Draft

TIERED ENVIRONMENTAL ASSESSMENT

United States Marine Corps Forces Reserve Wind Energy Program Site: Marine Forces Reserve Center, Galveston, TX

United States Marine Corps
Forces Reserve

November 2012

Acronyms

AGL	above ground level
APE	Area of Potential Effect
AQCR	Air Quality Control Region
ARPA	Archeological Resource Protection Act
AWEA	American Wind Energy Association
BGEPA	Bald and Golden Eagle Protection Act
BMP	best management practice
CAA	Clean Air Act
CBC	Christmas Bird Count
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CGP	Construction General Permit
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
dBA	A-weighted decibel
DNH	Determination of No Hazard
DoD	Department of Defense
DOH	Determination of Hazard
DoN	Department of the Navy
EA	Environmental Assessment
EMI	Electromagnetic Interference
EO	Executive Order
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
FICON	Federal Interagency Committee on Noise
FM	frequency modulation
FONSI	Finding of No Significant Impact
ft	foot (feet)
FY	Fiscal Year
GCM	general conservation measure
GHG	greenhouse gas
GWP	Global Warming Potential
HHM	Hardy-Heck-Moore, Inc.
IBA	Important Bird Area
IFR	Instrument Flight Rules
INRMP	Integrated Natural Resources Management Plan
km	kilometer
KOP	Key Observation Points
kW	kilowatt
L_{dn}	Day-Night Average Sound Level
MARFORRES	Marine Forces Reserve
MBTA	Migratory Bird Treaty Act
MCO	Marine Corps Order
MW	megawatt
MWh/yr	megawatt-hours per year
mph	miles per hour
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NAVFAC	Naval Facilities Engineering Command
NAVFAC EFD	Naval Facilities Engineering Command, Engineering Field Division
NAVFAC ESC	Naval Facilities Engineering Service Center
NEPA	National Environmental Policy Act
NEXRAD	Next Generation Weather Radar
NGO	non-governmental organizations
NHPA	National Historic Preservation Act
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NPH	Notice of Presumed Hazard
NREL	National Renewable Energy Laboratory
NRHP	National Register of Historic Places
O_3	ozone
Pb	lead
PM_{10}	particulate matter less than or equal to 10 microns in diameter
$PM_{2.5}$	particulate matter less than or equal to 2.5 microns in diameter
PSD	Prevention of Significant Deterioration
RONA	Record of Non-Applicability
rpm	revolutions per minute
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SO_2	sulfur dioxide
SO_x	sulfur oxides
TCEQ	Texas Commission on Environmental Quality
TPWD	Texas Parks and Wildlife Division
TX	Texas
U.S.	United States
USACE	U.S. Army Corps of Engineers
USC	U.S. Code
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USMC	U.S. Marine Corps
VFR	Visual Flight Rules
VOC	volatile organic compound
WHSRN	Western Hemisphere Shorebird Reserve Network

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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, Galveston, 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 §§ 4321-4370h), as implemented by the Council on Environmental Quality (40 Code of Federal Regulations [CFR] Parts 1500-1508); DoN NEPA regulations (32 CFR Part 775); and USMC NEPA directives (Marine Corps Order 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, Galveston, 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*. This Tiered EA analyzes the site-specific impacts of the proposed installation and operation of a single 100-kW wind turbine. 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.

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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*. 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, Galveston, Texas (TX). The MARFORRES Center is located on a U.S. Coast Guard (USCG) Reserve installation at the northeast end of Galveston Island and the U.S. Army Corps of Engineers (USACE) Galveston Office is also a tenant at the site.

Purpose and Need for Proposed Action

The purpose of the proposed action is to develop wind as an energy source at MARFORRES Center, Galveston 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 Center, Galveston 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, Galveston, 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 [see Section 2.2 of this EA], 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.

