDUCTED.

A. This shadow flicker analysis was performed utilizing windPRO, which is the most commonly used software world-wide for performing shadow flicker studies. It has the capability to calculate detailed shadow flicker maps across an entire area of interest or at site-specific locations using shadow receptors.

Shadow maps which indicate where the shadows will be cast and for how long, are generated using windPRO, calculating the shadow flicker in varying user-defined resolutions. Standard resolution was used for this study and represents shadow flicker being calculated every three

minutes of every day over the period of an entire year over a grid with a 20 m by 20 m resolution.

In addition to generating a shadow flicker map, the amount of shadow flicker that may occur at a specific point can be calculated more precisely by placing a shadow receptor at the location of interest and essentially "recording" the shadow flicker that occurs as the relative sunrise to sunset motion of the sun is simulated throughout an entire year.

The point-specific shadow flicker calculation is run at a higher resolution as compared to the shadow flicker map calculation to utilize the highest precision available within windPRO. Shadow flicker at each shadow receptor location is calculated every minute of every day for an entire year. Shadow receptors can be configured to represent an omni-directional window of a specific size at a specific point (greenhouse mode) or a window facing a single direction of a specific size at a specific point (single direction mode). The shadow receptors used in this analysis were configured as greenhouse-mode receptors representing a 1 m x 1 m window located 1 m above ground level. This represents more of a "worst-case" scenario, and, thus, will produce more conservative results since it assumes that all windows are always in direct line of sight with the turbines and the sun.

As a part of the calculation method, windPRO must determine whether or not a turbine will be visible at the receptor locations and not blocked by local topography. It does this by performing a preliminary Zones of Visual Influence calculation, utilizing 10 m grid spacing. If a particular turbine is not visible within the 10 m x 10 m area that the shadow receptor is contained within, then that turbine is not included in the shadow flicker calculation for that receptor.

The inputs for the windPRO shadow flicker calculation include the following:

- Turbine Coordinates: The location of a wind turbine in relation to a shadow receptor is one of the most important factors in determining shadow flicker impacts. A line-of-site is required for shadow flicker to occur. The intensity of the shadow flicker is dependent upon the distance from the wind turbine and weather conditions.

- Turbine Specifications: A wind turbine's total height and rotor diameter will be included in the windPRO shadow flicker model. The taller the wind turbine, the more likely shadow flicker could have an impact on local shadow receptors as the ability to clear obstacles (such as hills or trees) is greater, although in this analysis, no credit is taken for any such blockage from trees. The larger the rotor diameter is, the wider the area where shadows will be cast. Also included with the turbine specifications are the cut-in and cut-out wind speeds within which the wind turbine is operational. If the wind speed is below the cut-in threshold or above the cut-out threshold, the turbine rotor will not be spinning and thus shadow flicker will not occur. The blade width is also taken into consideration. The wider the blade is, the farther from the wind turbine the shadow effect will persist.

- Shadow Receptor Coordinates: As with the wind turbine coordinates, the elevation, distance and orientation of a shadow receptor in relation to the wind turbines and the sun are the main factors in determining the impact of shadow flicker.

- Monthly Sunshine Probabilities: windPRO calculates sunrise and sunset times to determine the total annual hours of daylight for the modeled area. To further refine the shadow flicker calculations, the monthly probability of sunshine is included to account for cloud cover. The greater the probability of cloud cover, the less of an impact from shadow flicker. The monthly sunshine probabilities for many of the larger cities across the United States are available from the National Climatic Data Center. For this study, 18 years' worth of monthly sunshine probability data was retrieved for Huron, SD, which was the closest, most representative station, to create the long-term representative monthly sunshine probabilities.

- Joint Wind Speed and Direction Frequency Distribution: A set of long-term corrected wind distributions was provided by Crowned Ridge Wind, LLC to represent the annual wind speed and direction distribution for the project site.

This data was used to estimate the probable number of operational hours for the wind turbines from each of the 12 wind direction sectors. During operation, the wind turbine rotors will always be assumed to face into the wind and automatically orient themselves as the wind direction changes. Shadow flicker can only occur when the blades are turning and the wind turbine rotor is between the sun and the receptor. Shadow flicker is most significant when the rotor is facing the sun.

- USGS Digital Elevation Model (DEM) (height contour data): For this study, 3 m USGS NED DEMs were used to construct 10-foot interval height contour lines for the windPRO shadow flicker model. The height contour information is important to the shadow flicker calculation since it allows the model to place the wind turbines and the shadow receptors at the correct elevations. The height contour lines also allow the model to include the topography of the site when calculating the zones of visual influence surrounding the wind turbine and shadow receptor locations.

The actual calculation of potential shadow flicker at a given shadow receptor is carried out by simulating the environment near the wind turbines and the shadow receptors. The position of the sun relative to the turbine rotor disk and the resulting shadow is calculated in time steps of one minute throughout an entire year. If the shadow of the rotor disk (which in the calculation is assumed solid) at any time casts a shadow on a receptor window, then this step will be registered as one minute of shadow flicker. The calculation also requires that the sun must be at least 3.0° above the horizon in order to register shadow flicker. When the sun angle is less than 3.0°, the shadow quickly becomes too diffuse to be distinguishable since the amount of atmosphere that the light must pass through is 15 times greater than when the sun is directly overhead.

The sun's path with respect to each wind turbine location is calculated by the software to determine the paths of cast shadows for every minute of every day over a full year. The turbine runtime and direction are calculated from the site's long-term wind speed and direction distribution. The effects of cloud cover are calculated using long-term reference data (monthly

sunshine probability) to arrive at the projected annual flicker time at each receptor.

Shadow flicker does not extend beyond a distance of approximately 1,700 meters from the wind turbine base, which is why all occupied structures within a conservative distance of 2 kilometer (km) from a wind turbine were included in the analysis.

Q. WHAT WAS THE SHADOW AND FLICKER STANDARD YOU APPLIED?

A. There are no federal shadow flicker regulations. There are regulations in both Codington and Grant Counties that require a limit of 30 hours of shadow flicker per year, which is the standard used in the study.

Q. WHAT WERE THE RESULTS OF YOUR SHADOW AND FLICKER STUDY?

A. Using the conservative modeling methodology which includes the use of greenhouse sensors, turbines always facing the sun, and no credit for any blockage by trees or buildings, the Project is not projected to result in shadow flicker levels above 30 hours per year at any residence, business, or building owned and/or maintained by a governmental entity.

A total of 125 existing residences within 2 km of a wind turbine were analyzed and standard resolution realistic shadow flicker maps were generated for the turbine array. The 125 shadow receptors were then modeled as greenhouse-mode receptors and the estimated shadow flicker was calculated for the array. No shadow receptors are expected to experience more than 29 hours and 50 minutes of shadow flicker per year. Therefore, CRW would be in compliance with Codington County Ordinance #68, Section 5.22.03, paragraph 13, as well as Grant County Ordinance 2016-01C, Section 1211.04, paragraph 14, both of which limit shadow flicker to 30 hours per year.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.

STATE OF NORTH DAKOTA)
) ss
COUNTY OF GRAND FORKS)

I, Jay Haley, being duly sworn on oath, depose and state that I am the witness identified in the foregoing prepared testimony and I am familiar with its contents, and that the facts set forth are true to the best of my knowledge, information and belief.

Jay Haley

Subscribed and sworn to before me this 28th day of January, 2019.

SEAL

CAROL ENGLUND
Notary Public
State of North Dakota
My Commission Expires April 11, 2023

Carol Englund
Notary Public

My Commission Expires April 11, 2023

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF SOUTH DAKOTA

IN THE MATTER OF THE APPLICATION OF CROWNED RIDGE, LLC FOR A FACILITIES PERMIT TO CONSTRUCT A 300-MEGAWATT WIND FACILITY

Docket No. EL19-

DIRECT TESTIMONY

OF KIMBERLY WELLS, PH.D.

January 28, 2019

INTRODUCTION AND QUALIFICATIONS

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is Kimberly Wells. I am employed by NextEra Energy Resources, LLC ("NextEra"). I am based in Houston, Texas at 601 Travis Street, Suite 1900, Houston, Texas 77002.

Q. WHAT IS YOUR JOB AND WHAT ARE YOUR JOB RESPONSIBILITIES?

A. I am the Environmental Services Manager for NextEra's Mid-Continent Region. My team is responsible for all environmental permitting in the Mid-Continent Region that includes the state of South Dakota for any renewable energy project.

