

*Final*

---

# **TIERED ENVIRONMENTAL ASSESSMENT**

United States Marine Corps Forces Reserve  
Wind Energy Program Site:  
Marine Forces Reserve Center, Amarillo, Texas

United States Marine Corps  
Forces Reserve

And

Navy Region Southeast

August 2011



## Acronyms

APE	Area of Potential Effect	mph	miles per hour
AQCR	Air Quality Control Region	MW	megawatt
ARPA	Archaeological Resources Protection Act	MWh/yr	megawatt-hours per year
AWEA	American Wind Energy Association	N <sub>2</sub> O	nitrous oxide
BCC	Birds of Conservation Concern	NAAQS	National Ambient Air Quality Standards
BCR	Bird Conservation Region	NAVFAC	Naval Facilities Engineering Command
BGEPA	Bald and Golden Eagle Protection Act	NAVFAC ESC	Naval Facilities Engineering Service Center
BMP	best management practice	NEPA	National Environmental Policy Act
CAA	Clean Air Act	NEXRAD	Next Generation Weather Radar
CEQ	Council on Environmental Quality	NGO	non-governmental organizations
CFR	Code of Federal Regulations	NHPA	National Historic Preservation Act
CGP	Construction General Permit	NO <sub>2</sub>	nitrogen dioxide
CH <sub>4</sub>	methane	NO <sub>x</sub>	nitrogen oxides
CNIC	Commander Navy Installations Command	NOSC	Navy Operational Support Center
CO	carbon monoxide	NPDES	National Pollutant Discharge Elimination System
CO <sub>2</sub>	carbon dioxide	NPH	Notice of Presumed Hazard
CO <sub>2</sub> e	carbon dioxide equivalent	NREL	National Renewable Energy Laboratory
CREZ	Competitive Renewable Energy Zone	NRHP	National Register of Historic Places
CWA	Clean Water Act	NRSE	Navy Region Southeast
dba	A-weighted decibel	O <sub>3</sub>	ozone
DNH	Determination of No Hazard	Pb	lead
DoD	Department of Defense	PM <sub>10</sub>	particulate matter less than or equal to 10 microns in diameter
DOH	Determination of Hazard	PM <sub>2.5</sub>	particulate matter less than or equal to 2.5 microns in diameter
DoN	Department of the Navy	PSD	Prevention of Significant Deterioration
EA	Environmental Assessment	RONA	Record of Non-Applicability
EMI	Electromagnetic Interference	rpm	revolutions per minute
EO	Executive Order	SHPO	State Historic Preservation Office(r)
ESA	Endangered Species Act	SIP	State Implementation Plan
FAA	Federal Aviation Administration	SO <sub>2</sub>	sulfur dioxide
FAR	Federal Aviation Regulations	SO <sub>x</sub>	sulfur oxides
FCC	Federal Communications Commission	SWPPP	Stormwater Pollution Prevention Plan
FEMA	Federal Emergency Management Agency	TARL	Texas Archaeological Research Laboratory
FICON	Federal Interagency Committee on Noise	TCP	Traditional Cultural Properties
FM	frequency modulation	TPWD	Texas Parks and Wildlife Division
FONSI	Finding of No Significant Impact	TX	Texas
ft	foot (feet)	U.S.	United States
FY	Fiscal Year	USC	United States Code
GCM	general conservation measure	USDA	United States Department of Agriculture
GHG	greenhouse gas	USEPA	United States Environmental Protection Agency
GWP	Global Warming Potential	USFWS	United States Fish and Wildlife Service
HMM	Hardy-Heck-Moore, Inc.	USMC	United States Marine Corps
IFR	Instrument Flight Rules	VFR	Visual Flight Rules
INRMP	Integrated Natural Resources Management Plan	VOC	volatile organic compound
KOP	Key Observation Point		
kW	kilowatt		
L <sub>dn</sub>	Day-Night Average Sound Level		
MARFORRES	Marine Forces Reserve		
MBTA	Migratory Bird Treaty Act		
MCO	Marine Corps Order		

*FINAL*

**TIERED ENVIRONMENTAL ASSESSMENT**

**Lead Agency for the EA:** United States Marine Corps Forces Reserve  
**Title of Proposed Action:** United States Marine Corps Forces Reserve Wind Energy Program Site:  
Marine Forces Reserve Center, Amarillo, TX  
**Designation:** Tiered Environmental Assessment

**Abstract**

The Department of the Navy (DoN) has prepared this Environmental Assessment (EA) for the United States Marine Corps (USMC) Forces Reserve (MARFORRES) in accordance with the National Environmental Policy Act (NEPA) of 1969 (42 United States Code [USC] §§ 4321-4370h), as implemented by the Council on Environmental Quality (CEQ) (40 Code of Federal Regulations [CFR] Parts 1500-1508); DoN NEPA regulations (32 CFR Part 775); and USMC NEPA directives (Marine Corps Order [MCO] P5090.2A, change 2). This EA is tiered from the Programmatic EA for the *MARFORRES Wind Energy Program*. The program was officially established when a Finding of No Significant Impact (FONSI) was signed on 18 May 2011. The proposed action is to develop wind energy at MARFORRES Center, Amarillo, Texas (TX) under the *MARFORRES Wind Energy Program*. Implementation of the proposed action would involve the installation and operation of a single 100-kilowatt (kW) wind turbine consistent with the program criteria specified in the Programmatic EA for the *MARFORRES Wind Energy Program*. The proposed action would be on land owned by the DoN/Commander Navy Installations Command (CNIC), for which Navy Region Southeast (NRSE) is the property record holder and MARFORRES is a tenant. This Tiered EA analyzes the site-specific impacts of the proposed installation and operation of a single 100-kW wind turbine at two alternative locations. The following resource areas have been analyzed: land use, noise, geological resources, water resources, biological resources, cultural resources, visual resources, socioeconomics, air quality, utilities, airspace, health and safety, hazardous materials, and transportation. This Tiered EA finds that the proposed action would not have a significant impact on the environment.

**Prepared By:** Department of the Navy  
**Point of Contact:** Mr. Alain D. Flexer, Esq.  
Energy Manager  
Marine Forces Reserve, Facilities  
2000 Opelousas Ave  
Bldg 1, Rm 2W4700  
New Orleans, LA 70146-5400  
Email: [alain.flexer@usmc.mil](mailto:alain.flexer@usmc.mil)  
Tel: (504) 697-9571  
Fax: (504) 697-9739

**August 2011**



## EXECUTIVE SUMMARY

This Environmental Assessment (EA) has been prepared by the Department of the Navy (DoN) for the United States Marine Corps (USMC) Forces Reserve (MARFORRES) in accordance with the National Environmental Policy Act (NEPA) of 1969 (42 United States Code [USC] 4321, as amended), regulations implemented by the Council on Environmental Quality (CEQ) (Title 40 Code of Federal Regulations [CFR] Parts 1500-1508), DoN Procedures for Implementing NEPA (32 CFR Part 775), and USMC NEPA directives (Marine Corps Order [MCO] P5090.2A, change 2). This EA is tiered from the Programmatic EA for the *MARFORRES Wind Energy Program* (MARFORRES 2011). The program was officially established when a Finding of No Significant Impact (FONSI) was signed on 18 May 2011. This Tiered EA analyzes the site-specific impacts of the proposed installation and operation of a single 100-kilowatt (kW) (*note*: 100 kW = 0.1 megawatt [MW]) wind turbine at the MARFORRES Center, Amarillo, Texas (TX). The proposed action would be on land owned by the DoN/Commander Navy Installations Command (CNIC), for which Navy Region Southeast (NRSE) is the property record holder and MARFORRES is a tenant.

### **Purpose and Need for Proposed Action**

The purpose of the proposed action is to develop wind as an energy source at MARFORRES Center, Amarillo in support of the *MARFORRES Wind Energy Program*. The purpose of the *MARFORRES Wind Energy Program* is to reduce dependency on fossil fuels and increase energy security and efficiency through development of wind energy projects at MARFORRES facilities across the U.S. (MARFORRES 2011). MARFORRES Center, Amarillo has been identified as a facility with a wind resource that is readily available and economically feasible to develop as a renewable energy source.

The proposed action is needed to enable MARFORRES to achieve specific goals regarding energy production and usage. These goals have been set by Executive Orders (EOs), legislative acts, and agencies like the U.S. Environmental Protection Agency (USEPA), the Department of Defense (DoD), and the DoN. These energy goals seek to increase the efficiency of energy production, delivery and usage, reduce greenhouse gas (GHG) emissions, and expand the use of renewable energy.

### **Proposed Action**

The proposed action is to develop wind energy at MARFORRES Center, Amarillo under the *MARFORRES Wind Energy Program* and would entail the installation of a 100-kW wind turbine. The majority of the 5.3-acre property on which the Reserve Center is located is occupied by office buildings and paved parking areas. A north-south running concrete storm drain channel separates the eastern portion of the property, which contains the Reserve Center, from the western portion, which contains a motor pool.

Implementation of the proposed action would conform to the program criteria (i.e., siting and design criteria, best management practices [BMPs], and general conservation measures [GCMs]) that were adopted in the Programmatic EA. A relatively small (100-kW) wind turbine was identified as suited to (1) the energy requirements of this small MARFORRES facility; and (2) land available for a small wind energy facility.

It is estimated that the construction phase would last 1 to 3 months and would commence in fiscal year (FY) 2012. All construction activities would be conducted in accordance with BMPs provided in the Programmatic EA. The 155-ft tall wind turbine would be tied in behind the MARFORRES facility's electricity meter and, when the wind is blowing with corresponding production of electricity, the wind



turbine would augment the power supply for the combined Navy and USMC use of the facility, reducing the need for power from the grid. Two alternative siting locations are carried forward for analysis.

#### Alternative 1 (Preferred Alternative)

The proposed location under Alternative 1 would be in a small grass field south of the Reserve Center offices, near the concrete storm drain on the eastern half of the property. The installation of a turbine at this site would have minimal, if any, effects on activities and land use at the facility. The total permanent footprint (foundation, gravel access area/road, connection to transformer) would be approximately 0.10 acre and the total construction footprint (both permanent and temporary) would be 0.45 acre.

#### Alternative 2

The proposed location under Alternative 2 would be in the far southwest corner of the paved motor pool, on the western portion of the property. The total permanent footprint (foundation, gravel access area/road, connection to transformer) would be approximately 0.10 acre and the total construction footprint (both permanent and temporary) would be 0.45 acre.

#### **No-Action Alternative**

Under the no-action alternative, MARFORRES would not pursue the installation of a 100-kW wind turbine at MARFORRES Center, Amarillo, and would continue to rely on the electrical grid for purchase of all electricity needs at this facility. MARFORRES would seek to develop other types of renewable energy (e.g., solar) at this facility and/or develop wind energy at other MARFORRES facilities to achieve specific goals regarding energy production and usage. Analysis of the no-action alternative is required under CEQ regulations (40 CFR § 1502.14[d]). The no-action alternative for this Tiered EA represents the continuation of baseline conditions for each resource as described under *Existing Conditions* in Chapter 3.

#### **Environmental Consequences**

This EA evaluates the potential environmental consequences of the proposed action on the following: land use, noise, geological resources, water resources, biological resources, cultural resources, visual resources, socioeconomics, air quality, utilities, airspace, health and safety, hazardous materials, and transportation. Table ES-1 summarizes environmental consequences of the alternatives described above.

Based on the analyses presented in this EA, the proposed 100-kW wind turbine would have minor or no significant impacts. In addition, the program would reduce the MARFORRES facility's need to draw upon the mix of energy resources provided by the local utility, and would lessen the indirect impacts associated with the use of those resources. The no-action alternative would continue the status quo at the MARFORRES facility.



**Table ES-1. Summary of Environmental Consequences**

Resource Area	Alternative 1	Alternative 2	No-Action Alternative
Land Use	○	○	○
Noise	○	○	○
Geology and Soils	○	○	○
Water Resources	○	○	○
Biological Resources	●	●	○
Cultural Resources	○	○	○
Visual Resources	●	●	○
Socioeconomics	○	○	○
Air Quality	○/+	○/+	○
Utilities	○	○	○
Airspace	○	○	○
Health and Safety	○	○	○
Hazardous Materials	○	○	○
Transportation	○	○	○

Notes: ○ = Negligible or no adverse impacts; ● = Minor adverse but not significant impacts; + = Beneficial impacts;  
● = Significant impacts.



*Final*

**TIERED ENVIRONMENTAL ASSESSMENT**

**UNITED STATES MARINE CORPS FORCES RESERVE WIND ENERGY PROGRAM SITE:  
MARINE FORCES RESERVE CENTER, AMARILLO, TX**

**TABLE OF CONTENTS**

**ACRONYMS.....Inside Front Cover**

**EXECUTIVE SUMMARY.....ES-1**

**CHAPTER 1 PURPOSE AND NEED FOR PROPOSED ACTION.....1-1**

1.1 INTRODUCTION ..... 1-1

1.2 PROJECT BACKGROUND ..... 1-1

1.3 PROJECT AREA ..... 1-1

1.4 PURPOSE OF AND NEED FOR THE PROPOSED ACTION ..... 1-4

1.5 REGULATORY REQUIREMENTS..... 1-4

1.6 PERMITS AND CONSULTATIONS/CONCURRENCES ..... 1-5

1.7 AGENCY COORDINATION AND PUBLIC INVOLVEMENT ..... 1-5

1.8 DOCUMENT ORGANIZATION..... 1-5

**CHAPTER 2 PROPOSED ACTION AND ALTERNATIVES .....2-1**

2.1 INTRODUCTION ..... 2-1

2.2 SITING AND DESIGN CRITERIA ..... 2-1

2.2.1 Exclusionary Criteria..... 2-1

2.2.2 Evaluative Criteria..... 2-2

2.2.3 Design Criteria ..... 2-3

2.3 PROPOSED ACTION ..... 2-4

2.3.1 Project Location ..... 2-4

2.3.2 Project Design ..... 2-4

2.3.3 Site Preparation and Turbine Installation ..... 2-6

2.3.4 Turbine Operations and Maintenance ..... 2-9

2.4 PROPOSED ACTION ALTERNATIVES ..... 2-9

2.4.1 Alternative 1 (Preferred Alternative) ..... 2-9

2.4.2 Alternative 2..... 2-10

2.5 ALTERNATIVES TO THE PROPOSED ACTION ..... 2-10

2.5.1 Alternatives Considered but Eliminated..... 2-10

2.5.2 No-Action Alternative..... 2-11

**CHAPTER 3 ENVIRONMENTAL CONSEQUENCES.....3-1**

3.1 INTRODUCTION ..... 3-1

3.2 LAND USE..... 3-1

3.2.1 Definition of Resource ..... 3-1

3.2.2 Existing Conditions ..... 3-1

3.2.3 Environmental Consequences ..... 3-2

3.3 NOISE..... 3-3



---

3.3.1	Definition of Resource .....	3-3
3.3.2	Existing Conditions .....	3-3
3.3.3	Environmental Consequences .....	3-3
3.4	GEOLOGICAL RESOURCES .....	3-6
3.4.1	Definition of Resource .....	3-6
3.4.2	Existing Conditions .....	3-6
3.4.3	Environmental Consequences .....	3-6
3.5	WATER RESOURCES .....	3-7
3.5.1	Definition of Resource .....	3-7
3.5.2	Existing Conditions .....	3-7
3.5.3	Environmental Consequences .....	3-7
3.6	BIOLOGICAL RESOURCES .....	3-8
3.6.1	Definition of Resource .....	3-8
3.6.2	Existing Conditions .....	3-8
3.6.3	Environmental Consequences .....	3-9
3.7	CULTURAL RESOURCES .....	3-11
3.7.1	Definition of Resource .....	3-11
3.7.2	Existing Conditions .....	3-12
3.7.3	Environmental Consequences .....	3-12
3.8	VISUAL RESOURCES .....	3-13
3.8.1	Definition of Resource .....	3-13
3.8.2	Existing Conditions .....	3-13
3.8.3	Environmental Consequences .....	3-14
3.9	SOCIOECONOMICS .....	3-16
3.9.1	Definition of Resource .....	3-16
3.9.2	Existing Conditions .....	3-16
3.9.3	Environmental Consequences .....	3-16
3.10	AIR QUALITY .....	3-17
3.10.1	Definition of Resource .....	3-17
3.10.2	Existing Conditions .....	3-18
3.10.3	Environmental Consequences .....	3-18
3.11	UTILITIES .....	3-20
3.11.1	Definition of Resource .....	3-20
3.11.2	Existing Conditions .....	3-20
3.11.3	Environmental Consequences .....	3-20
3.12	AIRSPACE .....	3-21
3.12.1	Definition of Resource .....	3-21
3.12.2	Existing Conditions .....	3-21
3.12.3	Environmental Consequences .....	3-21
3.13	HEALTH AND SAFETY .....	3-22
3.13.1	Definition of Resource .....	3-22
3.13.2	Existing Conditions .....	3-22
3.13.3	Environmental Consequences .....	3-22
3.14	HAZARDOUS MATERIALS .....	3-23
3.14.1	Definition of Resource .....	3-23
3.14.2	Existing Conditions .....	3-23



3.14.3	Environmental Consequences .....	3-23
3.15	TRANSPORTATION .....	3-24
3.15.1	Definition of Resource .....	3-24
3.15.2	Existing Conditions .....	3-24
3.15.3	Environmental Consequences .....	3-24
3.16	NO-ACTION ALTERNATIVE .....	3-25
<b>CHAPTER 4 CUMULATIVE IMPACTS.....</b>		<b>4-1</b>
4.1	INTRODUCTION .....	4-1
4.2	CUMULATIVE SETTING .....	4-1
4.2.1	Regional Setting .....	4-1
4.2.2	Other Projects at MARFORRES Center, Amarillo.....	4-1
4.2.3	Other Wind Energy Projects within Texas.....	4-1
4.3	RESOURCE SPECIFIC IMPACTS .....	4-3
4.3.1	Land Use .....	4-3
4.3.2	Noise.....	4-3
4.3.3	Geological Resources .....	4-3
4.3.4	Water Resources.....	4-3
4.3.5	Biological Resources.....	4-3
4.3.6	Cultural Resources .....	4-4
4.3.7	Visual Resources.....	4-4
4.3.8	Socioeconomics.....	4-4
4.3.9	Air Quality.....	4-4
4.3.10	Utilities .....	4-5
4.3.11	Airspace.....	4-6
4.3.12	Health and Safety .....	4-6
4.3.13	Hazardous Materials.....	4-6
4.3.14	Transportation .....	4-6
<b>CHAPTER 5 OTHER CONSIDERATIONS REQUIRED BY NEPA .....</b>		<b>5-1</b>
5.1	IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF NATURAL OR FINITE RESOURCES ...	5-1
5.2	RELATIONSHIP BETWEEN LOCAL SHORT-TERM USE OF THE HUMAN ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM NATURAL RESOURCE PRODUCTIVITY ..	5-1
5.3	MEANS TO MITIGATE AND/OR MONITOR ADVERSE ENVIRONMENTAL IMPACTS.....	5-1
<b>CHAPTER 6 REFERENCES .....</b>		<b>6-1</b>
<b>CHAPTER 7 PERSONS AND AGENCIES CONTACTED.....</b>		<b>7-1</b>
<b>CHAPTER 8 PREPARERS .....</b>		<b>8-1</b>
<b>APPENDIX A: AIR QUALITY CALCULATIONS AND RECORD OF NON-APPLICABILITY (RONA).....</b>		<b>A-1</b>
<b>APPENDIX B: BIOLOGICAL RESOURCE INFORMATION.....</b>		<b>B-1</b>
<b>APPENDIX C: SHADOW FLICKER ANALYSIS .....</b>		<b>C-1</b>
<b>APPENDIX D: CORRESPONDENCE.....</b>		<b>D-1</b>



### List of Figures

<b><u>Figure</u></b>	<b><u>Page</u></b>
1-1 Location of MARFORRES Center, Amarillo, TX .....	1-2
1-2 Vicinity Map: Amarillo Wind Energy Project.....	1-3
2-1 Amarillo Wind Energy Project Location .....	2-5
2-2 100-kW Northern Power 100 wind turbine.....	2-6
2-3 Amarillo Wind Energy Project Design .....	2-7
3.3-1 Noise Levels .....	3-4
3.8-1 Visual Simulation of the Proposed Wind Turbine.....	3-15

### List of Tables

<b><u>Table</u></b>	<b><u>Page</u></b>
ES-1 Summary of Environmental Consequences .....	ES-3
1-1 Stakeholder List for Amarillo .....	1-6
3.3-1 Noise Levels under Alternative 1 at Sensitive Receptors .....	3-5
3.3-2 Noise Levels under Alternative 1 at Sensitive Receptors .....	3-5
3.10-1 Estimated Emissions Resulting from Implementation of the Proposed Action.....	3-18
3.10-2 Range of Energy Output under the Proposed Action.....	3-19
3.10-3 Estimated GHG Emissions under the Proposed Action.....	3-19
4-1 Status of Wind Energy Projects within or Neighboring Potter County .....	4-2

# **CHAPTER 1**

## **PURPOSE AND NEED FOR PROPOSED ACTION**

---

### **1.1 INTRODUCTION**

This Environmental Assessment (EA) has been prepared by the Department of the Navy (DoN) for the United States Marine Corps (USMC) Forces Reserve (MARFORRES) in accordance with the National Environmental Policy Act (NEPA) of 1969 (42 United States Code [USC] 4321, as amended), regulations implemented by the Council on Environmental Quality (CEQ) (Title 40 Code of Federal Regulations [CFR] Parts 1500-1508), DoN Procedures for Implementing NEPA (32 CFR Part 775), and USMC NEPA directives (Marine Corps Order [MCO] P5090.2A, change 2). This EA is tiered from the Programmatic EA for the *MARFORRES Wind Energy Program* (MARFORRES 2011). The program was officially established when a Finding of No Significant Impact (FONSI) was signed on 18 May 2011. This Tiered EA analyzes the site-specific impacts of the proposed installation and operation of a 100-kilowatt (kW) (note: 100 kW = 0.1 megawatt [MW]) wind turbine at MARFORRES Center, Amarillo, Texas (TX). The proposed action would be on land owned by the DoN/Commander Navy Installations Command (CNIC), for which Navy Region Southeast (NRSE) is the property record holder and MARFORRES is a tenant. It is estimated that the construction phase would last 1 to 3 months and would commence in fiscal year (FY) 2012.

### **1.2 PROJECT BACKGROUND**

The *MARFORRES Wind Energy Program* supports Department of Defense (DoD) long-range goals to increase energy self-sufficiency through the use of renewable energy sources. The program is to develop small-scale wind energy projects at MARFORRES facilities where (a) wind has been identified as a readily available and economically feasible source for renewable energy production; and (b) a project can occur without having a significant environmental impact. Projects may consist of one to four wind turbines ranging in size (nameplate rating) from less than 100 kW to 2.5 MW. In the Programmatic EA (MARFORRES 2011), MARFORRES adopted siting and design criteria (refer to Section 2.2), best management practices (BMPs), and general conservation measures (GCMs), collectively referred to as program criteria, that would avoid and/or eliminate potentially significant environmental impacts. The proposed action and the analyses herein conform to the program criteria.

### **1.3 PROJECT AREA**

The proposed action would be implemented at the MARFORRES Center, Amarillo, TX (Figure 1-1), home of the Anti-Terrorism Battalion, 4th Marine Division. A Naval Reserve Center is also located on the property. The Navy owns the facility and MARFORRES is a tenant. The Reserve Center is located at 2500 Tee Anchor Blvd., in a commercial-industrial area bounded on the north by Tee Anchor Blvd. and on the south by Interstate 40/Highway 287, within the City of Amarillo. Residential areas are north of Tee Anchor Blvd. beginning at 10<sup>th</sup> Avenue, whereas city property comprising roughly 50 acres of disturbed land and flood control basins, known collectively as T-Anchor Lake, is immediately south and southwest of the Reserve Center (Figure 1-2).



**Figure 1-1**  
**Location of MARFORRES Center**  
**Amarillo, TX**



**LEGEND**

----- Reserve Center



0 0.05 0.1 0.2  
 [Scale bar] Miles

**Figure 1-2**  
**Vicinity Map: Amarillo Wind Energy Project**



#### 1.4 PURPOSE OF AND NEED FOR THE PROPOSED ACTION

The purpose of the proposed action is to develop wind as an energy source at MARFORRES Center, Amarillo in support of the *MARFORRES Wind Energy Program*. The purpose of the *MARFORRES Wind Energy Program* is to reduce dependency on fossil fuels and increase energy security and efficiency through development of wind energy projects at MARFORRES facilities across the U.S (MARFORRES 2011). MARFORRES Center, Amarillo has been identified as a facility with a wind resource that is readily available and economically feasible to develop as a renewable energy source.

The proposed action is needed to enable MARFORRES to achieve specific goals regarding energy production and usage. These goals have been set by Executive Orders (EOs), legislative acts, and agencies like the U.S. Environmental Protection Agency (USEPA), the DoD, and the DoN. These energy goals seek to increase the efficiency of energy production, delivery and usage, reduce greenhouse gas (GHG) emissions, and expand the use of renewable energy. The following relevant energy policies have shaped the need for the proposed action:

- Energy Independence and Security Act of 2007;
- Energy Policy Act of 2005;
- EO 13423 - Strengthening Federal Environmental, Energy, and Transportation Management;
- EO 13514 - Federal Leadership in Environmental, Energy, and Economic Performance; and

#### 1.5 REGULATORY REQUIREMENTS

This Tiered EA has been prepared to address the following statutory/regulatory requirements as described in the Programmatic EA (MARFORRES 2011):

- Endangered Species Act (ESA) (16 USC §§ 1531-1544);
- Migratory Bird Treaty Act (MBTA) (16 USC §§ 703-712);
- Bald and Golden Eagle Protection Act (BGEPA) (16 USC §§ 668-668c);
- Sikes Act and Sikes Act Improvement Act (16 USC §§ 670a to 670o), Conservation Programs on Government Lands;
- Clean Air Act (CAA) (42 USC §§ 7401-7671q);
- Clean Water Act (CWA), Sections 401, 402, and 404 (33 USC §§ 1251-1387);
- National Historic Preservation Act (NHPA) of 1966 (16 USC §§ 470-470x-6);
- Archaeological Resources Protection Act (ARPA) of 1979 (16 USC §§ 470aa-470mm);
- Federal Aviation Regulations (FAR) Part 77 – Obstructions Affecting Navigable Airspace;
- EO 13186 - Responsibilities of Federal Agencies to Protect Migratory Birds;
- EO 11990 - Protection of Wetlands;
- EO 11988 - Floodplain Management;
- EO 13148 - Greening the Government through Leadership in Environmental Management;
- EO 12898 - Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations; and



- EO 13045 - Protection of Children from Environmental Health Risks and Safety Risks.

### **1.6 PERMITS AND CONSULTATIONS/CONCURRENCES**

No permits are required in support of the proposed project. The following consultations and agency concurrences have occurred, and all concurrence letters are provided in Appendix D, *Correspondence*.

- The U.S. Fish and Wildlife Service (USFWS) was consulted informally to clarify and address requirements of the ESA, MBTA, and BGEPA. Because ESA-listed species, as well as bald and golden eagles, do not occur in the project area and would not be affected, no further actions were required under the ESA and BGEPA. MBTA concerns are addressed in this EA.
- Section 106 NHPA consultation has been concluded. A letter of concurrence finding “no historic properties affected” was received from the Texas State Historic Preservation Office (SHPO) (Appendix D).
- The Federal Aviation Administration (FAA) has issued a Determination of No Hazard (DNH) to air navigation regarding the proposed turbine (Appendix D); no further action is required.

### **1.7 AGENCY COORDINATION AND PUBLIC INVOLVEMENT**

As part of the NEPA process, MARFORRES developed a list of stakeholders including government agencies and non-governmental organizations (NGOs) or other interested parties in an attempt to solicit input on the proposed action (Table 1-1). The coordination with and/or input from the stakeholders will inform a decision on the proposed action. Opportunity for public input will occur in conjunction with publication of the Notice of Availability of the EA and Draft FONSI in a local newspaper. Comments received will be considered prior to implementing the action.

### **1.8 DOCUMENT ORGANIZATION**

The organization of this Tiered EA is as follows: Chapter 1 defines the purpose of and need for the proposed action; Chapter 2 describes the proposed action alternatives, alternatives considered but eliminated, and the no-action alternative; Chapter 3 describes the existing conditions and environmental consequences of each alternative; Chapter 4 describes the potential cumulative environmental impacts associated with the proposed action; Chapter 5 addresses other considerations required by NEPA; Chapter 6 lists all references cited in this EA; Chapter 7 provides agencies and persons contacted; and Chapter 8 provides the list of preparers.



**Table 1-1. Stakeholder List for Amarillo**

<i>Agency/ Organization Name</i>	<i>Potential Role/Interest In Project</i>
<i>Federal Agencies</i>	
USFWS: Arlington Field Office/ West Texas Sub-office (Lubbock, TX)	Key regulatory and natural resource trustee responsibilities under the ESA, MBTA, and BGEPA.
FAA	The FAA has oversight of any object that could have an impact on the navigable airspace or communications/navigation technology of aviation (commercial or military) or DoD operations; undertakes an initial aeronautical study within the relevant FAA region, and issues either a DNH to air navigation or a Notice of Presumed Hazard (NPH).
<i>State and Local Government Agencies</i>	
Texas Parks and Wildlife Department	State trustee agency for plants and wildlife. Provided state guidance in <i>Recommendations for Wind Energy Development</i> (Draft, February 2008).
Texas Commission on Environmental Quality	Responsible for protecting the state's human and natural resources, including implementation of the National Pollutant Discharge Elimination System (NPDES) permit program for the state of Texas.
Texas SHPO	Responsible for the listing and protection of historic properties under the NHPA and related statutes.
City of Amarillo Planning Department	The Planning Department manages the development process by providing guidance on current and long-range issues to promote quality development in the City of Amarillo.
City of Amarillo Engineering Department	Administers the City's Stormwater Management Program.
Rick Husband Amarillo International Airport	The nearest runway for this major international airport is approximately 4.3 miles to the east of the proposed project site.
Tradewind Airport	This small airport is approximately 2 miles southwest of the proposed project site.
<i>NGOs and Other Interested Parties</i>	
AEP Texas	Local utility provider that would issue Interconnect Agreement, if required.

## **CHAPTER 2**

# **PROPOSED ACTION AND ALTERNATIVES**

---

### **2.1 INTRODUCTION**

This chapter describes the proposed action, action alternatives, alternatives considered but eliminated from further analysis, and the no-action alternative. The proposed action is to develop wind energy at MARFORRES Center, Amarillo, TX, under the *MARFORRES Wind Energy Program* and would entail the installation of a single 100-kW wind turbine. Implementation of the proposed action would conform to the program criteria (i.e., siting and design criteria, BMPs, and GCMs) that were adopted in the Programmatic EA (MARFORRES 2011).

### **2.2 SITING AND DESIGN CRITERIA**

The Programmatic EA for the *MARFORRES Wind Energy Program* (MARFORRES 2011) identified siting and design criteria that would be applied to select and evaluate alternative sites and designs (including number and size of turbine[s]) at a specific MARFORRES facility. Siting and design criteria can be either exclusionary or evaluative. Exclusionary criteria define conditions that would exclude a site and/or design from further consideration because of an adverse impact. Evaluative criteria are based on desirable conditions that reduce potential impacts and favor the selection of one alternative over another.

#### **2.2.1 Exclusionary Criteria**

1. Site locations and designs whose impact on wetlands or Waters of the U.S. would exceed the threshold or could not meet the terms and conditions for a Section 404 Nationwide Permit would be excluded.
2. Site locations that result in a turbine being placed within 500 ft of USFWS-recognized habitat for noise-sensitive wildlife species would be excluded unless consultation with USFWS confirms that the species and its habitat would not be adversely affected.
3. Site locations and designs that are *likely to adversely affect* an ESA-listed species or its critical habitat would be excluded unless all required terms and conditions and, to the extent feasible, recommended conservation measures that are specified in a Section 7 Biological Opinion are incorporated into the project.
4. Areas where wind turbine development has been restricted by another federal agency or by a state regulatory agency because of the proximity of sensitive bird or bat species (e.g., New Jersey Department of Environmental Protection 2009) would be excluded. Any corresponding species-specific buffer distances for sensitive species would be incorporated as siting and design criteria.
5. Site locations and designs that would alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register of Historic Places (NRHP) in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association, would be excluded. Site locations and designs would also avoid impacts to resources of cultural, traditional, or religious significance to Native American tribes.
6. Site locations and designs for which predicted noise levels at sensitive non-DoD receptor locations (e.g., residences, parks) would exceed federal noise standards would be excluded.



7. Site locations and designs for which construction emissions would exceed *de minimis* thresholds, and for which a Conformity Determination indicates that the project would not conform to the applicable SIP would be excluded.
8. Site locations and designs must be compatible with DoD air/ground operations and training requirements.
9. Site locations and designs must meet FAA requirements to avoid height obstructions to aircraft. The FAA would be notified early in the planning process to identify siting and design requirements.
10. Site locations and designs for which turbine operations would be within line of sight, cause unavoidable electromagnetic interference (EMI), and substantially interfere with civilian or military radars would be excluded. Civilian and military radar operators in the general area of a turbine location would be contacted as necessary in the planning process to determine if radar interference may be a problem, in which case MARFORRES would coordinate with the operators to determine if there are feasible technological solutions.

### 2.2.2 Evaluative Criteria

1. As much as possible, projects would be located on previously disturbed or altered landscapes, avoiding less disturbed, relatively natural areas (*Note*: land with previous underground disturbance may not be suitable for wind turbine foundation installation).
2. Projects would consolidate infrastructure requirements (e.g., transmission lines or roads) and temporary construction areas (e.g., use the same crane pads or staging/laydown areas at a project site for multiple turbines) for efficient use of land.
3. Where there are potential noise, visual, shadow flicker, or safety concerns associated with the proximity of non-DoD lands to potential wind turbine locations, projects would consider reducing the number/size of wind turbines or relocating wind turbine sites further within the MARFORRES facility boundaries and/or away from the affected non-DoD areas.
4. Site locations and designs should (a) provide a minimum setback from any residence, public highway, or area of concentrated public use (such as a park or shopping area) outside of the MARFORRES facility that is consistent with local ordinances, plans, or policies regarding minimum setbacks of wind turbines from such areas; and (b) avoid conflicts with local ordinances, plans or policies regarding maximum heights of wind turbines.
5. Site locations and designs that *may affect* an ESA-listed species or its critical habitat would be less preferred unless, through informal consultation with USFWS, necessary and sufficient measures to ensure that the action is *not likely to adversely affect* the species or its designated critical habitat have been identified and incorporated into the action.
6. Locations and designs of small-scale wind energy projects should avoid overlap with, and, where practicable and effective in reducing potential impacts, maximize distance from, the following circumstances:
  - Locations with valuable mineral deposits, paleontological resources, or within the viewshed of unique geological features.
  - Wetlands and other Waters of the U.S.
  - Areas within a 100-year floodplain or otherwise subject to flooding.



- Habitats that are protected under an installation's Integrated Natural Resources Management Plan (INRMP) or that support ESA-listed species.
- Locations with federally or state-listed, or otherwise designated sensitive species, including migratory birds of conservation concern.
- Breeding and wintering bald or golden eagle use areas.
- Daily or seasonal flight patterns of migratory birds and bats.
- Areas near known bat hibernacula, breeding, and maternity/nursery colonies.
- Landscape features such as native (undisturbed) grasslands, scrub, woodlands, or wetlands that are known to be attractive to migratory birds.
- Scenic views associated with an NRHP-eligible historic property or recreation site, or where a turbine would alter the unique visual character of the landscape.
- Locations with soil contamination present in amounts and concentration levels of which make wind energy projects incompatible under prevailing governmental and industry standards.

### **2.2.3 Design Criteria**

1. In order to minimize impacts to bird and bat populations, the following design features should be implemented:
  - Use tubular supports with pointed nacelle tops, rather than lattice supports, and avoid placing external ladders and platforms on tubular towers to minimize bird perching and nesting opportunities.
  - If turbines are taller than 200 ft (including the rotor swept area), use the minimum amount of pilot warning and obstruction avoidance lighting required by the FAA. All lights within the turbine facility should light synchronously. Use only the minimum number of strobe, strobe-like, or blinking red incandescent lights, with the minimum required intensity. Preferably install dual strobe lights per nacelle. No steady burning lights should be used on turbines or facility infrastructures.
  - Safety lighting on buildings or other infrastructure should be focused downward to reduce skyward illumination. Lights should also be equipped with motion detectors to reduce continuous illumination.
  - Where feasible, bury electric power lines or place insulated, shielded lines on the surface to avoid electrocution risks to birds.
  - Above-ground lines, transformers, and conductors should follow the Avian Power Line Interaction Committee 1994 and 2006 guidance. Aboveground lines should not be placed in wetlands or over canyons.
  - Reduce motion smear by using blades with staggered stripes or incorporating a black blade with two white blades to aid in reducing collisions. Since the effectiveness of this measure is unknown, it is not part of the proposed action.
2. Implement measures to reduce noise levels below noise guidelines for an affected land use. Measures could include, but are not limited to:
  - reduce number of wind turbines;
  - modify design (e.g., blade design, tower height, orientation) or operations (i.e., reduce or eliminate nighttime operations or change to a different sound level power curve, if available);
  - provide vegetative (trees) or other screening in between wind turbines and sensitive receptors; or
  - locate wind turbine sites sufficiently far away from sensitive receptors.



3. If initial analysis indicates a potential visual impact on a historic property or scenic view, the following should be implemented:
  - reduce the size of the turbine(s);
  - select a location that shield(s) the turbine(s) from view and minimizes contrast between the turbine(s) and the property or viewshed of concern; or
  - if feasible and approved by the FAA, modify the color or lighting of the turbine(s) to lessen contrast with the surrounding landscape.