The proposed action is at the MARFORRES Center, Galveston, TX, at the mouth of Galveston Bay. The Galveston Ship Channel is just to the north of the project site. The proposed wind turbine site is located approximately 300 feet (ft) to the south of the MARFORRES Center and the USCG Station and USACE District Offices are to the west/southwest (Figure 2-1). A helicopter pad is located approximately 700 ft to the southwest of the proposed site. The 155-ft tall wind turbine would be tied MARFORRES Center. When the wind is blowing with corresponding production of electricity, the wind turbine would augment the power supply for the Reserve Center, reducing the need for power from the grid. Any electrical power in excess of the Reserve Center's needs would be diverted to the electricity grid.

It is estimated that the construction phase would last 1 to 3 months and would commence in fiscal year (FY) 2013. The total permanent footprint (foundation, gravel access area/road, connection to transformer) would be approximately 0.10 acre; there would be no additional temporary construction footprint. All construction activities would be conducted in accordance with BMPs provided in the Programmatic EA.

No-Action Alternative

Under the no-action alternative, MARFORRES would not pursue the installation of one 100-kW wind turbine at MARFORRES Center, Galveston. The MARFORRES Center, USCG Station, and USACE District Offices would continue to rely on the electrical grid for purchase of all electricity needs at these facilities. 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]). However, the no-action alternative is not a viable option because it does not meet the purpose of and need for the proposed action. 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 proposed action and the no-action alternative. 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	Proposed Action	No-Action Alternative
Land Use	○	○
Noise	○	○
Geological Resources	○	○
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.

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TIERED ENVIRONMENTAL ASSESSMENT

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

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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 U.S. 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 MARFORRES Center, Galveston, Texas (TX). It is estimated that the construction phase would last 1 to 3 months and commence in fiscal year (FY) 2013.

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 would 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 LOCATION

The proposed action is at the MARFORRES Center, Galveston, TX, at the mouth of Galveston Bay (Figure 1-1). The MARFORRES Center is located on a U.S. Coast Guard (USCG) Reserve installation at the northeast end of Galveston Island known as Fort Point (Figure 1-2). The U.S. Army Corps of Engineers (USACE) Galveston Office is also a tenant at the site. The project site is across the channel from Seawolf Park, which is located on Pelican Island. The Galveston Ship Channel is just to the north of the project site (Figure 1-2).

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, Galveston 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 Center, Galveston has been identified as a facility with a wind resource that is readily available and economically feasible to develop as a renewable energy source.