Q. **PLEASE DESCRIBE YOUR BACKGROUND AND QUALIFICATIONS?**

A. I received my PhD in Fisheries and Wildlife Sciences from the University of Missouri in 2005, a M.S. in Fisheries and Wildlife Sciences from Oklahoma State University in 2000, and a B.S. in Renewable Natural Resources with an emphasis in Wildlife Ecology from the University of Arizona in 1998. In addition, I am also a Certified Wildlife Biologist and Certified Wetland Delineator. I have 19 years of professional experience with environmental permitting, wildlife ecology, and natural resource management. I have worked in state government, private consulting, and private industry sectors. I have been involved with permitting wind energy projects for the last 13 years.

Q. HAS THIS TESTIMONY BEEN PREPARED BY YOU OR UNDER YOUR DIRECT SUPERVISION?

A. Yes.

Q. **HAVE YOU PREVIOUSLY TESTIFIED BEFORE THE SOUTH DAKOTA PUBLIC UTILITIES COMMISSION?**

A. No.

PURPOSE OF TESTIMONY

Q. PLEASE DESCRIBE THE PURPOSE OF YOUR TESTIMONY.

A. The purpose of my testimony is provide an overview of the environmental studies conducted for Crowned Ridge Wind, LLC (CRW) at the Crowned Ridge Wind Energy Project in Codington and Grant counties, South Dakota (the Project). The Project Area is approximately 53,200 acres spanning Codington and Grant counties.

ENVIRONMENTAL STUDIES

Q. WHAT WAS THE OVERALL APPROACH TO ENVIRONMENTAL ANALYSIS OF THE WIND FACILITY SITE?

A. CRW completed desktop analyses and site-specific field studies to determine the potential for presence of sensitive natural resources. Surveys were designed to comply with applicable regulations and guidelines, including the U.S. Fish and Wildlife Service (USFWS) Land-based Wind Energy Guidelines, USFWS Eagle Conservation Plan Guidance, state cultural resource protection laws, and relevant water resource protection regulations (e.g., Clean Water Act). Data collected during these analyses and surveys informed an iterative process of refined infrastructure micro-siting, whereby CRW refined the Project configuration over a period of several months. The current Project site layout is compatible with existing land use, utilizes the wind resource in an efficient manner, and avoids and minimizes impacts to natural (e.g., wetlands, wildlife) and cultural (e.g., cairns, stone circles) resources.

Q. DISCUSS THE ENVIRONMENTAL SURVEYS AND/OR STUDIES CONDUCTED FOR THE WIND FACILITY.

A. The environmental studies and field surveys conducted for the Project, the dates of those studies/surveys, and the status of each are provided in the table below.

Environmental Studies and Surveys for the Project

Study	Dates	Status
Raptor nest aerial surveys	April and May 2017; Spring 2018	Complete
Avian point count surveys	April – November 2017	Complete
Bat desktop habitat assessment	September 2018	Complete
Bat acoustic monitoring	April – November 2017	Complete
Dakota skipper/Poweshiek skipperling adult survey	June – July 2018	Complete
Whooping crane desktop habitat assessment	Summer 2018	Complete
Sound level modeling	2018 – 2019	Complete
Shadow flicker modeling	2018 – 2019	Complete
Level I cultural resources records search	May 2018	Complete
Level III intensive cultural resources survey of High Probability Areas within Project disturbance footprint (in accordance with the Cultural Resource Monitoring and Management Plan)	June – December 2017; April – November 2018	Complete
Wetland and stream delineation	Fall 2018	Ongoing

Additionally, numerous other wildlife studies were conducted for earlier iterations of the Project Area during the last decade and during the process of refining the Project location. Those studies are listed in the table below.

Environmental Studies and Surveys for previous iterations of the CRW Project		
Study	**Dates**	**Survey Area**
Avian use survey (spring)	March 2007 – June 2008	Earlier iteration of Project Area
Dakota skipper habitat delineation	June 2008	Earlier iteration of Project Area
Avian use survey (fall)	August – November 2008	Earlier iteration of Project Area
Dakota skipper habitat delineation	June – July 2009	Earlier iteration of Project Area
Avian use survey (fall)	August – November 2014	Earlier iteration of Project Area
Eagle survey	March – November 2014; November – March 2015	Earlier iteration of Project Area
Dakota skipper habitat evaluation	2015	Earlier iteration of Project Area
Bat habitat assessment	Summer 2015	Nearby study area
Bat acoustic monitoring	August – October 2015; April – October 2016	Earlier iteration of Project Area
Raptor nest survey	March – April 2016	Earlier iteration of Project Area
Lek survey	April – May 2016	Earlier iteration of Project Area
Bat acoustic monitoring	April – October 2016	Earlier iteration of Project Area
Dakota skipper/Powshiek skipperling habitat assessment	September 2016	Earlier iteration of Project Area

Avian use survey	April 2016 – February 2017	Earlier iteration of Project Area

Q. IS THERE ANY ENVIRONMENTAL STUDY WORK YET TO BE COMPLETED FOR THE WIND FACILITY?

A. Yes. CRW is in the process of finishing wetland and stream delineation field surveys, and cultural resources surveys.

Q. DOES THE REMAINING ENVIRONMENTAL STUDY WORK NEED TO BE COMPLETED IN ORDER TO DETERMINE WHETHER THE WIND FACILITY COMPLIES WITH STATE SITING REQUIREMENTS?

A. No, the remaining survey work is not anticipated to affect the environmental analysis set forth in the Application, or the conclusion that the Project will meet all applicable State permitting requirements. Additionally, the Project has been designed (and will operate in a manner) so that remaining desktop analysis and in-field survey work will not affect the Project's ability to comply with other local and Federal permitting requirements.

ENVIRONMENTAL SITE ANALYSIS

Q. PLEASE PROVIDE A GENERAL OVERVIEW OF THE WIND FACILITY SITE FROM A LAND USE PERSPECTIVE?

A. The Project is located entirely on private land, which includes undeveloped rural areas, agricultural lands, and residential farmsteads. The predominant land use within the Project Area is grass/pasture (46.6% of total area) followed by agricultural (35.8% of total area). Within the Project Construction Easement, the predominant land use is agricultural (70.5% of total area) followed by grass/pasture (26.1%). Two active sand and gravel pits are present in the area and are located in T118N R51W Section 15 and 16. Additionally, rural residence and farmsteads are

located within the Project Construction Easement. For additional details see Sections 11.1 and 13.1 of the application.

Q. WHAT STEPS WILL CRW TAKE TO AVOID, MINIMIZE, AND/OR MITIGATE IMPACTS TO THE EXISTING LAND USES?

A. The Project is compatible with existing land use and is not anticipated to result in sizable permanent impacts to the surrounding land, including agricultural operations. Temporary impacts will occur from construction and installation of other ancillary features, such as collection and communication lines, or from crane walks and temporary access. Where temporary impacts occur, the land will be returned to pre-construction conditions. Long-term operation of the Project is not expected to adversely impact rural lifestyles or create hardships for rural residents. The Project will contribute to rural lifestyles by improving road conditions and access through the Project Area. Because operation of the Project is a compatible land use, the additional easement income for the agricultural landowners is expected to facilitate continued farming and ranching of the lands in agricultural production. Landowners also will be compensated for crop damage during Project construction and operations that impact agricultural lands.

Q. DISCUSS THE EXISTING GEOLOGICAL AND SOIL RESOURCES, SEISMIC RISKS, AND SUBSIDENCE POTENTIAL IN THE WIND FACILITY AREA.

A. The unconsolidated geologic materials within the Project Area are composed of glacial till consisting of ground moraine, end moraine, stagnation moraine, and undifferentiated moraine that generally are of low permeability, although sand and gravel glacial outwash deposits and aeolian dusts and sands are present in these materials. Compiled information indicates that economically valuable mineral deposits, such as sand and gravel, occur in three locales in the Project Area. One-hundred-two (102) soil associations were identified in the Project Area, while 69 soil associations were identified in the Project Construction Easement. Of the 69 soil associations in

the Project Construction Easement, 36 of those have an increased potential for erosion. Prime farmland comprises 43.2% of the Project Area and farmland of statewide importance comprises 17.9% of the Project Area. The risk of seismic activity in the Project Area is considered low, and there is no known subsidence potential or slope instability problems exist within the Project Area.