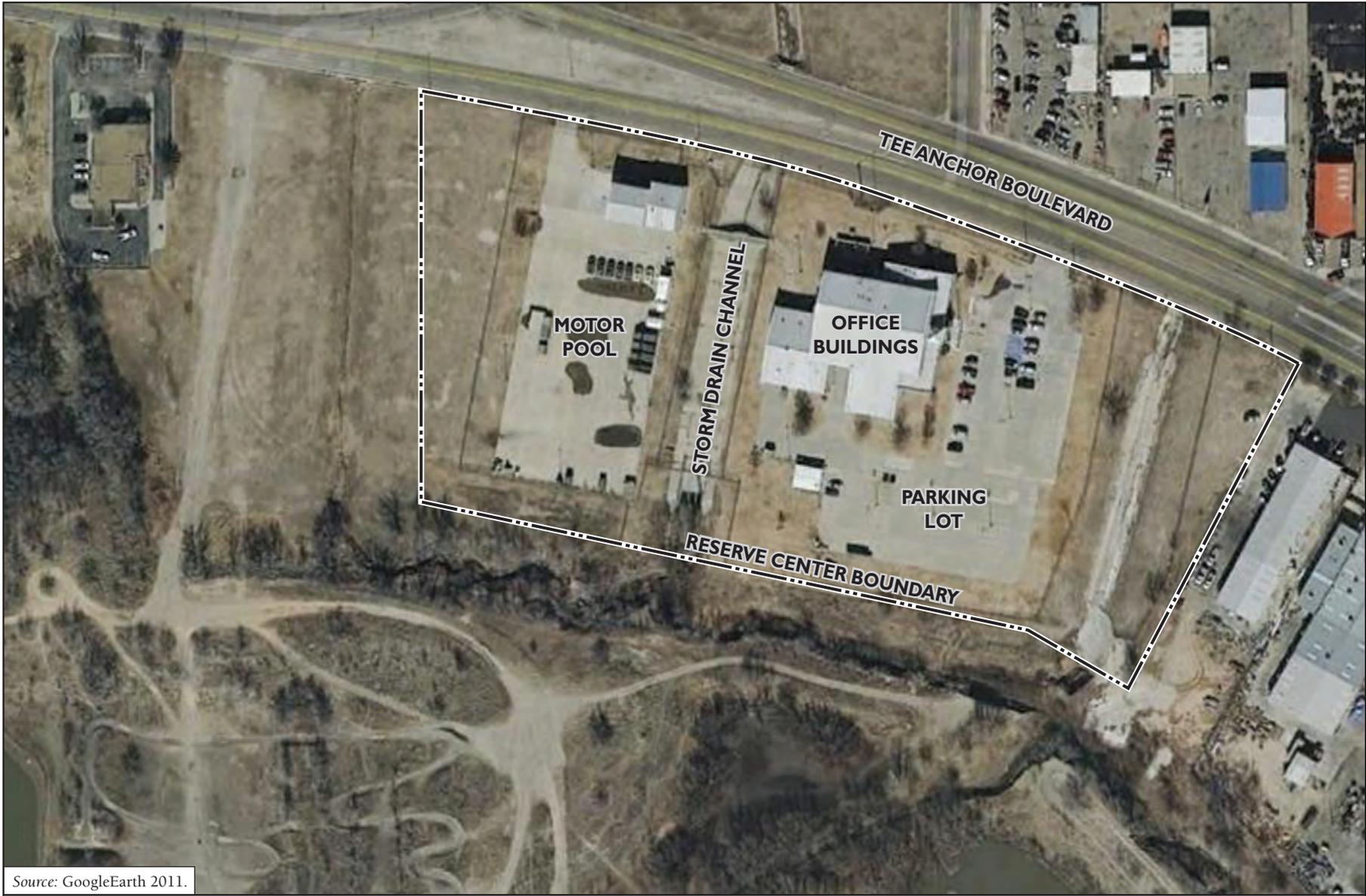
## **2.3 PROPOSED ACTION**

### **2.3.1 Project Location**

The proposed project is located at the MARFORRES Center, Amarillo, TX (Figure 1-2). The majority of the 5.3-acre Reserve Center is occupied by office buildings and paved parking areas and is divided by a north-south running concrete storm drain channel that is 50 feet (ft) wide and 15 ft deep (Figure 2-1). All runoff from the site and surrounding lands drains to T-Anchor Lake, which is used for flood control by the city. The Reserve Center office buildings and parking lots are located in the eastern portion of the Reserve Center and the western portion contains a motor pool which is frequently full of vehicles (Naval Facilities Engineering Service Center [NAVFAC ESC] 2010).

### **2.3.2 Project Design**

The MARFORRES Center, Amarillo, is relatively small, with the majority of its 5.3 acres occupied by buildings and paved parking areas. Through an investigation of energy needs, wind turbine construction requirements, and land availability, a single 100-kW wind turbine was identified as suited to (1) the energy requirements of the small MARFORRES facility and (2) land available for a small wind energy facility. A wind turbine of this size can be tied in behind the facility's electricity meter and, when the wind is blowing with corresponding production of electricity, the wind turbine would augment the power supply for the combined Navy and USMC use of the facility, reducing the need for power from the grid. The scale and location of the proposed project are environmentally favorable, minimizing potential impacts consistent with the siting and design criteria of the Programmatic EA (MARFORRES 2011) (refer to Section 2.4, *Proposed Action Alternatives*, for details).



Source: GoogleEarth 2011.

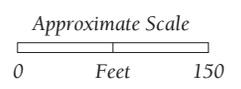


Figure 2-1  
Amarillo Wind Energy Project Location



The proposed 100-kW turbine would have a hub height of 121 ft and rotor diameter of 69 ft for a combined height of 155 ft (Figure 2-2). The minimum (cut-in) and maximum (cut-out) wind speeds at which the turbine generates usable power are approximately 7.8 miles per hour (mph) and 56 mph, respectively, and the maximum rotational speed is 59 revolutions per minute (rpm) (Northern Power Systems 2010a).

### **2.3.3 Site Preparation and Turbine Installation**

The proposed turbine would be located in a previously disturbed area that is currently a grass field and would require minimal, if any, grading for site preparations (Figure 2-3). The base of the turbine would be anchored to a spread foot foundation, an octagonal, concrete foundation 10 ft deep and fitting within a 57-ft by 57-ft square. Excavation of the foundation would be done by backhoe. Most of the foundation would be buried, with only the pedestal, to which the turbine base would be attached, being above ground. In addition to the concrete foundation, a 20-ft wide gravel area would surround the base of the turbine and would be connected to the adjacent parking lot (Alternative 1) or motor pool (Alternative 2) via a gravel road to provide access for maintenance vehicles. A large paved parking lot located adjacent to the site would be utilized as the crane pad and staging/laydown areas (Figure 2-3).

The proposed wind turbine would be connected to a new dedicated transformer mounted on a new 8-ft by 8-ft concrete pad located adjacent to the turbine access area (Figure 2-3). The new transformer would then be connected to an existing, pad-mounted transformer located on the north side of the office buildings (Figure 2-3). The existing transformer provides power to the Reserve Center offices and motor pool maintenance facility. The turbine would be connected to the new pad-mounted transformer and then the existing transformer via a new cable (Figure 2-3) installed in an excavated trench approximately 2.5 ft wide and 4 ft deep. A “ditch-witch” (trenching machine) would be used to excavate the trench. The spoils would be mounded temporarily along the edges of the trench while the digging progresses, and would be pushed back and compacted over the cable as soon as it is installed. No above ground power poles would be required. All major turbine components, including the tower, generator, and blades, would be delivered via two 48-ft flatbed trucks.

Construction activities would be conducted in accordance with the applicable BMPs from the Programmatic EA (MARFORRES 2011) or as otherwise determined appropriate to minimize environmental impacts (see below). The program was officially established when a FONSI was signed on 18 May 2011.



(Source: Northern Power Systems 2010b)

**Figure 2-2. 100-kW Northern Power 100 wind turbine.**

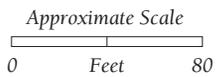
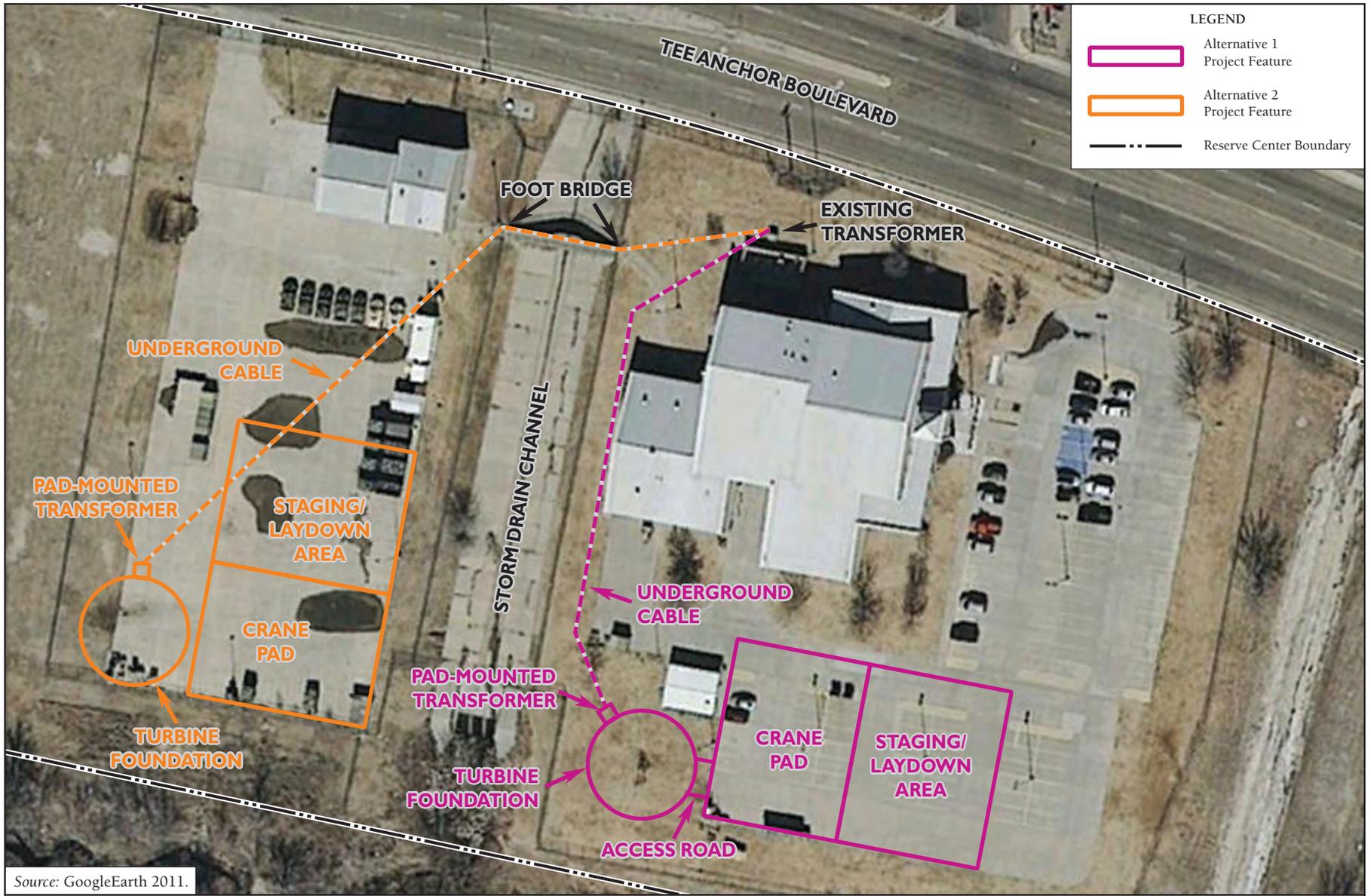


Figure 2-3  
Amarillo Wind Energy Project Design





### Construction BMPs

1. Prior to construction within the base flood (1% annual probability of flooding) elevation of T-Anchor Lake, the City Engineer would be consulted to ensure the project has no impact on the storage capacity of T-Anchor Lake. To minimize the possibility of flood impacts to the new project components, the top of the turbine foundation (15-ft diameter) and transformer pad (8-ft by 8-ft) would be raised to 1 ft above the base flood elevation.
2. MARFORRES and the Navy would coordinate with the City of Amarillo regarding the use of public roads during project construction to minimize any disruption of local traffic.
3. Current Wind Energy Standards of the International Electrotechnical Commission would be followed in the design, construction, and operation of the proposed wind turbine.
4. All mechanized clearing and grading, vehicle traffic, equipment staging, and the deposition of soil would be confined to the temporary and/or permanent project footprint or to other disturbed or developed land.
5. At least 7 days before project initiation, the project boundary (including temporary features such as staging/laydown areas and access roads) would be clearly marked with flagging, fencing, or signposts. All project-related activities would occur within the project boundary.
6. Heavy equipment and construction activities would be restricted to existing roads and disturbed areas to the maximum extent practicable. Staging/laydown areas would be located in disturbed habitats and would be delineated on the grading plans. Vehicle operation and staging/laydown areas would be defined by staking and flagging between stakes to prevent operations outside these areas.
7. Construction trucks would carry water and shovels or fire extinguishers in the field. The use of shields, protective mats, or other fire prevention equipment would be used during grinding and welding to prevent or minimize the potential for fire, and vehicles would not be driven or parked in areas where catalytic converters could ignite dry vegetation. No smoking or disposal of cigarette butts would take place within vegetated areas.
8. The contractor will be required to implement BMPs for erosion and sedimentation controls to prevent the erosive loss of sediment from the construction area and subsequent deposition into T-Anchor Lake. BMPs could include sandbags, silt fences, earthen berms, fiber rolls, sediment traps, erosion control blankets, check dams in medium-sized channels, or straw bale dikes in smaller drain channels.
9. Onsite containment and cleanup capabilities would be provided, as necessary, to prevent the release of hazardous materials.
10. If evidence of contaminated soils is uncovered during construction, construction would be halted and cleanup procedures would be initiated, as required.
11. All fill material brought to the construction site from off base would be checked to ensure that it is clean – specifically, that it is free from contaminants and does not contain any seeds or plant materials from non-native or invasive species.
12. The action proponent, or their contractor, would ensure that construction and solid waste (including asphalt or concrete) resulting from construction activities is disposed of properly and not discarded onsite.



13. All trash would be disposed of properly. All food-related trash would be placed in sealed bins and removed from the site regularly. All equipment and waste would be removed from the site.
14. No off-road construction vehicle operations would occur outside of the project boundary.
15. If night work and consequent lighting are required, light fixtures would be shielded downward.
16. If sanitary facilities are not available at MARFORRES, construction workers would use portable chemical toilets, with secondary containment basins to prevent spillage. Chemical toilets would not be placed within 100 ft of surface water.
17. In the event of an inadvertent discovery of a potential cultural resource during site construction, construction activity at that location will cease until the potential resource is evaluated by a qualified archaeologist and/or Tribal representative(s), as appropriate. Construction may proceed once the discovery is determined to have no potential significance, subject to the completion of documentation and consultation with the SHPO, if required. If applicable, procedures required under the Native American Graves and Repatriation Act (43 CFR Part 10) will be followed.

#### **2.3.4 Turbine Operations and Maintenance**

The proposed 100-kW wind turbine has an operational lifetime of 20 years (Northern Power Systems 2010a). The amount of energy generated from the operation of the turbine is determined by the nominal power output (nameplate capacity) of the turbine and the naturally varying wind conditions at the site. The average annual wind speed for the Amarillo project site is approximately 19 mph (National Renewable Energy Lab [NREL] 2010), which would produce approximately 47% of the nameplate capacity for the proposed 100-kW turbine (Northern Power Systems 2010a). This equates to an energy output of 400 megawatt-hours per year (MWh/yr) (Northern Power Systems 2010a), which is roughly the amount of electricity that would be used by 38 households per year in this region (Department of Energy 2006).

Turbine operations and maintenance would be as described in the Programmatic EA. Applicable BMPs and GCMs, either from the Programmatic EA (MARFORRES 2011) or as otherwise determined appropriate to minimize environmental impacts are listed below.

##### Operations BMPs

1. Avoid creating or maintaining habitat features that attract birds and bats. Examples include removing carrion, maintaining vegetation to heights to reduce prey availability, minimizing water ponding, and avoiding the creation of situations where prey base would increase (e.g., rock piles or eroded turbine pads with openings underneath that are suitable for rodents will attract raptors).
2. If the turbine becomes permanently non-operational, it will be removed.
3. The turbine would have the minimal amount of lighting required by FAA for pilot warning, using only red, or dual red and white strobe, strobe-like, or flashing lights, not steady-burning lights on the turbine. Lighting on other project infrastructure for security purposes would be minimized, focused downward, and motion or heat activated, thereby operating only when needed.

#### **2.4 PROPOSED ACTION ALTERNATIVES**

##### **2.4.1 Alternative 1 (Preferred Alternative)**

Under Alternative 1, the proposed site would be in a small grass field located south of the Reserve Center offices, near the concrete storm drain on the eastern half of the property (Figure 2-3). While being closer



to this building than would be considered ideal, the approximately 8,300 square ft area surrounding this site is the largest available at the Reserve Center, without occupying valuable parking/vehicle staging space. The installation of a turbine at this site would have minimal, if any, impact on activities and land use at the facility. A small covered break area is approximately 40 ft from the turbine site but the proposed turbine should not compromise it in any way. The large paved parking lot directly east of this site would be utilized for the crane pad and staging/laydown areas (Figure 2-3). Although the direct distance between the proposed turbine and tie-in point to the existing transformer is 375 ft, an underground cable would be routed along the west side of the office buildings for a total of approximately 420 ft (NAVFAC ESC 2010).

The total permanent footprint (foundation, gravel access area/road, connection to transformer) would be approximately 0.10 acre (4,300 square ft) and the total construction footprint (both permanent and temporary) would be 0.45 acre.

#### **2.4.2 Alternative 2**

Under Alternative 2, the proposed site would be located in the far southwest corner of the paved motor pool, on the western portion of the property. This site, along with the entire motor pool division, is separated from the Reserve Center office buildings by a 50 ft wide, 15 ft deep concrete storm drain channel. An underground cable would cross the motor pool parking lot, then be routed along the foot-bridge at the north end of the motor pool staging area, then continue to access an electrical tie-in point at the transformer. This would involve saw cutting the approximately 300-ft long section through the parking lot and trenching an approximately 120 ft section east of the foot-bridge. The large paved parking area making up the motor pool would be utilized for the crane pad and staging/laydown areas.

The total permanent footprint (foundation, gravel access area/road, connection to transformer) would be approximately 0.10 acre (4,300 square ft) and the total construction footprint (both permanent and temporary) would be 0.45 acre.

Alternative 2 is not preferred because it would have slightly greater construction costs and impacts (discussed in Section 3.2, 3.8, and 3.15).

### **2.5 ALTERNATIVES TO THE PROPOSED ACTION**

NEPA and the USMC Environmental Compliance and Protection Manual (MCO 5090.2A) require the exploration of a reasonable range of alternatives to a proposed action, as well as analysis of a no-action alternative. The range of alternatives includes alternative locations for the action as well as alternative means to accomplish the same objectives.

#### **2.5.1 Alternatives Considered but Eliminated**

The alternative listed below is limited to one that falls within the scope (i.e., size, number, location, and design) of proposed action for the *MARFORRES Wind Energy Program* as described in the Programmatic EA. Additional *Alternatives Considered but Eliminated* are provided in Chapter 2 of the Programmatic EA (MARFORRES 2011).

##### **2.5.1.1 Installation of Multiple and/or Larger Wind Turbines**

Under the *MARFORRES Wind Energy Program*, the installation and operation of up to four wind turbines ranging in size up to 2.5 MW was considered for MARFORRES facilities. However, energy produced by multiple and/or larger wind turbines would exceed the energy consumption for the Reserve Center, requiring a more complicated metering arrangement through the Interconnect Agreement with the local



utility provider. In addition, multiple and/or larger wind turbines would place a greater strain on the limited available land at the Reserve Center and could have proportionately greater environmental effects. Therefore, only a single, 100-kW wind turbine was considered for MARFORRES Center, Amarillo.

### **2.5.2 No-Action Alternative**

Under the no-action alternative, MARFORRES would not pursue the installation of a 100-kW wind turbine at MARFORRES Center, Amarillo and would continue to rely on the electrical grid for purchase of all electricity needs at this facility. MARFORRES would seek to develop other types of renewable energy (e.g., solar) at this facility and/or develop wind energy at other MARFORRES facilities to achieve specific goals regarding energy production and usage. Analysis of the no-action alternative is required under CEQ regulations (40 CFR § 1502.14[d]). The no-action alternative for this Tiered EA represents the continuation of baseline conditions for each resource as described under *Existing Conditions* in Chapter 3.

## **CHAPTER 3**

# **AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES**

---

---

### **3.1 INTRODUCTION**

This chapter includes the definition of resource and describes the existing conditions and environmental consequences of the proposed action for each environmental resource and issue area that would be potentially affected by the proposed implementation of the *MARFORRES Wind Energy Program* at MARFORRES Center, Amarillo. The definition of resource summarizes the definition provided for each resource in the Programmatic EA (MARFORRES 2011). The existing conditions and environmental consequences sections focus on aspects of the following resources potentially subject to impacts: land use, noise, geological resources, water resources, biological resources, cultural resources, visual resources, socioeconomics, air quality, utilities, airspace, health and safety, hazardous materials, and transportation. In addition, the level of impact analysis is commensurate with the anticipated level of impact. The analysis is structured by the key “analysis items” identified for each resource in the Programmatic EA (MARFORRES 2011). The analysis items are coded with a one or two-letter abbreviation for the resource to which they apply (LU for Land Use, N for Noise, etc.). The program was officially established when a FONSI was signed on 18 May 2011.

### **3.2 LAND USE**

#### **3.2.1 Definition of Resource**

The attributes of land use considered in this analysis include general land use patterns, land ownership, special use areas, local ordinances, regulating activities, type and intensity of development on non-DoD land adjacent to the Reserve Center, and land management plans that guide the region’s growth. General land use patterns that characterize the types of uses within a particular area can include urban, agricultural, residential, commercial, industrial, military, scenic, natural, or recreational. Land ownership is a categorization of land according to type of owner. The major land ownership categories include private, federal, and state. Land management plans include those documents prepared by agencies to establish appropriate goals for future use and development. As part of this process, sensitive land use areas are often identified by agencies as being worthy of more rigorous or protective management. In an urban or suburban context, land use goals and controls are defined in General, Master, Comprehensive, or Five-Year Plans and are implemented through zoning or local ordinances.

#### **3.2.2 Existing Conditions**

The proposed project site is on the MARFORRES Center, which is co-located with a Naval Reserve Center as part of the Navy Operational Support Center (NOSC), within the City of Amarillo. The fence line lies approximately 50 ft to the west and to the south of the proposed turbine site. A small, covered break area is located approximately 40 ft north of the proposed turbine site. The Reserve Center’s main building is approximately 140 ft north of the proposed turbine location. T-Anchor Lake, a city-owned stormwater drainage basin, is the only other land use outside of the Reserve Center within approximately 360 ft of the proposed project location. There has been interest by local residents to develop T-Anchor Lake into a recreational site such as a zoo, botanical garden, or park since the 1960s, but these efforts have been unsuccessful due to high earthwork costs and previous archaeological finds (Welch 2009, Steed 2009).



The NOSC, as well as its neighbors south of Tee Anchor Boulevard, is zoned as heavy commercial; the City of Amarillo's zoning ordinance specifically allows wind generators in such districts (City of Amarillo 2010a). The nearest neighbor, Amarillo Electric Specialists, is located approximately 140 ft east of the proposed project location. Neighboring land north of Tee Anchor Boulevard is zoned as light commercial. There are no special use areas near the site.

A residential neighborhood lies approximately 750 ft to the north of the proposed project location. Between this residential development and the proposed turbine location lie the Reserve Center's main building complex, Tee Anchor Blvd. (also known as U.S. Business Route 287), 10<sup>th</sup> Avenue, and more commercial development. The Children's Learning Center lies approximately 750 ft to the west of the proposed turbine location. The Kimble Learning Center lies to the west of the Children's Learning Center, approximately 950 ft from the proposed project. The Ashmore Inn and Suites lies approximately 1,050 ft to the southwest of the proposed project location, on the far side of T-Anchor Lake.

### 3.2.3 Environmental Consequences

#### 3.2.3.1 Alternative 1

- *Analysis Item LU-1: Would construction or operations result in adverse impacts to land use on the installation?*

The Alternative 1 location chosen for construction of the wind turbine at the Reserve Center is compatible with the mission of the facility. A small, insignificant portion of the parking lot would be temporarily unavailable for use during construction to provide room for the crane pad and staging/laydown area. The only permanent impact would be the loss of a small portion of an open, grassy area for use as the wind turbine foundation. There is no potential for other conflicts with training, operations, or long-range plans. Furthermore, the site is suitable for wind energy development, there is interest at the facility for such development, and the proposed location is appropriate considering land use on the installation. Therefore, construction and operation of the proposed wind turbine would only minimally affect land use on the installation.

- *Analysis Item LU-2: Would the siting, design, construction, or operation of the turbine(s) be in conflict with adjacent land uses, local zoning, or land use planning?*

Although a MARFORRES facility is not required to comply with local planning and zoning for adjacent non-DoD property, a conflict with height, setback requirements, or land use would be considered during siting and design (per criteria identified in the Programmatic EA [MARFORRES 2011]). However, there are no City of Amarillo or other local ordinances pertaining to wind turbine installation or operation, and Alternative 1 would not affect adjacent land uses such as T-Anchor Lake, the Children's Learning Center, or the various other commercial or residential uses in the vicinity. Moreover, there are no conflicts with long-range plans such as Amarillo's Comprehensive Plan (City of Amarillo 2010b). As such, construction and operation of the proposed turbine would not conflict with adjacent land uses, local zoning, or land use planning.

#### 3.2.3.2 Alternative 2

- *Analysis Item LU-1: Would construction or operations result in adverse impacts to land use on the installation?*

Potential impacts for Alternative 2 would be the same as for Alternative 1, with the exception that construction would temporarily impact a portion of the motor pool instead of the parking lot, and that the turbine foundation would permanently remove a small portion (the southwest corner) of the motor pool



(Figure 2-3). Therefore, construction and operation of the proposed turbine would minimally impact land use on the installation.

- *Analysis Item LU-2: Would the siting, design, construction, or operation of the turbine(s) be in conflict with adjacent land uses, local zoning, or land use planning?*

Potential impacts for Alternative 2 would be the same as for Alternative 1, although the distance to the Children's Learning Center would be reduced from approximately 750 ft to approximately 450 ft, and the distance to the southeast corner of the Kimble Learning Center would be reduced from approximately 950 ft to approximately 600 ft. As was the case with Alternative 1, construction and operation of the proposed turbine would not conflict with adjacent land uses, local zoning, or land use planning.

### 3.3 NOISE

#### 3.3.1 Definition of Resource

Noise is generally defined as any sound that interferes with communication, is intense enough to damage hearing, or is otherwise annoying (Federal Interagency Committee on Noise [FICON] 1992). Noise can be intermittent or continuous, steady or impulsive, as well as stationary or transient. Stationary noise sources are typically associated with specific land uses (e.g., schools or industrial facilities). Transient noise sources move through the environment, either along relatively established paths (e.g., highways, railroads, and aircraft flight tracks around airports) or randomly. There are a wide range of responses to noise depending on the type of noise and the characteristics of the sound source, as well as the sensitivity and expectations of the receptor, the time of day, and the distance between the noise source and the receptor (e.g., a person or animal).

#### 3.3.2 Existing Conditions

The Reserve Center is located near the center of the highly developed City of Amarillo. Existing sources of noise that would affect the project site include both heavy and light commercial facilities 460 ft to the north and to the east, a large transportation corridor (Tee Anchor Blvd. and 10<sup>th</sup> Avenue) 360 ft to the north, and Interstate 40 approximately 0.35 mile to the south.

With respect to Alternative 1, the nearest sensitive receptors include the small, covered break area 40 ft to the north, Amarillo Electric Specialists (a heavy commercial development) approximately 140 ft to the east, a residential neighborhood approximately 750 ft to the north, the Children's Learning Center 750 ft to the west, and the Kimble Learning Center 950 ft to the west. These corresponding distances would be 300 ft, 230 ft, 730 ft, 460 ft, and 660 ft, respectively, for Alternative 2. As indicated in Figure 3.3-1 of the Programmatic EA (MARFORRES 2011), the maximum normally acceptable Day-Night Average Sound Level ( $L_{dn}$ ) for heavy commercial areas such as those adjacent to the project site is 80 A-weighted decibels (dBA) while the maximum normally acceptable  $L_{dn}$  for the nearest residential areas, which would be applicable to the learning centers, is 65 dBA.

#### 3.3.3 Environmental Consequences

##### 3.3.3.1 Alternative 1

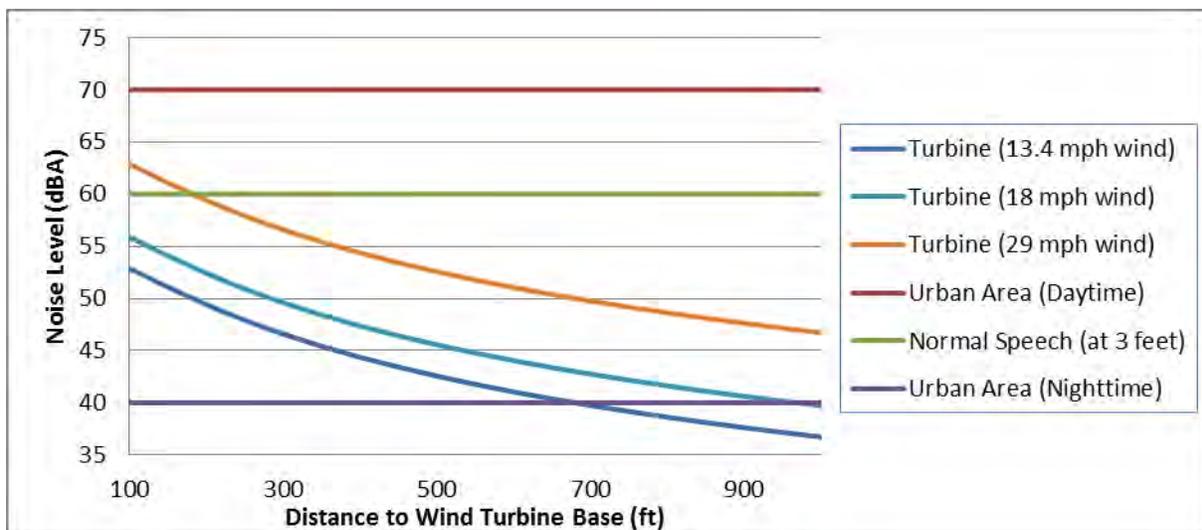
Noise impacts associated with the proposed wind turbine would include short-term noise generated by construction activities and long-term noise due to operation of the wind turbine.

- *Analysis Item N-1: Would construction activities result in noise impacts to surrounding land uses or sensitive receptors?*

Construction activities would include delivering materials (e.g., construction equipment and turbine components) to the project site, preparing the site (involving minor grading), excavating/constructing the foundation, and then erecting and assembling the turbine with a crane. Noise associated with construction would be intermittent and of relatively limited duration of 1 to 3 months. Furthermore, construction would occur only during daytime hours, when noise impacts are generally less severe than at night. Finally, construction noise at the sensitive receptors, 750 ft from the proposed project, is expected to be less than the noise generated by daytime vehicle traffic immediately adjacent to the sensitive receptors. As such, noise impacts from construction activities would be short-term and minor. Therefore, noise-related impacts from the construction under Alternative 1 would not be significant.

- *Analysis Item N-2: Would operations result in noise impacts to surrounding land uses or sensitive receptors?*

NREL (2003) conducted an independent analysis of noise produced by the Northwind 100 turbine, which is the turbine proposed for installation at the MARFORRES Center. Under the proposed action, the noise level at 100 ft from the base of a single Northwind 100 turbine with a typical wind speed of 13.4 mph would be 53 dBA. With an 18 mph wind speed, the noise generated would increase to 56 dBA at 100 ft. The operational noise generated with a 29 mph wind speed at 100 ft would be 63 dBA and is conservatively assumed to represent the worst case scenario as this is the lowest wind speed at which the turbine would produce the maximum amount of energy (100 kW). As shown in Figure 3.3-1, the noise levels for various wind speeds decrease with distance from the wind turbine. The operational noise levels under Alternative 1 for nearby sensitive receptors are provided in Table 3.3-1. It should be noted that received noise levels reflect the slant distance to the turbine hub, which is greater than the distance to the base of the tower. As indicated in Table 3.3-1, noise levels would generally be well below the maximum normally acceptable  $L_{dn}$  of 80 dBA for heavy commercial areas and 65 dBA for residential areas and schools (Figure 3.3-1 in MARFORRES 2011).



Note: Based on NREL 2003.

**Figure 3.3-1. Expected Noise Levels from the Proposed Wind Turbine**

**Table 3.3-1. Noise Levels under Alternative 1 at Sensitive Receptors**

Sensitive Receptor	Distance to Wind Turbine Base	Maximum Normally Acceptable $L_{dn}$	Noise Level (dBA) by Wind Speed		
			13.4 mph	18 mph	29 mph
Break Area	40 ft	65	55	58	65
Amarillo Electric Specialists	140 ft	80	51	54	61
Residential Development to the North	750 ft	65	39	42	49
Children's Learning Center	750 ft	65	39	42	49
Kimble Learning Center	950 ft	65	37	40	47

While turbine noise rises with wind speed, background noise also rises in parallel. One study showed that background noise at wind speeds above approximately 18 mph would typically mask the noise generated by wind turbines (Danish Wind Turbine Manufactures Association 2002 cited in Rogers *et al.* 2006). NREL's measurements suggest that the turbine noise would be difficult to hear above background noise at approximately 400 ft, regardless of wind speed. Therefore, operational noise impacts under Alternative 1 would not be significant.

### 3.3.3.2 Alternative 2

- *Analysis Item N-1: Would construction activities result in noise impacts to surrounding land uses or sensitive receptors?*

Potential impacts for Alternative 2 would be the same as for Alternative 1, with the exception that construction would have a slightly greater, although still minor, temporary impact on sensitive receptors due to the closer proximity of construction activities to the sensitive receptors. Therefore, noise-related impacts from the construction under Alternative 2 would not be significant.

- *Analysis Item N-2: Would operations result in noise impacts to surrounding land uses or sensitive receptors?*

Potential impacts for Alternative 2 would be similar as for Alternative 1. The operational noise levels under Alternative 2 for nearby sensitive receptors are provided in Table 3.3-2. As indicated in Table 3.3-2, noise levels would generally be well below the maximum normally acceptable  $L_{dn}$  of 80 dBA for heavy commercial areas and 65 dBA for residential areas and schools (Figure 3.3-1 in MARFORRES 2011). Similar to Alternative 1, it is also expected that the wind turbine would be inaudible at either the Children's Learning Center or at the Kimble Learning Center during the day when they are in use. It is further expected that the wind turbine would be inaudible at the residential neighborhood during both the day and the night. Therefore, operational noise impacts under Alternative 2 would not be significant.

**Table 3.3-2. Noise Levels under Alternative 1 at Sensitive Receptors**

Sensitive Receptor	Distance to Wind Turbine	Maximum Normally Acceptable $L_{dn}$	Noise Level (dBA) by Wind Speed		
			13.4 mph	18 mph	29 mph
Amarillo Electric Specialists	230 ft	80	48	51	58
Break Area	300 ft	65	47	50	57
Amarillo Electric Specialists	140 ft	80	51	54	61
Children's Learning Center	460 ft	65	43	46	53
Kimble Learning Center	660 ft	65	40	43	50
Residential Development to the North	730 ft	65	39	42	49



### 3.4 GEOLOGICAL RESOURCES

#### 3.4.1 Definition of Resource

Geological resources are defined as the topography, geology, and geological hazards of a given area. Refer to Section 3.4, *Geological Resources*, on page 3-7 of the Programmatic EA (MARFORRES 2011) for more details.

#### 3.4.2 Existing Conditions

The proposed site is at an elevation of approximately 3,611 feet. It has flat topography and no valuable mineral deposits, paleontological resources, or unique geological features are located at or near the site. The project is located in a geologic region that is characterized by the stable core of the continent that has experienced little tectonic activity during the Cenozoic Era. The potential for seismic and faulting hazards is classified as minor in this region.

#### 3.4.3 Environmental Consequences

##### 3.4.3.1 Alternative 1

- *Analysis Item GR-1: Would site development result in a substantial alteration of topography or increase in erosion?*

The Alternative 1 project area is previously disturbed with flat topography and would require minimal grading. Because the project site is on flat terrain, the soil erosion risk is low for the project area. The construction footprint would be 0.45 acre and therefore, compliance with the state issued construction general permit (CGP) would not be required. However, erosion from grading and construction activities would be controlled through the use of appropriate erosion control BMPs such as sandbags, silt fences, earthen berms, fiber rolls, sediment traps, erosion control blankets, check dams in medium-sized channels, or straw bale dikes in smaller drain channels. Therefore, there would be no significant impacts to topography or soils.

There would be no impact during operation because there would be no ground disturbance following construction.

- *Analysis Item GR-2: Would construction result in the destruction of valuable mineral deposits, paleontological resources, or unique geological features?*

There are no valuable mineral deposits, paleontological resources, or unique geological features located at or near the project site. Therefore, there would be no impacts to mineral deposits, paleontological resources, or unique geological features.

- *Analysis Item GR-3: What potential impacts from geological hazards would exclude the project from consideration?*

The project site has flat topography and the potential for seismic and faulting hazards is classified as minor. The foundation would be designed to support the wind turbine based on soil boring tests performed at the site. Therefore, there would be no impacts from geological hazards under Alternative 1.

##### 3.4.3.2 Alternative 2

The impacts under Alternative 2 would be the same as those under Alternative 1 and would not be significant.



### 3.5 WATER RESOURCES

#### 3.5.1 Definition of Resource

Water resources as defined in this EA are sources of water available for use by humans, flora, or fauna, including surface water, groundwater, nearshore waters, wetlands, and floodplains. Refer to Section 3.5, *Water Resources*, on page 3-8 of the Programmatic EA (MARFORRES 2011) for more details.

#### 3.5.2 Existing Conditions

The only surface water features located near the proposed project footprint are the storm drain channel running through the Reserve Center (Figure 2-3) and T-Anchor Lake located to the south of the Reserve Center (Figure 1-2). T-Anchor Lake is a playa lake that was excavated and divided into sub-basins and is now used to manage stormwater runoff from the surrounding developed areas. The proposed project footprint contains no wetlands. However, both proposed turbine locations are located within the 100-year floodplain of T-Anchor Lake (Playa Lake 21), which has a 100-year base flood elevation of 3,616 ft. The surface area of Playa Lake 21 is approximately 77 acres when filled to the 100-year base flood elevation (Federal Emergency Management Agency [FEMA] 2010).

#### 3.5.3 Environmental Consequences

##### 3.5.3.1 Alternative 1

➤ *Analysis Item WR-1: Would construction or operations substantially degrade surface water quality?*

The construction footprint under Alternative 1 would be 0.45 acre and, therefore, compliance with the state issued CGP would not be required. However, appropriate BMPs would be implemented at the construction site as part of the proposed action to minimize increased runoff and erosion and subsequent impacts to surface water quality. These BMPs would minimize erosion and sedimentation from grading and construction activities (refer to Section 3.4.3.1 for a list of potential BMPs) and, therefore, minimize sedimentation of the adjacent storm drain channel and T-Anchor Lake.

During operations under Alternative 1, there would be potential to affect surface water quality due to increased runoff associated with impervious areas and from spills or leaks of contaminants associated with routine maintenance of the proposed wind turbine. The permanent project footprint would be 0.10 acre, resulting in only minor increases in storm runoff. The application of a spill prevention plan during routine maintenance activities would minimize potential impacts from contaminant spills.

Therefore, there would be no adverse impacts to surface water quality under Alternative 1.