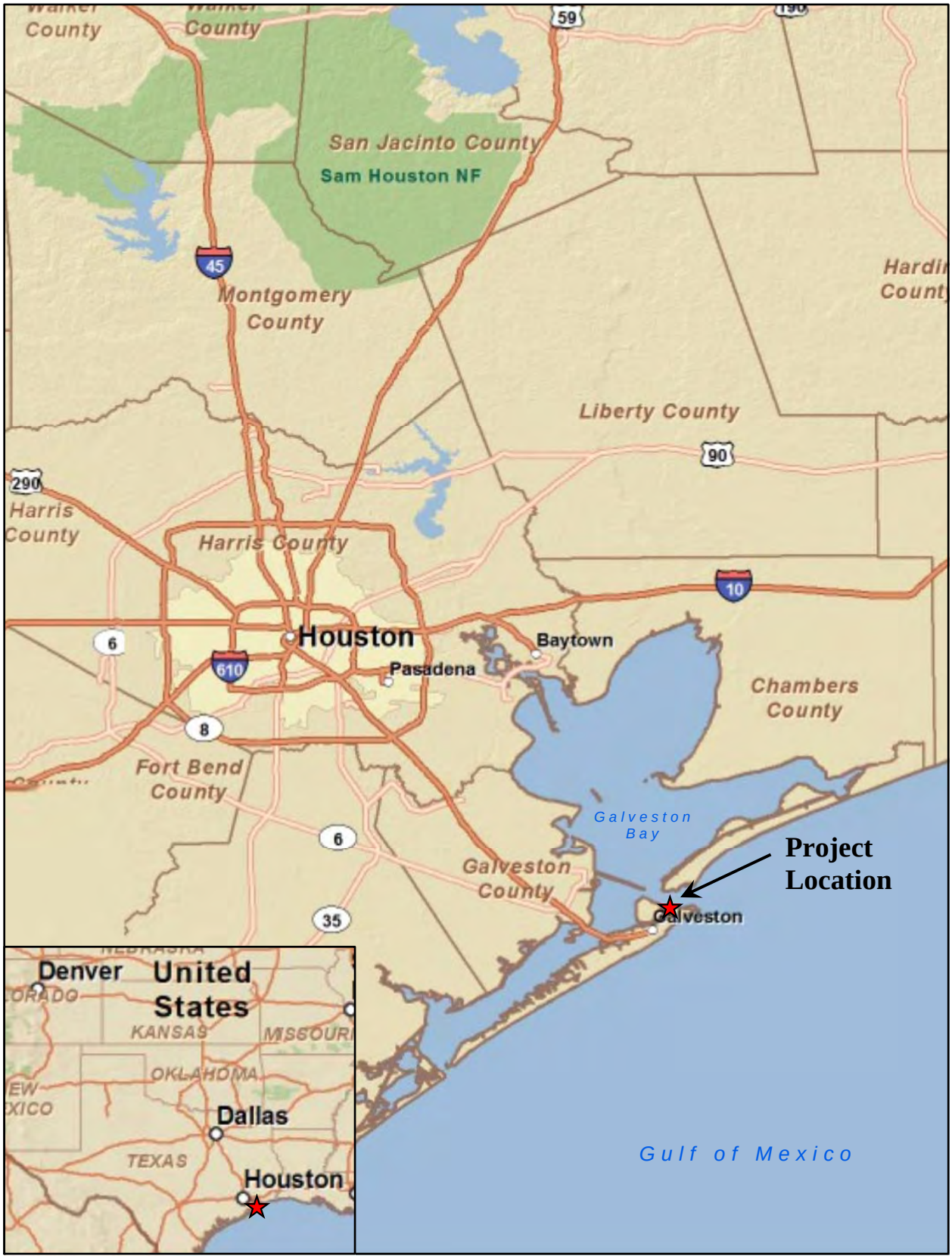


Figure 1-1
Location of MARFORRES Center
Galveston, TX

Figure 1-2
Vicinity Map: Galveston Wind Energy Project

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
- DoN Response to EO 13514.

1.5 REGULATORY SETTING

The preparation of this Tiered EA is based on NEPA requirements, as outline in the following guidance documents:

- NEPA of 1969 (42 USC §§ 4321-4370h), which requires federal agencies to take into consideration the potential environmental consequences of proposed actions in their decision-making processes;
- CEQ regulations (40 CFR Parts 1500-1508), which implement the requirements of NEPA;
- DoN procedures for implementing NEPA (32 CFR § 775), which provide DoN policy for implementing the CEQ regulations and NEPA; and
- MCO P5090.2A, changes 1 and 2, dated 21 May 2009, *Environmental Compliance and Protection Manual*, which establishes USMC procedures for implementing NEPA.

This Tiered EA has also 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;
- Coastal Zone Management Act (CZMA) (16 USC §§ 1451-1466);
- 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);
- Archeological Resource 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 AUTHORIZATION/CONCURRENCE REQUIRED

The following permits and agency concurrences are required prior to a decision on the proposed action:

- If ESA-listed species may occur at the project site, Section 7 ESA informal consultation would occur, and the project would not go forward without concurrence from the U.S. Fish and Wildlife Service (USFWS) that the action is not likely to adversely affect any ESA-listed species **[pending]**;
- The Federal Aviation Administration (FAA) has issued a Determination of No Hazard (DNH) to air navigation for two turbines each with a maximum height of 414 ft above ground level (AGL) at slightly different locations than the one now proposed (Appendix B). **[Note: MARFORRES will confirm that the DNH applies to the smaller turbine now proposed.]**
- Section 106 NHPA consultation and concurrence with findings of either "no historic properties affected" or "no adverse effect" from the Texas State Historic Preservation Officer (SHPO);
- The Texas Commission on Environmental Quality (TCEQ) implements the National Pollutant Discharge Elimination System (NPDES) permit program, ensuring compliance with general permit for construction activities (TXR150000);
- No excavation or filling of a CWA jurisdictional wetland or other water of the U.S. except in accordance with a Nationwide Permit received from the USACE; and
- A Coastal Consistency Determination has been submitted to, and concurrence received from, the Texas Department of State, Division of Coastal Resources in compliance with the CZMA **[pending]**.