Q. WHAT STEPS WILL CRW TAKE TO AVOID, MINIMIZE, AND/OR MITIGATE POTENTIAL IMPACTS TO GEOLOGIC AND SOIL RESOURCES?

A. As discussed in Section 9.1.2 of the Application, the geological conditions, including geological formations, seismic risk, and subsidence potential are not anticipated to be impacted by the construction and operation of the Project.

To reduce adverse effects to soils, the Project will develop and implement a Storm Water Pollution Prevention Plan (SWPPP) and use Best Management Practices (BMPs) during construction to protect topsoil and minimize soil erosion. Soil areas disturbed during construction will be decompacted and returned to pre-construction contours to the extent practicable and in accordance with landowner agreements. The goal is to have all surfaces drain naturally, blend in with the undisturbed natural terrain, and for the surfaces to be left in a condition to facilitate re-vegetation, provide for proper drainage, and prevent erosion. Construction laydown areas and temporary travel paths will be restored in accordance with landowner agreements and the SWPPP.

Q. DISCUSS THE HYDROLOGIC RESOURCES, INCLUDING SURFACE AND UNDERGROUND RESOURCES, PRESENT WITHIN THE WIND FACILITY AREA.

A. Section 10.0 of the Application describes the following types of hydrological resources within the Project Area:

Groundwater. Most groundwater resources in the Project Area occur in deposits of sand and gravel or the Dakota Formation that are generally at depths greater than 100 feet (ft.) below the land surface. The Antelope Valley Aquifer is in a northwest/southeast-trending belt in northeastern Codington County and southwestern Grant County, while northeast/southwest-trending outwash deposits are present in the southwestern portion of the Project Area, which is associated with the Big Sioux Aquifer. Additionally, shallow groundwater occurs in the soils within the Project Area at depths ranging from 0 inches at the soil surface to greater than 80 inches.

Surface Water. The Project is in one hydrologic region (the Missouri), covers five major watersheds within Hydrologic Unit Code (HUC) 10 (e.g., South Fork Whetstone River, North Fork Yellow Bank River, South Fork Yellow Bank River, Big Sioux Basin, and Willow Creek), and encompasses 12 sub-watersheds (HUC 12), as defined by the USGS. Three named streams and multiple unnamed tributaries to these streams are located within the Project Area. According to the National Wetland Inventory data, most wetlands within the Project Area are freshwater emergent and comprise 2,291.7 acres of the Project Area. Electronic FEMA floodplain data indicates that one water body within the Project Construction Easement contains 100-year-floodplains. USFWS managed wetland easements and South Dakota Game, Fish, and Parks managed waterfowl production areas are present within the Project Area. In the Project Area, there are no National Park Service Nationwide Rivers Inventory designated stream or river segments and no impaired waters present.

Q. WHAT MEASURES WILL CRW EMPLOY TO AVOID, MINIMIZE, AND/OR MITIGATE POTENTIAL IMPACTS TO HYDROLOGIC RESOURCES?

A. Temporary impacts to groundwater may occur from dewatering activities, but permanent impacts to groundwater are not expected. If construction dewatering is anticipated, a Temporary Water Right will be obtained from the SDDENR and the CRW will ensure that required discharge monitoring is conducted, appropriate BMPs are utilized, and the SWPPP will be amended accordingly.

Project facilities have been sited to avoid both temporary and permanent impacts to wetlands and waterbodies to the extent possible. Through avoidance measures, the CRW has limited impacts to wetlands and waterbodies to minimal areas associated with access roads. Impacts to wetlands and waterbodies that may result because of access road construction are minor and would be authorized under USACE Nationwide Permit (NWP) 12 for utility lines and associated facilities in waters of the U.S. These authorized, permanent impacts to wetland areas may remain beyond the Project's operational lifetime. Disturbed surfaces would be restored as nearly as possible to their preconstruction conditions during Project decommissioning.

Collector lines will be sited to avoid intersecting wetland or other waterbodies to the extent practical. Where collector lines must intersect wetlands or other waterbodies, the CRW will bore under these features to the extent practical to minimize impacts to these resources.

To limit impacts to hydrological resources caused by soil erosion, groundwater contamination, or stormwater runoff, CRW will obtain a South Dakota General Permit for Storm Water Discharges Associated with Construction Activity (SDR100000), develop and implement a SWPPP, and use BMPs to reduce impacts during construction. As required by SDR100000 and the SWPPP, any vehicle fueling within the Project Area will employ appropriate BMPs and will occur at an appropriate distance from waterways determined by site-specific conditions, such as ground cover, slope, and soil type.

Q. ARE AQUATIC ECOSYSTEMS PRESENT IN THE WIND FACILITY SITE AND, IF SO, WHAT MEASURES WILL CRW EMPLOY TO AVOID, MINIMIZE, AND/OR MITIGATE POTENTIAL IMPACTS?

A. As discussed above, wetlands and waterbodies are present within the Project Area, but impacts have been avoided and minimized to the extent practicable. The primary potential for impact to any aquatic ecosystem would be as a result of increased sediment or total suspended solids in aquatic resources due to construction-related soil erosion. Where activities must occur in or near wetland areas, standard construction BMPs will be implemented to minimize impacts. Impacts resulting from the construction of access roads would be minor and authorized under the United States Army Corps of Engineers Nationwide Permit 12 for utility lines and associated facilities in waters of the U.S. Permanent impacts resulting from disturbed surfaces would be restored to nearly as possible to their preconstruction conditions during Project decommissioning. Based on current species information, no federally- or state-listed aquatic species would be impacted by the Project.

Q. WHAT VEGETATION IS PRESENT WITHIN THE WIND FACILITY AREA, AND HOW WILL IMPACTS BE AVOIDED, MINIMIZED, OR MITIGATED?

A. As presented in Section 11.1 of the Application, the predominant land cover type in the Project Construction Easement is agricultural (70.5% of total area) followed by grass/pasture (26.1% of total area). Wooded areas are limited (0.3% of total area) within the Project Construction Easement. Fifteen species of noxious weeds regulated within Codington and/or Grant Counties have the potential to occur.

The project components have been sited to avoid treed and native prairie areas to the extent practicable. In areas where impacts cannot be avoided, temporary impacts would be minimized through construction BMPs as described in the Project SWPPP. Where temporary impacts occur, the land will be returned to pre-construction conditions. Additionally, to avoid the spread of noxious weeds, CRW will use native vegetation (weed-free) seed mixes to revegetate disturbed areas where feasible and pending landowner preferences.

Q. ARE ANY FEDERALLY-LISTED SPECIES, FEDERALLY-DESIGNATED CRITICAL HABITAT, OR STATE-LISTED SPECIES PRESENT WITHIN THE WIND FACILITY SITE?

A. No federally-listed species or federally-designated critical habitats are known to occur or have been detecting occurring in the Project Area. For more information see Section 11.3 of the Application.

Q. IS THE WIND FACILITY ANTICIPATED TO IMPACT FEDERALLY-LISTED SPECIES, FEDERALLY-DESIGNATED CRITICAL HABITAT, OR STATE-LISTED SPECIES?

A. No impacts to federally-listed species or federally-designated critical habitats are anticipated.

Q. DISCUSS THE ANALYSIS CONDUCTED OF EAGLE USE OF THE WIND FACILITY AREA.

A. Several avian use and raptor nest surveys have been completed for nearby study areas, for earlier iterations of the Project Area, and for the current Project Area. In the spring and fall of 2008, avian surveys were conducted for an earlier iteration of the Project in Grant, Codington, Deuel, and Brookings Counties. In 2015, studies in a nearby study area were conducted, in which a total

of 453 hours of survey were conducted over all four seasons. Most recently, large bird use surveys were completed for the current Project Area from April through November 2017, in which a total of 232 surveys across 29 points were completed. Additionally, eagle nest aerial surveys were conducted within the Project Area and a 10-mile buffer in 2017 and 2018.

Surveys indicate the presence of eagles in the vicinity of the Project Area, but none have been observed in the current Project Area. In 2008, three golden eagles and no bald eagles were observed in the study area. In 2015, four bald eagles and no golden eagles were observed. In 2017, no bald eagles or golden eagles were observed within the current Project Area. Aerial surveys documented three bald eagle nests within 10 miles of the Project Area, but no nests were observed in the current Project Area. The nearest bald eagle nest is approximately 0.83 miles south of the Project Area boundary.

Q. IS THE WIND FACILITY ANTICIPATED TO IMPACT BALD AND GOLDEN EAGLES?

A. No impacts to golden eagles or to bald eagles are anticipated from the Project. No turbines have been sited within 1.5 miles of a known occupied golden eagle or bald eagle nest.