➤ *Analysis Item WR-2: Would construction result in a substantial loss of the acreage or functionality of wetlands or Waters of the U.S.?*

The proposed project footprint contains no wetlands and is above the ordinary high water mark of T-Anchor Lake; therefore, there would be no impacts to wetlands or Waters of the U.S.

➤ *Analysis Item WR-3: Would the project be in compliance with EO 11988?*

The proposed turbine foundation, pad-mounted transformer, and a portion of the underground cable would be located within the 100-year floodplain of T-Anchor Lake (Playa Lake 21). Although an alternative location outside the 100-year floodplain would be preferable (per siting criteria identified in the Programmatic EA [MARFORRES 2011]), space is limited at the Reserve Center. The only locations suitable for installation of a wind turbine are along the southern edge of the Reserve Center (within the 100-year floodplain).



For development in a playa lake floodplain, the primary concern is that the development would result in an increase in base flood elevation due to decreased flood storage volume. However, the majority of the foundation, access road, and underground cable would not result in a change to topography (or subsequent decrease storage volume). To minimize the possibility of flood impacts to the new project components, the top of the turbine foundation (15-ft diameter) and transformer pad (8-ft by 8-ft) would be raised above ground to 1 ft above the base flood elevation. As a result, there would be some loss in flood storage volume during the 100-year flood. When considering that the surface area of Playa Lake 21 is approximately 77 acres while filled to the base flood elevation, and the project footprint above ground level (i.e., turbine base and transformer pad) would be approximately 0.0055 acres, the loss in flood storage volume would be negligible.

The City of Amarillo Engineering Department oversees development in flood zones (such as playas) in Amarillo. For any development below the base (100-year) flood level, the City of Amarillo requires that compensation to the loss of storage volume be made such that there is no increase in the post development base flood level. Acceptable compensation measures include excavation, pumping, gravity draining, or a combination of these measures (City of Amarillo 2008). To address this concern, MARFORRES contacted the City of Amarillo Engineering Department. The Department's representative confirmed that a wind turbine was an appropriate use in that area, that the proposed development would not cause an appreciable loss of storage volume or contribute to flooding, and that compensation or other measures would not be required (City of Amarillo Engineering Department 2011).

Insofar as there is no practicable alternative location above the base flood elevation of Playa Lake 21, and the project would not have an adverse impact on flooding or the floodplain, the project would be in compliance with EO 11988 and would not have a significant impact.

#### 3.5.3.2 Alternative 2

The impacts under Alternative 2 would be the same as those under Alternative 1 and would not be significant.

### **3.6 BIOLOGICAL RESOURCES**

#### **3.6.1 Definition of Resource**

Biological resources include native and naturalized plants and animals and the habitats in which they occur. As discussed in the Programmatic EA (MARFORRES 2011), the resources of primary concern with respect to small-scale wind energy projects include (1) protected habitats and the species they support; (2) ESA-listed, proposed, or candidate species; (3) bald and golden eagles; (4) migratory birds and bats; and (5) other species of conservation concern recognized at the state or federal level. Plants and animals are referred to by common names in this section; the corresponding scientific names can be found in the Integrated Taxonomic Information System ([www.itis.gov](http://www.itis.gov)).

#### **3.6.2 Existing Conditions**

A site reconnaissance survey was conducted in June 2011, and the corresponding report is provided in Appendix B. The two alternative sites under consideration are in already developed areas separated by a concrete drainage channel within the Reserve Center off of Tee Anchor Blvd. Alternative 1 would be constructed within a mowed grassy area with a single small tree at its center, whereas Alternative 2 would be constructed partly on pavement and partly in another mowed area (Figure 2-3). The alternative sites are adjacent to T-Anchor Lake, which is a remnant playa lake that was excavated and divided into sub-basins, and is now used to manage stormwater runoff from the surrounding developed areas. A small



drainage with riparian habitat lies between the basins and the Reserve Center property. The basins hold water most of the time and are surrounded by ruderal vegetation, shrubs and trees (Appendix B); the basins and associated vegetation are managed by the City of Amarillo.

### 3.6.3 Environmental Consequences

#### 3.6.3.1 Alternative 1

- *Analysis Item BR-1: Would the project destroy or substantially degrade a legally or Integrated Natural Resources Management Plan (INRMP)-protected habitat or resource (including protected species)?*

There are no legally protected habitats such as wetlands or other waters of the U.S., or habitat that would support protected species on the project site. There is no federally designated critical habitat for ESA-listed species on or near the property. The combined Navy-USMC property lacks sufficient natural resources to have warranted an INRMP. The adjacent stormwater ponds and surrounding vegetation at T-Anchor Lake are used by wildlife (Appendix B). Given the extent of development, traffic noise from Highway 287 and Interstate 40, and human activity in the areas surrounding T-Anchor Lake, no disturbance to wildlife is anticipated during construction. Based on the noise analysis (Section 3.3), the turbine would be relatively quiet when operating and would be only intermittently audible, if at all, in comparison to traffic noise from the surrounding roadways. No noise impacts on wildlife are anticipated.

- *Analysis Item BR-2: Would the project result in take of an ESA-listed, proposed, or candidate bird or bat species?*

Since the proposed action would not involve any disturbance to previously undeveloped land, its only potential effects would be to flying animals. The only ESA-listed bird or bat species listed by USFWS as occurring in Potter County is the whooping crane (USFWS 2011), which could only occur as a rare transient during migration. The Amarillo region is well outside of the whooping crane migration corridor, as mapped by USFWS (2009), and the possibility that a whooping crane would stop at this location in the middle of Amarillo is remote and discountable. The endangered interior least tern is reported by the Texas Parks and Wildlife Division (TPWD) as occurring in Potter County (TPWD 2010). Interior least terns occur along braided streams and rivers and nest on sand and gravel bars; they feed on fish and crustaceans (TPWD 2010). Interior least terns are not known or expected to occur at the project site or at T-Anchor Lake because of the absence of prey resources or suitable nesting or resting habitat. Hence, the proposed action will have no effect to threatened or endangered species nor result in the destruction or adverse modification of federally-designated critical habitat.

The mountain plover, a candidate species, also occurs in Potter County (TPWD 2010, Texas Natural Diversity Database 2010). Mountain plovers breed in Texas, but require high plains or short grass prairie for nesting and foraging, and they also utilize agricultural fields during non-breeding seasons. These habitat types are not present on the proposed site or within T-Anchor Lake; hence, no occurrence of, or effect on, this species would be anticipated.

- *Analysis Item BR-3: Is the project likely to result in injury or mortality to a bald or golden eagle?*

The last time bald eagles nested in this part of the Texas Panhandle was in 1916, in Palo Duro Canyon (Boal *et al.* 2006). Migrating or wintering bald eagles can occur in Potter County (TPWD 2010), but the nearest areas where they are regularly seen are in Randall County at Lake Tanglewood and Palo Duro Canyon, both of which are approximately 10 miles south of the proposed site. Bald eagles also commonly occur at Buffalo Lake National Wildlife Refuge 25 miles southwest of the proposed site



(USFWS 1997). There are no resources that would attract bald eagles to the vicinity of the proposed site or to T-Anchor Lake and they are unlikely to pass through the area during migration. Golden eagles are rare in the Texas Panhandle (Boal *et al.* 2008) and do not occur in Potter County (TPWD 2010). For these reasons, neither bald nor golden eagles are likely to occur in the area of the proposed turbine. The proposed action would have no impact on either species and does not require a permit or further action under the BGEPA.

- *Analysis Item BR-4: Is the project site in a known high-use regional migratory flyway for birds, or within a local bird and/or bat high-use movement corridor, breeding, roosting, wintering, hibernacula, or “stop-over” site, resulting in a high likelihood and frequency of collisions?*

Migratory Birds. The Texas Panhandle region is located along a spur of the Central Flyway that merges with the main portion of the flyway further south along the Gulf Coast. Some scientists estimate that between 1.5 and 3 million dabbling ducks migrate through this portion of the Texas Panhandle each year during migration. The Audubon Society has not identified any Important Bird Areas in the Panhandle region. While the land surrounding Amarillo contains important stopover habitats for migratory birds, especially waterfowl (Shackelford *et al.* 2005), the developed nature of the proposed site and surrounding environs make it unlikely that large numbers of migratory birds would use the area. The list of species observed on and adjacent to the property (Appendix B) includes a mix of prairie-, water-, and woodland-associated birds and urban species. Because the site is in a developed area bordered by the highway and further development, there would be no direct loss or fragmentation of habitat for migratory birds. Given the surrounding urban noise and activity, it is doubtful that construction or operational noise would have any impact on birds that might use T-Anchor Lake.

Given the small size of the proposed turbine and its location within a developed area, the risk of bird collisions is relatively low. By reference to published information on bird fatalities at wind turbines (MARFORRES 2011), the proposed turbine is expected to result in bird fatalities within the lower half of the spectrum observed at wind turbine sites, which would suggest not more than one individual per year for a single, 100 kW turbine. Hence, the likelihood of affecting a rare species or having any population-level effect is very low.

Refer to Analysis Item BR-5 below for additional discussion of species of concern.

Bats. Based on Davis and Schmidley (1994), the proposed site is within the distributional ranges of 12 species of bats, including western small-footed myotis, eastern pipistrelle, cave myotis, silver-haired bat, western pipistrelle, big brown bat, eastern red bat, hoary bat, Townsend’s big-eared bat, pallid bat, Brazilian free-tailed bat, and big free-tailed bat. No site-specific data are available on the occurrence of bats at the proposed site. The presence of water in T-Anchor Lake suggests the possibility of foraging habitat for bats, but this would be a small “island” surrounded by urban development. In contrast, to the south in Randall County, there are numerous playa lakes and other natural and man-made water bodies amid an extensive and less-developed agricultural landscape. Hence, the placement of a wind turbine at the site would present a relatively low risk of mortality to bats.

By reference to published information on bat fatalities at wind turbines (MARFORRES 2011), the proposed turbine is expected to result in bat fatalities that would be less than those documented at wind energy developments in agricultural or forested areas. This suggests bat fatalities of approximately one individual per year for a single 100 kW turbine.



- *Analysis Item BR-5: Would the project result in collisions and mortality to a bird of conservation concern or state species of concern?*

While all migratory birds are protected under the MBTA, species of concern are afforded special consideration. Potter County lies within Bird Conservation Region (BCR) #18, “Short Grass Prairie” (USFWS 2008). USFWS-designated Birds of Conservation Concern (BCC) that are known or suspected to occur in Potter County (other than those mentioned previously) include prairie falcon, upland sandpiper, long-billed curlew, Lewis’s woodpecker, burrowing owl, willow flycatcher, Bell’s vireo, Sprague’s pipit, lark bunting, and McCown’s longspur (Seyffert 2001). In addition, the state-listed threatened peregrine falcon occurs in Potter County (TPWD 2010, Seyffert 2001). However, the only species for which there is recent documentation of occurrence within 10 miles of the proposed site (based on sightings posted on eBird within the past 5 years) is the burrowing owl (2010, 5 miles east at Amarillo Airport) (eBird 2010). Based on the condition and surroundings of the proposed site, only transient occurrence, if any, of these species of concern is expected. None of these species were observed during the site reconnaissance survey (Appendix B), although the band-tailed pigeon, a species of concern in New Mexico, was observed; this was apparently a transient occurrence since that species is not known to breed in Texas.

In conclusion, biological resource impacts would be limited to a relatively low incidence of collision mortality to birds and bats, which would be on the order of a single individual per year which most likely affect common species and would not be expected to have any population-level effect. These impacts would not be significant.

#### 3.6.3.2 Alternative 2

The impacts of Alternative 2 would be the same as those of Alternative 1 and would not be significant.

### 3.7 CULTURAL RESOURCES

#### 3.7.1 Definition of Resource

As described in the Programmatic EA (MARFORRES 2011), cultural resources can be present within landscapes as districts, sites, buildings, structures, or objects, and also include Traditional Cultural Properties (TCPs), locations with enduring significance to the beliefs, customs, and/or practices of living communities. TCPs are considered eligible for nomination to the NRHP if they are associated with cultural practices or beliefs of a living community that are (a) rooted in the community’s history and (b) important in maintaining the continuing cultural identity of the community. Culturally sensitive locations called Areas of Native American Concern which may not be considered eligible for nomination to the NRHP may still be protected under the American Indian Religious Freedom Act.

Cultural resources that are currently listed in or have been determined eligible for listing in the NRHP are termed “historic properties.” Historic properties can include both prehistoric (prior to European contact) and historic (post-European contact) objects, sites, buildings, structures, and districts as well as TCPs. All historic properties within a project area constitute the affected environment for cultural resources.

The placement, design, construction, and operation of small wind energy facilities have the potential to affect historic properties lying within the Area of Potential Effects (APE) of the project. Two types of APE’s are defined for historic properties. A physical APE is the actual surface area that will be disturbed and includes the actual footprint of the proposed wind turbine tower foundation and the associated facilities to include access roads/areas, underground utility lines, and transformers as well as any associated temporary work spaces. For the current proposed action, the physical APE amounts to a total



of 0.45 acre. A visual APE is the area surrounding the turbine where it would be visible to the casual observer. Because the Texas SHPO (Texas Historical Commission) does not have specific guidelines for the visual effects of wind turbines (Henderson 2011), the analysis follows the guidelines for communications towers under the nationwide Programmatic Agreement with the Federal Communications Commission (FCC). For structures 100 to 200 ft in height (the proposed turbine would have a total height of 155 ft), the visual APE is defined as 0.5 mile. The effects on historic properties can be direct, indirect, and cumulative. All historic properties within a project's physical and visual APE constitute the Affected Environment for cultural resources. Additional information on the definition of this resource can be found in the Programmatic EA for the project (MARFORRES 2011).

### 3.7.2 Existing Conditions

A search of the database at the Texas Archaeological Research Laboratory (TARL) indicates that there are no known archaeological sites within 1 mile of the Reserve Center and no sites within the boundaries of the Reserve Center itself. Archaeological sites have been reported in the local press around the T-Anchor Lake, approximately 360 ft south of the Reserve Center, including a 2,600 year old burial (Welch 2009, Steed 2009). The Reserve Center is underlain by Pleistocene age loess (windblown silt) which is known to be sensitive for archaeological sites. The soils at the Reserve Center are classified as Urban land and Lofton-Urban land complex (Hardy-Heck-Moore, Inc. [HHM] 2004), with a majority (92%) located on Urban land soils and only the northeast corner of the facility located on Lofton-Urban land complex soils (U.S. Department of Agriculture [USDA] 2011). Urban land soils are highly disturbed soils that lack any integrity and thus their origins are unknown. The Lofton-Urban complex soils form in lacustrine deposits from the Pleistocene age Blackwater Draw formation (USDA 2011). A majority of the soils present at the Reserve Center have been highly impacted by construction activities associated with buildings, parking lots, walkways, and landscaped areas, and are unlikely to contain any intact archaeological deposits.

The buildings and structures at the Reserve Center were evaluated for eligibility to the NRHP in 2004 as part of a nationwide survey of Naval and MARFORRES Centers (HHM 2004). The two buildings (Administration/Training Facility and Vehicle Maintenance Facility) located at the Reserve Center at the time of the survey were constructed in 1990 and thus did not meet the 50-year threshold for historic properties. Additionally, the buildings were not considered to be significant to meet NRHP Eligibility Criteria Consideration G for structures less than 50 years old (HHM 2004).

A search of the TARL database revealed that there are no historic properties within the 0.5 mile visual APE for structures. All known historic properties including several historic districts (Route 66, Oliver-Eagle Addition, and Wolfen) in the city of Amarillo are located more than a mile away from the Reserve Center, to the west. Given the degree of development in the area around the Reserve Center, a single wind turbine 155 ft tall is unlikely to be visible from any historic property in Amarillo. There are no known TCPs or Areas of Native American Concern associated with the Reserve Center and the immediate surrounding area.

### 3.7.3 Environmental Consequences

#### 3.7.3.1 Alternative 1

- *Analysis Item CR-1: Would construction or operations result in adverse effects to a historic property?*

The construction and operation of a single wind turbine at the Reserve Center would not affect any known historic properties or other cultural resources within the APE of Alternative 1. The proposed location of



the wind turbine is in a previously disturbed, landscaped area at the southern edge of the facility. The underground cable would traverse previously disturbed, landscaped areas to the tie-in with an existing transformer approximately 375 ft to the north. There are no known archaeological sites within the Reserve Center boundaries and the potential for undetected subsurface cultural resources is extremely low given the degree of development that has occurred. However, as indicated in *Construction BMP #17* in the event of an inadvertent discovery of a potential cultural resource during site construction, construction activity at that location would cease until the potential resource is evaluated by a qualified archaeologist and/or Tribal representative(s), as appropriate. Construction may proceed once the discovery is determined to have no potential significance, subject to the completion of documentation and consultation with the SHPO, if required. If applicable, procedures required under the Native American Graves and Repatriation Act (43 CFR Part 10) will be followed.

None of the existing structures at the Reserve Center or within a 1 mile area around the proposed turbine have been determined to be eligible for the NRHP and thus there is no effect. Section 106 NHPA consultation has been concluded with a letter of concurrence with a finding of “no historic properties affected” from the Texas SHPO (Appendix D). Therefore, there would be no impact to cultural resources under Alternative 1.

#### 3.7.3.2 Alternative 2

➤ *Analysis Item CR-1: Would construction or operations result in adverse effects to a historic property?*

The impacts of Alternative 2 would be the same as those of Alternative 1 and would not be significant.

### 3.8 VISUAL RESOURCES

#### 3.8.1 Definition of Resource

Visual resources are the natural and cultural features that make up the landscape of a viewer from a vantage point. The features include the land, water, vegetation, structures, and other features within the viewshed of a casual observer. Impacts to the visual environment are measured by the degree of change that a proposed action causes to the viewshed of a viewer from a vantage point. Wind turbines have the potential to impact the visual environment by introducing a new and highly conspicuous feature to the viewshed of a casual viewer.

The rotating blades of a wind turbine can produce shadow flicker, which is the alternation of light and shadow caused by blade rotation when the turbine is in line of sight between the sun and another object or person. The potential effects of shadow flicker on individuals and land uses, as well as sensitive visual resources in affected areas, need to be considered as part of the visual analysis. Sensitive receptors include residential areas, schools, and office buildings. Sensitive receptors within 10 rotor diameters (690 ft) are considered in this analysis; at greater distances, shadow flicker becomes imperceptible due to the small relative size and low angle of the rotor to the viewer.

Additional information on the definition of this resource can be found in the Programmatic EA for the project (MARFORRES 2011).

#### 3.8.2 Existing Conditions

The general landscape of the Amarillo area is that of flat, gently rolling plains characteristic of the Southern Plains. Numerous tall buildings, especially the Chase Tower (350 feet high), form the skyline of downtown Amarillo, 1-2 miles west of the project area. Otherwise, the urban environment of Amarillo



is dominated by regular, blocky, rectangular- and square-shaped, low profile buildings, and both short and tall vertical structures (light poles, utility poles, radio towers) and long, linear, parallel roadways, sidewalks, and utility lines. The lines in the built environment of Amarillo are straight, sharp, and bold and the overall texture of the built environment is coarse, rough, and bumpy. Colors of the buildings and structures are light, dull, and subtle consisting primarily of browns and grays. Light browns, dark reds, dark greens, and light greens are present in the open areas (landscaped areas, city parks, unpaved parking lots, etc.).

There are two receptors that are potentially sensitive to shadow flicker within 690 ft of Alternative 2: the Children's Learning Center and the Kimble Learning Center, approximately 450 ft and 600 ft west, respectively. There are no receptors sensitive to shadow flicker within 690 ft of Alternative 1. The Reserve Center building is not considered a sensitive shadow receptor for either alternative because of limited views from the south and west sides facing the turbine locations.

### 3.8.3 Environmental Consequences

#### 3.8.3.1 Alternative 1

➤ *Analysis Item VR-1: Would the wind turbine result in impacts to visual resources?*

The proposed wind turbine would have a weak to moderate degree of contrast with the surrounding landscape. The straight, linear form of the wind turbine would have virtually no contrast with the straight, linear form of the light poles and radio towers, but a high contrast with blocky, rectangular- and square-shaped forms of the buildings that are present. The net cumulative effect is a moderate contrast with regards to the forms in the existing landscape. The bold, straight lines of the proposed wind turbine would have no contrast with the bold straight lines of the existing structures (light poles and radio towers) and roads of the built environment. The white color of the proposed wind turbine would have a moderate contrast with the colors in the existing built environment which are dominated by dull, light browns and grays.

The analysis of visual impact was carried out from a Key Observation Point (KOP) located approximately 0.5 mile away (Figure 3.8-1). At this distance, the wind turbine would catch the attention of a casual observer but not dominate the landscape. As shown in Figure 3.8-1, the turbine would have strong contrast with low profile buildings, but have a low contrast with the adjacent radio tower, utility poles, and streetlamps. There would be a moderate contrast with the colors in the landscape, but at distances greater than 0.5 mile, the contrasts will become weak with both the forms and colors in the landscape and would only be observable but not draw the attention of a casual observer. Because of its low to moderate contrast with other structures and the developed character of the immediately surrounding landscape, the visual impact of the turbine would not be significant.

➤ *Analysis Item VR-2: Would shadow flicker result in impacts to nearby residential or office buildings?*

There are no sensitive receptors within the vicinity of the proposed wind tower structure. As such, there would be no shadow flicker impacts to sensitive receptors.

#### 3.8.3.2 Alternative 2

➤ *Analysis Item VR-1: Would the wind turbine result in impacts to visual resources?*

The impacts to visual resources under Alternative 2 would be the same as those under Alternative 1 and would not be significant.



➤ *Analysis Item VR-2: Would shadow flicker result in impacts to nearby residential or office buildings?*

The proposed wind turbine under Alternative 2 would be expected to produce a limited amount of shadow flicker near the rear exits at the southeast corners of the Children’s Learning Center and the Kimble



Learning Center. Importantly, children generally do not use these areas of the facilities. In the worst-case scenario, in which clouds never obscure the sun, the wind is always blowing, and the wind is always in line with the sun, the Children's Learning Center and the Kimble Learning Center would respectively not receive more than 30 and 14 hours of shadow flicker annually. Based on real sun and wind conditions, it is expected that these two learning centers would respectively receive less than 12 and 6 hours of shadow flicker annually. If shadow flicker were received, it would generally be from mid-January through mid-February between 8:30 a.m. and 9:30 a.m., or from late October through late-November between 7:45 a.m. and 9:45 a.m. (refer to Appendix C, *Shadow Flicker Analysis*, for additional details on how the analysis was performed as well as the full results). Therefore, operation of the proposed wind turbine would not result in significant impacts to nearby residential or office buildings.

### **3.9 SOCIOECONOMICS**

#### **3.9.1 Definition of Resource**

Socioeconomics is defined as the basic attributes and resources associated with the human environment, particularly population and economic activity. Economic activity typically encompasses employment, personal income, and industrial growth. Impacts on these fundamental socioeconomic components can influence other issues such as housing availability, utility capabilities, and fire and police protection.

Disadvantaged groups within the study area are specifically considered in order to assess the potential for disproportionate occurrence of impacts. Disadvantaged groups include minority, low-income, and youth (under the age of 18) populations.

#### **3.9.2 Existing Conditions**

Potter County has a population of 120,561, with 63.2% in the labor force, and a median income of \$35,817 (U.S. Census Bureau 2010). Potter County has a minority population of 28.7%, a population of 19.3% below the poverty level, and a population of 28.7% under the age of 18 (U.S. Census Bureau 2010).

#### **3.9.3 Environmental Consequences**

##### **3.9.3.1 Alternative 1**

➤ *Analysis Item SO-1: Would the proposed action result in a moderate to severe adverse impact to socioeconomics?*

Alternative 1 would not impact or would only negligibly impact socioeconomic conditions and impacts would be beneficial such as short-term construction jobs (the construction phase typically is from 1 to 3 months) and long-term maintenance needs (the life of the project). Most repairs and maintenance activities would be conducted by operations and maintenance contractor crews which would contribute to income, employment, and possibly housing in the area. Some monitoring and maintenance would be conducted by on-site engineering and maintenance personnel. Apart from the long-term economic benefits of deploying a local renewable energy resource to reduce demand on the grid, the amount of energy conserved and the resulting savings to MARFORRES would be too small to have an impact on the electricity provider, which in any case is able to adjust rates and fees (including interconnect charges) to remain profitable. Therefore, impacts on socioeconomics would be minor.



- *Analysis Item SO-2: Would the proposed action adversely affect children or have a disproportionate adverse effect on a low-income or minority community?*

Because the project location would be within a MARFORRES facility, Alternative 1 would not impact or would only negligibly impact low-income or minority communities and children. If local low income and/or minority labor forces are used, and impacts would be beneficial such as short-term construction jobs (the construction phase typically is from 1 to 3 months) and long-term maintenance needs (the life of the project). Therefore, impacts on children or a low-income or minority community would be minor.

### 3.9.3.2 Alternative 2

The socioeconomic impacts under Alternative 2 would be the same as those of Alternative 1 and would not be significant.

## 3.10 AIR QUALITY

### 3.10.1 Definition of Resource

Air quality is defined by ambient air concentrations of specific pollutants determined by the USEPA to be of concern with respect to the health and welfare of the general public. Seven major pollutants of concern, called “criteria pollutants,” are carbon monoxide (CO), sulfur dioxide (SO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>), ozone (O<sub>3</sub>), suspended particulate matter less than or equal to 10 microns in diameter (PM<sub>10</sub>), fine particulate matter less than or equal to 2.5 microns in diameter (PM<sub>2.5</sub>), and lead (Pb). SO<sub>2</sub> and NO<sub>2</sub> are commonly referred to and reported as oxides of sulfur (SO<sub>x</sub>) and oxides of nitrogen (NO<sub>x</sub>), respectively. Volatile organic compounds (VOCs) and NO<sub>x</sub> do not have established ambient standards but are important as precursors to O<sub>3</sub>. The USEPA has established National Ambient Air Quality Standards (NAAQS) for these pollutants. Section 176(c) of the 1990 CAA Amendments contains the General Conformity Rule (40 CFR §§ 51.850-860 and 40 CFR §§ 93.150-160). The General Conformity Rule (updated March 24, 2010) requires any federal agency responsible for an action in a nonattainment or maintenance area to determine that the action conforms to the applicable State Implementation Plan (SIP). Actions would conform to a SIP if their annual direct and indirect emissions remain less than the applicable *de minimis* thresholds. Formal conformity determinations are required for any actions that exceed these thresholds. Emissions of attainment pollutants are exempt from conformity analyses.

GHGs are gases that trap heat in the atmosphere. The most common GHGs emitted from natural processes and human activities include carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O). Each GHG is assigned a global warming potential (GWP). Total GHG emissions from a source are often reported as a CO<sub>2</sub> equivalent (CO<sub>2</sub>e). The CO<sub>2</sub>e is calculated by multiplying the emission of each GHG by its GWP and adding the results together to produce a single, combined emission rate representing all GHGs.

In the CAA Amendments of 1977, Congress specified the initial classification of lands for Prevention of Significant Deterioration (PSD) purposes. Certain lands, where existing air quality is “good” and is deemed to be of national importance, were designated as Class I and may not be reclassified. These mandatory Class I areas include all international parks, national memorial parks larger than 5,000 acres, and national parks larger than 6,000 acres that were in existence when the Amendments were passed. All other areas to which the PSD provisions apply were classified as Class II. These areas are granted special air quality protections under Section 162(a) of the federal CAA. 40 CFR § 51.307 requires the operator of any new major stationary source or major modification located within 100 kilometers of a Class I area to contact the federal land managers for that area. Locations and managing entities are listed at <http://www.epa.gov/visibility/class1.html>.



### 3.10.2 Existing Conditions

Amarillo, TX is located within Potter and Randall counties, and is part of Air Quality Control Region (AQCR) 211 – Amarillo-Lubbock Intrastate. This area attains the NAAQS for all criteria pollutants. For conformity rule applicability, *de minimis* thresholds only apply to nonattainment or maintenance areas; therefore, *de minimis* thresholds are not applicable for this area. There are no Class I areas within 100 km of the project area.

### 3.10.3 Environmental Consequences

#### 3.10.3.1 Alternative 1

- *Analysis Item AQ-1: Would construction or operational emissions exceed applicable de minimis thresholds, requiring a Conformity Determination, and if so, would emissions fail to conform to the applicable SIP?*

Emission sources associated with the proposed action would involve construction and operation of a single, relatively small (100-kW) wind turbine. Consistent with the Programmatic EA for the MARFORRES Wind Energy Program, the construction footprint for a 100-kW turbine would be approximately 0.45 acre and the use of heavy equipment during construction would be approximately 1 month (30 days). Estimated construction emissions due to implementation of the proposed action are shown in Table 3.10-1. Although *de minimis* thresholds do not apply to attainment areas, the estimated construction emissions would be below conformity *de minimis* levels even if the project site was within a nonattainment area. Appendix A includes a Record of Non-Applicability (RONA) for CAA Conformity for this project, which was signed on 8 June 2011 (Appendix A).

**Table 3.10-1. Estimated Emissions Resulting from Implementation of the Proposed Action**

Estimated Construction Emissions (duration 1 month)	Emissions (tons/year)					
	CO	VOCs	NO <sub>x</sub>	SO <sub>x</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>
One 100-kW Turbine	0.53	0.13	1.14	0.00	0.09	0.06
<i>de minimis</i> threshold <sup>1</sup>	NA	NA	NA	NA	NA	NA
Exceeds <i>de minimis</i> threshold?	No	No	No	No	No	No

Note: <sup>1</sup> Potter and Randall counties are in attainment of the NAAQS for all criteria pollutants. NA= not applicable; *de minimis* thresholds do not apply to attainment areas.

Sources: 40 CFR Part 81 § 81.344 – Texas; USEPA 2011a, b.

Operations and maintenance of the turbine would typically consist of two to three people who would visit the site approximately six times per year. These visits would consist of maintenance personnel driving a vehicle to and around the site. Emissions associated with these activities would be minimal and short-term and would not result in a major increase in air emissions.

One of the most important benefits of wind energy is that the production of electricity from wind power involves zero direct emissions of air pollutants. The energy output generated from wind turbines, with zero emissions of air pollutants, would displace roughly the same energy output that would otherwise be generated by a fossil fuel-powered plant, which generates GHGs and other harmful air pollutants. Table 3.10-2 includes the typical energy output under the proposed action, which amounts to the electricity savings per year that would no longer need to be generated by a fossil fuel-powered plant (coal, oil, or natural gas).



**Table 3.10-2. Range of Energy Output under the Proposed Action**

<i>Proposed Action</i>	<i>Energy Output (MWh/yr)</i>
One 100-kW Turbine	88 – 440

Therefore, operational activities associated with the proposed action would result in beneficial impacts to air quality by adding wind energy to the utility grid and replacing or reducing the use of fossil fuel-powered plants with more efficient and flexible types of power generation.

➤ *Analysis Item AQ-2: Would the proposed action contribute to global climate change?*

Currently, there are no formally adopted or published NEPA thresholds for GHG emissions. On 18 February 2010, the CEQ released draft guidance for addressing climate change in NEPA documents (CEQ 2010). The draft guidance recommends quantification of GHG emissions; however, the guidance is being substantively revised in light of comments and will be issued for a second comment period in 2011. Therefore, formulating significance criteria for GHG emissions is problematic, as it is difficult to determine what level of proposed emissions would substantially contribute to global climate change. In the case of wind energy projects, GHG emissions associated with construction would be expected to be somewhat off-set or reduced by the beneficial effects of adding wind energy to the utility grid; therefore, the wind energy project would likely contribute to an overall beneficial impact to global climate change in the region.

Construction Impacts

Estimated GHG emissions associated with construction activities under the proposed action scenarios are shown in Table 3.10-3.

**Table 3.10-3. Estimated GHG Emissions under the Proposed Action**

<i>Proposed Action Scenario</i>	<i>Metric Tons<sup>1</sup></i>			
	<i>CO<sub>2</sub></i>	<i>CH<sub>4</sub></i>	<i>N<sub>2</sub>O</i>	<i>CO<sub>2</sub>e</i>
One 100-kW Turbine	103.33	0.01	0.10	134

Notes: <sup>1</sup>CO<sub>2</sub>e = (CO<sub>2</sub> \* 1) + (CH<sub>4</sub>\* 21) + (N<sub>2</sub>O \* 310)

Compared with the estimated 7,054 million metric tons of GHG emissions from all construction in the U.S. in 2006 (USEPA 2008), construction associated with the proposed action would be negligible and would not significantly contribute to global climate change.

Operational Impacts

Operational impacts would be the same as those discussed under *Analysis Item AQ-1*. Operation of the wind turbines proposed under the proposed action would result in a reduction in GHG emissions and other harmful air pollutants. Therefore, the proposed action would negligibly contribute to global climate change and beneficial impacts to air quality would occur.

➤ *Analysis Item AQ-3: Would the proposed action result in impacts to Class I areas?*

There are no Class I areas within 100 km of the project area; therefore, Alternative 1 would not impact any Class I areas.



### 3.10.3.2 Alternative 2

- *Analysis Item AQ-1: Would construction or operational emissions exceed applicable de minimis thresholds, requiring a Conformity Determination, and if so, would emissions fail to conform to the applicable SIP?*

Potential impacts for Alternative 2 would be the same as for Alternative 1. Therefore, construction and operation of the proposed turbine would negligibly impact air quality.

- *Analysis Item AQ-2: Would the proposed action contribute to global climate change?*

Potential impacts for Alternative 2 would be the same as for Alternative 1. Therefore, construction and operation of the proposed turbine would negligibly contribute to global climate change.

- *Analysis Item AQ-3: Would the proposed action result in impacts to Class 1 areas?*

There are no Class I areas within 100 km of the project area; therefore, Alternative 2 would not impact any Class 1 areas.

## 3.11 UTILITIES

### 3.11.1 Definition of Resource

Utilities are defined as services such as electricity, natural gas, telephone, potable water, and sewage systems, which are typically provided by either public or private service companies (i.e., electricity, natural gas, and telephone) or municipalities (i.e., water and sewer systems). Each type of utility has its own associated infrastructure, such as pipelines, cables, conduits, electrical substations, and pumping stations, which allow for the provision of services to a specific location.

### 3.11.2 Existing Conditions

Both underground and overhead utilities are present at the Reserve Center. The existing utilities are owned and/or operated by the City of Amarillo Utilities Division (drinking water and sewer lines), Xcel Energy (electrical lines), Atmos Energy (natural gas lines), and AT&T Texas (telephone lines).

### 3.11.3 Environmental Consequences

#### 3.11.3.1 Alternative 1

- *Analysis Item UT-1: Would installation of the wind turbine(s) and associated infrastructure (e.g., new power lines) conflict with existing utility systems (e.g., power lines or buried pipelines)?*

Prior to any construction activities under Alternative 1, the local “One-Call Center” would be contacted to obtain detailed information on the location and depth of all existing utility lines in the project area. If existing utilities are identified within the project footprint and would potentially be impacted by construction activities, the project footprint or any trenching/excavation activities would be realigned to avoid impacts to existing utilities. Therefore, with implementation of the procedures discussed above, no impacts to existing utilities infrastructure would occur.

- *Analysis Item UT-2: Would the additional power generated by the new wind turbine(s) require installation of additional power lines?*

Under Alternative 1, the power output at full generation capacity would be 100 kW for the proposed wind turbine. For this small increase in electricity, existing electrical lines would typically have sufficient capacity. However, prior to any connection to the existing power grid, an Interconnect Agreement would be established between MARFORRES and Xcel Energy. The Interconnect Agreement would consider



the existing capacity and identify any necessary upgrades, modifications, or need for installation of additional power lines to accommodate project electricity generation. The upgrades/modifications identified in the Interconnect Agreement would be implemented as part of the proposed action prior to connection to the area's electricity distribution grid. Therefore, no impacts or minor impacts to electrical utility systems would occur with implementation of the proposed action.

#### 3.11.3.2 Alternative 2

The impacts under Alternative 2 would be the same as those under Alternative 1 and would not be significant.

### 3.12 AIRSPACE

#### 3.12.1 Definition of Resource

The nation's airspace is designed and managed by the FAA to meet both the individual and common needs of all military, commercial, and general aviation interests. Navigable airspace is categorized as either regulatory or nonregulatory. Within those two categories are four types of airspace: Controlled, Special Use, Uncontrolled, and Other. Airspace is further defined in terms of classifications according to the operating and flight rules that apply to each airspace area. The manner in which airspace is classified depends on (1) the complexity or density of aircraft operations within an airspace area; (2) the nature of those operations; (3) the level of safety required; and (4) national and public interest. Refer to the Programmatic EA (MARFORRES 2011) for detailed descriptions of the different airspace types and classifications. The operation of radars, television, radio, and cellular signals is also considered part of this resource.

#### 3.12.2 Existing Conditions

The Reserve Center is located approximately 4.4 miles (3.8 nautical miles) west of the Rick Husband Amarillo International Airport, under the airport's Class C airspace, and approximately 1.9 miles (1.5 nautical miles) from Tradewind Airport. There is a next generation weather radar (NEXRAD) station on the north side of Amarillo International Airport, 6.1 miles (5.3 nautical miles) from the project site. A radio tower for KJRT (88.3 FM) is located approximately 920 ft west of Alternative 1, or 610 ft west of Alternative 2. The proposed turbine location is not overlapped by any Special Use Airspace.

#### 3.12.3 Environmental Consequences

##### 3.12.3.1 Alternative 1

- *Analysis Item AS-1: Does the proposed project pose an operational problem for a particular airport resulting in a FAA issued Determination of Hazard (DOH)?*

No potential problems with airport operations have been identified. The proposed action has been coordinated with FAA and received a "Determination of No Hazard to Air Navigation" (Appendix D).

- *Analysis Item AS-2: Does the proposed project affect Visual Flight Rules (VFR) or Instrument Flight Rules (IFR) operations in the navigable airspace?*

No effects on military air or other VFR or IFR operations have been identified. The proposed action has been coordinated with FAA and received a "Determination of No Hazard to Air Navigation" (Appendix D).



- *Analysis Item AS-3: Does the proposed project result in EMI (radar, television interference, frequency modulation [FM] radio interference, cellular phone, satellite services)?*

The turbine design minimizes the potential for EMI because the rotor is of non-metallic composition and because power is produced by a brushless, permanent magnet generator. Due to the design and the fact that the proposed action is a single turbine of relatively small size and would be well removed from the NEXRAD station, the turbine is not expected to have any effect on NEXRAD operations. Similarly, the single small turbine is not expected to have any effect on the transmission or reception of television, radio, or cellular signals.

In conclusion, Alternative 1 would not have a significant impact on airspace.

#### 3.12.3.2 Alternative 2

Impacts of Alternative 2 would be the same as those of Alternative 1 and would not be significant.

### 3.13 HEALTH AND SAFETY

#### 3.13.1 Definition of Resource

Any aspect of the project that creates a potential risk to human health and safety requires consideration under NEPA. This includes occupational hazards to workers as well as the exposure of the general public to conditions creating the risk of immediate injury or long-term health hazards. The latter may include indirect effects related to noise, utilities, airspace, and hazardous materials, respectively, which are addressed in separate sections of this chapter.