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) in an attempt to solicit input on the proposed action. The coordination with and input from the agencies and organizations listed in Table 1.1 has helped to shape the analysis of the proposed 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, the no-action alternative, and alternatives considered but eliminated; Chapter 3 describes the existing conditions and environmental consequences of each alternative for each environmental resource and issue area; 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 cited references in the Programmatic EA; Chapter 7 provides agencies and persons contacted; and Chapter 8 provides the list of preparers.

Table 1-1. Stakeholder List for Galveston

Agency/ Organization Name	*Potential Role/Interest In Project*
Federal Agencies	
USFWS: Clear Lake Ecological Services Field Office	Key regulatory and natural resource trustee responsibilities under the ESA, MBTA, and BGEPA.
USACE – Galveston District	The USACE is a tenant at the project site. The operations branch maintains the levees and the shipping channel. The dredge spoils from the shipping channel are pumped through canals adjacent to the project site. There is also a regulatory branch at the site with responsibilities for CWA permits. The power produced from the wind turbine at the MARFORRES center location would be shared with the USACE district offices.
USCG	The Galveston project site is on the USCG Reserve installation. The power produced from the wind turbine at the MARFORRES center location would be shared with the USCG installation. USCG also has responsibilities for maritime issues of navigation and safety.
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 Determination of No Hazard (DNH) to air navigation or a Notice of Presumed Hazard (NPH).
State and Local Government Agencies	
Texas Parks and Wildlife Department (TPWD)	Provided state guidance in *Recommendations for Wind Energy Development* (Draft, February 2008); concurrence with bird and bat study plan prior to its implementation.
TCEQ	Responsible for protecting the state's human and natural resources, including implementation of the NPDES permit program for the state of Texas.
Texas Department of State, Division of Coastal Resources	Reviews federal actions in the Texas coastal zone to ensure consistency with the goals and policies of the Coastal Management Program to the maximum extent practicable.
Texas SHPO	Responsible for consultation and concurrence with findings of "no historic properties affected."
NGOs and Other Interested Parties	
Seawolf Park	Seawolf Park is within view of the proposed wind turbine locations. It is also home to some historical ships which are maintained by the Save our Ships program, comprised of armed forces veterans. The park is also popular for fishing and general recreation.
Houston Audubon Society	The society is responsible for the maintenance of several parks and sanctuaries in the vicinity of Galveston Island, including Bolivar Flats and Little Pelican Island. It has been recommended that results of the pre-construction study be made available to the Houston Audubon Society for comment in the draft phase.

CHAPTER 2
PROPOSED ACTION AND ALTERNATIVES

2.1 INTRODUCTION

This chapter describes the proposed action, action alternatives, alternatives considered but eliminated, and no-action alternative. The proposed action is to develop wind energy at MARFORRES Center, Galveston under the *MARFORRES Wind Energy Program*. The proposed action would entail the installation and operation of a single 100-kW wind turbine. Installation and operation of the proposed wind turbine 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 State Implementation Plan (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 wind turbine site is located approximately 300 ft to the south of the MARFORRES Center and the USCG Station and USACE District Offices are to the west/southwest (Figure 2-1). A helicopter pad is located approximately 700 ft to the southwest of the proposed site.

2.3.2 Project Design

Through an investigation of energy needs, wind turbine construction requirements, and land availability at MARFORRES Center, Galveston, a single 100-kW wind turbine was identified as suited to (1) the energy requirements of the small MARFORRES facility and (2) and 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 supply the facility's electrical loads. 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). Figure 2-2 shows details for the proposed project design.