Q. WHAT MEASURES WILL CRW IMPLEMENT TO AVOID, MINIMIZE, OR MITIGATE IMPACTS TO WILDLIFE SPECIES?

A. The following avoidance, minimization, and mitigation measures have been developed by CRW to avoid, minimize, or offset potential adverse impacts to wildlife from the Project.

- Avoid siting turbines in wetlands or other waterbodies.
- Avoid placing structures, or conducting any activity, on USFWS grassland or USFWS wetland/grassland combination easements.
- Site turbines more than 1.5 miles from known occupied bald eagle nests.

- Site turbines with consideration of SDGFP-documented leks.
- Minimize tree clearing.
- Re-vegetate disturbed areas to as close to pre-construction conditions as possible in coordination with the landowner and per applicable permit conditions and requirements.
- Conduct pre-construction bird nest clearance surveys or observe seasonal clearing restrictions to minimize impacts to breeding birds, including raptors, and summering bats.
- Avoid activity in potentially suitable habitat for the Dakota skipper and Poweshiek skipperling where possible.
- Minimize impacts to Dakota skippers and Poweshiek skipperlings by avoiding construction during the adult flight period (approximately June 15-July 15) to avoid mortality of breeding adults.
- Implement standard erosion control measures, including temporary sediment barriers, slope breakers, and mulching to avoid sedimentation and runoff to avoid impacts to wetlands and streams.
- During revegetation efforts in potentially suitable Dakota skipper and Poweshiek skipperling habitat, use seed mixes that incorporate vegetation that supports these prairie butterfly species.
- Complete one year of post-construction mortality monitoring and adhere to the Wildlife Response and Reporting System (WRRS) Manual for the life of the project. The WRRS standardizes and prescribes actions taken in response to any wildlife fatalities and/or injuries found within the Project Area boundaries.

Q. IS THE WIND FACILITY ANTICIPATED TO IMPACT EXISTING WATER OR AIR QUALITY?

A. Limited temporary impacts to water and air quality from construction activities may occur, but they will be minimized through the use of BMPs and implementation of a SWPPP. See Sections 15.2 and 16.2 of the Application for more details.

Q. WITH RESPECT TO CULTURAL RESOURCES, WHAT STEPS HAS CRW TAKEN TO IDENTIFY CULTURAL RESOURCES WITHIN THE WIND FACILITY SITE?

A. In accordance with the *Guidelines for Cultural Resource Surveys and Survey Reports in South Dakota* (For Review and Compliance) (South Dakota State Historical Society 2005), cultural

resources reviews were conducted for an area that includes a 1-mile buffer of the Project Construction Easement. The records search was conducted on May 15, 2018 through the Archaeological Research Center at the South Dakota State Historical Society for the Project Area. Additional background research conducted for the Project Area included review of the historical General Land Office plat maps available online from the Bureau of Land Management and a historic architectural survey reviewed buildings and structures within a 1-mile radius of the turbine locations. This search determined that 133 previously documented archaeological sites, 6 previously documented historic bridges, 83 previously documented standing historic structures, and 5 previously documented cemeteries have been recorded inside and within 1 mile outside of the Project Area.

A Level III cultural resources survey of the Project Construction Easement was performed from June to December 2017 and April to November 2018. Study areas included at least a 300 ft. radius around each proposed turbine location center point; this area was expanded to a radius of up to 500 ft. around some turbines to allow for an expanded construction area; 200 ft. width along access routes to turbines; and 100 ft. width along collection lines from turbines. The Level III Survey identified 960 Native American sites and isolated artifacts including four previously recorded sites or site components during Project Construction Easement surveys and identified 34 historic European-American archaeological sites or isolated artifact occurrences, including seven previously recorded historic archaeological sites or site components. The historic architectural survey further field-checked approximately 982 standing building and structure locations within 1 mile but outside of the Project Area (the project is set back from standing buildings and structures by design). The historic architectural survey focused on those sites where historic setting and feeling may be important and considered the potential visibility of Project turbines.

Q. PLEASE DISCUSS FURTHER CRW'S CONSULTATION REGARDING POTENTIAL

TRIBAL RESOURCES WITHIN THE WIND FACILITY AREA.

A. Tribal members from the Sisseton Wahpeton Oyate, Yankton Sioux, and Spirit Lake Nation selected to represent those tribes in identifying significant tribal resources were an integral part of the survey field team. Tribal members were responsible for identifying site of religious and cultural significance to the tribes, or traditional cultural properties (TCPs). The Level III Survey identified 960 Native American sites and isolated artifacts including four previously recorded sites or site components during Project Construction Easement surveys. All of the TCPs identified in this investigation are considered and recommended eligible for National Register of Historic Places (NRHP) listing. The Sisseton Wahpeton Oyate, Yankton Sioux, Rosebud Sioux and Spirit Lake Tribal Historic Preservation Officers and the Project developer have worked together to create a set of avoidance, minimization, and mitigation measures to address these impacts.

Q. WHAT STEPS WILL CRW TO AVOID, MINIMIZE, AND/OR MITIGATE IMPACTS TO CULTURAL AND TRIBAL RESOURCES?

A. The Project has been designed to avoid direct impacts to cultural resources. During Project activities, those sites that are evaluated as eligible for NRHP listing by the participating tribes or by SHPO, or of undetermined NRHP eligibility, will be protected by establishing avoidance measures at those portions of the resources that make them eligible for NRHP listing to exclude them from physical impacts from the Project. Indirect secondary effects from the introduction of new visual elements into the setting of NRHP-eligible tribal resources and historic buildings and structures could impact the integrity of these sites. However, regarding potentially affected historic and archaeological sites, state preservation law SDCL 1-19A-11.1 applies to those that are currently listed on the NRHP or South Dakota register of historic places, not simply those that are eligible for listing. Additionally, Project developers worked together with the consulting tribes

and archaeologists to create the avoidance, minimization, and mitigation measures identified for TCPs below:

- Standard avoidance or resource protection practices (e.g., barrier fencing, contractor training) where feasible in collaboration with the tribes listed here and the Project Developer.
- Identify possible willing and participating landowners (the landowners) who may be willing to work with the tribes on site preservation, accessibility, and protection of TCPs on their property.
- Conduct site revisits prior to construction.
- Facilitate post-construction site revisits for tribes with the landowners.
- Education/interpretation opportunities regarding tribal resource preservation and/or Native American perspectives, which may include sensitivity training when needed.

AGENCY COORDINATION

Q. PROVIDE AN OVERVIEW OF THE FEDERAL AND STATE AGENCY COORDINATION CONDUCTED BY CRW.

A. Throughout the Project planning process and development, CRW has coordinated with various Federal, State, Tribal, and local agencies to identify potential concerns regarding the Project. A summary of CRW's agency consultation efforts are provided in Section 24.2 of the Application and copies of agency correspondence and meeting summaries are included in Appendix B of the Application.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.

STATE OF TEXAS)
) ss
COUNTY OF HARRIS)

I, Kimberly Wells, being duly sworn on oath, depose and state that I am the witness identified in the foregoing prepared testimony and I am familiar with its contents, and that the facts set forth are true to the best of my knowledge, information and belief.

Kimberly Wells, Ph.D.

Subscribed and sworn to before me this 28th day of January 2019.

SEAL

MELISSA GRIFFIN
Notary Public, State of Texas
Comm. Expires 06-20-2021
Notary ID 131179641

Notary Public

My Commission Expires 6/20/21

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF SOUTH DAKOTA

IN THE MATTER OF THE APPLICATION OF CROWNED RIDGE, LLC FOR A FACILITIES PERMIT TO CONSTRUCT A 300 MEGAWATT WIND FACILITY

Docket No. EL19-

DIRECT TESTIMONY

OF MARK THOMPSON

January 29, 2019

INTRODUCTION AND QUALIFICATIONS

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. Mark Thompson, 700 Universe Blvd., Juno Beach FL 33408.

Q. WHAT IS YOUR JOB AND WHAT ARE YOUR JOB RESPONSIBILITIES?

A. I am the Manager of Wind Engineering within the Engineering & Construction ("E&C") organization at NextEra Energy Resources, LLC ("NEER"). As the Manager of Wind Engineering, one of my primary roles is to coordinate or provide support for the development of new wind sites that include underground collector systems, substations, and transmission lines. I also provide support in permit acquisition, system engineering, specification and standards development, material and services procurement, construction management, commissioning, system integration, compliance, and project close-out in heavily regulated, environmentally-sensitive, and multi-system operational environments.