#### 3.13.2 Existing Conditions

The Alternative 1 location is a small grass field surrounded by the Reserve Center's parking lot 40 ft to the east, the Reserve Center's main building 150 ft to the north, and a publicly accessible stormwater retention basin known as T-Anchor Lake, approximately 50 ft to the west and to the south. The nearest trail within T-Anchor Lake is located 140 ft south of the proposed wind turbine and is separated from the Reserve Center by a fence along the Reserve Center's boundary as well as a drainage ditch that lies 100 ft south of the proposed turbine location. The nearest section of the sidewalk following U.S. Highway 287 is located approximately 370 ft to the north, on the opposite side of the Reserve Center's main building. The Children's Learning Center is located approximately 750 ft to the northwest.

The Alternative 2 location is the southwest corner of the motor pool and would cover a small portion of the paved motor pool as well as a small portion of the adjacent grass clearing. The Reserve Center's main building is approximately 270 ft to the northeast. The nearest fence is 30 ft to the south and 40 ft to the west. The nearest trail within T-Anchor Lake is 200 ft to the south, and the drainage ditch is approximately 120 ft to the south. The nearest sidewalk following U.S. Highway 287 is approximately 360 ft to the north. The Children's Learning Center is approximately 460 ft to the northwest.

#### 3.13.3 Environmental Consequences

##### 3.13.3.1 Alternative 1

Given adherence to International Electrotechnical Commission standards for wind turbines and to federal and state requirements for worker safety at each wind energy site, the primary health and safety concern is the exposure of members of the public to accidents during construction or operation of the proposed turbine.



- *Analysis Item HS-1: Would construction or operation of the wind turbine(s) expose members of the general public, especially children, to health and safety hazards?*

Construction hazards would be similar to those existing at a typical construction site and would be related to the operation of large vehicles and pieces of equipment. With the implementation of measures in Section 2.3, as well as those in the Programmatic EA (MARFORRES 2011), construction would not expose members of the general public to health or safety hazards.

Operational hazards are primarily related to blade failure, particularly during a storm. The Northwind 100 wind turbine is equipped with internal sensors and three separate braking systems; should the sensors detect an imbalance among the blades, the braking systems would automatically be engaged and would shut down the turbine to prevent failure. Furthermore, the Northwind 100 would be designed to withstand the high-speed wind produced by the regional 50-year storm, during which members of the public are generally indoors. Finally, the nearest site where children gather is well removed from the proposed turbine location. Therefore, the public would not be exposed to health or safety hazards from the construction or operation of Alternative 1.

#### 3.13.3.2 Alternative 2

- *Analysis Item HS-1: Would construction or operation of the wind turbine(s) expose members of the general public, especially children, to health and safety hazards?*

Potential impacts for Alternative 2 would be the same as for Alternative 1, with the exception that the Children's Learning Center would be located 450 ft to the northwest and that the property boundary with T-Anchor Lake would be located approximately 30 ft to the south and 40 ft to the west. However, the Children's Learning Center would still be well removed from the proposed turbine location, and both a fence and drainage canal would similarly separate the turbine from the nearest trail in T-Anchor Lake, 200 ft to the south. Therefore, the public would not be exposed to health and safety hazards from the construction or operation of Alternative 2.

### 3.14 HAZARDOUS MATERIALS

#### 3.14.1 Definition of Resource

This section addresses the use, generation, or inadvertent release of hazardous materials by the proposed action. Hazardous materials include all chemicals listed by the USEPA under the Superfund Amendments and Reauthorization Act of 1986 (40 CFR § 355 *et seq.*).

#### 3.14.2 Existing Conditions

Based on the USEPA's Enviromapper, there are no Superfund sites located in the vicinity of the proposed site. Several businesses are monitored for hazardous waste, with the nearest occurring approximately 0.5 mile east of the project site. Due to the distance of these sites from the Reserve Center, none of these monitored businesses is likely to degrade to project site.

#### 3.14.3 Environmental Consequences

##### 3.14.3.1 Alternative 1

- *Analysis Item HM-1: Is there a potential for uncontrolled release of hazardous materials into the environment?*

Construction, operation, and maintenance of wind turbines would involve the use of small quantities of hazardous materials (e.g., fuel, oil, solvents, hydraulic fluid, antifreeze, lubricant, paints) and generation



of hazardous wastes. Appropriate procedures for the handling, storage, and disposal of hazardous materials and wastes would be implemented in accordance with the Resource Conservation and Recovery Act and other applicable federal, state, and local regulations. These would include preparation of a site-specific Stormwater Pollution Prevention Plan (SWPPP) for construction activities to include BMPs for spill prevention. In addition, the Spill Prevention Control and Countermeasures plan and Hazardous Waste Management Plan would be updated to include operations of the wind turbine. Given the small amounts of hazardous materials used and hazardous wastes generated, impacts would be minor.

➤ *Analysis Item HM-2: Is there pre-existing contamination on the project site?*

There are no Installation Restoration Program sites at the Reserve Center. During construction, procedures would be established in the event that previously unidentified contamination is encountered. These procedures would include immediately stopping construction activities in the general vicinity and contacting the installation hazardous materials point of contact. Procedures would then be implemented, as necessary, to ensure that any contamination is properly identified, evaluated, and remediated to acceptable levels prior to the continuation of construction activities. Therefore, impacts from hazardous materials would be minor.

#### 3.14.3.2 Alternative 2

The impacts under Alternative 2 would be the same as those under Alternative 1 and would not be significant.

### 3.15 TRANSPORTATION

#### 3.15.1 Definition of Resource

Transportation refers to the use of roads or waterways as affected by the proposed action. The only potential impacts are associated with the transport of equipment to and from the site for construction.

#### 3.15.2 Existing Conditions

The transportation network near the project site comprises major roads and smaller residential roads. U.S. Highway 287, a 4-lane highway, is located immediately north of the project site and connects to Interstate 40, a 6-lane, divided highway approximately 0.4 mile south of the project site. The wide entrance to the Reserve Center's main parking lot has access to all four of U.S. Highway 287's lanes in addition to a center turning lane. The entrance to the Reserve Center's motor pool is narrower and only has access to U.S. Highway 287's two southbound lanes due to a center divider.

#### 3.15.3 Environmental Consequences

##### 3.15.3.1 Alternative 1

➤ *Analysis Item TR-1: Would the proposed action result in conflict with public use of roads or waterways?*

All major turbine components, including the tower, generator, and blades, would be delivered via two 48-ft flatbed trucks. Based on the size and number of delivery trucks, as well as the size of the construction crane, no conflicts are expected with the use of public roads. Therefore, there would be no significant impacts to transportation.



### 3.15.3.2 Alternative 2

- *Analysis Item TR-1: Would the proposed action result in conflict with public use of roads or waterways?*

Similar to Alternative 1, all major turbine components would be delivered via two 48-ft flatbed trucks. However, making the turn into the narrow driveway may be a challenge to the crane and turbine-equipment truck drivers (NAVFAC ESC 2010), and, if deemed necessary to prevent potential conflicts, delivery could be scheduled during off-peak hours. Therefore, there would be no significant impacts to transportation.

### **3.16 NO-ACTION ALTERNATIVE**

For all resources, the no-action alternative would represent the continuation of existing conditions in the near term, resulting in no impacts. MARFORRES would seek to develop other types of renewable energy (e.g., solar) at this facility and/or develop wind energy at other MARFORRES facilities to achieve specific goals regarding energy production and usage. Separate NEPA documentation would be prepared for these separate MARFORRES renewable energy projects, as applicable.

## **CHAPTER 4**

# **CUMULATIVE IMPACTS**

---

### **4.1 INTRODUCTION**

Cumulative impacts refer to the incremental effects of a project when combined with the similar effects of past, present, and future actions. Cumulative impacts were considered at both the national level and the local level in the Programmatic EA for the *MARFORRES Wind Energy Program* (MARFORRES 2011). This Tiered EA analyzes the potential for cumulative impacts of the proposed installation and operation of a 100-kW wind turbine at MARFORRES Center, Amarillo in Potter County, TX on a resource and site-specific level. Section 4.2 presents the cumulative setting upon which each of the site-specific, resource-based analyses is based; Section 4.3 presents the site-specific, resource-based analyses.

### **4.2 CUMULATIVE SETTING**

The cumulative setting is described in three ways: the regional setting (Section 4.2.1); other existing, under construction, approved, or proposed projects at MARFORRES Center, Amarillo (Section 4.2.2), and the existing, under construction, approved, or proposed wind energy projects within the state, neighboring counties, and Potter County (Section 4.2.3).

#### **4.2.1 Regional Setting**

The proposed project site at MARFORRES Center, Amarillo, is located near the center of the 100.2 square miles encompassed by the highly developed City of Amarillo, near the center of the Texas panhandle. With the exception of T-Anchor Lake, a highly disturbed, 50-acre flood control basin immediately to the south of the proposed project, there are no significant undeveloped areas within a mile of the proposed project. Development in the local area generally consists of highly dense, single family subdivisions interspersed by commercial shopping centers. Interstate 40 runs east-west and lies approximately 0.35 mile south of the proposed project. The nearest contiguous, generally undisturbed land is approximately 4 miles to the northwest, although it is also surrounded by low density rural and agricultural development. Due to the highly developed nature of the area immediately surrounding the Reserve Center, the City of Amarillo's Comprehensive Plan focuses its discussion of growth and development on infilling the suburban sprawl that has developed along the edges of the City's core area, as well as promoting growth in northeast Amarillo. The closest area that could be subdivided for infill lies approximately one mile to the south of the proposed project, on the opposite side of Interstate 40.

#### **4.2.2 Other Projects at MARFORRES Center, Amarillo**

No major development projects or changes in operations at the MARFORRES Center are planned at this time. However, the Public Works Department, Fort Worth is planning on renovating the facilities and paving open areas for additional parking (NAVFAC ESC 2011).

#### **4.2.3 Other Wind Energy Projects within Texas**

The Texas panhandle is an ideal location for wind energy, which is largely due to Texas's unique political status combined with the strong winds and open land found within the panhandle. As such, much of the installed wind energy capacity in Texas is located within the panhandle. At 9,727 MW of operational wind turbines among 98 projects, Texas is home to more than one quarter (26.5%) of all installed wind energy capacity in the U.S. and is continuing to grow rapidly. Texas has more than two and a half times Iowa's total installed wind energy capacity, which ranks second in the country at 3,670 MW, and more



than 3.5 times California’s total installed capacity of 2,739 MW (American Wind Energy Association [AWEA] 2010).

The initial phase of the planned Tres Amigas Superstation will likely be constructed within the next 4 to 5 years in nearby Clovis, New Mexico, and would provide access to all three national power grids (see <http://www.scandiawind.com/images/Tres%20Amigas%2099%20year%20lease.docx> for more information). This, combined with the approved plan to increase transmission capacity from West Texas by an additional 18,500 MW, indicates that the rate of wind energy development in the Texas panhandle will continue to grow. Some of this growth will likely come from the Mariah Project, which is proposed to eventually grow to 10,000 MW of installed wind energy capacity within Parmer, Sherman, and Dallam Counties, the closest of which is approximately 60 miles to the southwest and to the north. See <http://www.scandiawind.com/ScandiaWindSouthwest.html> for more information on the Mariah Project.

Table 4-1 summarizes the existing and proposed wind energy projects within Potter County and its neighboring counties. There are no projects currently under construction within Potter County or any of its neighboring counties. The Wildorado Wind Ranch is the closest wind energy facility to the proposed project, approximately 16 miles to the west. If constructed, the Pantex wind energy facility will become the closest such facility, approximately 13 miles northeast of the proposed project.

**Table 4-1. Status of Wind Energy Projects within or Neighboring Potter County**

<i>Project Name</i>	<i>County</i>	<i>Size (MW)</i>	<i>Number of Turbines</i>
<b>Existing</b>			
Llano Estacado Wind Ranch	Carson	80	80
Majestic	Carson	79.5	53
Wege Wind Farm	Carson	10	8
Turkey Track	Hutchinson	169.5	113
Little Pringle I	Hutchinson	10	5
Little Pringle II	Hutchinson	10	5
JD Wind 7	Moore	10	8
JD Wind 8	Moore	10	8
JD Wind 9	Moore	10	8
JD Wind 10	Moore	10	8
JD Wind 11	Moore	10	8
Sunray I	Moore	10.5	7
Sunray II	Moore	39	26
Wildorado Wind Ranch	Potter, Oldham, Randall	161	70
<b>Total Existing</b>		<b>619.5</b>	<b>407</b>
<b>Proposed</b>			
Pantex	Carson	75	38
Majestic II	Carson	51	34
Big Pringle	Hutchinson	200	100
Channing Flats	Moore	19.2	12
Blue Creek	Moore	19.2	12
Palo Duro	Randall	400	200
<b>Total Proposed</b>		<b>764.4</b>	<b>396</b>

Sources: AWEA 2010; West Texas A&M University 2009a, 2009b; Wind Today 2009

In addition to the above existing and proposed projects, Texas has identified a number of Competitive Renewable Energy Zones (CREZs). The northeastern portion of CREZ 1 encompasses the majority of



Amarillo, including the proposed project site. The western portion of CREZ 4 includes the majority of the eastern boundary of Potter County and nearly all of Carson County. When including neighboring counties, CREZs 1, 2, 3, 4, and 21 are within the project's region. Importantly, CREZs 2 (approximately 25 miles southeast) and 4 (approximately 10 miles east) had the highest estimated capacity factor, at 43%, of all CREZs analyzed (Electric Reliability Council of Texas 2006), indicating the high likelihood of renewable energy development in these areas.

#### **4.3 RESOURCE SPECIFIC IMPACTS**

##### **4.3.1 Land Use**

Land use impacts from the proposed action would be relatively small (approximately 0.1 acre) within the boundaries of MARFORRES Center, Amarillo, would not adversely impact the facility's mission or essential activities, and would be insignificant in terms of any potential cumulative impact with future plans for development within the property. Furthermore, development of the site would not affect adjacent public or private lands or activities, including the Children's Learning Center. Past, present, and reasonably foreseeable projects are or would be separated geographically or temporally from the proposed project. As a result, there would be no potential cumulative impact for adjacent, non-DoD land use.

##### **4.3.2 Noise**

Based on the minimal impacts of the proposed action on noise (Section 3.3), the previous level of development in Amarillo, and the minimal other actions within the vicinity, there would be little to no potential for the project, when combined with past, present, or reasonably foreseeable actions in the region, to result in significant cumulative noise impacts.

##### **4.3.3 Geological Resources**

Impacts on geology and soils would be localized to the immediate area of a site and would be controlled through application of BMPs. As a result, the effect on local geological resources outside of the project site footprint would be negligible or minor, and there would be no potential for cumulative impacts.

##### **4.3.4 Water Resources**

Any impact on water resources would be localized to the immediate area of a site and would be controlled through the application of BMPs. The Proposed Action has been discussed with the city's engineering department to confirm that it would not have a measurable impact on water levels associated with flood storage in Playa Lake 21. As a result, the effect on local water resources would be negligible, with little potential for a cumulative impact.

##### **4.3.5 Biological Resources**

Based on the minimal impacts of the proposed action on habitats and species (Section 3.6), it is unlikely that there would be any overlapping effects on the same biological resources affected by other actions in the region. It is expected that approximately one individual bird and bat per year would be affected, and that these would belong to species that are common in the developed areas in and around Amarillo, such as the birds observed on the Reserve Center or fenceline during the reconnaissance survey (Appendix B). It is possible that individuals of the same species could be impacted by wind energy projects elsewhere within the region, but the project's contribution to a potential cumulative impact on bird or bat populations, if any, would be very minor. As a result, there is little if any potential for the project to add to the cumulative effects that may occur elsewhere, and cumulative impacts would not be significant.



#### **4.3.6 Cultural Resources**

As there are no identified cultural resources within the APE of the project, the proposed action would have no impact on resources of significance to Native American tribes, the integrity of the archaeological record of the region or the historic integrity of the City of Amarillo. Through implementation of *Construction BMP #17*, construction would cease in the event of an inadvertent discovery of a potential cultural resource during site construction; the potential resource would be evaluated by a qualified archaeologist and/or Tribal representative(s), as appropriate; and construction may proceed once the discovery is determined to have no potential significance, subject to the completion of documentation and consultation with the SHPO, if required. If applicable, procedures required under the Native American Graves and Repatriation Act (43 CFR Part 10) will be followed. As a result, there is little, if any, potential for the project to add to the cumulative effects that may occur elsewhere, and cumulative impacts would not be significant.

#### **4.3.7 Visual Resources**

The proposed action would not have a significant impact on the visual resources of the area around the proposed site. While the construction of the proposed wind turbine would affect the visual resources of a portion of the City of Amarillo, the effect is expected to only be a moderate one at distances of less than 0.5 mile. As well, the existing landscape in this area of Amarillo already contains a number of tall structures that attract the attention of the casual viewer. The cumulative effect of adding another tall structure to this existing landscape would not be significant.

#### **4.3.8 Socioeconomics**

The socioeconomic impacts of small-scale wind energy projects would be small, but beneficial in terms of local employment and reduced demand on the grid, adding incrementally to the economic benefits of the large wind energy projects listed in Table 4-1. The potential negative effect on the electricity provider due to reduced energy consumption by a local customer such as the Reserve Center is negligible, and over time, utilities are able to adjust rates and fees to market forces of supply, demand, and conservation to remain profitable. No adverse socioeconomic impacts on disadvantaged groups, neighborhoods, or children are anticipated. As a result, very minor, if any, cumulative socioeconomic impacts would occur.

#### **4.3.9 Air Quality**

Air quality impacts from the proposed wind energy site would be negligible. Potential cumulative impacts on air quality would be beneficial as net GHG emissions would be reduced. Cumulative air quality benefits include reducing the rate of climate change and reducing the emissions associated with the extraction, importation, and burning of fossil fuels for power generation. As a result, there would be a slight beneficial cumulative impact for air quality.

The potential effects of GHG emissions are by nature global and cumulative impacts, as individual sources of GHG emissions are not large enough to have an appreciable effect on climate change. Therefore, an appreciable impact on global climate change would only occur when proposed GHG emissions combine with GHG emissions from other man-made activities on a global scale.

However, because the current global trend data show an annual increase in GHG emissions, under the direction of Federal policies, the DoD, DoN, and USMC are pursuing a variety of initiatives to reduce our total contributions of GHG emissions. DoN leadership in broad-based programs to reduce energy consumption and shift to renewable and alternative fuels, thereby reducing emissions of carbon dioxide and other greenhouse gases. The following paragraphs summarize some of these initiatives, including



broad-based strategic programs to reduce energy consumption and shift to renewable and alternative fuels.

Executive Order 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*, was adopted in October 2009, and provides early strategic guidance to federal agencies in the management of GHG emissions. The early strategy directs the agencies to increase renewable energy use to achieve general GHG emission reductions. According to the provisions of EO 13514, federal agencies will be required to develop a 2008 baseline for scope 1 and 2 GHG emissions, and to develop a percentage reduction target for agency-wide reductions of scope 1 and 2 GHG emissions by FY 2020. As part of this effort, federal agencies will evaluate sources of GHG emissions, and develop, implement, and annually update an integrated Strategic Sustainability Performance Plan that will prioritize agency actions based on lifecycle return on investment. The intent is to evaluate GHG emissions on a lifecycle basis and to identify feasibility of sustainability strategies on that basis. The DoD is currently developing its Strategic Sustainability Performance Plan that will guide DoN and USMC initiatives to reduce GHG emissions.

The Commandant of the Marine Corps' *USMC Expeditionary Energy Strategy and Implementation Plan "Bases-To-Battlefield"* declares the intent to implement measures to conserve energy and to reduce GHG emissions and dependence on foreign oil (USMC 2011). The plan identifies goals to reduce energy intensity and increase the percentage of renewable electrical energy consumed, and requires base commanders to "evaluate the effectiveness of incorporating emerging technologies" including integrated photovoltaics, cool roofs, daylighting, ground source heat pumps, heat recovery ventilation, high efficiency chillers, occupancy sensors, premium efficiency motors, radiant heating, solar water heating, and variable air volume systems.

On October 16, 2009, the Secretary of the Navy, Ray Mabus, announced five energy targets for the DoN and USMC. The five energy targets are summarized below:

- When awarding contracts, appropriately consider energy efficiency and the energy footprint as additional factors in acquisition decisions.
- By 2012, demonstrate a Green Strike Group composed of nuclear vessels and ships powered by biofuel. By 2016, sail the Strike Group as a Great Green Fleet composed of nuclear ships, surface combatants equipped with hybrid electric alternative power systems running on biofuel, and aircraft running on biofuel.
- By 2015, cut petroleum use in its 50,000 non-tactical commercial fleet in half, by phasing in hybrid, flex fuel, and electric vehicles.
- By 2020, produce at least half of shore based installations' energy requirements from alternative sources. Also, 50 percent of all shore installations will be net zero energy consumers.
- By 2020, half of DoN's total energy consumption for ships, aircraft, tanks, vehicles, and shore installations will come from alternative sources.

As part of its efforts to encourage the development of alternative fuels, on January 22, 2010 the DoN and the Department of Agriculture signed a Memorandum of Understanding (MOU) to encourage the development of advanced biofuels and other renewable energy systems.

These examples illustrate the leadership role that the DoN and USMC play in achieving energy reductions that will contribute to the national effort to mitigate global climate change.

#### **4.3.10 Utilities**

Potential cumulative impacts on utilities would be addressed through implementation of an Interconnect Agreement between MARFORRES and Xcel Energy. This coordination with the local utility and



implementation of its requirements for new wind power connections to the grid would ensure that adverse cumulative impacts do not occur.

#### **4.3.11 Airspace**

As discussed in Section 3.12, the project action would not affect air traffic and is not expected to have any effect on radar and other transmission or reception of electromagnetic signals. Hence, there are no potential cumulative impacts.

#### **4.3.12 Health and Safety**

Based on the minimal impacts of the proposed action on Health and Safety (Section 3.13) and the minimal other actions within the vicinity, there would be little to no potential for the project to add to the cumulative effects that may occur elsewhere, and cumulative impacts would not be significant.

#### **4.3.13 Hazardous Materials**

Construction, operation, and maintenance of wind turbines would involve the use of small quantities of hazardous materials and generation of hazardous wastes. However, appropriate procedures for the handling, storage, and disposal of hazardous materials and wastes would be implemented under the proposed action in accordance with the Resource Conservation and Recovery Act and other applicable federal, state, and local regulations. As a result, the impacts from hazardous materials would be negligible or minor at each site and there would be little to no potential cumulative impacts.

#### **4.3.14 Transportation**

Based on the minimal impacts of the proposed action on Transportation (Section 3.15) and the minimal other actions within the vicinity, there would be little to no potential for the project to add to the cumulative effects that may occur elsewhere, and cumulative impacts would not be significant.



## **CHAPTER 5**

### **OTHER CONSIDERATIONS REQUIRED BY NEPA**

---

#### **5.1 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF NATURAL OR FINITE RESOURCES**

The proposed action would involve a relatively small commitment of land which is already developed, raw materials used in the manufacture of the turbine, and fuel consumed during construction. Operation of the turbine would reduce demand on the local utility grid which in turn would lessen the consumption of natural resources used in generating power, as well as incrementally reducing the need for expanded or new sources of energy in this rapidly growing region. The proposed action would not entail irreversible/irretrievable commitments of natural or cultural resources.

#### **5.2 RELATIONSHIP BETWEEN LOCAL SHORT-TERM USE OF THE HUMAN ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM NATURAL RESOURCE PRODUCTIVITY**

The siting and design process and the consideration of alternatives for the proposed action resulted in a project location and design that would have minimal impacts on the human and natural environment or future uses of the land and resources, and would not diminish long-term natural resource productivity. By reducing the consumption of natural resources used in power generation, the proposed action would contribute to the maintenance and enhancement of natural resource productivity.

#### **5.3 MEANS TO MITIGATE AND/OR MONITOR ADVERSE ENVIRONMENTAL IMPACTS**

The siting and design of the proposed action, specifically the placement of a small (100-kW) turbine within the already developed area of the Navy-MARFORRES facilities minimizes the potential for impacts consistent with the Programmatic EA (MARFORRES 2011). BMPs as presented in Section 2.3.2 further reduce the potential short-term impacts of construction. Mortality to birds and bats is expected to be on the order of approximately one individual bird and bat per year, which would be very difficult to detect except with a very labor-intensive monitoring program, which the impact does not warrant.

---

## **CHAPTER 6**

### **REFERENCES**

---

- American Wind Energy Association (AWEA). 2010. U.S. Wind Energy Projects – Texas. 30 September. Accessed March 22, 2011. Available online at: <http://archive.awea.org/projects/Projects.aspx?s=Texas>.
- Boal, C.W., M.D. Giovanni, and B.N. Beal. 2006. Successful nesting by a bald eagle pair in prairie grasslands of the Texas Panhandle. *Western North American Naturalist* 66:246-250.
- Boal, C.W., C.L. Haralson, and W.H. Howe. 2008. Status of Golden Eagles in the Texas Panhandle. *J. Raptor Research*, 42(3):220-224.
- City of Amarillo. 2008. Storm Water Management Criteria Manual. Available at: <http://www.ci.amarillo.tx.us/departments/engineering.html>.
- \_\_\_\_\_. 2010a. City of Amarillo Zoning Ordinance. December. Available online at: <http://www.ci.amarillo.tx.us/departments/planning/pdf/AmarilloZoningOrdinance.pdf>.
- \_\_\_\_\_. 2010b. Amarillo Comprehensive Plan. October 12. Available online at: [http://www.amarillo.gov/departments/planning/pdf/Adopted\\_Comp\\_Plan\\_10-12-10.pdf](http://www.amarillo.gov/departments/planning/pdf/Adopted_Comp_Plan_10-12-10.pdf).
- City of Amarillo Engineering Department. 2011. Personal communication via telephone, M. Reed, Engineer, with C. Barker, 28 July. Information about adhering to City of Amarillo requirements for building within the 100-year flood zone. Amarillo, TX.
- Council on Environmental Quality (CEQ). 2010. Memorandum for Heads of Federal Departments and Agencies. Draft NEPA Guidance on Consideration of the Effects of Climate Change and Greenhouse Gas Emissions. 18 February.
- Davis, W.B. and D.J. Schmidly. 1994. *The Mammals of Texas*. Available at: <http://www.nsr.ttu.edu/tmot1/Default.htm>.
- Department of Energy. 2006. East North Central Household Electricity Report. Available at: [http://www.eia.gov/emeu/reps/enduse/er01\\_enc.html](http://www.eia.gov/emeu/reps/enduse/er01_enc.html). Accessed on: 18 February 2011. 8 March.
- eBird. 2010. eBird: An online database of bird distribution and abundance [web application]. Version 2. eBird, Ithaca, New York. Available at: <http://www.ebird.org>. Accessed on: 28 March 2011.
- Electric Reliability Council of Texas. 2006. Analysis of Transmission Alternatives for Competitive Renewable Energy Zones in Texas. December. Available online at: [http://www.ercot.com/news/presentations/2006/ATTCH\\_A\\_CREZ\\_Analysis\\_Report.pdf](http://www.ercot.com/news/presentations/2006/ATTCH_A_CREZ_Analysis_Report.pdf).
- Federal Emergency Management Agency (FEMA). 2010. Flood Insurance Rate Map, Potter County, Texas, and Incorporated Areas: Map Number 48375C0533C. 4 June.
- Federal Interagency Committee on Noise (FICON). 1992. Federal Agency Review of Selected Airport Noise Analysis Issues.
- GoogleEarth. 2011. Google Earth. Available at: <http://www.google.com/earth/index.html>.
- Hardy-Heck-Moore, Inc. (HHM). 2004. Final Naval Reserve Force Cultural Resources Survey, Naval and Marine Corp Reserve Center Amarillo, Texas. November.



- Henderson, L. 2011. Section 106 History Reviewer, Texas Historical Commission. Telephone conversation with Dulaney Barclay (TEC), 14 May.
- Marine Forces Reserve (MARFORRES). 2011. Programmatic Environmental Assessment: United States Marine Corps Forces Reserve Wind Energy Program. April.
- Naval Facilities Engineering Service Center (NAVFAC ESC). 2010. Site Visit Report on Small Wind Technology at United States Marine Corps Reserve Center, Amarillo, Texas. May.
- \_\_\_\_\_. 2011. Personal communication via email with R. Barker, Project Manager, NAVFAC ESC. Comments on Draft Tiered EA, provided by email to M. Dungan and others, 15 June.
- Northern Power Systems. 2010a. Northern Power 100 Spec Sheet. Available at: <http://www.northernpower.com/>.
- \_\_\_\_\_. 2010b. Northern Power 100 Value Propositions. Available at: <http://www.northernpower.com/>.
- National Renewable Energy Laboratory (NREL). 2003. P. Migliore, J. van Dam, and A. Huskey. Acoustic Tests of Small Wind Turbines. National Wind Technology Center, Golden, Colorado. AIAA-2004-1185.
- \_\_\_\_\_. 2010. Texas Annual Average Wind Speed at 80 m. Available at [http://www.windpoweringamerica.gov/wind\\_resource\\_maps.asp?stateab=tx](http://www.windpoweringamerica.gov/wind_resource_maps.asp?stateab=tx). Accessed on 21 June 2010. 15 January.
- Rogers, A.L., J.F. Manwell, and S. Wright. 2006. Wind Turbine Acoustic Noise. Renewable Energy Research Laboratory. Available at: [www.ceere.org/rerl](http://www.ceere.org/rerl).
- Seyffert, K.D. 2001. Birds of the High Plains and Rolling Plains of Texas: A Field Checklist. Texas Parks and Wildlife, PWD BK W7000-760 (3/02). 16 pp.
- Shackelford, C.E., E.R. Rozenburg, W.C. Hunter and M.W. Lockwood. 2005. Migration and the Migratory Birds of Texas: Who They Are and Where They Are Going. Texas Parks and Wildlife PWD BK W7000-511 (11/05). Booklet, 34pp.
- Steed, K. 2009. T-Anchor skeleton put park plans on hold. ConnectAmarillo.com. July 30. Available online at: <http://www.connectamarillo.com/news/story.aspx?id=331136>.
- Texas Parks and Wildlife Department (TPWD). 2010. Annotated County List of Rare Species for Potter County. Last revised July 19, 2010. 4 p.
- Texas Natural Diversity Data Base. 2010. 9-quad element occurrence search centered on Amarillo project site. Data base accessed on 8/2/2010. 37 p.
- United States Census Bureau. 2010. America Community Survey: 2006-2008 data. Available at: <http://www.census.gov/acs/www/>.
- United States Department of Agriculture (USDA), Natural Resource Conservation Service. 2011. Custom Soil Resources Report for Potter County, Texas, Amarillo Site Soils. Web Soil Survey. Created February 17.
- United States Environmental Protection Agency (USEPA). 2008. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006 – Executive Summary. Available at: [http://www.epa.gov/climatechange/emissions/downloads/08\\_CR.pdf](http://www.epa.gov/climatechange/emissions/downloads/08_CR.pdf).
-



- \_\_\_\_\_. 2011a. General Conformity Regulatory Actions. Available at:  
<http://www.epa.gov/oar/genconform/regs.html>.
- \_\_\_\_\_. 2011b. The Green Book Nonattainment Areas for Criteria Pollutants. Available at:  
<http://www.epa.gov/oar/oaqps/greenbk/index.html>.
- United States Fish and Wildlife Service (USFWS). 1997. Birds of Buffalo Lake National Wildlife Refuge, Texas. U.S. Fish and Wildlife Service. Unpaginated. Jamestown, ND: Northern Prairie Wildlife Research Center Online. Available at: <http://www.npwrc.usgs.gov/bufflake.htm>. (Version 22MAY98).
- \_\_\_\_\_. 2008. Birds of Conservation Concern 2008. United States Department of Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, Virginia. 85 pp. Available at: <http://www.fws.gov/migratorybirds/>.
- \_\_\_\_\_. 2009. Whooping cranes and wind development – an issue paper. By Regions 2 and 6, USFWS. April.
- \_\_\_\_\_. 2011. Southwest Region Ecological Services. Endangered Species List, Species List for Texas. Available at: <http://www.fws.gov/southwest/es/EndangeredSpecies/lists/ListSpecies.cfm>. Accessed 19 April.
- United States Marine Corps (USMC). 2011. United States Marine Corps Expeditionary Energy Strategy and Implementation Plan “Bases-To-Battlefield.”
- Welch, K.S. 2009. T Anchor Lake: From playa to park. Amarillo Globe News. July 27. Available online at: [http://amarillo.com/stories/072709/new\\_news\\_14050175.shtml](http://amarillo.com/stories/072709/new_news_14050175.shtml).
- West Texas A&M University. 2009a. Wind Farms Texas. Revised 18 December 2009.
- \_\_\_\_\_. 2009b. Texas wind Farms
- Wind Today. 2009. Texas Wind Farms Completed as of December 31, 2009.



## **CHAPTER 7**

# **PERSONS AND AGENCIES CONTACTED**

---

---

Dave Haukos, USFWS Ecological Services, Lubbock - West Texas Sub-Office.

Linda Henderson. Section 106 History Reviewer, Texas Historical Commission, Austin, TX.

Reed, Mark. Engineer, City of Amarillo Engineering Department, Amarillo, TX.

Dorinda Scott, Texas Natural Diversity Database, Wildlife Diversity Program, Texas Parks and Wildlife Department, Austin, TX.

Len Winter, Historic Preservation Officer, Department of the Navy NAVFAC Southeast/Navy Region South, Jacksonville, FL.



## CHAPTER 8

### PREPARERS

---

This EA was prepared by TEC, for DoN and under the direction of NAVFAC ESC and the USACE Fort Worth District.

#### **Project Oversight: NAVFAC ESC**

**Kevin Frantz**, Project Oversight

**Casey Barker**, Project Manager

**Daniel Goodman**, Environmental Engineer

**Jill Lomeli**, Environmental Protection Specialist

**Ben Wilcox**, Mechanical Engineer

#### **Project Proponent: MARFORRES**

**Alain Flexer**, Energy Manager, MARFORRES, Facilities

**Chauncey Elston**, NEPA Coordinator

#### **Contract Management: USACE**

**Jack Mobley**, Contract Officer Representative

#### **Document Review: Headquarters Marine Corps and Commander, Navy Region Southeast**

**Sue Goodfellow**, Head, Conservation Section HQMC

**Veronda Johnson**, NEPA, Conservation Section HQMC

**Ryan Orndorff**, Natural Resource Specialist HQMC

**Jennifer Roper**, L CDR, CNRSE HQ N40L

**Royce Kemp**, Environmental, NAVFAC SE

#### **Document Preparation: TEC**

##### *Project Management and Quality Assurance*

**Mike Dungan**, Project Manager

*Ph.D., Ecology and Evolutionary Biology*

**J. Scott Coombs**, Deputy Project Manager, Geological Resources and Water Resources

*M.S., Marine Science*

**Kimberly Wilson**, Quality Assurance

##### *Technical Analysts*

**Dulaney Barclay**, Cultural Resources and Visual Resources

*M.A., Anthropology*

**Christine Davis**, Air Quality



*M.S., Environmental Management*

**Brian Hoffman**, Biological Resources

*M.S., Environmental and Forest Biology*

**Christopher Noddings**, Land Use, Noise, Visual, Health and Safety, and Transportation

*M.S., Environmental Science and Management*

**Melissa Johnson**, Visual Resources

*B.A., Anthropology*

*GIS & Graphic Design*

**Deirdre Stites**

*A.A., Geology*

**APPENDIX A**  
**AIR QUALITY CALCULATIONS AND RECORD OF NON-**  
**APPLICABILITY (RONA)**

---

---

---

## **RECORD OF NON-APPLICABILITY (RONA) FOR CLEAN AIR ACT CONFORMITY**

### **United States Marine Corps Forces Reserve Wind Energy Program Site: Marine Forces Reserve Center, Amarillo, TX**

#### **INTRODUCTION**

The U.S. Environmental Protection Agency (USEPA) published *Determining Conformity of General Federal Actions to State or Federal Implementation Plans; Final Rule*, in the 30 November 1993, Federal Register (40 CFR Parts 6, 51, and 93). The U.S. Navy published *Interim Guidance on Compliance with the Clean Air Act General Conformity Rule* in Appendix F, OPNAVINST 5090.1C, dated 30 October 2007. These publications provide implementing guidance to document Clean Air Act Conformity Determination requirements.

Federal regulations state that no department, agency, or instrumentality of the Federal Government shall engage in, support in any way or provide financial assistance for, license to permit, or approve any activity that does not conform to an applicable implementation plan. It is the responsibility of the Federal agency to determine whether a Federal action conforms to the applicable implementation plan, before the action is taken (40 CFR Part 1 51.850[a]).

The general conformity rule applies to federal actions proposed within areas which are designated as either nonattainment or maintenance areas for a National Ambient Air Quality Standard (NAAQS) for any of the criteria pollutants. Former nonattainment areas that have attained a NAAQS are designated as maintenance areas. Emissions of pollutants for which an area is in attainment are exempt from conformity analyses.

Amarillo, TX is located within Potter and Randall counties, and is part of Air Quality Control Region (AQCR) 211 – Amarillo-Lubbock Intrastate. This area attains the NAAQS for all criteria pollutants. For conformity rule applicability, *de minimis* thresholds only apply to nonattainment or maintenance areas; therefore, *de minimis* thresholds are not applicable for this area.

#### **PROPOSED ACTION**

Action Proponent: United States Marine Corps Forces Reserve

Location: Marine Forces Reserve Center, Amarillo, TX

Proposed Action Name: United States Marine Corps Forces Reserve Wind Energy Program Site:  
Marine Forces Reserve Center, Amarillo, TX

**Proposed Action Summary:** This project is tiered from the Programmatic EA for the Marine Forces Reserve (MARFORRES) Wind Energy Program. The proposed action is to develop wind energy at MARFORRES Center, Amarillo, TX under the MARFORRES Wind Energy Program. Implementation of the proposed action would involve the installation and operation of a single, 100-kilowatt (kW) wind turbine consistent with the program criteria specified in the Programmatic EA.

**Air Emissions Summary:** Emission sources associated with the proposed action would involve construction and operation of the single 100-kW wind turbine. Consistent with the Programmatic EA for the MARFORRES Wind Energy Program, the construction footprint for one small turbine would be approximately 0.45 acre and the use of heavy equipment during construction would be approximately 1 month (30 days). Estimated construction emissions due to implementation of the proposed action are shown in Table 1. Based on the air quality analysis for the proposed action, the maximum estimated construction emissions would be below conformity *de minimis* levels (Table 1).