Figure 2-1
Galveston Wind Energy Project Location

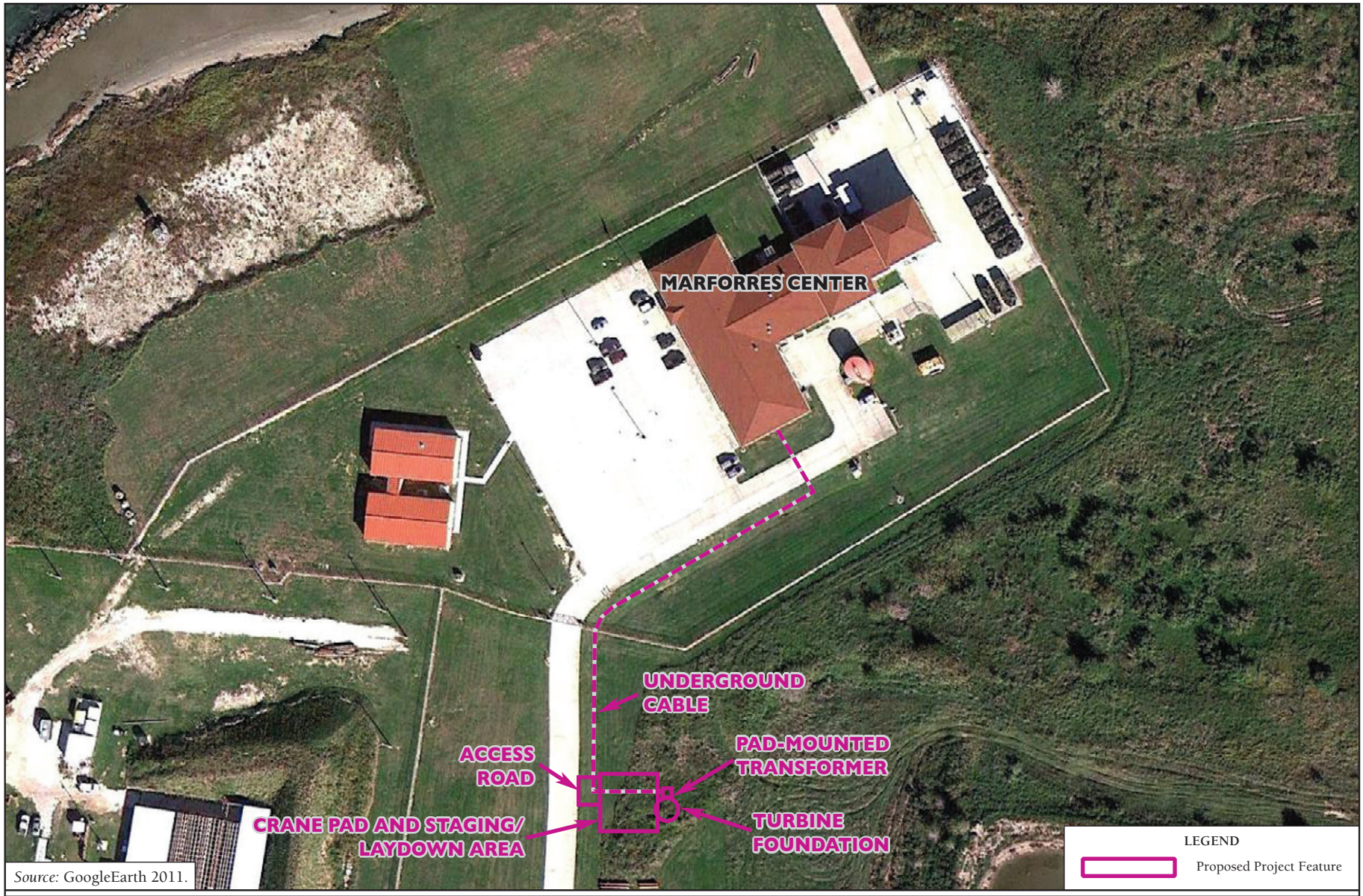


Figure 2-2
Galveston Wind Energy Project Design

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 2-3). 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).

(*Source*: Northern Power Systems 2010b)

Figure 2-3. 100-kW Northern Power 100 wind turbine.

2.3.3 Site Preparation and Turbine Installation

The depth of the foundation would be determined during design phase and based on geotechnical and soils reports. Because this is a coastal site with a shallow groundwater table, excavation for the foundation would include drilling and dewatering, and a mono-pile foundation would be used (similar to a bridge footing). High-pressure grout may be used with the mono-pile foundation.