Q. **WHAT IS THE ORGANIZATIONAL RELATIONSHIP BETWEEN NEER AND CROWDED RIDGE WIND, LLC?**

A. Crowned Ridge Wind, LLC ("CRW") is an indirect, wholly-owned subsidiary of NEER.

Q. **PLEASE DESCRIBE YOUR BACKGROUND AND QUALIFICATIONS**

A. I have over 17 years of experience in design, engineering, permitting, project management, and construction at both Florida Power & Light Company and NEER, including wind plants and their associated facilities. I hold a Bachelor of Science Degree in Electrical Engineering from the University of Technology, Jamaica in 1996 and a

Master's in Business Administration Degree from Nova Southeastern University in Florida in 1999.

Q. HAS THIS TESTIMONY BEEN PREPARED BY YOU OR UNDER YOUR DIRECT SUPERVISION?

A. Yes.

Q. **HAVE YOU PREVIOUSLY TESTIFIED BEFORE THE SOUTH DAKOTA PUBLIC UTILITIES COMMISSION?**

A. Yes, I submitted testimony in Docket EL18-019 related to Crowned Ridge Wind II's request for a facility permit for a transmission line.

PURPOSE OF TESTIMONY

Q. PLEASE DESCRIBE THE PURPOSE OF YOUR TESTIMONY.

A. The purpose of my testimony is address the design, construction, operation and maintenance ("O&M"), and decommissioning of the proposed Crowned Ridge Wind ("CRW") Facility ("Wind Facility" or "Project").

DESIGN AND CONSTRUCTION

Q. PLEASE DESCRIBE THE TECHNICAL DESIGN SPECIFICATIONS OF THE WIND TURBINES.

A. The Crowned Ridge Wind Farm would consist of 130 three bladed, horizontal-axis wind turbines. The Project will primarily utilize GE 2.3MW turbines with 116-meter (381-feet)

rotor diameter and 90-meter (295-feet) hub height. GE 2.3MW turbines with 116-meter (381-feet) rotor diameter and an 80- meter (262-feet) hub height will also be utilized in select locations.

The tubular towers proposed for the Project are conical steel structures and consist of 3 tubular steel sections with bolted connections. A steel door at the base of the tower provides secure access. An internal ladder with fall protection, which is connected to the steel wall of the tower, provides access to the top of the tower. The turbines will be grounded in accordance with National Electrical Safety Code ("NESC") standards and comply with all Federal Aviation Administration ("FAA") requirements. The towers will be painted off-white to minimize visual impact.

The main mechanical and electrical components of the wind turbine are housed in the nacelle. The nacelle is mounted on a sliding ring that allows it to rotate, or "yaw," into the wind. The nacelle components include the drive train, gearbox, and generator. The nacelle is housed in a steel-reinforced fiberglass shell that protects internal machinery from the environment. The housing is designed to allow for adequate ventilation to cool internal machinery. The nacelle is externally equipped with an anemometer and a wind vane to measure wind speed and direction. The generated electricity is conducted through cables within the tower to the down tower assembly mounted at the base of the turbine tower. A rotor assembly is mounted on the drive shaft and operates upwind of the tower. Also, electric motors within the rotor hub vary the pitch of each blade according to wind conditions to maximize turbine efficiency at varying wind speeds.

Q. PLEASE DESCRIBE HOW THE TURBINES WILL BE CONSTRUCTED.

A. The wind turbines will be constructed at a location that meets both permit and geological subsurface requirements. These locations are documented on a site plan with permitted access roads and crane path that would provide access during construction. At the foundation location, topsoil would be stripped and stockpiled for reclamation. The foundation is designed based on the physical attributes of the turbine tower (height and weight) and the geological characteristics of the soil below the ground. Equipment is used to excavate an 8 feet deep by 50 feet wide depression to facilitate the rebar cage, anchor bolts, and concrete for the foundation. The concrete is transported from either an on-site or off-site batch plant and poured over the nested rebar within the form. After the concreate has been cured, the native soil is used to back fill/cover up the majority of the foundation, leaving a one foot reveal known as pedestal, which will accommodate the turbine tower. The base section of the tower is affixed to the pedestal with anchor bolts. The mid and top sections are then sequentially connected with bolted flanges. The remaining excavated soil will be used to construct a pad to facilitate set up for the crane needed to raise tower sections, rotor, blades, and nacelle.

Q. PLEASE EXPLAIN WHAT REMEDIAL ACTIVITIES WILL OCCUR AFTER CONSTRUCTION.

A. After construction is concluded, crane paths and construction access roads are reclaimed to a width of approximately 16 feet to accommodate O&M activities. A post construction erosion plan is implemented to prevent site degradation due to water runoff. All wind turbine service roads constructed or widened for temporary construction efforts

will be removed, sub-based, e-compacted, and replaced with previously stockpiled native topsoil such that the land is restored to pre-construction conditions.

Q. PLEASE DESCRIBE THE DESIGN OF THE COLLECTOR SUBSTATION.

A. The collector substation is a fully fenced facility located approximately in the geographic center of the wind farm. The seven feet high fence is topped with one foot of barbed wire for a total of eight feet. The fence has an 18-20 feet wide access gate for equipment and vehicular access and man gate for personal access during operations. Located within the fenced area are equipment such as 34.5 kilovolt ("kV") medium voltage breakers, switches, support structures with insulators, and bus work used to connect the collector system to the generator step up unit ("GSU"). At the 230kV high voltage side of the substation are switches, breakers, metering unit, support structures with insulators, and bus work used to connect the substation to the transmission pull-off structures. The design of the station takes into account the clearance requirement as recommended by various governing bodies such as Institute of Electrical and Electronics Engineers and NESC. A control house is located within the fenced area and it contains all the controlling devices such as relay panels, Supervisory Control and Data Acquisition ("SCADA") Panels, communication panel, battery, and Programmable Logic Controls needed for the safe and reliable operation of the site.

Q. PLEASE DESCRIBE HOW THE COLLECTOR LINES WILL BE CONSTRUCTED FROM THE TURBINES TO THE COLLECTOR SUBSTATION.

A. Each wind turbine will be connected to the Project's collector substation by underground power cables called collection lines and fiber optic communication cables. A pad-mounted transformer at each turbine location converts the power from 690 volt to 34.5 kV. The permitted paths for the collection lines are included in the construction design drawings. The collection line contractor uses specialized equipment, known as trenchers, to open trenches approximately 12 inches wide and at least 36 inches deep, while simultaneously laying the power and fiber cables at the bottom of the trench. The trench is then backfilled. Junction boxes are installed above-ground where splicing of collection lines is required. In areas where trenching is not permitted, collection lines are installed using horizontal directional bores.

Q. PLEASE DESCRIBE HOW THE METEOROLOGICAL TOWERS ("MET") TOWERS WILL BE CONSTRUCTED.

A. The permanent MET are installed in a predetermined location that gives the best indication of the site's wind resource. The tower is selected based on the hub-height of the turbines to be installed. The foundation for the MET tower will be designed to meet the tower characteristics (height and weight) and the characteristics of the sub surface soil. In order to install the MET tower, the contractor would complete the following tasks:

- Clear and grub MET tower site;

- Auger hole for foundation;
- Install bolt cage for tower foundation;
- Pour concrete for foundation;
- Assemble tower, including MET stations arms;
- Install tower with required crane; and
- Install instrumentation (anemometer, wind vane, barometer).

Q. EXPLAIN THE SAFETY MEASURES THAT WILL BE EMPLOYED DURING CONSTRUCTION.

A. During construction a full time site safety officer will be present. The safety officer will be responsible for coordinating the safety programs for the entire Project. This includes meeting with the various contractors prior to mobilizing on site to assure their requirements satisfy the minimum requirements established for the site. Weekly "All-Hands" meetings are held to discuss safety. Safety meetings are also held at the start of the Project and continue daily through the duration of the Project life. Frequent safety audits are also conducted by the site supervisor.