**Table 1. Estimated Emissions Resulting from Implementation of the Proposed Action**

<i>Estimated Construction Emissions (duration 1 month)</i>	<i>Emissions (tons/year)</i>					
	<i>CO</i>	<i>VOCs</i>	<i>NO<sub>x</sub></i>	<i>SO<sub>x</sub></i>	<i>PM<sub>10</sub></i>	<i>PM<sub>2.5</sub></i>
One Small (100-kV) Turbine	0.53	0.13	1.14	0.00	0.09	0.06
<i>de minimis</i> threshold <sup>1</sup>	NA	NA	NA	NA	NA	NA
Exceeds <i>de minimis</i> threshold?	No	No	No	No	No	No

*Note:* <sup>1</sup> Potter and Randall counties are in attainment of the NAAQS for all criteria pollutants. NA= not applicable; *de minimis* thresholds do not apply to attainment areas.

*Sources:* 40 CFR Part 81 § 81.344 – Texas; USEPA 2011a, b.

Operations and maintenance of the turbine would typically consist of two to three people who would visit the site approximately six times per year. These visits would consist of maintenance personnel driving a vehicle to and around the site. Emissions associated with these activities would be minimal and short-term and would not result in a major increase in air emissions.

One of the most important benefits of wind energy is that the production of electricity from wind power involves zero direct emissions of air pollutants. The energy output generated from wind turbines, with zero emissions of air pollutants, would displace roughly the same energy output that would otherwise be generated by a fossil fuel-powered plant, which generates greenhouse gases and other harmful air pollutants. Table 2 includes the typical energy output under the proposed action, which amounts to the electricity savings per year that would no longer need to be generated by a fossil fuel-powered plant (coal, oil, or natural gas).

**Table 2. Range of Energy Output under the Proposed Action**

<i>Proposed Action</i>	<i>Energy Output (MWh/yr)</i>
One Small Turbine	88 – 440

Therefore, operational activities associated with the proposed action would result in beneficial impacts to air quality by adding wind energy to the utility grid and replacing or reducing the use of fossil fuel-powered plants with more efficient and flexible types of power generation.

Affected Air Basin: AQCR 211 – Amarillo-Lubbock Intrastate, Potter and Randall Counties

Date RONA prepared: 23 May 2011

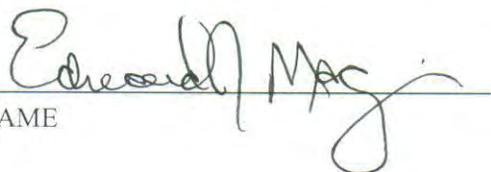
RONA Prepared By: United States Marine Corps Forces Reserve with direct support from TEC Inc.

#### **ATTAINMENT AREA STATUS AND EMISSIONS EVALUATION CONCLUSION**

Potter and Randall counties are in attainment of the NAAQS for all criteria pollutants. Therefore, *de minimis* thresholds are not applicable. The United States Marine Corps Forces Reserve concludes that *de minimis* thresholds for all criteria pollutants would not be exceeded as a result of implementation of the proposed action. The emissions data supporting that conclusion is shown in Table I, which is a summary of the calculations, methodology, and data provided in Attachment A. Therefore, the United States Marine Corps Forces Reserve concludes that further formal Conformity Determination procedures are not required, resulting in this Record of Non-Applicability (RONA) for Clean Air Act Conformity.

#### **RONA APPROVAL**

To the best of my knowledge, the information presented in this RONA is correct and accurate, and I concur in the finding that the proposed action does not require a formal Clean Air Act Conformity Determination.

  
NAME

  
Date

## REFERENCES

40 CFR Part 81 § 81.344. Designation of Areas for Air Quality Planning Purposes, Attainment Status Designations - Texas. Available at: [http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title40/40cfr81\\_main\\_02.tpl](http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title40/40cfr81_main_02.tpl).

USEPA. 2011a. General Conformity Regulatory Actions. Available at: <http://www.epa.gov/oar/genconform/regs.html>.

USEPA. 2011b. The Green Book Nonattainment Areas for Criteria Pollutants. Available at: <http://www.epa.gov/oar/oaqps/greenbk/index.html>.

## Emissions Summary

### *SMALL TURBINE: CONSTRUCTION EMISSIONS SUMMARY*

Emissions	Emissions (tons)							
	CO	VOC	NO <sub>x</sub>	SO <sub>x</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	CO <sub>2</sub>	CH <sub>4</sub>
One Small Turbine	0.53	0.13	1.14	0.00	0.09	0.06	113.91	0.01

### *SMALL TURBINE: GHG EMISSIONS SUMMARY*

Emissions	Emissions (Metric tons/year)			
	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	CO <sub>2e</sub>
One Small Turbine	103.33	0.01	0.10	134

**Notes:**

Conversion to Metric Tons = 1 short ton = 0.90718474 metric tons

$N_2O = NO_x * 0.095$

$CO_{2e} = (CO_2 * 1) + (CH_4 * 21) + (N_2O * 310)$

Construction Equipment Emissions

*Small Turbine*

Construction duration is assumed to be 1 month per small turbine

Construction	Fuel	HP	Load Factor	Emission Factors, g/bhp-hr								No of Equipment			Emissions, lbs/day								Emissions, tons/year							
				CO	VOC	NOx	SOx	PM10	PM2.5	CO2	CH4	Equipment	Hrs/day	Months	CO	VOC	NOx	SOx	PM10	PM2.5	CO2	CH4	CO	VOC	NOx	SOx	PM10	PM2.5	CO2	CH4
Tractor/Loader/Backhoe	Diesel	108	55	4.07	1.19	7.16	0.007	0.654	0.58206	568.3	0.108	2	4	1	4.26	1.25	7.50	0.01	0.69	0.61	595.38	0.11	0.06	0.02	0.10	0.00	0.01	0.01	7.74	0.00
Dump Truck	Diesel	479	57	1.82	0.57	5.55	0.006	0.295	0.26255	568.3	0.051	1	4	1	4.38	1.37	13.36	0.01	0.71	0.63	1368.31	0.12	0.06	0.02	0.17	0.00	0.01	0.01	17.79	0.00
Water Truck	Diesel	250	50	1.82	0.57	5.55	0.006	0.295	0.26255	568.3	0.051	1	4	1	2.01	0.63	6.12	0.01	0.33	0.29	626.45	0.06	0.03	0.01	0.08	0.00	0.00	0.00	8.14	0.00
Crane	Diesel	399	43	2.44	0.63	6.27	0.006	0.243	0.21627	568.3	0.053	1	4	1	3.69	0.95	9.49	0.01	0.37	0.33	859.84	0.08	0.05	0.01	0.12	0.00	0.00	0.00	11.18	0.00
Rough Terrain Forklift	Diesel	93	60	4.14	1.28	7.55	0.007	0.69	0.6141	568.3	0.115	1	4	1	2.04	0.63	3.72	0.00	0.34	0.30	279.65	0.06	0.03	0.01	0.05	0.00	0.00	0.00	3.64	0.00
Excavator	Diesel	168	57	2.19	0.59	6.15	0.006	0.229	0.20381	568.3	0.053	1	4	1	1.85	0.50	5.19	0.01	0.19	0.17	479.91	0.04	0.02	0.01	0.07	0.00	0.00	0.00	6.24	0.00
Crawler	Diesel	157	57.5	2.19	0.59	6.15	0.006	0.229	0.20381	568.3	0.053	1	4	1	1.74	0.47	4.90	0.00	0.18	0.16	452.42	0.04	0.02	0.01	0.06	0.00	0.00	0.00	5.88	0.00
Bobcat	Diesel	44	55	6.07	2.25	5.68	0.007	0.578	0.51442	568.3	0.203	1	4	1	1.30	0.48	1.21	0.00	0.12	0.11	121.28	0.04	0.02	0.01	0.02	0.00	0.00	0.00	1.58	0.00
Drill Rig	Diesel	291	75	3.16	0.7	6.71	0.006	0.271	0.24119	568.3	0.063	1	4	1	6.08	1.35	12.91	0.01	0.52	0.46	1093.78	0.12	0.08	0.02	0.17	0.00	0.01	0.01	14.22	0.00
Trencher	Diesel	63	75	4.35	1.47	8.72	0.007	0.734	0.65326	568.3	0.133	1	2	1	0.91	0.31	1.82	0.00	0.15	0.14	118.40	0.03	0.01	0.00	0.02	0.00	0.00	0.00	1.54	0.00
Compactor	Diesel	8	43	3.47	0.68	4.33	0.009	0.274	0.24386	568.3	0.061	1	2	1	0.05	0.01	0.07	0.00	0.00	0.00	8.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00
Compressor	Diesel	106	48	4.08	1.32	7.76	0.007	0.686	0.61054	568.3	0.119	1	4	1	1.83	0.59	3.48	0.00	0.31	0.27	254.99	0.05	0.02	0.01	0.05	0.00	0.00	0.00	3.31	0.00
Concrete Truck/Pump Truck	Diesel	210	20	1.82	0.57	5.55	0.006	0.295	0.26255	568.3	0.051	1	4	1	0.67	0.21	2.06	0.00	0.11	0.10	210.49	0.02	0.01	0.00	0.03	0.00	0.00	0.00	2.74	0.00
<b>TOTAL for 1 Small Turbine</b>														<b>30.81</b>	<b>8.75</b>	<b>71.82</b>	<b>0.07</b>	<b>4.02</b>	<b>3.58</b>	<b>6469.49</b>	<b>0.78</b>	<b>0.40</b>	<b>0.11</b>	<b>0.93</b>	<b>0.00</b>	<b>0.05</b>	<b>0.05</b>	<b>84.10</b>	<b>0.01</b>	

**Construction Truck Emissions**

**Small Turbine**

Proj. Construction Trucks	No. of Trucks	VMT		CO Running Exhaust (g/mi)	NO <sub>x</sub> Running Exhaust (g/mi)	VOC Running Exhaust (g/mi)	SO <sub>x</sub> Running Exhaust (g/mi)	PM10			PM2.5			CO <sub>2</sub> Running Exhaust (g/mi)	CH <sub>4</sub> Running Exhaust (g/mi)
		Speed (mph)	(mi/vehicle-day)					Running Exhaust (g/mi)	Tire Wear (g/mi)	Brake Wear (g/mi)	Running Exhaust (g/mi)	Tire Wear (g/mi)	Brake Wear (g/mi)		
Heavy-duty diesel trucks	10	27	40	6.303	17.209	1.262	0.019	0.713	0.036	0.028	0.656	0.009	0.012	1992.669	0.059
<b>Emissions, lbs/day</b>								<b>Emissions, tons/year</b>							
CO	NO <sub>x</sub>	VOCs	SO <sub>x</sub>	PM10	PM2.5	CO <sub>2</sub>	CH <sub>4</sub>	CO	NO <sub>x</sub>	VOCs	SO <sub>x</sub>	PM10	PM2.5	CO <sub>2</sub>	CH <sub>4</sub>
<b>5.56</b>	<b>15.18</b>	<b>1.11</b>	<b>0.02</b>	<b>0.69</b>	<b>0.60</b>	<b>1757.24</b>	<b>0.05</b>	<b>0.07</b>	<b>0.20</b>	<b>0.01</b>	<b>0.00</b>	<b>0.01</b>	<b>0.01</b>	<b>22.84</b>	<b>0.00</b>
<b>Total 1 Small Turbine =</b>								<b>0.07</b>	<b>0.20</b>	<b>0.01</b>	<b>0.00</b>	<b>0.01</b>	<b>0.01</b>	<b>22.84</b>	<b>0.00</b>

<b>Unpaved Road Emissions</b>		<b>PM10</b>	<b>PM2.5</b>
$E = k(s/12)^a(W/3)^b$	k	1.5	0.15
Assume s = 8.5	a	0.9	0.9
Assume W = 10	b	0.45	0.45
Assume 5 miles of travel per vehicle per day			
Emission Factor		1.8906	0.189060415
Control Efficiency		61%	61%
Emissions, lbs/day		2.5261	0.220100184
<b>1 Small Turbine (emissions, tons/year) =</b>		<b>0.03</b>	<b>0.00</b>

Personal Vehicles Emissions

*Small Turbine*

Vehicle Class	No. POVs	Speed (mph)	VMT (mi/vehicle day)	CO		NO <sub>x</sub>		VOCs					Running Evaporative		
				Running Exhaust (g/mi)	Start-Up (g/start) <sup>a</sup>	Running Exhaust (g/mi)	Start-Up (g/start) <sup>a</sup>	Running Exhaust (g/mi)	Start-Up (g/start) <sup>a</sup>	Hot-Soak (g/trip)	Resting Loss (g/hr)	Diurnal Evaporative (g/hr)	Diurnal Evaporative (g/hr)		
Light-duty truck, catalyst	15	33	40	2.924	11.289	0.284	0.56	0.055	0.816	0.183	0.024	0.047	0.054		
Vehicle Class	SO <sub>x</sub>		PM10				PM2.5				CO <sub>2</sub>		CH <sub>4</sub>		
	Running Exhaust (g/mi)	Start-Up (g/start) <sup>a</sup>	Running Exhaust (g/mi)	Start-Up (g/start) <sup>a</sup>	Tire Wear (g/mi)	Brake Wear (g/mi)	Running Exhaust (g/mi)	Start-Up (g/start) <sup>a</sup>	Tire Wear (g/mi)	Brake Wear (g/mi)	Running Exhaust (g/mi)	Start-Up (g/start) <sup>a</sup>	Running Exhaust (g/mi)	Start-Up (g/start) <sup>a</sup>	
Light-duty truck, catalyst	0.004	0.002	0.013	0.016	0.008	0.013	0.011	0.014	0.002	0.005	399.538	203.967	0.027	0.046	
Emissions, lbs/day								Emissions, tons/year							
CO	NO <sub>x</sub>	VOCs	SO <sub>x</sub>	PM10	PM2.5	CO <sub>2</sub>	CH <sub>4</sub>	CO	NO <sub>x</sub>	VOCs	SO <sub>x</sub>	PM10	PM2.5	CO <sub>2</sub>	CH <sub>4</sub>
4.24	0.39	0.20	0.01	0.05	0.02	535.2	0.04	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Total 1 Small Turbine =								0.06	0.01	0.00	0.00	0.00	0.00	6.96	0.00

**APPENDIX B**  
**BIOLOGICAL RESOURCE INFORMATION**

---

---

**Marine Corp Reserve Center Amarillo  
Natural Resource Impact Assessment  
for Proposed Wind Energy Project**



**Prepared for Marine Forces Reserve**



**Prepared by Paul A. Block**

**NAVFAC Atlantic**



## 1. Site Description

Marine Corp Reserve Center Amarillo (MCRC Amarillo) is located in the city of Amarillo and Randall County in Texas. MCRC Amarillo is approximately 6.7 acres with approximately 5.3 acres occupied by buildings and parking lots with the remaining as landscaped lawns. The entire site is surrounded by a security fence. See Figure 1 below.

**Figure 1: MCRC Amarillo**



MCRC Amarillo is located in a mixed use area of Amarillo with residential homes to the north, commercial/industrial to the east and west and an undeveloped area to the south. See Figure 2 .

## 2. Existing Conditions

### a. Wetlands

MCRC Amarillo contains no water resources with the exception of the one concrete drainage found near the center of the property. The proposed siting of the wind turbine is outside of the drainage area and

all necessary Best management Practices (BMPs) will be utilized to prevent impacts to this area during construction and operation.

## **b. Habitat**

### ***MCRC Amarillo***

MCRC Amarillo's habitat is considered urban and consisting of buildings, parking lots and associated infrastructure. The vegetation onsite consists of a few small trees (see Appendix 1) and lawn grasses. The entire compound is surrounded by a security fence. A concrete drainage is located in approximately the middle of the property flowing from north to the south. An additional concrete drainage is located adjacent to the property on the east side. Neither of the drainages contains significant vegetation. Adjacent property to the north, east and west are similar with a mixture of urban and suburban habitats that consist of trees, planted ornamental vegetation and lawns.

### ***Southern Adjacent Property***

The southern adjacent property is degraded and heavily disturbed (see Appendix 1). The topography of the area is manmade and consists of five stormwater ponds and rolling low hills. The ponds are deep and surrounded by steep banks that are the result of the placement of fill from the construction of the stormwater ponds. These ponds appear to be semi-permanent to permanent but highly dependent on the quantity and frequency of precipitation events. West Texas is in the middle of an extreme drought but four of the five ponds still contained water during my site survey. Inspection of aerial photo (Figure 2) shows all five containing water when this image was captured. Additional evidence of semi-permanence or permanence included shellfish, fish and turtle observations. These ponds appear to be maintained and contain little or no aquatic and shoreline vegetation (see Appendix 1).

The southern adjacent property contains a variety of habitats such as old field, deciduous woodlands, riparian corridors and open water (see Appendix 1). These areas are habitat to a variety of resident and seasonal wildlife species and offer food, water, cover and breeding locations to these species.

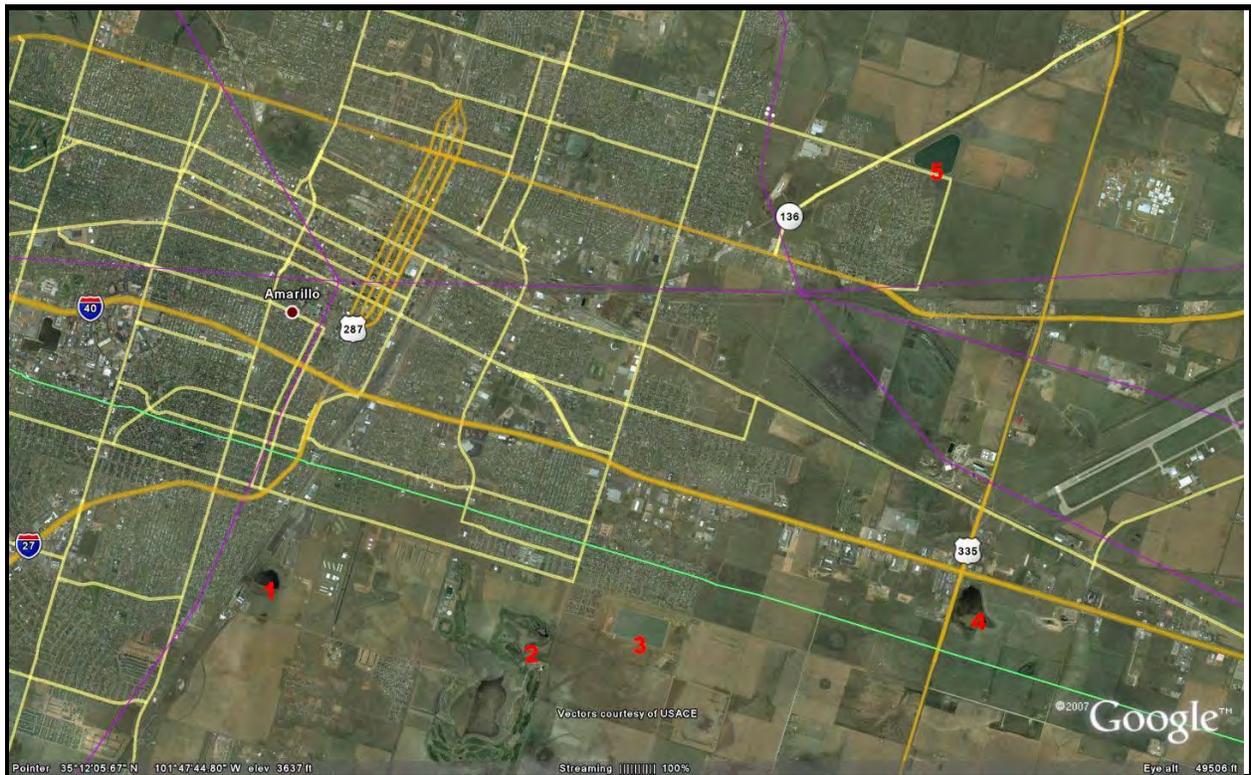
Figure 2: MCRC Amarillo and Adjacent Properties



### ***Off-Site Open Water Attractants***

Five off-site water bodies were surveyed as part of the site assessment to determine if any were significant wildlife attractants. These sites were a seasonally wet meadow (4), pond (1), stormwater retention pond (5), sewage treatment facilities (3) and golf course ponds (2). None of these sites were within a mile of MCRC Amarillo. No large concentrations of birds were observed at any of these sites but access was limited. Therefore, it is possible that they may attract migrating waterfowl during the spring and fall.

**Figure 3: Off-site Survey Locations**



### **c. Threatened and Endangered (T & E) Species**

Texas Parks and Wildlife publicizes a list of rare species in Randall County, TX, they include in this list federal and state threatened and endangered species, federal candidate and proposed species as well as several species not currently listed. The following table (Table 1) has all species that are federally and state listed as candidate, proposed, threatened and endangered but excludes the species not current regulated.

**Table 1: Listed Rare Species in Randall County, TX**

Common Name	Scientific Name	Federal Status	State Status	Habitat Onsite or Adjacent Property	Observed Onsite	Potential of Impact Onsite or Adjacent Property
<b>BIRDS</b>						
American Peregrine Falcon	<i>Falco peregrines anatum</i>		Threatened	No	No	Very Low
Bald Eagle	<i>Haliaeetus leucocephalus</i>		Threatened	No	No	Low
Interior Least Tern	<i>Sterna antillarum</i>	Listed Endangered	Endangered	No	No	None
Lesser Prairie-Chicken	<i>Tympanuchus pallidicinctus</i>	Candidate		No	No	None
Mountain Plover	<i>Charadrius montanus</i>	Proposed		No	No	None
Peregrine Falcon	<i>Falco peregrines</i>		Threatened	No	No	Very Low
Whooping Crane	<i>Grus americana</i>	Listed Endangered	Endangered	No	No	None
<b>MAMMALS</b>						
Black Bear	<i>Ursus americanus</i>		Threatened	No	No	None
Black-footed ferret	<i>Mustela nigripes</i>	Listed Endangered		No	No	None
Gray wolf	<i>Canis lupus</i>	Listed Endangered	Endangered	No	No	None
Palo Duro mouse	<i>Peromyscus truei comanche</i>		Threatened	No	No	None
<b>REPTILES</b>						
Texas horned lizard	<i>Phrynosoma cornutum</i>		Threatened	Possible	No	None

**T & E Mammals and Reptiles**

Four mammals and one reptile are included on this list. None of these mammals would be located onsite or the adjacent properties. The gray wolf (*Canis lupus*) and black-footed ferret (*Mustela nigripes*) though in their historic range are extirpated from the area. The black bear (*Ursus americanus*) and Palo Duro mouse (*Peromyscus truei comanche*) would not be located due to lack of habitat. No T & E bats have been observed in Randall County, TX. Known bats of Randall County are listed in Table 2.

**Table 2: List of Bats with Known Observations in Randall County, TX**

Common Name	Scientific Name	Federal or State Listed
California Myotis	<i>Myotis californicus</i>	No
Western Small-footed Myotis	<i>Myotis ciliolabrum</i>	No
Cave Myotis	<i>Myotis velifer</i>	No
Silver-haired Bat	<i>Lasionycteris noctivagans</i>	No
Western Pipistrelle	<i>Pipistrellus hesperus</i>	No
Big Brown Bat	<i>Eptesicus fuscus</i>	No
Eastern Red Bat	<i>Lasiurus borealis</i>	No
Hoary Bat	<i>Lasiurus cinereus</i>	No
Townsend’s Big-eared Bat	<i>Plecotus townsendii</i>	No
Pallid Bat	<i>Antrozous pallidus</i>	No
Brazilian Free-tailed Bat	<i>Tadarida brasiliensis</i>	No

The habitat for the Texas horned lizard (*Phrynosoma cornutum*), arid to semi-arid open sites with sparse vegetation exists on the southern adjacent property. But, due to the extreme habitat degradation and disturbance and the presence of feral cats/dogs it is unlikely that this species is present.

**T & E Birds**

***MCRC Amarillo***

MCRC Amarillo will attract birds that use the site year-round, spring/summer breeders, winter residents and a few seasonal migrants. But, the species mix will be mostly limited to those species common to urban/suburban locations with the exception of some transient usage from species using the adjacent property. No T & E species would be located onsite. See Appendix 2 for a list of species observed onsite during the site survey.

***Southern Adjacent Property***

This area will attract birds that use the site year-round, spring/summer breeders, winter residents and seasonal migrants. The site is located at the edge of the Central Flyway and likely attracts migrants in the spring and fall. Additionally, the availability of water in semi-arid west Texas is an attractant to bird species during all seasons. And finally, with the landscape location in the middle of urban/suburban Amarillo, the site will act as a greenspace attractant to many species migrating through the area. See Appendix 2 for a list of species observed onsite during the site survey.

Habitat preferences, current range maps and historic data from the closest geographically located Breeding Bird Survey 83101 (BBS) and Christmas Bird Count TXAM (CBC) routes plus seasonal bird observation data from Buffalo Lake National Wildlife Refuge (BLNWR) and US Department of Agriculture Wildlife Service’s Bird Strike Data from Rick Husband Amarillo International Airport was used for this analysis.

Based on this analysis, the lesser prairie chicken (*Tympanuchus pallidicinctus*) though in its historic range is extirpated from the area. This species was not recorded as observed in any of the data sets.

The whooping crane (*Grus americana*) would not be located due to lack of habitat. The whooping cranes migratory pathway to and from Wood Buffalo National Park/Aransas National Wildlife Refuge does not include the Panhandle of Texas except in rare instances. This species was not recorded as observed in any of the data sets except BLNWR data. The whooping crane is considered “accidental (fall)” at BLNWR which is defined as historic observations of once or twice.

The mountain plover (*Charadrius montanus*) would not be located due to lack of habitat. This species was not recorded as observed in any of the data sets except BLNWR data. The mountain plover is considered “rare (spring/fall) to accidental (summer)” at BLNWR which is defined as observed at intervals of two to five years (rare) and historic observations of once or twice (accidental).

The interior least tern (*Sterna antillarum*) would not be located due to lack of habitat. This species was not recorded as observed in any of the data sets except BLNWR data. The interior least tern is considered “accidental (spring, summer and fall)” at BLNWR which is defined as historic observations of once or twice.

The American peregrine falcon (*Falco peregrines anatum*) and peregrine falcon (*Falco peregrines*) will be addressed as one. The peregrine falcon would not be a resident onsite but usage may occur due to availability of prey (birds). This species was not recorded as observed in any of the data sets except BLNWR data. The peregrine falcon is considered “occasional (spring/fall) and rare (winter)” at BLNWR which is defined as observed at intervals of two to five years (rare) and seen few times during season (occasional).

The bald eagle (*Haliaeetus leucocephalus*) would not breed onsite due to lack of habitat though seasonal (fall, spring, winter) usage may occur due to availability of water and prey (fish and turtles). Of the listed species, only the bald eagle shows up in the CBC surveys and BLNWR data. The bald eagle is considered “occasional (fall), uncommon (spring) and common (winter)” at BLNWR which is defined as seen few times during season (occasional); present, not certain to be seen (uncommon) and certain to be seen in suitable habitats (common).

### **3. Impacts**

#### **a. Wetlands**

No water resource impacts are anticipated for the construction or operation of the proposed wind turbine and no US Army Corp of Engineer permit will be required for construction or operation. BMP will be utilized to prevent any potential near construction site impacts.

#### **b. Threatened and Endangered Species**

Two state listed species may use the site, peregrine falcon and bald eagle, but due to the sites location within an urban/suburban area of Amarillo diminishes the attractiveness of the site to these species.

Therefore, though a negative impact to an individual peregrine falcon and/or bald eagle is possible it is insignificant and discountable.

The construction and operation of a wind turbine will have no impact any federally listed species that may occur in the area including black-footed ferret, gray wolf, least interior tern, mountain plover, lesser prairie chicken and whooping crane. No further T & E species consultation is required prior to construction and operation of the proposed turbine.

If operators of the turbine and users of the site become aware of a significant impact to birds and bats caused by the operation of the turbine than mitigative measures may be considered and implemented to eliminate or significantly decrease these impacts.

**APPENDIX 1: SITE PHOTOS**

**Photo 1: MCRC Amarillo Parking Lot and fenceline at rear of facility**



**Photo 2: MCRC Amarillo Parking Lot**



**Photo 3: MCRC Amarillo Fenceline southeast edge of property**



**Photo 4: MCRC Amarillo area of proposed turbine**



**Photo 5: MCRC Amarillo area concrete drainage onsite**



**Photo 6: Field to west of MCRC Amarillo**



**Photo 7: Riparian corridor south of MCRC Amarillo**



**Photo 8: South adjacent property old field habitat**



**Photo 9: South adjacent property old field habitat**



**Photo 10: South adjacent property deciduous woodlands**



**Photo 11: South adjacent property old field habitat**



**Photo 12: South adjacent property dried Pond 1**



**Photo 13: South adjacent property dried Pond 1 dead fish**



**Photo 14: South adjacent property dried Pond 1 dead mullusks**



**Photo 15: South adjacent property Pond 2**



**Photo 16: South adjacent property Pond 3**



**Photo 17: South adjacent property Pond 3 connection to Pond 4**



**Photo 18: South adjacent property Pond 4**



**Photo 19: South adjacent property Pond 4 notice fish fins and turtle heads**



**Photo 20: South adjacent property Pond 5 nearly dry**



## APPENDIX 2: SITE ASSESSMENT WILDLIFE OBSERVATIONS

1. Great egret
  2. Western kingbird-RC
  3. Barn swallow-RC
  4. Great-tailed grackle-RC
  5. Western meadowlark-RC
  6. Rock pigeon-RC
  7. European starling-RC
  8. Mourning dove-RC
  9. Eurasian-collared dove-RC
  10. House sparrow-RC
  11. House finch
  12. Eastern mockingbird
  13. Swainson's hawk
  14. American kestrel
  15. Mallard duck
  16. Canada goose
  17. American avocet
  18. Violet-green swallow
  19. Killdeer
  20. Cinnamon teal duck
  21. Band-tailed pigeon
  22. Blue-winged teal duck
  23. Red fox
  24. Feral dog
  25. Feral cat
  26. Red-eared slider
  27. Carp sp.
  28. Mollusk sp.
- RC-Observed on Reserve Center site or fenceline

**APPENDIX C**  
**SHADOW FLICKER ANALYSIS**

---

---

# 1 APPENDIX C

## 2 SHADOW FLICKER ANALYSIS

---

### 3 1.0 INTRODUCTION

4 The rotating blades of a wind turbine can produce shadow flicker, which is the alternation of light and  
5 shadow caused by blade rotation when the turbine is in line of sight between the sun and another object or  
6 person. Potential for shadow flicker was analyzed using an industry-standard modeling software, EMD  
7 International's WindPro modeling software (version 2.7.486, released January 2011). The industry-  
8 standard, default settings were used whenever possible. Please see Section 4.2 of WindPro's  
9 knowledgebase (available at [http://help.emd.dk/knowledgebase/content/WindPRO2.7/04-  
10 UK\\_WindPRO2.7\\_ENVIRONMENT.pdf](http://help.emd.dk/knowledgebase/content/WindPRO2.7/04-UK_WindPRO2.7_ENVIRONMENT.pdf)) for the default settings and for additional, detailed information  
11 on how shadow flicker is modeled. Section 2.0, below, discusses the user-defined data input required by  
12 WindPro. Section 3.0 provides WindPro's full report.

### 13 2.0 MODELING DATA INPUT

#### 14 2.1 Sensitive Receptors

15 As described in Section 3.8.1 of the EA, there are two potential receptors sensitive to shadow flicker  
16 within 10 rotor diameters (690 ft) of the proposed turbine location for Alternative 2: the Children's  
17 Learning Center and the Kimble Learning Center. Each potential receptor was modeled as a 1 m by 1 m  
18 virtual window, 1 m above the ground. This virtual window was conservatively located at the southeast  
19 corner of the respective building where the property has the greatest potential for shadow flicker,  
20 regardless of whether an actual window is located at that corner. Furthermore, the virtual window was  
21 conservatively modeled in "greenhouse mode," allowing it to perfectly face the wind turbine regardless of  
22 the angle of associated building. Additionally, it was assumed that there were no other objects, including  
23 trees, that might disrupt the line of sight to the proposed wind turbine. As such, results over-estimate the  
24 amount of shadow flicker an actual window on the building might receive from the proposed wind  
25 turbine.

#### 26 2.2 Analysis Settings

27 The analysis was run at 1 minute intervals for an entire year. If any portion of the virtual window  
28 received shadow, it was assumed that the entire window received flicker for the duration of the minute  
29 modeled. The turbine manufacturer, Northern Power Systems, provided the maximum and minimum  
30 width of the turbine's three blades (33 inches and 9 inches, respectively). The ground surface is  
31 conservatively assumed to be flat despite the 4 to 5 ft increase in elevation at the receptor sites.

32 Real-case wind data was obtained from the closest dataset provided by the National Oceanic and  
33 Atmospheric Administration's (NOAA) National Operational Model Archive and Distribution System  
34 (NOMADS) via EMD's online WindPro data server. Real-case sunshine data, in terms of the average sun  
35 hours divided by possible sun hours for each month, was obtained directly from NOAA (at  
36 <http://www.ncdc.noaa.gov/oa/climate/online/ccd/avgsun.html>) and manually entered into WindPro.

### 37 3.0 RESULTS

38 The analysis was run first under the worst-case scenario and then under the real, or expected, scenario.  
39 The following pages provide WindPro's full report for both analyses.

Project: **Amarillo**  
 Description: MARFORRES CENTER, Amarillo Small Wind Project (1 Northwind 100kW wind turbine)  
 Alternative 2 Expected Scenario

Printed/Page: 6/6/2011 1:02 PM / 1  
 Licensed user: **Course Registration**  
 Time-limited until juni 27. 2011

Calculated: 6/6/2011 1:02 PM/2.7.486



## SHADOW - Main Result

Calculation: Alt 2 Real Case

### Assumptions for shadow calculations

Maximum distance for influence  
 Calculate only when more than 20 % of sun is covered by the blade  
 Please look in WTG table

Minimum sun height over horizon for influence: 3 °  
 Day step for calculation: 1 days  
 Time step for calculation: 1 minutes

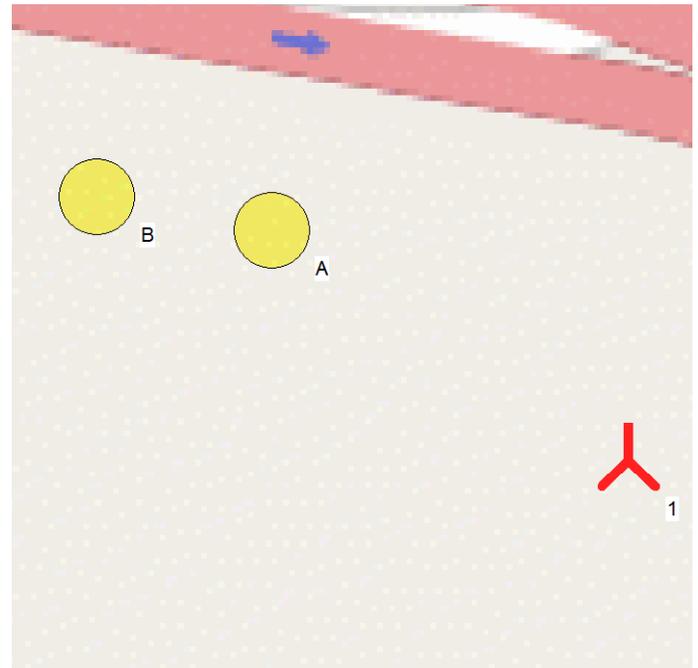
Sunshine probability S/S0 (Sun hours/Possible sun hours) []  
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.69 0.68 0.72 0.74 0.71 0.78 0.79 0.77 0.73 0.75 0.72 0.67

Operational hours are calculated from WTGs in calculation and wind distribution:  
 Default Meteo data description

Operational time  
 N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 489 434 299 270 381 945 1,978 1,440 710 376 262 339 7,922  
 Idle start wind speed: Cut in wind speed from power curve

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:

Height contours used:  
 Obstacles used in calculation  
 Eye height: 1.5 m  
 Grid resolution: 10 m



Scale 1:2,500  
 New WTG Shadow receptor

### WTGs

UTM NAD83 Zone: 14				WTG type				Shadow data			
East	North	Z	Row data/Description	Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM [RPM]
244,139.46	3,898,698.87	0.0	Alternative 2	Yes	Nothern Power	Northwind 100-100	100	21.0	36.9	370	59.0

### Shadow receptor-Input

UTM NAD83 Zone: 14										
No.	Name	East	North	Z	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
A	Children's Learning Center	244,023.12	3,898,778.23	0.0	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
B	Kimble Learning Center	243,964.89	3,898,791.15	0.0	1.0	1.0	1.0	-180.0	90.0	"Green house mode"

### Calculation Results

Shadow receptor		Shadow, expected values	
No.	Name	Shadow hours per year [h/year]	
A	Children's Learning Center	11:44	
B	Kimble Learning Center	5:11	

Project:

**Amarillo**

Description:

MARFORRES CENTER, Amarillo Small Wind Project (1 Northwind 100kW wind turbine)  
Alternative 2 Expected Scenario

Printed/Page

6/6/2011 1:02 PM / 2

Licensed user:

**Course Registration**  
Time-limited until juni 27. 2011

Calculated:

6/6/2011 1:02 PM/2.7.486



## SHADOW - Main Result

**Calculation:** Alt 2 Real Case

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
1	Alternative 2	42:59	16:54

Project: **Amarillo**

Description: **MARFORRES CENTER, Amarillo Small Wind Project (1 Northwind 100kW wind turbine)  
Alternative 2 Expected Scenario**