Adjacent to the turbine foundation, a 50-ft by 50-ft crane pad and staging/laydown area would be constructed in order to erect the turbine (Figure 2-2). The crane pad and staging/laydown area would be a leveled area of well compacted soil covered by gravel. Non-native backfill material may be needed for improved compaction. A 24-ft wide access road would also be constructed to connect the turbine to an existing road (Figure 2-2). Following construction, this gravel area and access road would be would be maintained to allow for parking and access to the turbine for maintenance.

The proposed wind turbine would be connected to a new dedicated transformer mounted on a new 8-ft by 8-ft, elevated (above flood events) concrete pad located adjacent to the turbine foundation access area (Figure 2-2). The turbine would be connected to the new pad-mounted transformer and then the MARFORRES Center buildings to the north via a new 450-ft underground cable (Figure 2-2) 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 and no spoils piles are expected. The new transformer would convert the turbine's output voltage to match the building's voltage and would be in addition to the disconnect and overcurrent protection required by the National Electrical Code for this type of connection.

The total permanent footprint (foundation, gravel access area/road, connection to transformer) would be approximately 0.10 acre; there would be no additional temporary construction footprint.

Construction activities would be conducted in accordance with the applicable BMPs and conservation measures from the Programmatic EA to minimize environmental impacts (MARFORRES 2011). The program was officially established when a FONSI was signed on 18 May 2011. Measures deemed appropriate for the proposed action are listed below; their implementation would be overseen by MARFORRES or its designee.

<u>Construction BMPs</u>

1. MARFORRES and would coordinate with the City of Galveston regarding the use of public roads during project construction to minimize any disruption of local traffic.

2. Current Wind Energy Standards of the International Electrotechnical Commission would be followed in the design, construction, and operation of the proposed wind turbine.

3. 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.

4. 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.

5. 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.

6. 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.

7. 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 nearby wetlands and nearshore waters. 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.

8. Onsite containment and cleanup capabilities would be provided, as necessary, to prevent the release of hazardous materials.

9. If evidence of contaminated soils is uncovered during construction, construction would be halted and cleanup procedures would be initiated, as required.

10. 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.

11. 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.

12. 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.

13. No off-road construction vehicle operations would occur outside of the project boundary.

14. If night work and consequent lighting are required, light fixtures would be shielded downward.

15. If sanitary facilities are not available at the MARFORRES Center, 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.

16. 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 Texas 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 Galveston project site is approximately 16 mph (National Renewable Energy Lab [NREL] 2010), which would produce approximately 30% of the nameplate capacity for the proposed 100-kW turbine (Northern Power Systems 2010a). This equates to an energy output of 300 megawatt-hours per year (MWh/yr) (Northern Power Systems 2010a), which is roughly the amount of electricity that would be used by 29 households per year in this region (U.S. 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 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.

2.4.1 Possible Action Alternatives

The alternatives listed below are limited to those that fall 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).

2.4.1.1 Alternative Turbine Locations

The project purpose and need require a location where wind energy could be economically developed with minimal environmental effects to serve the needs of the MARFORRES facility. In addition to the proposed locations, one additional turbine locations was identified as potential sites for smaller 100-kW wind turbines and two locations were identified for larger 1.8 MW turbines. However, these sites were not carried forward because (1) the sites were not compatible with current operations or (2) installation of a 100-kw turbine was not economically feasible at the large turbine locations due to cost of longer cable installation.

2.4.1.2 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, Galveston.