O&M

Q. PLEASE DESCRIBE WHAT IS INVOLVED IN THE O&M OF THE WIND FACILITY.

A. The Project is monitored 24/7 by a SCADA system. This system technology enables the monitoring and controlling of the entire Project, including the wind turbines. The

SCADA system collects data and allows real time adjustments to be made to the turbines to ensure optimum performance. The wind technicians are located on site at the O&M building and constantly monitor via inspections the performance of the turbines to ensure that they are operating in a safe, reliable, and efficient manner. The Renewable Operations Control Center, a full-time remote monitoring and control facility located in Juno Beach, Florida, further ensures safe and reliable operations by providing remote real-time monitoring of the Project 24 hours a day, 7 days a week.

Q. HOW MANY PERSONNEL WILL BE EMPLOYED TO CONDUCT O&M?

A. The Project site will employ ten (10) wind technicians, one (1) wind technician lead, and one (1) site manager, who have the following duties:

- Wind Technician – Conduct scheduled/unscheduled maintenances on Wind Turbines.
- Wind Technician Leader – Conducts work on the business side of the wind farm operation; also does some scheduled/unscheduled work on Wind Turbines.
- Wind Site Manager – Oversees all operations of the Wind Farm and manages all employees on site.

Q. PLEASE DESCRIBE THE DESIGN AND PURPOSE OF THE O&M FACILITY.

A. The O&M building is an approximately 5000 square-feet single story pre-fabricated building assembled on a concrete slab foundation. It is located directly adjacent to the collector substation. The O&M facility will include a main building with offices, spare parts storage, restrooms, a septic system, a shop area, outdoor parking facilities, a turn-around area for larger vehicles, outdoor lighting, and gated access with partial or full-perimeter fencing. The building houses operating personnel, operations, and communication equipment. The purpose of the O&M building is to provide accommodations for O&M personnel whose responsibility is to ensure that the facility will be maintained safely and operated in compliance with applicable North American Electric Reliability Corporation Reliability Standards.

DECOMMISSIONING

Q. WHAT IS THE ESTIMATED LIFE OF THE WIND FACILITY?

A. The Wind Facility contains an initial Power Purchase Agreement contract term of 25 years, which is also the estimated life of the facility. The estimated life of the Project can be increased through repowering.

Q. WILL THE WIND FACILITY BE DECOMMISSIONED AT THE END OF ITS USEFUL LIFE?

A. Yes.

Q. WHO WILL BE RESPONSIBLE FOR THE DECOMMISSIONING COSTS?

A. CRW will be responsible for all decommissioning costs.

Q. PROVIDE AN OVERVIEW OF THE DECOMMISSIONING PLAN.

A. The decommissioning of the Crowned Ridge project will involve;

- Removal of 130 wind turbine generators and all existing above ground facilities;
- Removal of roads and staging areas that are not desired by land owners to remain in place;
- Restore property or properties to pre-construction conditions;
- Restore property or properties with site specific characteristics such as topography, vegetation, drainage and other unique environment features; and
- Repair county roads impacted by movement of oversized loads or heavy haul vehicles and frequent vehicle trips.

Q. PROVIDE AN OVERVIEW OF THE DECOMMISSIONING PLAN IN THE CONTEXT OF THE CODINGTON AND GRANT COUNTY REQUIREMENTS.

A. CRW will comply with the local requirements concerning the decommissioning of the Project. Per Codington and Grant County requirements, CRW will adhere to the following:

- CRW is responsible for decommissioning the Project, and for all costs associated with decommissioning the Project and associated facilities;
- Five (5) years from the date of issuance of a conditional use permit, the Codington County Board may require a performance bond, surety bond, letter of credit, corporate guarantee, or other form of financial assurance that is acceptable to the Board to cover the anticipated costs of decommissioning the CRW Wind Facility;
- The Grant County Board may also require a performance bond, surety bond, escrow account, letter of credit, corporate guarantee, or other form of financial assurance that

is acceptable to the Board to cover the anticipated costs of decommissioning the CRW Wind Facility (Grant County);

- At least thirty (30) days prior to construction, CRW is required to file a decommissioning plan for Board approval in accordance with the County requirements (Grant County); and
- Within 120 days of completion of construction, the CRW shall submit to the County a decommissioning plan describing the manner in which the permittees anticipate decommissioning the project (Codington County).

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.

STATE OF FLORIDA)

) ss

COUNTY OF PALM BEACH)

I, Mark Thompson, being duly sworn on oath, depose and state that I am the witness identified in the foregoing prepared testimony and I am familiar with its contents, and that the facts set forth are true to the best of my knowledge, information and belief.

Mark Thompson

Subscribed and sworn to before me this 29 day of January 2019.

SEAL

Notary Public

My Commission Expires _____

NANCY E. LLAMA
MY COMMISSION # FF 900481
EXPIRES: November 14, 2019
Bonded Thru Notary Public Underwriters

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF SOUTH DAKOTA

IN THE MATTER OF THE APPLICATION OF CROWNED RIDGE WIND, LLC FOR A FACILITIES PERMIT TO CONSTRUCT A 300 MEGAWATT WIND FACILITY

Docket No. EL19-

DIRECT TESTIMONY AND EXHIBITS

OF TYLER WILHELM AND SAM MASSEY

January 29, 2019

INTRODUCTION AND QUALIFICATIONS

Q. PLEASE STATE YOUR NAMES AND BUSINESS ADDRESS.

A. Tyler Wilhelm and Sam Massey. Our business address is 700 Universe Blvd., Juno Beach, Florida, 33408.

Q. WHAT IS YOUR JOB AND WHAT ARE YOUR JOB RESPONSIBILITIES?

A. We are both employed by NextEra Energy Resources, LLC ("NEER"). Mr. Wilhelm is a Project Manager of Renewable Development at NEER. Mr. Massey is Director of Renewable Development at NEER. Together, we are responsible for the development, permitting, community outreach, regulatory compliance, and meeting the commercial operations date ("COD") for the 300 megawatt ("MW") Crowned Ridge wind generation project ("Project"). The Project's COD is planned for first quarter of 2020.

Q. WHAT IS THE ORGANIZATIONAL RELATIONSHIP BETWEEN NEER AND CROWDED RIDGE WIND, LLC?

A. Crowned Ridge Wind, LLC ("CRW") is an indirect, wholly-owned subsidiary of NEER. NEER, through its affiliated entities, is the world's largest generator of renewable energy from the wind and sun, generating over 19,000 MWs in 29 states and Canada. NEER affiliates in the State of South Dakota own the following wind facilities: Day County Wind, South Dakota Wind Energy Center, and Wessington Springs Wind.

Q. PLEASE DESCRIBE YOUR PROFESSIONAL BACKGROUNDS.

A. Mr. Wilhelm has been employed by NEER since 2015, in the capacity of Land Services Representative, Associate Project Manager, and Project Manager on NEER's Midcontinent Renewable Development team. As a Project Manager, Mr. Wilhelm manages NEER's development efforts within the state of South Dakota. Since 2015, Mr. Wilhelm has actively developed multiple renewable energy projects within 4 mid-western states contributing to the procurement of over 200 MWs of renewable generation. His involvement in the development process has included efforts such as landowner and community outreach, lease negotiations, local and state permitting, and project origination. Prior to joining NEER, Mr. Wilhelm attended the University of South Dakota where he received his B.A in Business.

Mr. Massey has been employed by NEER since 2014, in the capacity of Project Director and Director of Renewable Development on NEER's Midcontinent and Coastal Renewable Development team. As a Director of Renewable Development, Mr. Massey directs the development of renewable energy projects across multiple states in the Midwest and mountain west regions. Since 2014, Mr. Massey has developed over 600 MWs of generation projects. Prior to joining NEER, Mr. Massey spent 10 years in the U.S. Navy as a commissioned officer, serving on multiple submarine patrols and a combat tour to Afghanistan, where he was subsequently awarded the Bronze Star for meritorious service.

Q. HAS THIS TESTIMONY BEEN PREPARED BY YOU OR UNDER YOUR DIRECT SUPERVISION?

A. Yes.

Q. HAVE EITHER OF YOU PREVIOUSLY TESTIFIED BEFORE THE PUBLIC SERVICE COMMISSION OF SOUTH DAKOTA?

A. No.

PURPOSE OF TESTIMONY

Q. PLEASE DESCRIBE THE PURPOSE OF THE TESTIMONY.

A. The purpose of our testimony is to provide an overview: (1) of the Project; (2) development activities; (3) the benefits associated with the Project.

OVERVIEW OF THE WIND FACILITY

Q. PLEASE DESCRIBE THE PROPOSED WIND FACILITY.

A. The Project is situated within an approximately 53,200-acre Project Area spanning across parts of Codington County and Grant County, South Dakota. The Project will total approximately 300 MWs of installed capacity and will consist of 130 three bladed, upwind, horizontal-axis wind turbines, a collector substation, and an operations and maintenance ("O&M") facility located approximately 14-miles north-east of Watertown, South Dakota.