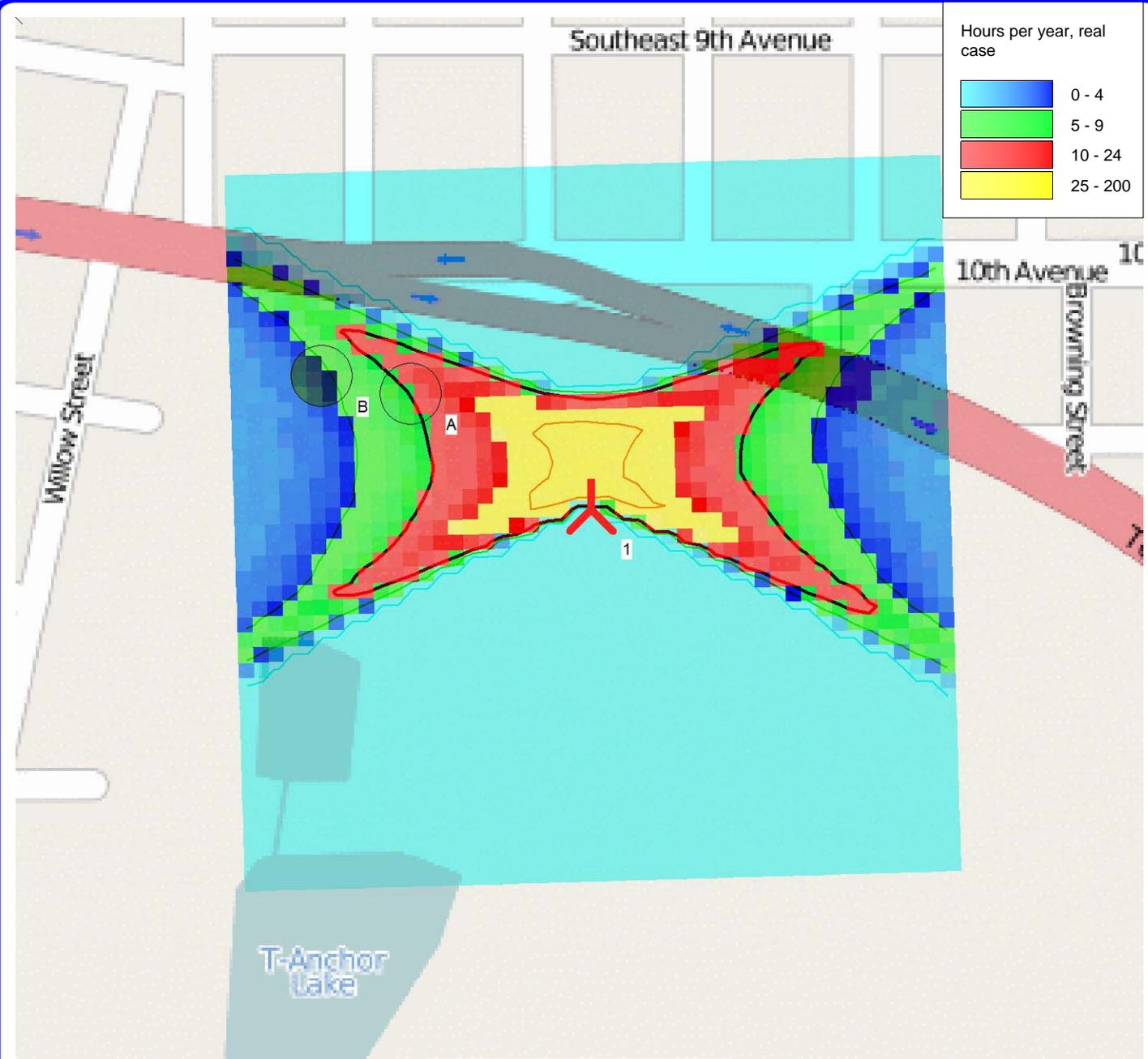
Printed/Page: 6/6/2011 1:05 PM / 1  
Licensed user: **Course Registration**  
Time-limited until juni 27. 2011

Calculated: 6/6/2011 1:02 PM/2.7.486



### SHADOW - Map

Calculation: Alt 2 Real Case



0 50 100 150 200 m

Map: WindPRO map , Print scale 1:4,000, Map center UTM NAD 83 Zone: 14 East: 244,140.00 North: 3,898,689.96

New WTG

Shadow receptor

Isolines showing shadow in Hours per year, real case

0 5 10 50

Project: **Amarillo** Description: **MARFORRES CENTER, Amarillo Small Wind Project (1 Northwind 100kW wind turbine) Alternative 2 Expected Scenario**

Printed/Page: 6/6/2011 1:03 PM / 1  
 Licensed user: **Course Registration**  
 Time-limited until juni 27. 2011



Calculated: 6/6/2011 1:02 PM/2.7.486

**SHADOW - Calendar**

Calculation: Alt 2 Real Case Shadow receptor: A - Children's Learning Center

**Assumptions for shadow calculations**

Maximum distance for influence 210 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

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

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.69 0.68 0.72 0.74 0.71 0.78 0.79 0.77 0.73 0.75 0.72 0.67

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 489 434 299 270 381 945 1,978 1,440 710 376 262 339 7,922  
 Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June	July	August	September	October	November	December		
1	07:56	07:48	08:48 (1)	07:18	07:36	06:57	06:35	06:37	06:56	07:20	07:42	08:21 (1)	07:37	
	17:46	18:15	36 09:24 (1)	18:42	20:08	20:32	20:56	21:06	20:52	20:17	19:34	30 08:51 (1)	17:36	
2	07:57	07:47	08:48 (1)	07:17	07:34	06:56	06:34	06:37	06:57	07:20	07:43	08:21 (1)	07:38	
	17:47	18:16	36 09:24 (1)	18:43	20:09	20:33	20:57	21:06	20:52	20:16	19:33	17:53	31 08:52 (1)	17:36
3	07:57	07:46	08:48 (1)	07:16	07:33	06:55	06:34	06:37	06:58	07:21	07:44	08:20 (1)	07:39	
	17:48	18:17	36 09:24 (1)	18:44	20:10	20:34	20:57	21:06	20:51	20:14	19:31	17:52	33 08:53 (1)	17:36
4	07:57	07:45	08:49 (1)	07:14	07:31	06:54	06:34	06:38	06:58	07:22	07:44	08:19 (1)	07:40	
	17:49	18:18	36 09:25 (1)	18:45	20:10	20:35	20:58	21:06	20:50	20:13	19:30	17:51	35 08:54 (1)	17:35
5	07:57	07:44	08:49 (1)	07:13	07:30	06:53	06:34	06:38	06:59	07:23	07:45	08:19 (1)	07:41	
	17:49	18:19	36 09:25 (1)	18:45	20:11	20:36	20:58	21:06	20:49	20:11	19:28	17:50	35 08:54 (1)	17:35
6	07:57	07:43	08:49 (1)	07:12	07:29	06:52	06:33	06:39	07:00	07:23	07:46	08:19 (1)	07:42	
	17:50	18:20	35 09:24 (1)	18:46	20:12	20:36	20:59	21:06	20:48	20:10	19:27	17:49	35 08:54 (1)	17:35
7	07:57	07:43	08:50 (1)	07:10	07:27	06:51	06:33	06:39	07:01	07:24	07:47	08:19 (1)	07:43	
	17:51	18:21	34 09:24 (1)	18:47	20:13	20:37	21:00	21:06	20:47	20:09	19:26	17:48	36 08:55 (1)	17:35
8	07:57	07:42	08:50 (1)	08:09	07:26	06:50	06:33	06:40	07:02	07:25	07:48	08:19 (1)	07:43	
	17:52	18:22	33 09:23 (1)	18:48	20:14	20:38	21:00	21:06	20:46	20:07	19:24	17:47	36 08:55 (1)	17:35
9	07:57	07:41	08:51 (1)	08:08	07:24	06:49	06:33	06:41	07:02	07:26	07:48	08:19 (1)	07:44	
	17:53	18:23	31 09:22 (1)	19:49	20:14	20:39	21:01	21:05	20:45	20:06	19:23	17:47	36 08:55 (1)	17:36
10	07:57	07:40	08:52 (1)	08:06	07:23	06:48	06:33	06:41	07:03	07:26	07:49	08:19 (1)	07:45	
	17:54	18:24	29 09:21 (1)	19:50	20:15	20:40	21:01	21:05	20:44	20:04	19:22	17:46	36 08:55 (1)	17:36
11	07:57	07:39	08:53 (1)	08:05	07:22	06:48	06:33	06:42	07:04	07:27	07:50	08:19 (1)	07:46	
	17:55	18:25	27 09:20 (1)	19:51	20:16	20:40	21:02	21:05	20:43	20:03	19:20	17:45	36 08:55 (1)	17:36
12	07:57	07:38	08:54 (1)	08:04	07:20	06:47	06:33	06:42	07:05	07:28	07:51	08:19 (1)	07:46	
	17:56	18:26	25 09:19 (1)	19:52	20:17	20:41	21:02	21:04	20:42	20:01	19:19	17:44	36 08:55 (1)	17:36
13	07:56	07:37	08:56 (1)	08:02	07:19	06:46	06:33	06:43	07:05	07:29	07:52	08:20 (1)	07:47	
	17:57	18:27	21 09:17 (1)	19:52	20:18	20:42	21:02	21:04	20:41	20:00	19:17	17:44	35 08:55 (1)	17:36
14	07:56	07:36	08:57 (1)	08:01	07:18	06:45	06:33	06:44	07:06	07:29	07:52	08:20 (1)	07:48	
	17:58	18:28	19 09:16 (1)	19:53	20:18	20:43	21:03	21:04	20:39	19:59	19:16	17:43	35 08:55 (1)	17:37
15	07:56	07:35	09:00 (1)	07:59	07:17	06:44	06:33	06:44	07:07	07:30	07:53	08:21 (1)	07:48	
	17:58	18:29	13 09:13 (1)	19:54	20:19	20:44	21:03	21:03	20:38	19:57	19:15	17:42	33 08:54 (1)	17:37
16	07:56	08:58 (1)	07:34	07:58	07:15	06:44	06:33	06:45	07:08	07:31	07:54	08:22 (1)	07:49	
	17:59	9 09:07 (1)	18:30	19:55	20:20	20:44	21:04	21:03	20:37	19:56	19:14	17:42	32 08:54 (1)	17:37
17	07:56	08:56 (1)	07:33	07:57	07:14	06:43	06:33	06:45	07:08	07:31	07:55	08:22 (1)	07:50	
	18:00	14 09:10 (1)	18:31	19:56	20:21	20:45	21:04	21:02	20:36	19:54	19:12	17:41	32 08:54 (1)	17:37
18	07:55	08:54 (1)	07:31	07:55	07:13	06:42	06:33	06:46	07:09	07:32	07:56	08:23 (1)	07:50	
	18:00	17 09:11 (1)	18:32	19:57	20:22	20:46	21:04	21:02	20:35	19:53	19:11	17:40	30 08:53 (1)	17:38
19	07:55	08:53 (1)	07:30	07:54	07:11	06:41	06:33	06:47	07:10	07:33	07:57	08:24 (1)	07:51	
	18:01	20 09:13 (1)	18:33	19:57	20:22	20:47	21:05	21:01	20:34	19:51	19:10	17:40	28 08:52 (1)	17:38
20	07:54	08:52 (1)	07:29	07:52	07:10	06:41	06:33	06:47	07:11	07:34	07:58	08:26 (1)	07:52	
	18:02	22 09:14 (1)	18:34	19:58	20:23	20:47	21:05	21:01	20:32	19:50	19:08	17:39	26 08:52 (1)	17:39
21	07:54	08:52 (1)	07:28	07:51	07:09	06:40	06:33	06:48	07:11	07:34	07:58	08:27 (1)	07:52	
	18:03	24 09:16 (1)	18:34	19:59	20:24	20:48	21:05	21:00	20:31	19:48	19:07	17:39	24 08:51 (1)	17:39
22	07:54	08:51 (1)	07:27	07:50	07:08	06:39	06:34	06:49	07:12	07:35	07:59	08:28 (1)	07:53	
	18:04	26 09:17 (1)	18:35	20:00	20:25	20:49	21:05	21:00	20:30	19:47	19:06	17:38	22 08:50 (1)	17:40
23	07:53	08:50 (1)	07:26	07:48	07:06	06:39	06:34	06:50	07:13	07:36	08:00	08:29 (1)	07:53	
	18:05	28 09:18 (1)	18:36	20:01	20:26	20:50	21:06	20:59	20:29	19:46	19:05	17:38	20 08:49 (1)	17:40
24	07:53	08:49 (1)	07:24	07:47	07:05	06:38	06:34	06:50	07:14	07:37	08:01	08:31 (1)	07:54	
	18:06	30 09:19 (1)	18:37	20:01	20:26	20:50	21:06	20:58	20:27	19:44	19:04	17:38	17 08:48 (1)	17:41
25	07:52	08:49 (1)	07:23	07:45	07:04	06:38	06:34	06:51	07:14	07:37	08:02	08:33 (1)	07:54	
	18:07	32 09:21 (1)	18:38	20:02	20:27	20:51	21:06	20:58	20:26	19:43	19:03	17:37	14 08:47 (1)	17:41
26	07:51	08:49 (1)	07:22	07:44	07:03	06:37	06:35	06:52	07:15	07:38	08:03	08:35 (1)	07:54	
	18:08	32 09:21 (1)	18:39	20:03	20:28	20:52	21:06	20:57	20:25	19:41	19:01	5 09:34 (1)	10 08:45 (1)	17:42
27	07:51	08:48 (1)	07:21	07:43	07:02	06:37	06:35	06:52	07:16	07:39	08:04	09:29 (1)	07:54	
	18:09	33 09:21 (1)	18:40	20:04	20:29	20:53	21:06	20:56	20:24	19:40	19:00	14 09:43 (1)	17:37	17:43
28	07:50	08:48 (1)	07:20	07:41	07:01	06:36	06:35	06:53	07:17	07:40	08:05	09:27 (1)	07:55	
	18:10	35 09:23 (1)	18:41	20:05	20:30	20:53	21:06	20:56	20:22	19:38	18:58	19 09:46 (1)	17:36	17:43
29	07:50	08:48 (1)		07:40	07:00	06:36	06:36	06:54	07:17	07:40	08:06	09:25 (1)	07:55	
	18:12	35 09:23 (1)		20:05	20:31	20:54	21:06	20:55	20:21	19:37	18:57	23 09:48 (1)	17:36	17:44
30	07:49	08:47 (1)		07:38	06:58	06:35	06:36	06:55	07:18	07:41	08:07	09:24 (1)	07:56	
	18:13	36 09:23 (1)		20:06	20:31	20:55	21:06	20:54	20:20	19:35	18:56	25 09:49 (1)	17:36	17:45
31	07:48	08:48 (1)		07:37	06:55	06:35	06:35	06:55	07:19	07:42	08:08	09:22 (1)	07:56	
	18:14	36 09:24 (1)		20:07	20:55	20:55	21:06	20:53	20:18	19:32	18:55	28 09:50 (1)	17:45	17:45
Potential sun hours	312	305	370	392	434	434	443	418	373	351	310	305		
Total, worst case	429	447								114	773			
Sun reduction	0.69	0.68								0.75	0.72			
Oper. time red.	0.90	0.90								0.90	0.90			
Wind dir. red.	0.63	0.63								0.63	0.63			
Total reduction	0.39	0.39								0.43	0.41			
Total, real	168	172								48	316			

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

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

Project: **Amarillo** Description: **MARFORRES CENTER, Amarillo Small Wind Project (1 Northwind 100kW wind turbine) Alternative 2 Expected Scenario**

Printed/Page: 6/6/2011 1:03 PM / 2  
 Licensed user: **Course Registration**  
 Time-limited until juni 27. 2011



Calculated: 6/6/2011 1:02 PM/2.7.486

## SHADOW - Calendar

Calculation: Alt 2 Real Case Shadow receptor: B - Kimble Learning Center

### Assumptions for shadow calculations

Maximum distance for influence: 210 m  
 Minimum sun height over horizon for influence: 3 °  
 Day step for calculation: 1 days  
 Time step for calculation: 1 minutes

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

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.69 0.68 0.72 0.74 0.71 0.78 0.79 0.77 0.73 0.75 0.72 0.67

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 489 434 299 270 381 945 1,978 1,440 710 376 262 339 7,922  
 Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:56	07:48	08:28 (1)	07:18	07:36	06:57	06:35	06:37	06:56	07:20	07:42	07:37
	17:46	18:15	08:45 (1)	18:42	20:08	20:32	20:56	21:06	20:52	20:17	19:34	17:54
2	07:57	07:47	08:27 (1)	07:17	07:34	06:56	06:34	06:37	06:57	07:20	07:43	07:38
	17:47	18:16	08:46 (1)	18:43	20:09	20:33	20:57	21:06	20:52	20:16	19:33	17:53
3	07:57	07:46	08:26 (1)	07:16	07:33	06:55	06:34	06:37	06:58	07:21	07:44	07:39
	17:48	18:17	08:47 (1)	18:44	20:10	20:34	20:57	21:06	20:51	20:14	19:31	17:52
4	07:57	07:45	08:26 (1)	07:14	07:31	06:54	06:34	06:38	06:58	07:22	07:44	07:40
	17:49	18:18	08:49 (1)	18:45	20:10	20:35	20:58	21:06	20:50	20:13	19:30	17:51
5	07:57	07:44	08:25 (1)	07:13	07:30	06:53	06:34	06:38	06:59	07:23	07:45	07:41
	17:49	18:19	08:49 (1)	18:45	20:11	20:36	20:58	21:06	20:49	20:11	19:28	17:50
6	07:57	07:43	08:25 (1)	07:12	07:29	06:52	06:33	06:39	07:00	07:23	07:46	07:42
	17:50	18:20	08:50 (1)	18:46	20:12	20:36	20:59	21:06	20:48	20:10	19:27	17:49
7	07:57	07:43	08:24 (1)	07:10	07:27	06:51	06:33	06:39	07:01	07:24	07:47	07:43
	17:51	18:21	08:50 (1)	18:47	20:13	20:37	21:00	21:06	20:47	20:09	19:26	17:48
8	07:57	07:42	08:24 (1)	08:09	07:26	06:50	06:33	06:40	07:02	07:25	07:48	07:43
	17:52	18:22	08:50 (1)	18:48	20:14	20:38	21:00	21:06	20:46	20:07	19:24	17:47
9	07:57	07:41	08:24 (1)	08:08	07:24	06:49	06:33	06:41	07:02	07:26	07:48	07:44
	17:53	18:23	08:50 (1)	19:49	20:14	20:39	21:01	21:05	20:45	20:06	19:23	17:47
10	07:57	07:40	08:24 (1)	08:06	07:23	06:48	06:33	06:41	07:03	07:26	07:49	07:45
	17:54	18:24	08:50 (1)	19:50	20:15	20:40	21:01	21:05	20:44	20:04	19:22	17:46
11	07:57	07:39	08:24 (1)	08:05	07:22	06:48	06:33	06:42	07:04	07:27	07:50	07:46
	17:55	18:25	08:50 (1)	19:51	20:16	20:40	21:02	21:05	20:43	20:03	19:20	17:45
12	07:57	07:38	08:25 (1)	08:04	07:20	06:47	06:33	06:42	07:05	07:28	07:51	07:46
	17:56	18:26	08:50 (1)	19:52	20:17	20:41	21:02	21:04	20:42	20:01	19:19	17:44
13	07:56	07:37	08:26 (1)	08:02	07:19	06:46	06:33	06:43	07:05	07:29	07:52	07:47
	17:57	18:27	08:49 (1)	19:52	20:18	20:42	21:02	21:04	20:41	20:00	19:17	17:44
14	07:56	07:36	08:26 (1)	08:01	07:18	06:45	06:33	06:44	07:06	07:29	07:52	07:48
	17:58	18:28	08:48 (1)	19:53	20:18	20:43	21:03	21:04	20:39	19:59	19:16	17:43
15	07:56	07:35	08:28 (1)	07:59	07:17	06:44	06:33	06:44	07:07	07:30	07:53	07:48
	17:58	18:29	08:47 (1)	19:54	20:19	20:44	21:03	21:03	20:38	19:57	19:15	17:42
16	07:56	07:34	08:29 (1)	07:58	07:15	06:44	06:33	06:45	07:08	07:31	07:54	07:49
	17:59	18:30	08:46 (1)	19:55	20:20	20:44	21:04	21:03	20:37	19:56	19:14	17:42
17	07:56	07:33	08:31 (1)	07:57	07:14	06:43	06:33	06:45	07:08	07:32	07:55	07:50
	18:00	18:31	08:44 (1)	19:56	20:21	20:45	21:04	21:02	20:36	19:54	19:12	17:41
18	07:55	07:32	08:34 (1)	07:55	07:13	06:42	06:33	06:46	07:09	07:32	07:56	07:50
	18:00	18:32	08:41 (1)	19:57	20:22	20:46	21:04	21:02	20:35	19:53	19:11	17:40
19	07:55	07:30	07:54	07:11	06:41	06:33	06:47	07:10	07:33	07:57	07:57	07:51
	18:01	18:33	19:57	20:22	20:47	21:05	21:01	20:34	19:51	19:10	17:40	17:38
20	07:54	07:29	07:52	07:10	06:41	06:33	06:47	07:11	07:34	07:58	07:58	07:52
	18:02	18:34	19:58	20:23	20:47	21:05	21:01	20:32	19:50	19:08	17:39	17:39
21	07:54	07:28	07:51	07:09	06:40	06:33	06:48	07:11	07:34	07:58	07:58	07:52
	18:03	18:34	19:59	20:24	20:48	21:05	21:00	20:31	19:48	19:07	17:39	17:39
22	07:54	07:27	07:50	07:08	06:39	06:34	06:49	07:12	07:35	07:59	07:59	07:53
	18:04	18:35	20:00	20:25	20:49	21:05	21:00	20:30	19:47	19:06	17:38	17:40
23	07:53	07:26	07:48	07:06	06:39	06:34	06:50	07:13	07:36	08:00	07:30	07:53
	18:05	18:36	20:01	20:26	20:50	21:06	20:59	20:29	19:46	19:05	17:38	17:40
24	07:53	07:24	07:47	07:05	06:38	06:34	06:50	07:14	07:37	08:01	07:31	07:54
	18:06	18:37	20:01	20:26	20:50	21:06	20:58	20:27	19:44	19:04	9 09:03 (1)	17:38
25	07:52	07:23	07:45	07:04	06:38	06:34	06:51	07:14	07:37	08:02	09:00 (1)	07:32
	18:07	18:38	20:02	20:27	20:51	21:06	20:58	20:26	19:43	19:03	14 09:14 (1)	17:37
26	07:51	07:22	07:44	07:03	06:37	06:35	06:52	07:15	07:38	08:03	08:58 (1)	07:33
	18:08	18:39	20:03	20:28	20:52	21:06	20:57	20:25	19:41	19:01	18 09:16 (1)	17:37
27	07:51	07:21	07:43	07:02	06:37	06:35	06:52	07:16	07:39	08:04	08:57 (1)	07:34
	18:09	18:40	20:04	20:29	20:53	21:06	20:56	20:24	19:40	19:00	20 09:17 (1)	17:37
28	07:50	07:20	07:41	07:01	06:36	06:35	06:53	07:17	07:40	08:05	08:56 (1)	07:35
	18:10	18:41	20:05	20:30	20:53	21:06	20:56	20:22	19:38	18:58	22 09:18 (1)	17:36
29	07:50	07:20	07:40	07:00	06:36	06:36	06:54	07:17	07:40	08:06	08:55 (1)	07:35
	18:12	18:42	20:05	20:31	20:54	21:06	20:55	20:21	19:37	18:57	24 09:19 (1)	17:36
30	07:49	08:31 (1)	07:38	06:58	06:35	06:36	06:55	07:18	07:41	08:07	08:55 (1)	07:36
	18:13	9 08:40 (1)	20:06	20:31	20:55	21:06	20:54	20:20	19:35	18:56	24 09:19 (1)	17:36
31	07:48	08:30 (1)	07:37	06:35	06:35	06:55	07:19	07:42	08:08	08:54 (1)		07:56
	18:14	13 08:43 (1)	20:07	20:55	20:55	20:53	20:18	20:18	18:55	26 09:20 (1)		17:45
Potential sun hours	312	305	370	392	434	434	443	418	373	351	310	305
Total, worst case	22	385								157	255	
Sun reduction	0.69	0.68								0.75	0.72	
Oper. time red.	0.90	0.90								0.90	0.90	
Wind dir. red.	0.60	0.60								0.60	0.60	
Total reduction	0.37	0.37								0.40	0.39	
Total, real	8	141								63	99	

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

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

Project: **Amarillo** Description: **MARFORRES CENTER, Amarillo Small Wind Project (1 Northwind 100kW wind turbine) Alternative 2 Expected Scenario**

Printed/Page: 6/6/2011 1:05 PM / 1  
 Licensed user: **Course Registration**  
 Time-limited until juni 27. 2011



Calculated: 6/6/2011 1:02 PM/2.7.486

### SHADOW - Calendar per WTG

Calculation: Alt 2 Real Case WTG: 1 - Alternative 2

#### Assumptions for shadow calculations

Maximum distance for influence: 210 m  
 Minimum sun height over horizon for influence: 3 °  
 Day step for calculation: 1 days  
 Time step for calculation: 1 minutes

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

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.69 0.68 0.72 0.74 0.71 0.78 0.79 0.77 0.73 0.75 0.72 0.67

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 489 434 299 270 381 945 1,978 1,440 710 376 262 339 7,922  
 Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:56 17:46	07:48 08:28-08:45/17 18:15 08:48-09:24/36	07:18 18:42	07:36 20:08	06:57 20:32	06:35 20:56	06:37 21:06	06:56 20:52	07:20 20:17	07:42 19:34	07:08 07:54-08:20/26 17:54 08:21-08:51/30	07:37 17:36
2	07:57 17:47	07:47 08:27-08:46/19 18:16 08:48-09:24/36	07:17 18:43	07:34 20:09	06:56 20:33	06:34 20:57	06:37 21:06	06:57 20:52	07:20 20:16	07:43 19:33	07:09 07:54-08:20/26 17:53 08:21-08:52/31	07:38 17:36
3	07:57 17:48	07:46 08:26-08:47/21 18:17 08:48-09:24/36	07:16 18:44	07:33 20:10	06:55 20:34	06:34 20:57	06:37 21:06	06:58 20:51	07:21 20:14	07:44 19:31	07:10 07:54-08:21/27 17:52 08:21-08:53/32	07:39 17:36
4	07:57 17:49	07:45 08:26-08:50/24 18:18 08:50-09:25/35	07:14 18:45	07:31 20:10	06:54 20:35	06:34 20:58	06:38 21:06	06:58 20:50	07:22 20:13	07:44 19:30	07:11 07:54-08:21/27 17:51 08:21-08:54/33	07:40 17:35
5	07:57 17:49	07:44 08:25-08:50/25 18:19 08:50-09:25/35	07:13 18:45	07:30 20:11	06:53 20:36	06:34 20:58	06:38 21:06	06:59 20:49	07:23 20:11	07:45 19:28	07:12 07:55-08:21/26 17:50 08:21-08:54/33	07:41 17:35
6	07:57 17:50	07:43 08:25-08:51/26 18:20 08:51-09:24/33	07:12 18:46	07:29 20:12	06:52 20:36	06:33 20:59	06:39 21:06	07:00 20:48	07:23 20:10	07:46 19:27	07:13 07:55-08:20/25 17:49 08:20-08:54/34	07:42 17:35
7	07:57 17:51	07:43 08:24-08:51/27 18:21 08:51-09:24/33	07:10 18:47	07:27 20:13	06:51 20:37	06:33 21:00	06:39 21:06	07:01 20:47	07:24 20:09	07:47 19:26	07:14 07:56-08:20/24 17:48 08:20-08:55/35	07:42 17:35
8	07:57 17:52	07:42 08:24-08:51/27 18:22 08:51-09:23/32	08:09 18:48	07:26 20:14	06:50 20:38	06:33 21:00	06:40 21:06	07:02 20:46	07:25 20:07	07:48 19:24	07:15 07:57-08:18/21 17:47 08:19-08:55/36	07:43 17:35
9	07:57 17:53	07:41 08:24-08:50/26 18:23 08:51-09:22/31	08:08 19:49	07:24 20:14	06:49 20:39	06:33 21:01	06:41 21:05	07:02 20:45	07:26 20:06	07:48 19:23	07:16 07:58-08:17/19 17:47 08:19-08:55/36	07:44 17:36
10	07:57 17:54	07:40 08:24-08:50/26 18:24 08:52-09:21/29	08:06 19:50	07:23 20:15	06:48 20:40	06:33 21:01	06:41 21:05	07:03 20:44	07:26 20:04	07:49 19:22	07:17 07:59-08:16/17 17:46 08:19-08:55/36	07:45 17:36
11	07:57 17:55	07:39 08:24-08:50/26 18:25 08:53-09:20/27	08:05 19:51	07:22 20:16	06:48 20:40	06:33 21:02	06:42 21:05	07:04 20:43	07:27 20:03	07:50 19:20	07:18 08:01-08:14/13 17:45 08:19-08:55/36	07:46 17:36
12	07:57 17:56	07:38 08:25-08:50/25 18:26 08:54-09:19/25	08:04 19:52	07:20 20:17	06:47 20:41	06:33 21:02	06:42 21:04	07:05 20:42	07:28 20:01	07:51 19:19	07:19 08:03-08:12/9 17:44 08:19-08:55/36	07:46 17:36
13	07:56 17:57	07:37 08:26-08:49/23 18:27 08:56-09:17/21	08:02 19:52	07:19 20:18	06:46 20:42	06:33 21:02	06:43 21:04	07:05 20:41	07:29 20:00	07:52 19:17	07:20 08:20-08:55/35 17:44	07:47 17:36
14	07:56 17:58	07:36 08:26-08:48/22 18:28 08:57-09:16/19	08:01 19:53	07:18 20:18	06:45 20:43	06:33 21:03	06:44 21:04	07:06 20:39	07:29 19:59	07:52 19:16	07:21 08:20-08:55/35 17:43	07:48 17:37
15	07:56 17:58	07:35 08:28-08:47/19 18:29 09:00-09:13/13	07:59 19:54	07:17 20:19	06:44 20:44	06:33 21:03	06:44 21:03	07:07 20:38	07:30 19:57	07:53 19:15	07:22 08:21-08:54/33 17:42	07:48 17:37
16	07:56 17:59	07:34 08:29-08:46/17 18:30	07:58 19:55	07:15 20:20	06:44 20:44	06:33 21:04	06:45 21:03	07:08 20:37	07:31 19:56	07:54 19:14	07:23 08:22-08:54/32 17:42	07:49 17:37
17	07:55 18:00	07:33 08:31-08:44/13 18:31	07:57 19:56	07:14 20:21	06:43 20:45	06:33 21:04	06:45 21:02	07:08 20:36	07:31 19:54	07:55 19:12	07:24 08:22-08:54/32 17:41	07:50 17:37
18	07:55 18:00	07:31 08:34-08:41/7 18:32	07:55 19:57	07:13 20:22	06:42 20:46	06:33 21:04	06:46 21:02	07:09 20:35	07:32 19:53	07:56 19:11	07:25 08:23-08:53/30 17:40	07:50 17:38
19	07:55 18:01	07:30 08:53-09:13/20 18:33	07:54 19:57	07:11 20:22	06:41 20:47	06:33 21:05	06:47 21:01	07:10 20:34	07:33 19:51	07:57 19:10	07:26 08:24-08:52/28 17:40	07:51 17:38
20	07:54 18:02	07:29 08:52-09:14/22 18:34	07:52 19:58	07:10 20:23	06:41 20:47	06:33 21:05	06:47 21:01	07:11 20:32	07:34 19:50	07:58 19:08	07:27 08:26-08:52/26 17:39	07:52 17:39
21	07:54 18:03	07:28 08:52-09:16/24 18:34	07:51 19:59	07:09 20:24	06:40 20:48	06:33 21:05	06:48 21:00	07:11 20:31	07:34 19:48	07:58 19:07	07:28 08:27-08:51/24 17:39	07:52 17:39
22	07:54 18:04	07:27 08:51-09:17/26 18:35	07:50 20:00	07:08 20:25	06:39 20:49	06:34 21:05	06:49 21:00	07:12 20:30	07:35 19:47	07:59 19:06	07:29 08:28-08:50/22 17:38	07:53 17:40
23	07:53 18:05	07:26 08:50-09:18/28 18:36	07:48 20:01	07:06 20:26	06:39 20:50	06:34 21:06	06:50 20:59	07:13 20:29	07:36 19:46	08:00 19:05	07:30 08:29-08:49/20 17:38	07:53 17:40
24	07:53 18:06	07:24 08:49-09:19/30 18:37	07:47 20:01	07:05 20:26	06:38 20:50	06:34 21:06	06:50 20:58	07:14 20:27	07:37 19:44	08:01 09:03-09:12/9 19:04	07:31 08:31-08:48/17 17:38	07:54 17:41
25	07:52 18:07	07:23 08:49-09:21/32 18:38	07:45 20:02	07:04 20:27	06:38 20:51	06:34 21:06	06:51 20:58	07:14 20:26	07:37 19:43	08:02 09:00-09:14/14 19:03	07:32 08:33-08:47/14 17:37	07:54 17:41
26	07:51 18:08	07:22 08:49-09:21/32 18:39	07:44 20:03	07:03 20:28	06:37 20:52	06:35 21:06	06:52 20:57	07:15 20:25	07:38 19:41	08:03 08:58-09:16/18 19:01 09:34-09:39/5	07:33 08:35-08:45/10 17:37	07:54 17:42
27	07:51 18:09	07:21 08:48-09:21/33 18:40	07:43 20:04	07:02 20:29	06:37 20:53	06:35 21:06	06:52 20:56	07:16 20:24	07:39 19:40	08:04 08:57-09:17/20 19:00 09:29-09:43/14	07:34 08:35-08:45/10 17:37	07:55 17:43
28	07:50 18:10	07:20 08:48-09:23/35 18:41	07:40 20:05	07:01 20:30	06:36 20:53	06:35 21:06	06:53 20:56	07:17 20:22	07:40 19:38	08:05 08:56-09:18/22 18:58 09:27-09:46/19	07:35 08:36-08:46/10 17:36	07:55 17:43
29	07:50 18:12	07:19 08:48-09:23/35 18:12	07:39 20:05	07:00 20:31	06:36 20:54	06:36 21:06	06:54 20:55	07:17 20:21	07:40 19:37	08:06 08:55-09:19/24 18:57 09:25-09:48/23	07:35 08:37-08:47/10 17:36	07:55 17:44
30	07:49 18:13	08:31-08:40/9 08:47-09:23/36	07:38 20:06	06:58 20:31	06:35 20:55	06:36 21:06	06:55 20:54	07:18 20:20	07:41 19:35	08:07 08:55-09:19/24 18:56 09:24-09:49/25	07:36 08:38-08:48/17 17:36	07:56 17:45
31	07:48 18:14	08:30-08:43/13 08:48-09:24/36	07:37 20:07	07:31 20:31	06:35 20:55	06:35 21:06	06:55 20:53	07:19 20:18	07:41 20:18	08:08 08:54-09:20/26 18:55 09:22-09:50/28	07:36 08:39-08:49/10 17:36	07:56 17:45
	Potential sun hours Sum of minutes with flicker	312 451	305 831	370 0	392 0	434 0	443 0	418 0	373 0	351 271	310 1026	305 0

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

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

Project:

**Amarillo**

Description:

MARFORRES CENTER, Amarillo Small Wind Project (1 Northwind 100kW wind turbine)  
Alternative 2 Expected Scenario

Printed/Page

6/6/2011 1:04 PM / 1

Licensed user:

**Course Registration**

Time-limited until juni 27. 2011

Calculated:

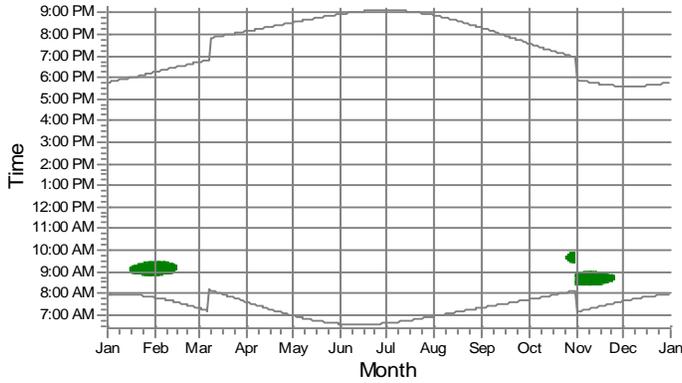
6/6/2011 1:02 PM/2.7.486



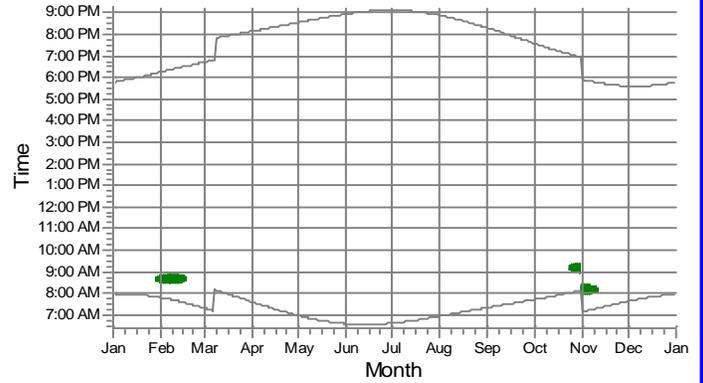
### SHADOW - Calendar, graphical

Calculation: Alt 2 Real Case

A: Children's Learning Center



B: Kimble Learning Center



WTGs



1: Alternative 2

Project: **Amarillo**  
 Description: MARFORRES CENTER, Amarillo Small Wind Project (1 Northwind 100kW wind turbine)  
 Alternative 2 Expected Scenario

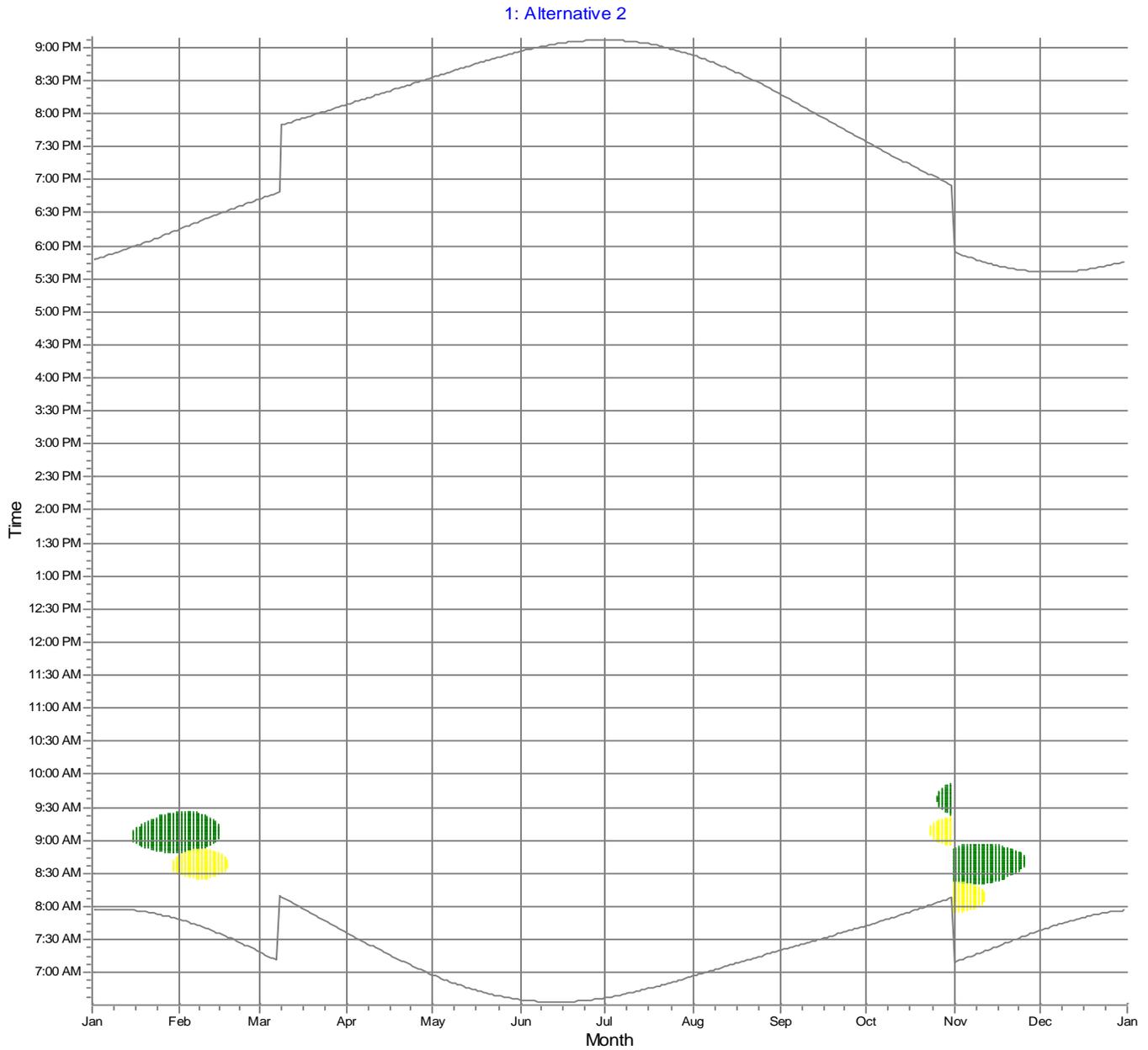
Printed/Page: 6/6/2011 1:05 PM / 1  
 Licensed user:  
**Course Registration**  
 Time-limited until juni 27. 2011