2.4.2 No-Action Alternative

Under the no-action alternative, MARFORRES would not pursue the installation of one 100-kW wind turbine at MARFORRES Center, Galveston. The MARFORRES Center, USCG Station, and USACE District Offices would continue to rely on the electrical grid for purchase of all electricity needs at these facilities. 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]). However, the no-action alternative is not a viable option because it does not meet the purpose of and need for the proposed action. 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
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, Galveston. 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 at MARFORRES Center, Galveston, TX, is at the mouth of Galveston Bay (see Figure 1-1). The MARFORRES Center is located on a USCG Reserve installation at the northeast end of Galveston Island known as Fort Point (see Figure 1-2). The proposed wind turbine site is an open area located approximately 300 ft to the south and southeast of the Reserve Center's main office building and the Reserve Center's two auxiliary buildings, respectively. The USCG Reserve's main office buildings are located approximately 950 to 1200 ft to the southwest of the proposed turbine site, although other USCG office and support buildings and infrastructure are located nearer to the proposed wind turbine location. **[Note: please provide more specific information for inclusion, as appropriate.]** A helipad is located approximately 700 ft to the southwest. The USACE Galveston District Office is located approximately 1,300 ft to the southwest of the proposed turbine location, on the other side of Ferry Road.

The northwest corner of the federally-owned, 605-acre area known as the Galveston East End Flats is located approximately 250 ft to the southeast of the proposed turbine location. Due to the island's limited land available for development, the City of Galveston has requested East End Flats ownership to be transferred to the City to allow for additional development. However, the first phase of the 50-year Dredge Material Management Plan calls for the flats to be used by the USACE and the Port of Galveston as a disposal ground for spoils dredged from the Houston and Galveston shipping channels until 2016. Thereafter, the plan allows the flats to be used for disposing additional dredge spoils until 2046, if necessary. Eventually, the East End Flats is expected to be filled with dredge spoils, at which time the land is expected to be available to the City to be used as desired (Meyers 2010). The City of Galveston has zoned the East End Flats, as well as all DoD and USCG property, as "one family, one dwelling" (1F-1) (City of Galveston 2012).

The military and USCG property boundaries are bordered by a fence and the proposed turbine location is well removed from publically accessible areas; the USCG Reserve's entrance is the nearest such area, approximately 1,200 ft to the southwest of the proposed turbine location. The Galveston Ship Channel, Apffel Park, and Seawolf Park (on Pelican Island, across the channel) are respectively located approximately 2,000 ft to the north, 2,900 ft to the east, and 3,000 ft to the west of the proposed turbine location.

3.2.3 Environmental Consequences

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

The proposed location chosen for construction of the wind turbine at the Reserve Center is compatible with the mission of the facility. The permanent footprint would impact 0.10 acre of open area south of the Reserve Center building; there would be no additional temporary construction footprint. 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 Galveston or other local ordinances pertaining to wind turbine installation or operation, and with a 161% setback from the nearest edge of the East End Flats, the proposed action would not affect adjacent land uses, including the potential future recreational, residential, or commercial use of the flats. As such, 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 at the edge of the highly developed northeast end of the City of Galveston. Existing sources of noise that would affect the project site include operations at the various USCG Reserve support facilities and vessel movement in the Galveston Ship Channel, respectively 50 ft to the southwest and 2,000 ft to the north of the proposed turbine location.

The nearest sensitive receptors include the Reserve Center's main and auxiliary office buildings, respectively located 300 ft to the north and northwest of the proposed turbine location, as well as one of the USCG Reserve's auxiliary office building located approximately 530 ft to the southwest of the proposed turbine site. 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 office buildings is 75 A-weighted decibels (dBA), and the maximum normally acceptable L_{dn} for residential and recreational areas is 65 dBA.

3.3.3 Environmental Consequences

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.