The Project will utilize 117 GE 2.3 MW turbines with 116-meter (381-feet) rotor diameter and 90-meter (295-feet) hub height, and 13 GE 2.3MW turbines with 116-meter (381-feet) rotor diameter and an 80- meter (262-feet) hub height. Twenty alternate turbine locations have been identified and will use GE 2.3MW with 116-meter (381-feet) rotor diameter and 90-meter (295-feet) hub height. In the end, a maximum of 130 turbines in total will be constructed. Alternate turbines are included to provide flexibility through the permitting and construction process in the event an unforeseen condition arises during construction that indicates a primary turbine location should be dropped and an alternate turbine location activated.

The Project will utilize the proposed Crowned Ridge 34-mile 230 kV generation tie line and a new reactive power compensation substation to transport the generation from the Project's collector substation to the Project's point of interconnection located at the Big Stone South 230 kV Substation owned by Otter Tail Power Company. The Crowned Ridge 34-mile 230kV generation tie line and new reactive power compensation substation were approved in Docket EL17-050 on November 21, 2018. The location of the turbines for CRW is illustrated in the map attached as Exhibit TW SM-1.

CRW requests that the permit allow turbines to be shifted within 500 feet of their currently proposed locations, with the understanding that any such shifts would still need to comply with setback and noise and shadow flicker thresholds and adhere to all applicable local, State, and Federal requirements. Although such shifts are not expected to be needed, such flexibility would allow for CRW to accommodate proposed shifts from local stakeholders and governing bodies where possible.

Q. EXPLAIN WHY THE WIND FACILITY IS NEEDED.

A. On July 6, 2017, the Minnesota Public Service Commission approved Northern States Power's ("NSP") Petition for Approval of the Acquisition of Wind Generation from the Company's 2016-2030 Integrated Resource Plan, which included NSP's power purchase agreement ("PPA") with CRW. Similarly, the North Dakota Public Service Commission issued an order approving an advance determination of prudence for the PPA between NSP and CRW on December 6, 2018.

Q. WHO WILL BE RESPONSIBLE FOR OBTAINING ALL APPLICABLE FEDERAL, STATE, AND LOCAL PERMITS?

A. CRW will be responsible for obtaining all applicable federal, state, and local permits.

Q. WHO WILL CONSTRUCT THE PROJECT?

A. CRW will construct the Project.

Q. WHO WILL CONDUCT O&M ON THE WIND FACILITY?

A. CRW will be responsible for the O&M for the facility.

Q. HAVE ALL NECESSARY PROPERTY RIGHTS BEEN SECURED FOR THE WIND FACILITY?

A. At this time 99% of the necessary property rights have been obtained by CRW for the construction and O&M of the Project. CRW anticipates all necessary property rights to be obtained by March 1, 2019.

DEVELOPMENT ACTIVITIES

Q. PROVIDE AN OVERVIEW OF THE DEVELOPMENT ACTIVITIES.

A. Development activities for the Project commenced in 2008. Over the past 10 years the CRW has been actively engaging stakeholders by working closely with landowners, tribal and local governments, and federal and state agencies to design the Project. Stakeholders have been approached directly to address concerns with the proposed siting and placement of the Project's infrastructure.

CRW conducted informational events on April 25, 2017 in the town of Gary located in Deuel County, on October 2, 2017 and on November 16, 2017 in the city of Watertown located in Codington County. At these events stakeholders were provided information pertaining to the status of the Project's development, current development activities in process within the Project Area, potential impacts to the Project's layout, and a permitting timeline.

CRW conducted meetings with Grant County officials (the Grant County Commissioners, the Grant County Planning and Zoning Officer, and the Grant County Auditor) on November 8, 2016 and December 20, 2016 as well as on January 17, April 4, June 6 and June 20 in 2017. As a result of these meetings, CRW was able to better understand proposed changes to the Grant County zoning ordinance and how CRW could proactively develop the Project to ensure compliance.

CRW met with the Codington County Planner and First District Association of Local Governments on February 9, April 5, May 23, and August 31 of 2017 to discuss the requirements of the Codington County siting ordinances and the county's expectations through the development and construction of the Project.

Although there is no federal nexus that mandates Tribal consultations, the CRW has voluntarily consulted with the Sisseton Wahpeton Oyate ("SWO") tribe. As a result of these consultations, the SWO tribe and CRW have successfully worked together on the following issues: (1) siting Project infrastructure to avoid direct impacts to lands containing cultural sensitivities; (2) minimizing construction impacts by reducing the size or revising the location of construction easements; and (3) managing access to locations where Project infrastructure is proposed to avoid impacts during the surveying process.

Project team members have also engaged the local telecommunication company to exchange general information on the Project, such as location of Project Area and proposed Project infrastructure, and obtain documentation from the local telecommunication company on the location of existing utilities within or adjacent to the proposed Project area. The information allow for CRW to continue working with all necessary telecommunication companies to assess areas where interference could potentially occur, make necessary adjustments to minimize the chances of interference, design for underground crossing of existing utilities, as well as implement a mitigation plan to address how interferences would be cured through the operations and

maintenance phase of the Project. This collaboration will continue until Project's layout is finalized.

Additionally, CRW will continue its coordination with the Federal Aviation Administration ("FAA") to: (1) obtain the Determinations of No Hazard ("DNH") and (2) apply for the permitted use of an Aircraft Detection Lighting System ("ADLS"). Per both Codington and Grant County ordinances, towers will be marked as required by the FAA. There will be no lights on the towers other than what is required by the FAA. This restriction will not apply to infrared heating devices used to protect the monitoring equipment.

The preferred manner of lighting is by using an ADLS. Subject to FAA approval, applicants will install an ADLS within one (1) year of approval by FAA. In the event FAA does not approve the use of an ADLS system, CRW will comply with all lighting and markings otherwise required by FAA. CRW intends to apply for the use of an ADLS upon receiving DNHs from the FAA, which is expected in the second quarter of 2019. CRW will continue this collaborative process with landowners, tribal and local governments, and federal and state agencies throughout the development, construction and operation phases of the Project.

Q. PROVIDE THE STATUS OF THE LOCAL CONDITIONAL USE PERMITS.

A. CRW has obtained local Conditional Use Permits ("CUP") for the Project from both the Codington County Board of Adjustment on July 16, 2018 and the Grant County Board of

Adjustment on December 17, 2018. The Grant County Board of Adjustment also awarded a CUP approval on March 13, 2016 for a portion of the Project that is located within the f/k/a Cattle Ridge Wind Project Area previously owned by Geronimo Energy, LLC. The Cattle Ridge Wind Project was acquired from Geronimo Energy, LLC on November 22, 2017.

Although some alterations and improvements have been made to the locations of Project infrastructure since the awarded CUPs, CRW will ensure that the Project's final configuration will meet or exceed the setback distances, and noise and shadow flicker thresholds as required by both the Codington and Grant County ordinances.

Q. WHAT ARE THE LOCAL SET BACKS REQUIRED IN THE CUP AND DOES THE WIND FACILITY COMPLY WITH THE SET BACKS?

A. The Project meets or exceeds all local setback requirements as approved within the Codington and Grant County CUPs. The required setbacks are as follows for each county:

Codington County Setback Requirements:

- 550' from participating occupied residence, business, church, or school;
- 1,500' from non-participating occupied residence, business, church, or school (within all Districts other than Town Districts);
- 5,280' from non-participating occupied residence, business, church, or school (within Town Districts);

- 5,280' from Municipal Boundaries at the time of CUP Application;
- 110% of the height of the wind turbine from right-of-way of public roads;
- 110% the height of the wind turbines from any property line;
- Noise level generated by wind energy system shall not exceed 50 dBA, average A-weighted Sound pressure level effects at the property line of existing non-participating residences, businesses, and buildings owned and/or maintained by a governmental entity; and
- Flicker at any receptor shall not exceed thirty (30) hours per year within the analysis area for all schools, churches, businesses and occupied dwellings within a one (1) mile radius of each turbine within the Project.