Calculated:  
 6/6/2011 1:02 PM/2.7.486

**SHADOW - Calendar per WTG, graphical**

Calculation: Alt 2 Real Case WTG: 1 - Alternative 2



Shadow receptor



A: Children's Learning Center



B: Kimble Learning Center

Project: **Amarillo** Description: MARFORRES CENTER, Amarillo Small Wind Project (1 Northwind 100kW wind turbine)  
Alternative 2 Worst Case Scenario

Printed/Page: 6/6/2011 1:09 PM / 1  
Licensed user: **Course Registration**  
Time-limited until juni 27. 2011

Calculated: 6/6/2011 1:08 PM/2.7.486



## SHADOW - Main Result

Calculation: Alt 2 Worst Case

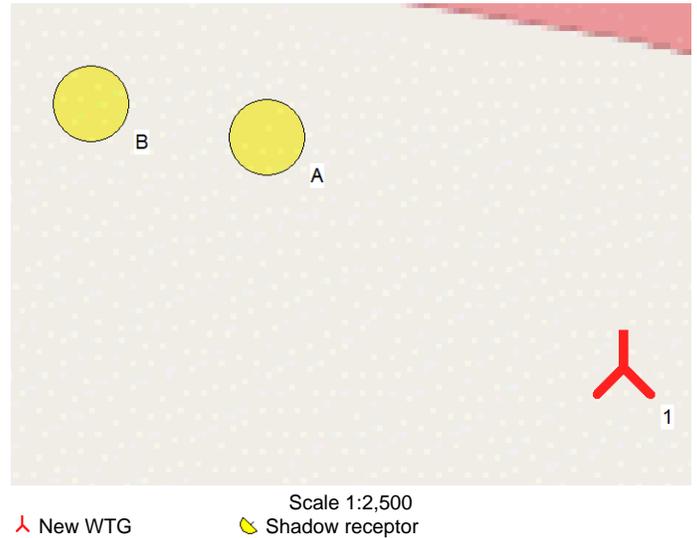
### Assumptions for shadow calculations

Maximum distance for influence  
Calculate only when more than 20 % of sun is covered by the blade  
Please look in WTG table

Minimum sun height over horizon for influence 3 °  
Day step for calculation 1 days  
Time step for calculation 1 minutes  
The calculated times are "worst case" given by the following assumptions:  
The sun is shining all the day, from sunrise to sunset  
The rotor plane is always perpendicular to the line from the WTG to the sun  
The WTG is always operating

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:

Height contours used:  
Obstacles used in calculation  
Eye height: 1.5 m  
Grid resolution: 10 m



### WTGs

UTM NAD83 Zone: 14	East	North	Z	Row data/Description	WTG type			Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.	Type-generator				Calculation distance [m]	RPM [RPM]
1	244,139.46	3,898,698.87	0.0	Alternative 2	Yes	Nothern Power	Northwind 100-100	100	21.0	36.9	370	59.0

### Shadow receptor-Input

No.	Name	UTM NAD83 Zone: 14		Z	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
		East	North							
A	Children's Learning Center	244,023.12	3,898,778.23	0.0	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
B	Kimble Learning Center	243,964.89	3,898,791.15	0.0	1.0	1.0	1.0	-180.0	90.0	"Green house mode"

### Calculation Results

Shadow receptor

No.	Name	Shadow, worst case		
		Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]
A	Children's Learning Center	29:23	63	0:36
B	Kimble Learning Center	13:39	40	0:26

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
1	Alternative 2	42:59	

Project:  
**Amarillo**

Description:  
MARFORRES CENTER, Amarillo Small Wind Project (1 Northwind 100kW wind turbine)  
Alternative 2 Worst Case Scenario

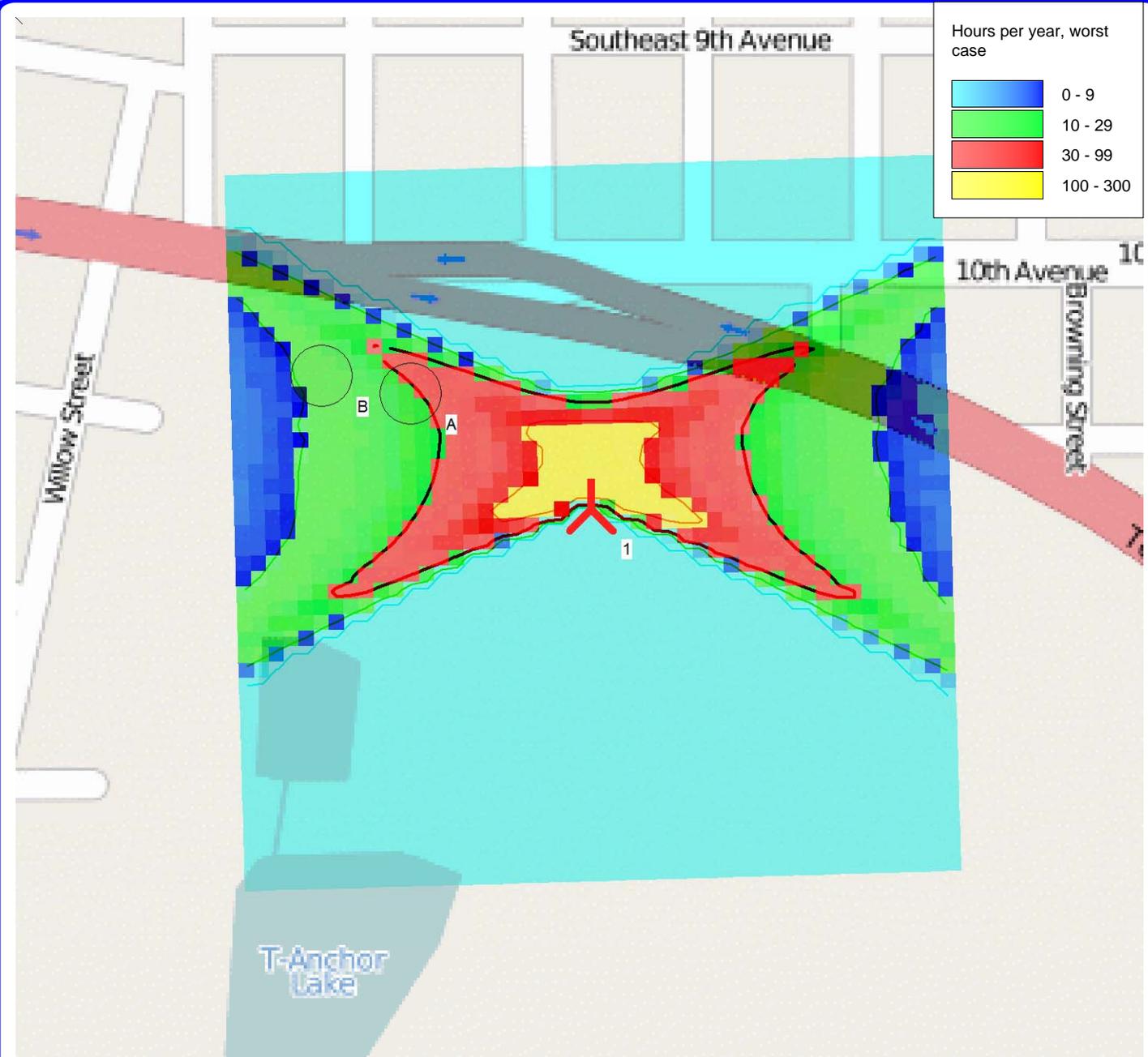
Printed/Page  
6/6/2011 1:10 PM / 1  
Licensed user:  
**Course Registration**  
Time-limited until juni 27. 2011

Calculated:  
6/6/2011 1:08 PM/2.7.486



**SHADOW - Map**

Calculation: Alt 2 Worst Case



0 50 100 150 200 m

Map: WindPRO map , Print scale 1:4,000, Map center UTM NAD 83 Zone: 14 East: 244,140.00 North: 3,898,689.96

New WTG

Shadow receptor

Isolines showing shadow in Hours per year, worst case

0 10 30 100

Project: **Amarillo** Description: **MARFORRES CENTER, Amarillo Small Wind Project (1 Northwind 100kW wind turbine) Alternative 2 Worst Case Scenario**

Printed/Page: 6/6/2011 1:09 PM / 1  
 Licensed user: **Course Registration**  
 Time-limited until juni 27. 2011



Calculated: 6/6/2011 1:08 PM/2.7.486

## SHADOW - Calendar

Calculation: Alt 2 Worst Case Shadow receptor: A - Children's Learning Center

### Assumptions for shadow calculations

Maximum distance for influence 2,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

The calculated times are "worst case" given by the following assumptions:

- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December		
1	07:56 17:46	07:48 18:15	08:48 (1) 09:24 (1)	07:18 18:42	07:36 20:08	06:57 20:32	06:35 20:56	06:37 21:06	06:56 20:52	07:20 20:17	07:42 19:34	07:08 17:54	08:21 (1) 08:51 (1)	07:37 17:36
2	07:57 17:47	07:47 18:16	08:48 (1) 09:24 (1)	07:17 18:43	07:34 20:09	06:56 20:33	06:34 20:57	06:37 21:06	06:57 20:52	07:20 20:16	07:43 19:33	07:09 17:53	08:21 (1) 08:52 (1)	07:38 17:36
3	07:57 17:48	07:46 18:17	08:48 (1) 09:24 (1)	07:16 18:44	07:33 20:10	06:55 20:34	06:34 20:57	06:37 21:06	06:58 20:51	07:21 20:14	07:44 19:31	07:10 17:52	08:20 (1) 08:53 (1)	07:39 17:36
4	07:57 17:49	07:45 18:18	08:49 (1) 09:25 (1)	07:14 18:45	07:31 20:10	06:54 20:35	06:34 20:58	06:38 21:06	06:58 20:50	07:22 20:13	07:44 19:30	07:11 17:51	08:19 (1) 08:54 (1)	07:40 17:35
5	07:57 17:49	07:44 18:19	08:49 (1) 09:25 (1)	07:13 18:45	07:30 20:11	06:53 20:36	06:34 20:58	06:38 21:06	06:59 20:49	07:23 20:11	07:45 19:28	07:12 17:50	08:19 (1) 08:54 (1)	07:41 17:35
6	07:57 17:50	07:43 18:20	08:49 (1) 09:24 (1)	07:12 18:46	07:29 20:12	06:52 20:36	06:33 20:59	06:39 21:06	07:00 20:48	07:23 20:10	07:46 19:27	07:13 17:49	08:19 (1) 08:54 (1)	07:42 17:35
7	07:57 17:51	07:43 18:21	08:50 (1) 09:24 (1)	07:10 18:47	07:27 20:13	06:51 20:37	06:33 21:00	06:39 21:06	07:01 20:47	07:24 20:09	07:47 19:26	07:14 17:48	08:19 (1) 08:55 (1)	07:43 17:35
8	07:57 17:52	07:42 18:22	08:50 (1) 09:23 (1)	08:09 18:48	07:26 20:14	06:50 20:38	06:33 21:00	06:40 21:06	07:02 20:46	07:25 20:07	07:48 19:24	07:15 17:47	08:19 (1) 08:55 (1)	07:43 17:35
9	07:57 17:53	07:41 18:23	08:51 (1) 09:22 (1)	08:08 19:49	07:24 20:14	06:49 20:39	06:33 21:01	06:41 21:05	07:02 20:45	07:26 20:06	07:48 19:23	07:16 17:47	08:19 (1) 08:55 (1)	07:44 17:36
10	07:57 17:54	07:40 18:24	08:52 (1) 09:21 (1)	08:06 19:50	07:23 20:15	06:48 20:40	06:33 21:01	06:41 21:05	07:03 20:44	07:26 20:04	07:49 19:22	07:17 17:46	08:19 (1) 08:55 (1)	07:45 17:36
11	07:57 17:55	07:39 18:25	08:53 (1) 09:20 (1)	08:05 19:51	07:22 20:16	06:48 20:40	06:33 21:02	06:42 21:05	07:04 20:43	07:27 20:03	07:50 19:20	07:18 17:45	08:19 (1) 08:55 (1)	07:46 17:36
12	07:57 17:56	07:38 18:26	08:54 (1) 09:19 (1)	08:04 19:52	07:20 20:17	06:47 20:41	06:33 21:02	06:42 21:04	07:05 20:42	07:28 20:01	07:51 19:19	07:19 17:44	08:19 (1) 08:55 (1)	07:46 17:36
13	07:56 17:57	07:37 18:27	08:56 (1) 09:17 (1)	08:02 19:52	07:19 20:18	06:46 20:42	06:33 21:02	06:43 21:04	07:05 20:41	07:29 20:00	07:52 19:17	07:20 17:44	08:20 (1) 08:55 (1)	07:47 17:36
14	07:56 17:58	07:36 18:28	08:57 (1) 09:16 (1)	08:01 19:53	07:18 20:18	06:45 20:43	06:33 21:03	06:44 21:04	07:06 20:39	07:29 19:59	07:52 19:16	07:21 17:43	08:20 (1) 08:55 (1)	07:48 17:37
15	07:56 17:58	07:35 18:29	08:58 (1) 09:13 (1)	07:59 19:54	07:17 20:19	06:44 20:44	06:33 21:03	06:44 21:03	07:07 20:38	07:30 19:57	07:53 19:15	07:22 17:42	08:21 (1) 08:54 (1)	07:48 17:37
16	07:56 17:59	07:34 09:07 (1)	07:58 18:30	07:55 19:55	07:15 20:20	06:44 20:44	06:33 21:04	06:45 21:03	07:08 20:37	07:31 19:56	07:54 19:14	07:23 17:42	08:22 (1) 08:54 (1)	07:49 17:37
17	07:56 18:00	07:33 09:10 (1)	07:57 18:31	07:56 19:56	07:14 20:21	06:43 20:45	06:33 21:04	06:45 21:04	07:08 20:36	07:31 19:54	07:55 19:12	07:24 17:41	08:22 (1) 08:54 (1)	07:50 17:37
18	07:55 18:00	07:31 09:11 (1)	07:55 18:32	07:55 19:57	07:13 20:22	06:42 20:46	06:33 21:04	06:46 21:02	07:09 20:35	07:32 19:53	07:56 19:11	07:25 17:40	08:23 (1) 08:53 (1)	07:50 17:38
19	07:55 18:01	07:30 09:13 (1)	07:54 18:33	07:54 19:57	07:11 20:22	06:41 20:47	06:33 21:05	06:47 21:01	07:10 20:34	07:33 19:51	07:57 19:10	07:26 17:40	08:24 (1) 08:52 (1)	07:51 17:38
20	07:54 18:02	07:29 09:14 (1)	07:52 18:34	07:52 19:58	07:10 20:23	06:41 20:47	06:33 21:05	06:47 21:01	07:11 20:32	07:34 19:50	07:58 19:08	07:27 17:39	08:26 (1) 08:52 (1)	07:52 17:39
21	07:54 18:03	07:28 09:16 (1)	07:51 18:34	07:51 19:59	07:09 20:24	06:40 20:48	06:33 21:05	06:48 21:00	07:11 20:31	07:34 19:48	07:58 19:07	07:28 17:39	08:27 (1) 08:51 (1)	07:52 17:39
22	07:54 18:04	07:27 09:17 (1)	07:50 18:35	07:50 19:59	07:08 20:25	06:39 20:49	06:34 21:05	06:49 21:00	07:12 20:30	07:35 19:47	07:59 19:06	07:29 17:38	08:28 (1) 08:50 (1)	07:53 17:40
23	07:53 18:05	07:26 09:18 (1)	07:48 18:36	07:48 19:59	07:06 20:26	06:39 20:50	06:34 21:06	06:50 20:59	07:13 20:29	07:36 19:46	08:00 19:05	07:30 17:38	08:29 (1) 08:49 (1)	07:53 17:40
24	07:53 18:06	07:24 09:19 (1)	07:47 18:37	07:47 19:59	07:05 20:26	06:38 20:50	06:34 21:06	06:50 20:58	07:14 20:27	07:37 19:44	08:01 19:04	07:31 17:38	08:31 (1) 08:48 (1)	07:54 17:41
25	07:52 18:07	07:23 09:21 (1)	07:45 18:38	07:45 19:59	07:04 20:27	06:38 20:51	06:34 21:06	06:51 20:58	07:14 20:26	07:37 19:43	08:02 19:03	07:32 17:37	08:33 (1) 08:47 (1)	07:54 17:41
26	07:51 18:08	07:22 09:21 (1)	07:44 18:39	07:44 19:59	07:03 20:28	06:37 20:52	06:35 21:06	06:52 20:57	07:15 20:25	07:38 19:41	08:03 19:01	07:33 17:37	08:35 (1) 08:45 (1)	07:54 17:42
27	07:51 18:09	07:21 09:22 (1)	07:41 18:40	07:43 19:59	07:02 20:29	06:37 20:53	06:35 21:06	06:52 20:56	07:16 20:24	07:39 19:40	08:04 19:00	07:34 17:37	08:46 (1) 09:43 (1)	07:55 17:43
28	07:50 18:10	07:20 09:23 (1)	07:40 18:41	07:41 19:59	07:01 20:30	06:36 20:53	06:35 21:06	06:53 20:56	07:17 20:22	07:40 19:38	08:05 18:58	07:35 17:38	08:47 (1) 09:46 (1)	07:55 17:43
29	07:50 18:12	07:19 09:24 (1)	07:39 18:42	07:40 19:59	07:00 20:31	06:36 20:54	06:36 21:06	06:54 20:55	07:17 20:21	07:40 19:37	08:06 18:57	07:35 17:38	08:48 (1) 09:48 (1)	07:55 17:44
30	07:49 18:13	07:18 09:25 (1)	07:38 18:43	07:38 19:59	06:58 20:32	06:35 20:54	06:36 21:06	06:55 20:54	07:18 20:20	07:41 19:35	08:07 18:56	07:36 17:38	08:49 (1) 09:49 (1)	07:56 17:45
31	07:48 18:14	07:17 09:26 (1)	07:37 18:44	07:37 19:59	06:57 20:33	06:35 20:55	06:36 21:06	06:55 20:53	07:19 20:18	07:42 19:35	08:08 18:55	07:36 17:38	08:50 (1) 09:50 (1)	07:56 17:45
Potential sun hours	312	305	447	370	392	434	434	443	418	373	351	310	773	305
Total, worst case	429	447	370	392	434	434	443	418	373	351	310	773	305	305

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

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

Project: **Amarillo** Description: **MARFORRES CENTER, Amarillo Small Wind Project (1 Northwind 100kW wind turbine) Alternative 2 Worst Case Scenario**

Printed/Page: 6/6/2011 1:09 PM / 2  
 Licensed user: **Course Registration**  
 Time-limited until juni 27. 2011



Calculated: 6/6/2011 1:08 PM/2.7.486

## SHADOW - Calendar

Calculation: Alt 2 Worst Case Shadow receptor: B - Kimble Learning Center

### Assumptions for shadow calculations

Maximum distance for influence 2,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

The calculated times are "worst case" given by the following assumptions:

- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:56 17:46	07:48 18:15	08:28 (1) 08:45 (1)	07:18 18:42	07:36 20:08	06:57 20:32	06:35 20:56	06:37 21:06	06:56 20:52	07:20 19:34	07:08 17:54	07:54 (1) 08:20 (1)
2	07:57 17:47	07:47 18:16	08:27 (1) 08:46 (1)	07:17 18:43	07:34 20:09	06:56 20:33	06:34 20:57	06:37 21:06	06:57 20:52	07:20 19:33	07:09 17:53	07:54 (1) 08:20 (1)
3	07:57 17:48	07:46 18:17	08:26 (1) 08:47 (1)	07:16 18:44	07:33 20:10	06:55 20:34	06:34 20:57	06:37 21:06	06:58 20:51	07:21 19:31	07:10 17:52	07:54 (1) 08:20 (1)
4	07:57 17:49	07:45 18:18	08:26 (1) 08:49 (1)	07:14 18:45	07:31 20:10	06:54 20:35	06:34 20:58	06:38 21:06	06:58 20:50	07:22 19:30	07:11 17:51	07:54 (1) 08:20 (1)
5	07:57 17:49	07:44 18:19	08:25 (1) 08:49 (1)	07:13 18:45	07:30 20:11	06:53 20:36	06:34 20:58	06:38 21:06	06:59 20:49	07:23 19:28	07:12 17:50	07:55 (1) 08:20 (1)
6	07:57 17:50	07:43 18:20	08:25 (1) 08:50 (1)	07:12 18:46	07:29 20:12	06:52 20:36	06:33 20:59	06:39 21:06	07:00 20:48	07:23 19:27	07:13 17:49	07:55 (1) 08:19 (1)
7	07:57 17:51	07:43 18:21	08:24 (1) 08:50 (1)	07:10 18:47	07:27 20:13	06:51 20:37	06:33 21:00	06:39 21:06	07:01 20:47	07:24 19:26	07:14 17:48	07:56 (1) 08:19 (1)
8	07:57 17:52	07:42 18:22	08:24 (1) 08:50 (1)	08:09 18:48	07:26 20:14	06:50 20:38	06:33 21:00	06:40 21:06	07:02 20:46	07:25 19:24	07:15 17:47	07:57 (1) 08:18 (1)
9	07:57 17:53	07:41 18:23	08:24 (1) 08:50 (1)	08:08 19:49	07:24 20:14	06:49 20:39	06:33 21:01	06:41 21:05	07:02 20:45	07:26 19:23	07:16 17:47	07:58 (1) 08:17 (1)
10	07:57 17:54	07:40 18:24	08:24 (1) 08:50 (1)	08:06 19:50	07:23 20:15	06:48 20:40	06:33 21:01	06:41 21:05	07:03 20:44	07:26 19:22	07:17 17:46	07:59 (1) 08:16 (1)
11	07:57 17:55	07:39 18:25	08:24 (1) 08:50 (1)	08:05 19:51	07:22 20:16	06:48 20:40	06:33 21:02	06:42 21:05	07:04 20:43	07:27 19:20	07:18 17:45	08:01 (1) 08:14 (1)
12	07:57 17:56	07:38 18:26	08:25 (1) 08:50 (1)	08:04 19:52	07:20 20:17	06:47 20:41	06:33 21:02	06:42 21:04	07:05 20:42	07:28 19:19	07:19 17:44	08:03 (1) 08:12 (1)
13	07:56 17:57	07:37 18:27	08:26 (1) 08:49 (1)	08:02 19:52	07:19 20:18	06:46 20:42	06:33 21:02	06:43 21:04	07:05 20:41	07:29 19:20	07:52 17:44	07:47 07:59 (1)
14	07:56 17:58	07:36 18:28	08:26 (1) 08:48 (1)	08:01 19:53	07:18 20:18	06:45 20:43	06:33 21:03	06:44 21:04	07:06 20:39	07:29 19:19	07:52 17:43	07:48 07:57 (1)
15	07:56 17:58	07:35 18:29	08:28 (1) 08:47 (1)	07:59 19:54	07:17 20:19	06:44 20:44	06:33 21:03	06:44 21:03	07:07 20:38	07:30 19:17	07:53 17:42	07:49 07:58 (1)
16	07:56 17:59	07:34 18:30	08:29 (1) 08:46 (1)	07:58 19:55	07:15 20:20	06:44 20:44	06:33 21:04	06:45 21:03	07:08 20:37	07:31 19:16	07:54 17:42	07:49 07:59 (1)
17	07:56 18:00	07:33 18:31	08:31 (1) 08:44 (1)	07:57 19:56	07:14 20:21	06:43 20:45	06:33 21:04	06:45 21:02	07:08 20:36	07:32 19:14	07:55 17:41	07:50 07:58 (1)
18	07:55 18:00	07:32 18:32	08:34 (1) 08:41 (1)	07:55 19:57	07:13 20:22	06:42 20:46	06:33 21:04	06:46 21:02	07:09 20:35	07:32 19:11	07:56 17:40	07:50 07:59 (1)
19	07:55 18:01	07:30 18:33	07:54 19:57	07:11 20:22	06:41 20:47	06:33 21:05	06:47 21:01	07:10 20:34	07:33 19:11	07:57 19:10	07:51 17:40	07:51 07:58 (1)
20	07:54 18:02	07:29 18:34	07:52 19:58	07:10 20:23	06:41 20:47	06:33 21:05	06:47 21:01	07:11 20:32	07:34 19:10	07:58 19:08	07:52 17:39	07:52 07:59 (1)
21	07:54 18:03	07:28 18:34	07:51 19:59	07:09 20:24	06:40 20:48	06:33 21:05	06:48 21:00	07:11 20:31	07:34 19:48	07:58 19:07	07:52 17:39	07:52 07:59 (1)
22	07:54 18:04	07:27 18:35	07:50 20:00	07:08 20:25	06:39 20:49	06:34 21:05	06:49 21:00	07:12 20:30	07:35 19:47	07:59 19:06	07:53 17:38	07:53 07:59 (1)
23	07:53 18:05	07:26 18:36	07:48 20:01	07:06 20:26	06:39 20:50	06:34 21:06	06:50 20:59	07:13 20:29	07:36 19:46	08:00 19:05	07:30 17:38	07:53 07:59 (1)
24	07:53 18:06	07:24 18:37	07:47 20:01	07:05 20:26	06:38 20:50	06:34 21:06	06:50 20:58	07:14 20:27	07:37 19:44	08:01 19:04	07:31 17:38	07:54 07:59 (1)
25	07:52 18:07	07:23 18:38	07:45 20:02	07:04 20:27	06:38 20:51	06:34 21:06	06:51 20:58	07:14 20:26	07:37 19:43	08:02 19:03	07:32 17:37	07:54 07:59 (1)
26	07:51 18:08	07:22 18:39	07:44 20:03	07:03 20:28	06:37 20:52	06:35 21:06	06:52 20:57	07:15 20:25	07:38 19:41	08:03 19:01	07:33 17:37	07:54 07:59 (1)
27	07:51 18:09	07:21 18:40	07:43 20:04	07:02 20:29	06:37 20:53	06:35 21:06	06:52 20:56	07:16 20:24	07:39 19:40	08:04 19:00	07:34 17:37	07:55 07:59 (1)
28	07:50 18:10	07:20 18:41	07:41 20:05	07:01 20:30	06:36 20:53	06:35 21:06	06:53 20:56	07:17 20:22	07:40 19:38	08:05 18:58	07:35 17:36	07:55 07:59 (1)
29	07:50 18:12	07:19 18:42	07:40 20:05	07:00 20:31	06:36 20:54	06:36 21:06	06:54 20:55	07:17 20:21	07:40 19:37	08:06 18:57	07:35 17:36	07:55 07:59 (1)
30	07:49 18:13	08:31 (1) 08:40 (1)	07:38 20:06	07:38 20:31	06:58 20:55	06:36 21:06	06:55 20:54	07:18 20:20	07:41 19:35	08:07 18:56	07:36 17:36	07:56 07:59 (1)
31	07:48 18:14	08:30 (1) 08:43 (1)	07:37 20:07	07:37 20:31	06:55 20:55	06:35 21:06	06:55 20:53	07:19 20:18	07:19 19:35	08:08 18:55	07:36 17:36	07:56 07:59 (1)
Potential sun hours	312	305	385	370	392	434	443	418	373	351	310	305
Total, worst case	22	385	370	392	434	443	418	373	351	157	255	305

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

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

Project: **Amarillo** Description: **MARFORRES CENTER, Amarillo Small Wind Project (1 Northwind 100kW wind turbine) Alternative 2 Worst Case Scenario**

Printed/Page: 6/6/2011 1:10 PM / 1  
 Licensed user: **Course Registration**  
 Time-limited until juni 27. 2011



Calculated: 6/6/2011 1:08 PM/2.7.486

### SHADOW - Calendar per WTG

Calculation: Alt 2 Worst Case WTG: 1 - Alternative 2

#### Assumptions for shadow calculations

Maximum distance for influence 2,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

The calculated times are "worst case" given by the following assumptions:  
 The sun is shining all the day, from sunrise to sunset  
 The rotor plane is always perpendicular to the line from the WTG to the sun  
 The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:56 17:46	07:48 08:28-08:45/17 18:15 08:48-09:24/36	07:18 20:08 18:42 08:27-08:46/19	07:36 20:08 07:34 20:09	06:57 20:32 06:56 20:33	06:35 20:56 06:34 20:57	06:37 21:06 06:37 21:06	06:56 20:52 06:57 20:52	07:20 20:17 07:20 20:16	07:42 19:34 07:43 19:33	07:08 07:54-08:20/26 17:54 08:21-08:51/30	07:37 17:36 07:38 17:36
2	07:57 17:47	07:46 08:26-08:47/21 18:16 08:48-09:24/36	07:16 20:09 18:43 20:09	07:33 20:33 20:33 20:33	06:55 20:57 06:54 20:57	06:34 21:06 06:37 21:06	06:37 21:06 06:37 21:06	06:58 07:21 06:58 07:21	07:21 07:44 07:21 07:44	07:44 19:31 07:44 19:31	07:10 07:54-08:21/27 17:53 08:21-08:52/31	07:39 17:36 07:39 17:36
3	07:57 17:48	07:45 08:26-08:50/24 18:17 08:48-09:24/36	07:14 20:10 18:44 20:10	07:31 20:31 20:34 20:34	06:54 20:54 06:54 20:54	06:34 21:06 06:37 21:06	06:38 21:06 06:38 21:06	06:58 20:51 06:58 20:51	07:22 07:44 07:22 07:44	07:44 19:31 07:44 19:31	07:11 07:54-08:21/27 17:52 08:21-08:53/32	07:40 17:36 07:40 17:36
4	07:57 17:49	07:44 08:25-08:50/25 18:18 08:50-09:25/35	07:13 20:11 18:45 20:11	07:30 20:30 20:35 20:35	06:53 20:53 06:53 20:53	06:34 21:06 06:37 21:06	06:38 21:06 06:38 21:06	06:59 20:49 06:59 20:49	07:23 07:45 07:23 07:45	07:45 19:30 07:45 19:30	07:12 07:55-08:21/26 17:51 08:21-08:54/33	07:41 17:35 07:41 17:35
5	07:57 17:49	07:43 08:25-08:51/26 18:19 08:50-09:25/35	07:12 20:12 18:45 20:12	07:29 20:29 20:36 20:36	06:52 20:52 06:52 20:52	06:33 21:06 06:36 21:06	06:39 21:06 06:39 21:06	07:00 20:48 07:00 20:48	07:23 07:46 07:23 07:46	07:46 19:28 07:46 19:28	07:13 07:55-08:20/25 17:50 08:21-08:54/33	07:42 17:35 07:42 17:35
6	07:57 17:50	07:43 08:24-08:51/27 18:20 08:51-09:24/33	07:10 20:12 18:46 20:12	07:27 20:27 20:36 20:36	06:51 20:51 06:51 20:51	06:33 21:06 06:36 21:06	06:39 21:06 06:39 21:06	07:01 20:48 07:01 20:48	07:24 07:47 07:24 07:47	07:47 19:27 07:47 19:27	07:14 07:56-08:20/24 17:49 08:20-08:54/34	07:42 17:35 07:42 17:35
7	07:57 17:51	07:42 08:24-08:51/27 18:21 08:51-09:24/33	07:09 20:13 18:47 20:13	07:26 20:26 20:37 20:37	06:50 20:50 06:50 20:50	06:33 21:06 06:36 21:06	06:41 21:06 06:41 21:06	07:02 20:47 07:02 20:47	07:25 07:48 07:25 07:48	07:48 19:26 07:48 19:26	07:15 07:57-08:18/21 17:48 08:20-08:55/35	07:43 17:35 07:43 17:35
8	07:57 17:52	07:41 08:24-08:50/26 18:22 08:51-09:23/32	07:08 20:14 18:48 20:14	07:24 20:24 20:38 20:38	06:49 20:49 06:49 20:49	06:33 21:06 06:36 21:06	06:41 21:06 06:41 21:06	07:02 20:46 07:02 20:46	07:26 07:48 07:26 07:48	07:48 19:24 07:48 19:24	07:16 07:58-08:17/19 17:47 08:19-08:55/36	07:44 17:35 07:44 17:35
9	07:57 17:53	07:40 08:24-08:50/26 18:23 08:51-09:22/31	07:06 20:15 19:49 20:15	07:23 20:23 20:39 20:39	06:48 20:48 06:48 20:48	06:33 21:06 06:36 21:06	06:41 21:06 06:41 21:06	07:03 20:45 07:03 20:45	07:26 07:49 07:26 07:49	07:49 19:23 07:49 19:23	07:17 07:59-08:16/17 17:47 08:19-08:55/36	07:45 17:35 07:45 17:35
10	07:57 17:54	07:39 08:24-08:50/26 18:24 08:52-09:21/29	07:05 20:16 19:50 20:16	07:22 20:22 20:40 20:40	06:48 20:48 06:48 20:48	06:33 21:06 06:36 21:06	06:45 21:06 06:45 21:06	07:04 20:44 07:04 20:44	07:27 07:50 07:27 07:50	07:50 19:22 07:50 19:22	07:18 08:01-08:14/13 17:46 08:19-08:55/36	07:46 17:35 07:46 17:35
11	07:57 17:55	07:38 08:25-08:50/25 18:25 08:53-09:20/27	07:04 20:20 19:51 20:20	07:20 20:20 20:40 20:40	06:47 20:47 06:47 20:47	06:33 21:06 06:36 21:06	06:42 21:06 06:42 21:06	07:05 20:43 07:05 20:43	07:28 07:51 07:28 07:51	07:51 19:20 07:51 19:20	07:19 08:03-08:12/9 17:45 08:19-08:55/36	07:46 17:35 07:46 17:35
12	07:57 17:56	07:37 08:26-08:49/23 18:27 08:56-09:17/21	07:02 20:18 19:52 20:18	07:19 20:19 20:42 20:42	06:46 20:46 06:46 20:46	06:33 21:06 06:36 21:06	06:43 21:06 06:43 21:06	07:05 20:41 07:05 20:41	07:29 07:52 07:29 07:52	07:52 19:17 07:52 19:17	07:20 08:20-08:55/35 17:44 08:20-08:55/35	07:47 17:36 07:47 17:36
13	07:56 17:57	07:36 08:26-08:48/22 18:28 08:57-09:16/19	07:01 20:18 19:53 20:18	07:18 20:18 20:43 20:43	06:45 20:45 06:45 20:45	06:33 21:06 06:36 21:06	06:44 21:06 06:44 21:06	07:06 20:39 07:06 20:39	07:29 07:52 07:29 07:52	07:52 19:16 07:52 19:16	07:21 08:20-08:55/35 17:43 07:57-08:18/21	07:48 17:37 07:48 17:37
14	07:56 17:58	07:35 08:28-08:47/19 18:29 09:00-09:13/13	07:09 20:19 19:54 20:19	07:17 20:17 20:44 20:44	06:44 20:44 06:44 20:44	06:33 21:06 06:36 21:06	06:45 21:06 06:45 21:06	07:08 20:38 07:08 20:38	07:31 07:54 07:31 07:54	07:54 19:15 07:54 19:15	07:23 08:22-08:54/32 17:42 07:58-08:17/19	07:49 17:37 07:49 17:37
15	07:56 17:59	07:34 08:29-08:46/17 18:30 08:31-08:44/13	07:08 20:15 19:55 20:15	07:15 20:15 20:41 20:41	06:44 20:44 06:44 20:44	06:33 21:06 06:36 21:06	06:45 21:06 06:45 21:06	07:08 20:37 07:08 20:37	07:31 07:54 07:31 07:54	07:54 19:14 07:54 19:14	07:24 08:22-08:54/32 17:41 07:58-08:17/19	07:49 17:37 07:49 17:37
16	07:55 18:00	07:33 08:31-08:44/13 18:31 08:34-08:47/17	07:07 20:14 19:56 20:14	07:14 20:14 20:45 20:45	06:43 20:43 06:43 20:43	06:33 21:06 06:36 21:06	06:45 21:06 06:45 21:06	07:08 20:36 07:08 20:36	07:31 07:55 07:31 07:55	07:55 19:12 07:55 19:12	07:24 08:22-08:54/32 17:41 07:58-08:17/19	07:50 17:37 07:50 17:37
17	07:55 18:00	07:31 08:34-08:47/17 18:32 08:37-08:50/13	07:05 20:13 19:57 20:13	07:13 20:13 20:46 20:46	06:42 20:42 06:42 20:42	06:33 21:06 06:36 21:06	06:46 21:06 06:46 21:06	07:09 20:35 07:09 20:35	07:32 07:56 07:32 07:56	07:56 19:11 07:56 19:11	07:25 08:23-08:53/30 17:40 07:58-08:17/19	07:50 17:38 07:50 17:38
18	07:55 18:01	07:30 08:35-09:13/20 18:33 08:38-08:51/16	07:03 20:10 19:57 20:10	07:11 20:11 20:47 20:47	06:41 20:41 06:41 20:41	06:33 21:06 06:36 21:06	06:47 21:06 06:47 21:06	07:10 20:34 07:10 20:34	07:33 07:57 07:33 07:57	07:57 19:10 07:57 19:10	07:26 08:24-08:52/28 17:40 07:58-08:17/19	07:51 17:38 07:51 17:38
19	07:55 18:01	07:29 08:36-09:14/22 18:34 08:39-08:52/18	07:02 20:07 19:58 20:07	07:10 20:10 20:47 20:47	06:41 20:41 06:41 20:41	06:33 21:06 06:36 21:06	06:47 21:06 06:47 21:06	07:11 20:32 07:11 20:32	07:34 07:58 07:34 07:58	07:58 19:08 07:58 19:08	07:27 08:26-08:52/26 17:39 07:58-08:17/19	07:52 17:39 07:52 17:39
20	07:54 18:02	07:28 08:37-09:16/24 18:34 08:40-08:53/13	07:01 20:08 19:59 20:08	07:09 20:09 20:48 20:48	06:40 20:40 06:40 20:40	06:33 21:06 06:36 21:06	06:48 21:06 06:48 21:06	07:11 20:31 07:11 20:31	07:34 07:58 07:34 07:58	07:58 19:07 07:58 19:07	07:28 08:27-08:51/24 17:39 07:58-08:17/19	07:52 17:39 07:52 17:39
21	07:54 18:03	07:27 08:38-09:17/26 18:35 08:41-08:54/13	07:00 20:07 19:58 20:07	07:08 20:08 20:49 20:49	06:39 20:39 06:39 20:39	06:34 21:06 06:37 21:06	06:49 21:06 06:49 21:06	07:12 20:30 07:12 20:30	07:35 07:59 07:35 07:59	07:59 19:06 07:59 19:06	07:29 08:28-08:50/22 17:38 07:58-08:17/19	07:53 17:40 07:53 17:40
22	07:54 18:04	07:26 08:39-09:18/28 18:36 08:42-08:55/19	07:00 20:06 19:57 20:06	07:06 20:06 20:49 20:49	06:39 20:39 06:39 20:39	06:34 21:06 06:37 21:06	06:50 21:06 06:50 21:06	07:13 20:29 07:13 20:29	07:36 08:00 07:36 08:00	08:00 19:05 08:00 19:05	07:30 08:29-08:49/20 17:38 07:58-08:17/19	07:53 17:40 07:53 17:40
23	07:53 18:05	07:24 08:40-09:19/30 18:37 08:43-08:56/21	07:00 20:05 19:56 20:05	07:05 20:05 20:48 20:48	06:38 20:38 06:38 20:38	06:34 21:06 06:37 21:06	06:50 21:06 06:50 21:06	07:14 20:27 07:14 20:27	07:37 19:44 07:37 19:44	08:01 09:03-09:12/9 19:04 19:04	07:31 08:31-08:48/17 17:38 07:58-08:17/19	07:54 17:41 07:54 17:41
24	07:53 18:06	07:23 08:41-09:21/32 18:38 08:44-08:57/23	07:00 20:04 19:55 20:04	07:04 20:04 20:47 20:47	06:38 20:38 06:38 20:38	06:34 21:06 06:37 21:06	06:51 21:06 06:51 21:06	07:14 20:26 07:14 20:26	07:37 19:43 07:37 19:43	08:02 09:00-09:14/14 19:05 19:05	07:32 08:33-08:47/14 17:37 07:58-08:17/19	07:54 17:41 07:54 17:41
25	07:52 18:07	07:22 08:42-09:21/32 18:39 08:45-08:58/14	07:00 20:03 19:54 20:03	07:03 20:03 20:46 20:46	06:37 20:37 06:37 20:37	06:35 21:06 06:38 21:06	06:52 21:06 06:52 21:06	07:15 20:25 07:15 20:25	07:38 19:41 07:38 19:41	08:03 08:58-09:16/18 19:05 19:05	07:33 08:35-08:45/10 17:37 07:58-08:17/19	07:54 17:42 07:54 17:42
26	07:51 18:08	07:21 08:43-09:21/33 18:40 08:46-08:59/15	07:00 20:02 19:55 20:02	07:02 20:02 20:49 20:49	06:37 20:37 06:37 20:37	06:35 21:06 06:38 21:06	06:52 21:06 06:52 21:06	07:16 20:24 07:16 20:24	07:39 19:40 07:39 19:40	08:04 08:55-09:19/24 19:06 19:06	07:34 07:58-08:17/19 17:37 07:58-08:17/19	07:55 17:43 07:55 17:43
27	07:51 18:09	07:20 08:44-09:23/35 18:41 08:47-09:26/16	07:00 20:01 19:56 20:01	07:01 20:01 20:53 20:53	06:36 20:36 06:36 20:36	06:35 21:06 06:38 21:06	06:53 21:06 06:53 21:06	07:17 20:22 07:17 20:22	07:40 19:38 07:40 19:38	08:05 08:56-09:18/22 19:07 19:07	07:35 07:58-08:17/19 17:36 07:58-08:17/19	07:55 17:43 07:55 17:43
28	07:50 18:10	07:19 08:45-09:24/36 18:42 08:48-09:27/17	07:00 20:00 19:57 20:00	07:00 20:00 20:54 20:54	06:36 20:36 06:36 20:36	06:35 21:06 06:38 21:06	06:54 21:06 06:54 21:06	07:17 20:22 07:17 20:22	07:40 19:38 07:40 19:38	08:06 08:55-09:19/24 19:08 19:08	07:35 07:58-08:17/19 17:36 07:58-08:17/19	07:55 17:43 07:55 17:43
29	07:50 18:12	07:18 08:46-09:25/37 18:43 08:49-09:28/8	07:00 20:00 19:58 20:00	07:00 20:00 20:55 20:55	06:36 20:36 06:36 20:36	06:35 21:06 06:38 21:06	06:54 21:06 06:54 21:06	07:17 20:22 07:17 20:22	07:40 19:38 07:40 19:38	08:06 08:55-09:19/24 19:09 19:09	07:35 07:58-08:17/19 17:36 07:58-08:1	