Grant County Setback Requirements:

- 1,500' from participating residence, business, church, or school, building owner and/or operated by a governmental entity;
- 1,500' from non-participating residence, business, church, or school, building owned and/or operated by a governmental entity;
- 5,280' from municipal boundaries existing at the time of CUP Application;
- 500' or 110% of the vertical height of the wind turbine, whichever is greater, from Public right-of-way;
- 500' or 110% of the vertical height of the wind turbine, whichever is greater;
- Noise level shall not exceed 45 dBA, average A-weighted Sound pressure including constructive interference effects measured twenty-five (25) feet from the perimeter of

the existing non-participating residences, businesses, and buildings owned and/or maintained by a governmental entity;

- Noise level shall not exceed 50 dBA, average A-weighted Sound pressure including constructive interference effects measured twenty-five (25) feet from the perimeter of participating residences, businesses, and buildings owned and/or maintained by a governmental entity; and
- Flicker at any receptor shall not exceed thirty (30) hours per year within the analysis area for all schools, churches, businesses and occupied dwellings within a one (1) mile radius of each turbine within the Project.

Q. WERE TURBINE, ACCESS ROAD, AND COLLECTOR LINE LOCATIONS COORDINATED WITH LANDOWNERS?

A. Yes. Upon completion of field surveys for natural and cultural resources, the Project's preliminary site plan was created. CRW conducted several meetings with landowners to discuss the proposed placement of project infrastructure and to take into consideration feedback from landowners. CRW incorporated landowner feedback and made revisions to the site plan where feasible to help preserve the use of private lands and maintain compatibility with farming operations. For example, in some cases landowners preferred for CRW to adjust the approaches and/or the alignment of turbine access roads to utilize existing farming approaches off of county roads or to avoid noted acreage that produces higher yields. CRW also adopted changes to county setback requirements during the development process. Shifts to turbine placement were recommended, but could not

always be adopted on a landowner's property due to a new setback requirement from a participating landowner's residence or minimum setback requirements from a nearby municipal boundary.

BENEFITS OF THE WIND FACILITY

Q. ARE THERE ANY BENEFITS ASSOCIATED WITH THE WIND FACILITY FOR SOUTH DAKOTA?

A. Yes, South Dakota will benefit from the proposed Project. Specifically, the Project will produce the following benefits: (1) the delivery of 300 MWs of zero-emissions wind energy; (2) the creation of approximately 250 temporary construction jobs, which will include employing local workers if qualified and available; (3) supporting the local economy through the purchase of regional goods and services, including increasing the use of hotels and restaurants in Codington and Grant County; (4) the creation of 7–12 permanent O&M jobs; (5) increasing sales/use tax and contractor excise tax revenues; (6) the generation of property tax revenues of approximately $41 million over the contracted life of the Project; (7) land lease payments to landowners of approximately $40 million over the contracted term of the project; and (8) approximately $400 million in capital investment within the state of South Dakota.

Q. HOW MANY HOMES CAN BE SERVED BY THE CLEAN ENERGY THAT THE WIND FACILITY WILL DELIVER?

A. The Wind Facility will deliver enough energy to power more than 150,000 homes.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes, it does.

STATE OF FLORIDA)
) ss
COUNTY OF PALM BEACH)

I, Tyler Wilhelm, being duly sworn on oath, depose and state that I am the witness identified in the foregoing prepared testimony and I am familiar with its contents, and that the facts set forth are true to the best of my knowledge, information and belief.

Tyler Wilhelm

Subscribed and sworn to before me this 29 day of January 2019.

SEAL

NANCY E. LLAMA
MY COMMISSION # FF 900481
EXPIRES: November 14, 2019
Bonded Thru Notary Public Underwriters

Notary Public

My Commission Expires _____

STATE OF FLORIDA)
) ss
COUNTY OF PALM BEACH)

I, Sam Massey, being duly sworn on oath, depose and state that I am the witness identified in the foregoing prepared testimony and I am familiar with its contents, and that the facts set forth are true to the best of my knowledge, information and belief.

Sam Massey

Subscribed and sworn to before me this 29 day of January 2019.

SEAL

NANCY E. LLAMA
MY COMMISSION # FF 900481
EXPIRES: November 14, 2019
Bonded Thru Notary Public Underwriters

Notary Public

My Commission Expires _____

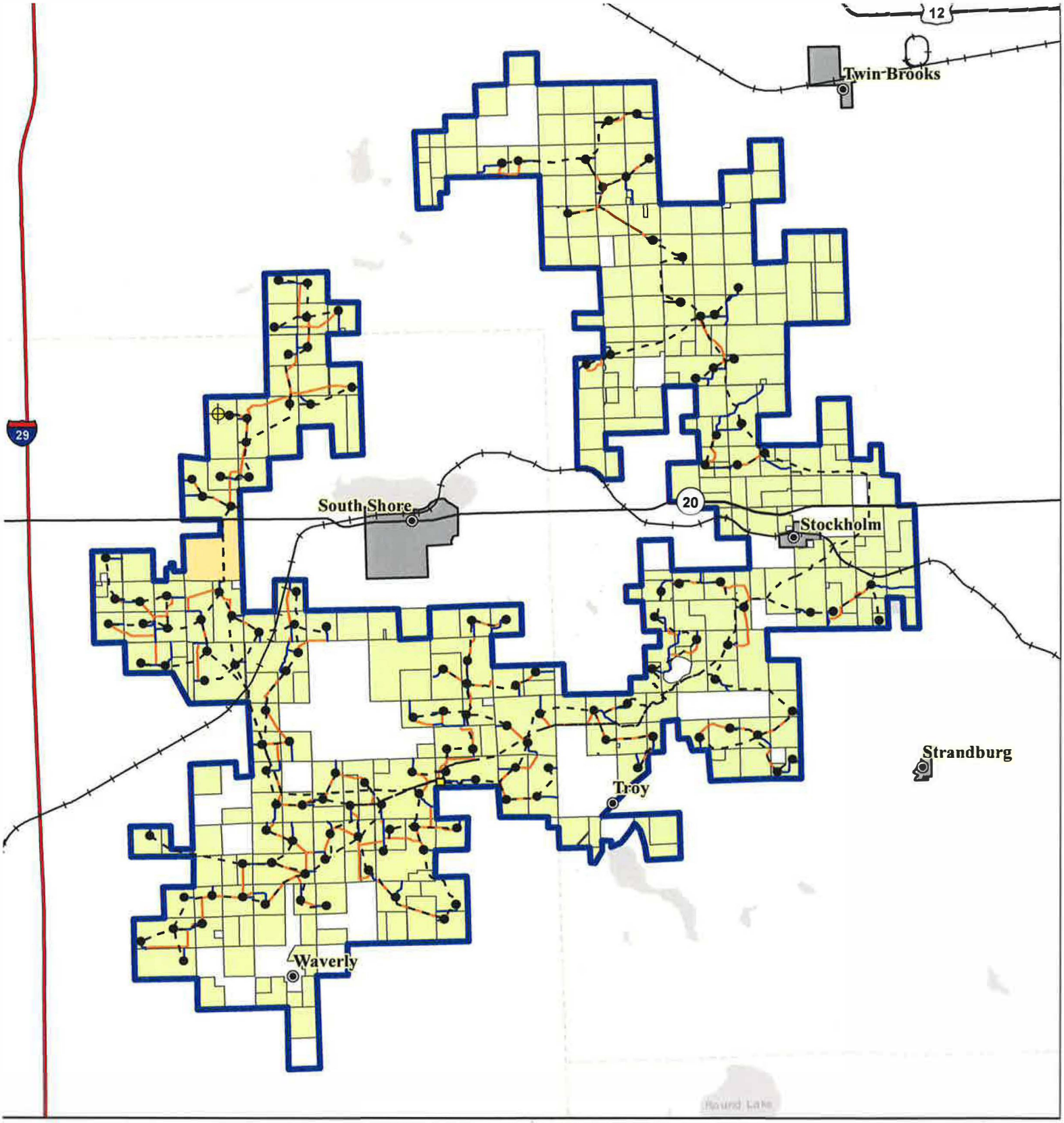


Figure 3. Project Map

Crowned Ridge Wind Farm

- MET Tower
- Turbine
- City
- Proposed Turbine Access Road
- Collector Line
- Crane Path
- Railroad
- Interstate Highway
- U.S. Highway
- State Highway
- O&M Facility/ Substation
- Town Boundary
- Project Boundary

Lease Status

- Lease, Signed
- Pending Approval

Base Map: World Light Gray Canvas Base
Sources: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Codington and Grant Counties, South Dakota

000960

Projection: NAD 1983 UTM Zone 14N

SWCA