Project: **Amarillo** Description: MARFORRES CENTER, Amarillo Small Wind Project (1 Northwind 100kW wind turbine)  
Alternative 2 Worst Case Scenario

Printed/Page: 6/6/2011 1:11 PM / 1  
Licensed user: **Course Registration**  
Time-limited until juni 27. 2011

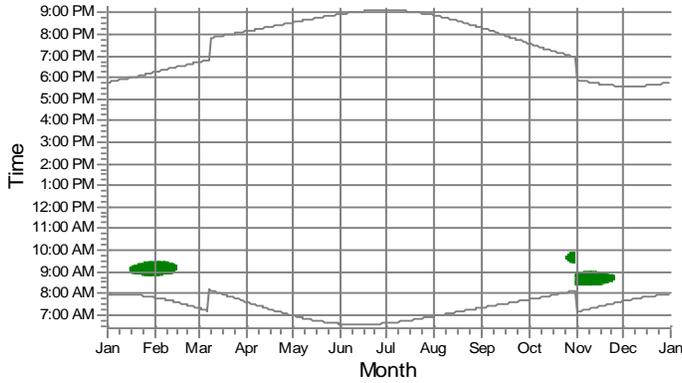


Calculated: 6/6/2011 1:08 PM/2.7.486

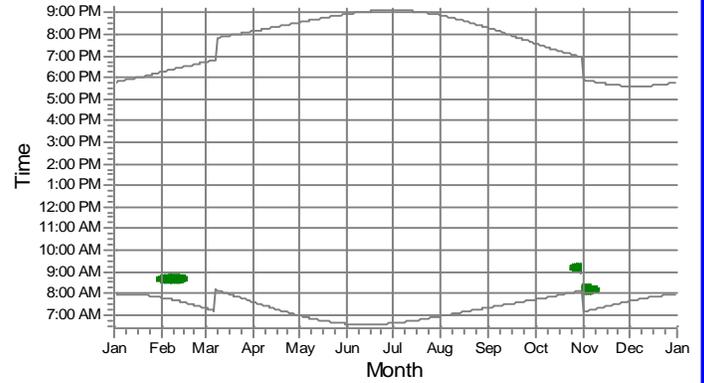
**SHADOW - Calendar, graphical**

Calculation: Alt 2 Worst Case

A: Children's Learning Center



B: Kimble Learning Center



WTGs

1: Alternative 2

Project:

**Amarillo**

Description:

MARFORRES CENTER, Amarillo Small Wind Project (1 Northwind 100kW wind turbine)  
Alternative 2 Worst Case Scenario

Printed/Page

6/6/2011 1:10 PM / 1

Licensed user:

**Course Registration**

Time-limited until juni 27. 2011

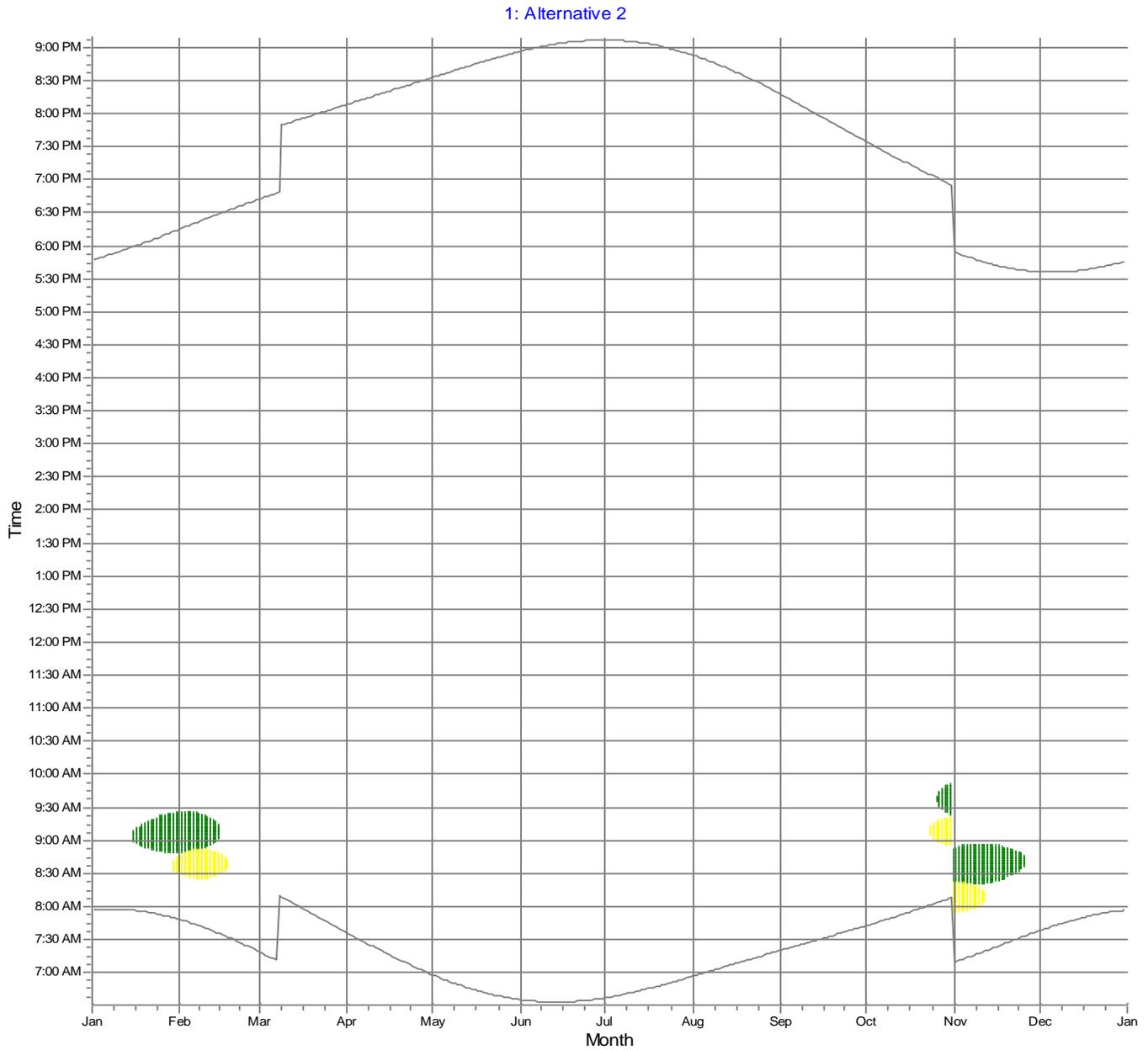
Calculated:

6/6/2011 1:08 PM/2.7.486



### SHADOW - Calendar per WTG, graphical

Calculation: Alt 2 Worst Case WTG: 1 - Alternative 2



**APPENDIX D**  
**CORRESPONDENCE**

---

---



**UNITED STATES MARINE CORPS**

MARINE FORCES RESERVE  
4400 DAUPHINE STREET  
NEW ORLEANS, LOUISIANA 70146-5400

IN REPLY REFER TO  
11011  
FAC/adf  
01 Jun 11

State Historic Preservation Office  
ATTN: mark Wolfe  
Texas Historical Commission  
P. O. Box 12276  
Austin, TX 78711

To the State Historic Preservation Officer:

The United States Marine Corps, Marine Forces Reserve (MARFORRES) requests a consultation under Section 106 of the National Historic Preservation Act for their small wind energy project at the MARFORRES Reserve Training Center in Amarillo. The proposed project includes a single 100 kW wind turbine, 155 feet in total height, with the associated electrical infrastructure required for converting the wind energy into electricity for use by the MARFORRES Center.

The enclosed materials include application information for a SHPO consultation request, a map of the proposed project site, and an architectural survey report for the area of potential effects associated with the site.

Please send your response to the following point of contact:

MARFORRES, Attn: Alain Flexer, Facilities  
4400 Dauphine Street  
New Orleans, LA 70146-5400  
(504) 678-8489

In addition, if you have any questions, please call Casey Barker, environmental planner, at (805) 982-1478. Your prompt attention to this matter is greatly appreciated.

Sincerely,

  
E. J. MAGUIRE  
Deputy AC/S Facilities

**TEXAS HISTORICAL COMMISSION**

**REQUEST FOR SHPO CONSULTATION:  
Projects Subject to Section 106 of the National Historic Preservation Act  
and/or the Antiquities Code of Texas**

*Submission of this form only initiates consultation with the Texas Historical Commission, the State Historic Preservation Officer (SHPO) for Texas. The SHPO may require additional information to complete the review for some projects.*

*FCC projects: this form should not be completed when submitting Form 620 or 621 for communications towers.*

Section 106 of the National Historic Preservation Act of 1966, as amended, requires federal agencies to consider the effects of their undertakings on historic properties and to consult with the State Historic Preservation Officer (SHPO) regarding the undertaking. An undertaking is any action by or on behalf of a federal agency that has the potential to affect historic resources and includes funding, permits, or other approvals. Federal agencies are required to identify historic resources that may be affected and to avoid, minimize, or mitigate any adverse effects. The Section 106 regulations are codified in 36 CFR 800 and are available from the Advisory Council on Historic Preservation website at [www.achp.gov](http://www.achp.gov). Regulations allow 30 days upon receipt for SHPO review.

The Antiquities Code of Texas (Title 9, Chapter 191 of the Texas Natural Resources Code) is intended to protect historic and archeological landmarks and is applicable to public lands owned by the state of Texas or a political subdivision of the state, including state agencies, counties, cities, school districts, and public colleges and universities, as well as other public authorities. Notification of the Texas Historical Commission is required before breaking ground at a project location on state or local public land.

- This is a new submission  
Complete all pages of this form and include required attachments.
- This is additional information relating to original submission made on or about \_\_\_\_\_  
Complete only the first page of this form and add any new information, including attachments.

1. Project Information		
PROJECT NAME Marine Forces Reserve (MARFORRES) Small Wind Project		
PROJECT ADDRESS 2500 Tee Anchor Blvd.	PROJECT CITY Amarillo	PROJECT ZIP CODE(S) 79104
PROJECT COUNTY OR COUNTIES Potter		
PROJECT TYPE (Check all that apply)		
<input type="checkbox"/> Road/Highway Construction or Improvement	<input type="checkbox"/> Repair, Rehabilitation or Renovation of Structure(s)	
<input type="checkbox"/> Site Excavation	<input type="checkbox"/> Addition to Existing Structure(s)	
<input checked="" type="checkbox"/> Utilities & Infrastructure	<input type="checkbox"/> Demolition or Relocation of Existing Structure(s)	
<input type="checkbox"/> New Construction	<input type="checkbox"/> None of these	
BRIEF PROJECT SUMMARY: Please provide a one or two sentence description to explain the project. More details will be provided separately in Part 5, the Project Work Description Attachment. The proposed project is for the construction of a 100 kilowatt wind turbine (155 feet total height) and associated electrical infrastructure for the operation of the wind turbine.		

2. Project Contact Information			
PROJECT CONTACT NAME Alain Flexer	TITLE Facilities Manager	ORGANIZATION MARFORRES	
ADDRESS 4400 Dauphine St.	CITY New Orleans	STATE LA	ZIP 70146
PHONE (504) 678-8489	EMAIL alain.flexer@usmc.mil		

For SHPO Use Only	Date Stamp Below:
Track Review to:	
<input type="checkbox"/> Archeology Division: Reviewer:	
<input type="checkbox"/> History Programs Division: Reviewer:	
<input type="checkbox"/> Architecture Division: Reviewer:	

### 3. Federal Involvement

Does this project involve approval, permit, license, or funding from a federal agency?

Yes (Please complete this section)  No (Skip to next box)

FEDERAL AGENCY

FEDERAL PROGRAM, FUNDING, OR PERMIT TYPE:

US Marine Corps, Marine Reserve Forces Command (MARFORRES)

American Reinvestment and Recovery Act (ARRA)

FEDERAL AGENCY CONTACT PERSON

PHONE

Alain Flexer, Facilities

(504) 678-8489

ADDRESS

EMAIL

MARFORRES, Facilities

alain.flexer@usmc.mil

4400 Dauphine St.

New Orleans, LA 70146-5400

Has the federal agency (if other than HUD) formally delegated authority to consult with SHPO on the agency's behalf?  Yes (Please attach delegation letter)  No

### 4. State Involvement

Does this project involve approval, permit, license, or funding from a state agency?

Yes (Please complete this section)  No (Skip to next box)

STATE AGENCY

STATE PROGRAM, FUNDING, OR PERMIT TYPE:

STATE AGENCY CONTACT PERSON

PHONE

ADDRESS

EMAIL

Will this project involve public land owned by the State of Texas or a political subdivision of the state? (State Agency, County, City, School District, Public Authority, Public College or University, etc.)

Yes  No

CURRENT OR FUTURE OWNER OF THE PUBLIC LAND

### 5. Project Work Description

**Attach** a detailed written description of the project that fully explains what will be constructed, altered, or demolished. Include architectural or engineering plans, site plans, specifications, or NEPA documents, as necessary, to illustrate the project.

### 6. Identification of Project Location and Area of Potential Effect (APE)

The APE includes the entire area within which historic properties could be affected by the project. This includes all areas of construction, demolition, and ground disturbance (direct effects) and the broader surrounding area that might experience visual or other effects from the project (indirect effects).

1. **Attach** map(s) indicating the location and specific boundaries of the project. Road names must be included and legible. Identify the project location, boundaries, and APE on the map(s) as precisely as possible. Suggested maps may include USGS 7.5 minute quadrangle maps (or relevant portions thereof), tax maps, satellite images, etc. The number and types of map(s) will depend on the nature and complexity of the project as well as the extent of the APE. **Projects involving ground disturbance must include the appropriate 7.5 minute USGS quadrangle.**
2. **Attach** a brief written description of the APE, including a discussion of the potential for direct and indirect effects that might result from the project and the justification for the boundaries chosen for the APE.

PROJECT NAME

Marine Forces Reserve (MARFORRES) Small Wind Project

VER 0110

**7. Identification of Historic Properties within the APE (Attach additional materials as necessary)**

**A. Archeological Resources**

Does this project involve ground-disturbing activity?

- Yes (Please complete this section)       No (Skip to Structures section)

Describe the nature, width, length, and depth of the proposed ground-disturbing activity.

Ground disturbance will be limited to the turbine foundation, a concrete transformer pad for a dedicated transformer, and a trench for the electrical cables. The total area of disturbance will be less than one acre.

Describe previous land use and disturbances.

More than 90% of the facility is covered by Urban Land complex soils. Past dredging of the ponds to the south may have impacted soils at the site as well as road construction (Tee Anchor Blvd) to the north. Past construction of two buildings, one structure, paved parking lot, walkways, and landscape areas have also impacted soils at the site.

Describe the current land use and conditions.

The majority of the land at the 5.3 acre Navy/Marine Corps installation consists of buildings, structures, paved lots, and landscaped areas. The MARFORRES Center and a Navy Operational Support Center are co-located at the installation.

**B. Structures**

Are there any structures, buildings, or designed landscape features (park, cemetery, etc.) 45 years old or older within the project area or APE?

- Yes       No

Is the project located within or adjacent to a district that is listed in or eligible for the National Register of Historic Places? Eligible districts may include locally designated districts or areas identified in historic resource surveys.

- Yes, name of district:       No       Do not know

If the Texas Historic Sites Atlas (<http://atlas.thc.state.tx.us>) has been consulted, were previously identified architectural resources identified within the project area or APE?

- Yes       No       Did not consult Atlas

If the answer to any of the above questions is yes, use the space below or provide an attachment indentifying each structure, building, designed landscape feature, or district within the APE that is 45 years old or older. Include an actual or estimated date of construction and the location of each of the features.

A list of historic properties is presented in Table 1. of the attachment for 6. Identification of Project Location and Area of Potential Effect.

Does the project involve the rehabilitation, alteration, removal, or demolition of any structure, building, designed landscape feature, or district that is 45 years old or older?

- Yes       No

If yes, include information with the attachments for Part 5: Project Work Description and Part 8: Photographs.

**8. Photographs**

**Attach** clear, high-resolution color photographs that illustrate the project area and APE as defined in Section 6. Images from the internet are not acceptable due to low resolution. Photography should document the project area and properties within the APE, including clear views of any buildings or structures. Please number and label all photographs, and include a map or site plan labeled to show the location and direction of each view. Where applicable, include photographs of the surrounding area from the project site and streetscape images. Should your project entail the alteration of existing structures, please also provide photographs of the existing conditions of sites, buildings, and exterior and interior areas to be affected.

**9. Consulting Parties/Public Notification (Section 106 only)**

**Attach** a description of the actions taken to notify the public or invite consultation with parties other than SHPO. Provide a summary of any consultation and comments received from consulting parties or the public.

The SHPO is only one consulting party under Section 106. Refer to 36 CFR 800.2 for information about other participants who are entitled to comment on the Section 106 process, including Native American tribes, interested parties, and the public. Consultation with the SHPO is not a substitution for consultation with Native American tribes. When identifying historic resources within the APE and determining the effect of an undertaking, applicants should consider consulting with the county historical commission and the local historic preservation officer, if any.

PROJECT NAME

Marine Forces Reserve (MARFORRES) Small Wind Project

**10. Applicant's Determination of Effect (Section 106 only)**

An effect occurs when an action alters the characteristics of a property that qualify it for listing in the National Register of Historic Places, including changes to the property's location, design, setting, materials, workmanship, feeling, and association. Effects can be direct or indirect, and can be physical, visual, audible, or economic. They may include a change in ownership or change in use.

- No Historic Properties Affected** based on 36 CFR 800.4(d)(1). Please provide the basis for this determination.
- No Adverse Effect** on historic properties based on 36 CFR 800.5(b). Please explain why the criteria of adverse effect at 36 CFR 800.5(a)(1) were not found to be applicable for your project.
- Adverse Effect** on historic properties based on 36 CFR 800.5(d)(2). Please explain why the criteria of adverse effect at 36 CFR 800.5(a)(1) were found to be applicable to your project. You may also wish to include an explanation of how these adverse effects might be avoided, minimized, or mitigated.

In the space below or as an attachment, please explain the effect of the project on historic properties. There are no historic markers, National Register-listed historic properties, or historic districts within the 800 meter or one-half mile visual area of potential effect (<http://atlas.thc.state.tx.us/shell-map-address.htm>).

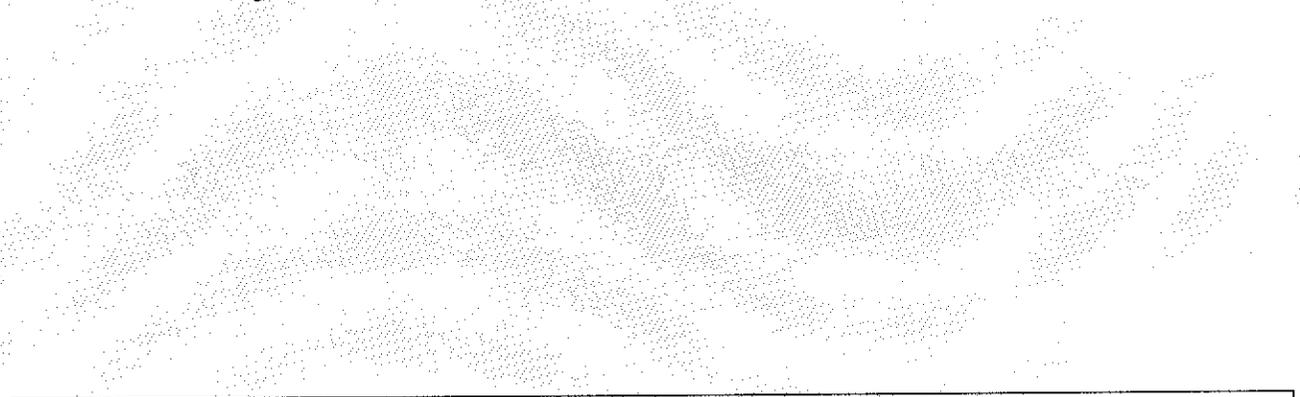
**Submit Completed Form and Attachments to:**

Via mail:  
 Mark Wolfe  
 State Historic Preservation Officer  
 Texas Historical Commission  
 PO Box 12276  
 Austin, TX 78711

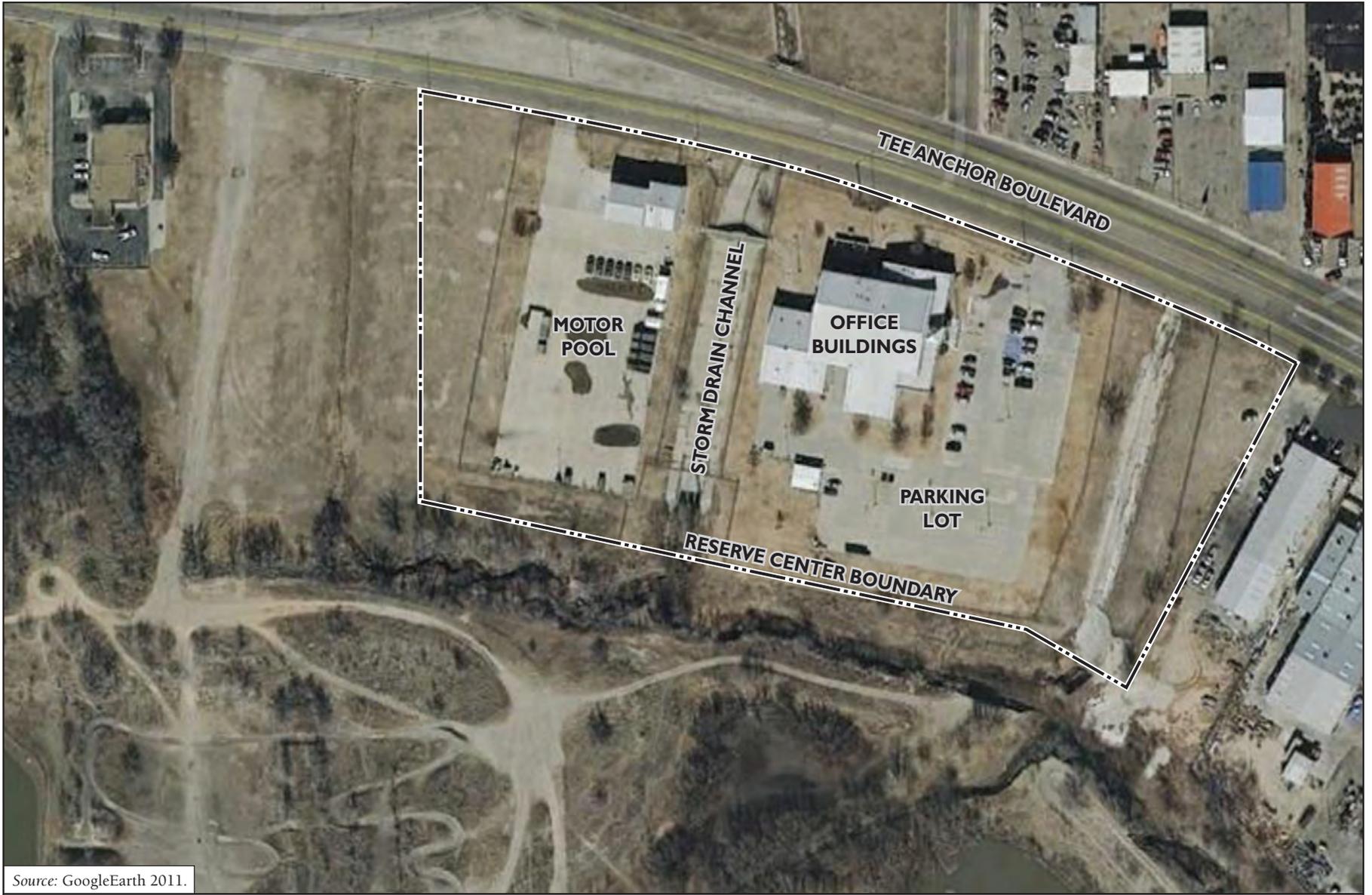
Via hand delivery or private express delivery:  
 Mark Wolfe  
 State Historic Preservation Officer  
 Texas Historical Commission  
 108 West 16<sup>th</sup> St.  
 Austin, TX 78701

**Faxes and email are not acceptable.**

**For SHPO Use Only**

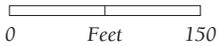


PROJECT NAME			
Marine Forces Reserve (MARFORRES) Small Wind Project			
PROJECT ADDRESS	PROJECT CITY	PROJECT ZIP CODE(S)	
2500 Tee Anchor Blvd.	Amarillo	79104	
PROJECT COUNTY OR COUNTIES			
Potter			
PROJECT CONTACT NAME	TITLE	ORGANIZATION	
Alain Flexer	Facilities Manager	MARFORRES	
ADDRESS	CITY	STATE	ZIP
4400 Dauphine St.	New Orleans	LA	70146
PHONE	EMAIL		
(504) 678-8489	alain.flexer@usmc.mil		



Source: GoogleEarth 2011.

Approximate Scale



Amarillo Wind Energy Project Location





D-8

**Project Work Description:** A 100 kilowatt (kW) wind turbine and its supporting infrastructure will be constructed at the Marine Corps Reserve (MARFORRES) Center located at the Amarillo Marine Corps Reserve facility in Potter County. The precise location for the wind turbine is 35.1984 degrees N, 101.8095 degrees W.

The 100 kW wind turbine consists of a tower with a height of 121 feet and a rotor with a diameter of 69 feet. The total height of the wind turbine is thus approximately 155 feet. For more details on the wind turbine type, visit the website [northernpower.com](http://northernpower.com) and review the links for the Northern Power 100. For immediate reference, Figure 1 shows an installed Northern Power 100 wind turbine. The wind turbine would be constructed over a one to three month period as the tower, rotor blades, and other components would be brought to the construction site, assembled, and erected by a crane. The electrical infrastructure, consisting of a transformer, dedicated to the wind turbine, and underground cables, will then be installed.



Figure 1: Northern Power 100 Installed in a General Urban Setting

The electrical cables will run from the turbine location, with its dedicated transformer, underground to an existing transformer. The existing transformer is located about 375 feet north of the turbine location. The new cables need to be routed around an existing building, so the total cable length will be about 420 feet.

Ground disturbance would be limited to the turbine foundation, the new transformer and concrete pad, and the trench dug for the electrical cables. The turbine foundation would likely be a spread-foot foundation which looks like a truncated pyramid with a hexagonal or octagonal base. The installation of such a foundation would require digging a pit no greater than 57 feet wide and long and 10 feet deep. Most of the foundation would be buried, with only the pedestal, to which the turbine base would be attached, being above ground. The cable trench will be about 420 feet long, only a few feet deep and wide, and will be excavated using a “ditch witch” type machine. The total temporary impact area is about 0.5 acre. Existing paved areas will be used for equipment staging and crane operations. The permanent impact area consists of the turbine foundation and new transformer; it is less than 0.05 acre.

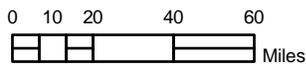
**Site Plan Overview:** Attached to this project description is a map of the project area with an overview of project construction activities and ground disturbance. The title of the map is Amarillo Wind Energy Project Design. The preferred action is highlighted in pink.

**Identification of project location and area of potential effect:** A second attachment, Location of MARFORRES Center and Vicinity Map, contains region and street level maps of the project area.

A search of the publicly available database maintained by the Texas Archaeological Research Laboratory was conducted (<http://atlas.thc.state.tx.us/shell-map-address.htm>). The search was centered at the address of the MARFORRES Center, with a nominal search radius of 1000 meters. Table 1 lists the properties and districts found near the project site. The visual area of potential effect is a circle of 800 meters (one-half mile) radius, in accordance with the standard visual area of potential effect for a wireless communications tower less than 200 feet tall.

Table 1: Historic Properties and Archaeological Sites in Project Vicinity

<b>Name</b>	<b>Type</b>	<b>Distance and Direction from Project Site (m)</b>
Amarillo Livestock Auction	Historic Marker	1500 N
Atchison-Topeka and Santa Fe Railroad Co. Depot and Locomotive No. 5000	National Register District	1900 NW
Atchison-Topeka and Santa Fe No. 5000 "Madam Queen"	Historic Marker	2100 NW
Amarillo	Historic Marker	2400 NW
Henry B. Sanborn	Historic Marker	2400 NW
Potter County Courthouse	Historic Marker	2500 NW
Establishing of Potter County	Historic Marker	2700 NW
Potter County Library	Historic Marker	2800 NW
Amarillo US Post Office and Courthouse	National Register Property	2700 NW
Potter County Courthouse and Library	National Register Property	2700 NW
Santa Fe Building	Historic Marker	2800 W
Atchison-Topeka and Santa Fe Railroad	Historic Marker	2600 W
Bivins Home	Historic Marker	2600 W
Site of Significant Archaeological Find, American Mammoths	Historic Marker	2600 W
Old First Baptist Church	Historic Marker	2800 W
Bivins Library	National Register Property	2800 W
Central Presbyterian Church	National Register Property	2900 W
Kouns-Jackson House	National Register Property	2900 W
First Baptist Church	National Register Property	2800 W
Henry B. and Ellen M. Sanborn House	National Register Property	2900 W
Polk St. Methodist Church	National Register Property	2700 W
Jons-Gilvin House	National Register Property	2200 W
Shelton-Houghton House	National Register Property	2800 W
Shuford-Killough House	Historic Marker	2600 W
HW and Katie Galbraith House	Historic Marker	2800 W
Houghton House	Historic Marker	2800 W
Herring-Crudgington House	Historic Marker	2800 W
Eakle-Archer House	Historic Marker	3000 SW
Llano Cemetary	Historic Marker	2600 SW
Llano Cemetary Historic District	National Register District	2200 SW



**Location of MARFORRES Center  
Amarillo, TX**





**LEGEND**

----- Reserve Center



0 0.05 0.1 0.2 Miles

**Vicinity Map: Amarillo Wind Energy Project**



D-14



D-15



D-16

**TEXAS HISTORICAL COMMISSION**  
*real places telling real stories*

July 12, 2011

MARFORRES  
ATTN: Alain Flexer, Facilities  
4400 Dauphine Street  
New Orleans, LA 70146-5400

*Re: SHPO Consultation for MARFORRES Reserve Training Center in Amarillo (100KW Wind Turbine)*

Dear Alain Flexer:

Thank you for your correspondence describing the above referenced project. This letter serves as comment on the proposed undertaking from the State Historic Preservation Officer, the Executive Director of the Texas Historical Commission (THC).

Our review staff, led by William McWhorter has reviewed your submission of the above mentioned MARFORRES Reserve Training Center Small Wind Project and agree with the United States Marine Corps, Marine Forces Reserve's (MARFORRES) findings of "**NO HISTORIC PROPERTIES AFFECTED,**" in respect to this project's proposed undertaking at MARFORRES Reserve Training Center in Amarillo. Project may proceed.

Thank you for your cooperation in this state and federal review process, and for your efforts to preserve the irreplaceable heritage of Texas. If you have any questions concerning our review or if we may be of further assistance, please contact Mr. William McWhorter at 512/463-5833.

Sincerely,



for  
Mark Wolfe,  
Executive Director





Federal Aviation Administration  
 Air Traffic Airspace Branch, ASW-520  
 2601 Meacham Blvd.  
 Fort Worth, TX 76137-0520

Aeronautical Study No.  
 2010-WTW-16795-OE

Issued Date: 01/07/2011

Alain Flexer  
 Marine Forces Reserve (Facilities)  
 4400 Dauphine St  
 New Orleans, LA 70146-5400

**\*\* DETERMINATION OF NO HAZARD TO AIR NAVIGATION \*\***

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure: Wind Turbine Marine Corps Reserve Amarillo NW 100 WT01  
 Location: Amarillo, TX  
 Latitude: 35-11-54.23N NAD 83  
 Longitude: 101-48-34.11W  
 Heights: 155 feet above ground level (AGL)  
 3765 feet above mean sea level (AMSL)

This aeronautical study revealed that the structure does not exceed obstruction standards and would not be a hazard to air navigation provided the following condition(s), if any, is(are) met:

It is required that FAA Form 7460-2, Notice of Actual Construction or Alteration, be completed and returned to this office any time the project is abandoned or:

- At least 10 days prior to start of construction (7460-2, Part I)
- Within 5 days after the construction reaches its greatest height (7460-2, Part II)

Based on this evaluation, marking and lighting are not necessary for aviation safety. However, if marking and/or lighting are accomplished on a voluntary basis, we recommend it be installed and maintained in accordance with FAA Advisory circular 70/7460-1 K Change 2.

This determination expires on 07/07/2012 unless:

- (a) extended, revised or terminated by the issuing office.
- (b) the construction is subject to the licensing authority of the Federal Communications Commission (FCC) and an application for a construction permit has been filed, as required by the FCC, within 6 months of the date of this determination. In such case, the determination expires on the date prescribed by the FCC for completion of construction, or the date the FCC denies the application.

**NOTE: REQUEST FOR EXTENSION OF THE EFFECTIVE PERIOD OF THIS DETERMINATION MUST BE E-FILED AT LEAST 15 DAYS PRIOR TO THE EXPIRATION DATE. AFTER RE-EVALUATION OF CURRENT OPERATIONS IN THE AREA OF THE STRUCTURE TO DETERMINE THAT NO**

SIGNIFICANT AERONAUTICAL CHANGES HAVE OCCURRED, YOUR DETERMINATION MAY BE ELIGIBLE FOR ONE EXTENSION OF THE EFFECTIVE PERIOD.

Additional wind turbines or met towers proposed in the future may cause a cumulative effect on the national airspace system. This determination is based, in part, on the foregoing description which includes specific coordinates and heights . Any changes in coordinates will void this determination. Any future construction or alteration requires separate notice to the FAA.

This determination does include temporary construction equipment such as cranes, derricks, etc., which may be used during actual construction of the structure. However, this equipment shall not exceed the overall heights as indicated above. Equipment which has a height greater than the studied structure requires separate notice to the FAA.

This determination concerns the effect of this structure on the safe and efficient use of navigable airspace by aircraft and does not relieve the sponsor of compliance responsibilities relating to any law, ordinance, or regulation of any Federal, State, or local government body.

If we can be of further assistance, please contact our office at (405) 954-5189. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2010-WTW-16795-OE.

**Signature Control No: 133909380-135250784**

( DNE -WT )

Brenda Mumper  
Specialist