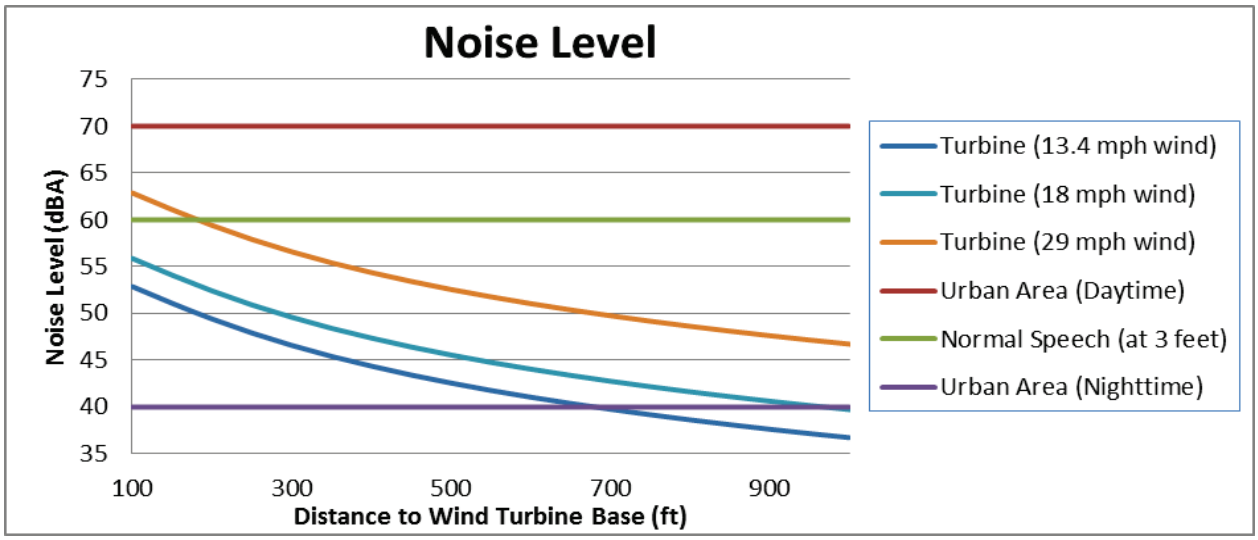
- *Analysis Item N-1: Would construction activities result in noise impacts to surrounding land uses or sensitive receptors?*

Construction would consist of delivering the materials (e.g., construction equipment and turbine components) to the project site, preparing the site (involving minor grading as well as excavating and pouring the foundation), and then erecting and assembling the turbine with a crane. Construction of a wind turbine under the proposed action has the potential to increase noise levels near construction activities. However, 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 is expected to be less than the noise generated by ongoing operations at the USCG Reserve support facilities and vessel movement in the Galveston Ship Channel. As such, noise impacts from construction activities would be short-term and minor. Therefore, noise-related impacts from the implementation of the proposed action 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 Reserve 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) (Figure 3.3-1). At the Reserve Center's main and auxiliary office buildings, 300 ft from the proposed turbine location, the noise levels would respectively be reduced to 47, 50, and 57 dBA. At the USCG Reserve's auxiliary office building, 530 ft from the proposed turbine location, the noise levels would respectively be reduced to 42, 45, and 52 dBA. As such, noise levels at the nearest sensitive receptors would be well below the maximum normally acceptable L_{dn} of 75 dBA for office buildings (Figure 3.3-1 in MARFORRES 2011).



Note: Based on NREL 2003.

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

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 would not be significant.

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 has flat topography and no valuable mineral deposits, paleontological resources, or unique geological features located at or near the site. The project is in the Atlantic and Gulf coastal plains geologic region where the potential for seismic and faulting hazards is classified as minor.

3.4.3 Environmental Consequences

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

The project area has flat topography and would require minimal grading. The construction footprint would be 0.10 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 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 the proposed action.

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

Galveston Bay is located approximately 900 ft to the north and northwest of the proposed project footprint (see Figure 2-1). The proposed project footprint contains no wetlands; however a recent wetland delineation conducted on the Reserve Center in 2010 and 2011 (Tetra Tech 2011a) identified wetlands approximately 200 ft to the east of the proposed turbine location (Figure 3.5-1). The project footprint is located within the 100-year floodplain which has a 100-year base flood elevation of 11 ft (Federal Emergency Management Agency [FEMA] 2002).

3.5.3 Environmental Consequences

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

The construction footprint would be 0.10 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

(*Source*: Tetra Tech 2011a)

Figure 3.5.1. Wetlands in Project Vicinity.

(refer to Section 3.4.3 for a list of potential BMPs) and, therefore, minimize sedimentation of the adjacent storm drain channel and Galveston Bay.

During operations, 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 the proposed action.

- *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 or Waters of the U.S.; 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 project is located within the 100-year coastal flood hazard zone (base flood elevation of 11 ft). Although an alternative location outside of the floodplains would be preferable (per siting criteria

identified in the Programmatic EA [MARFORRES 2011]), the entire Reserve Center is located within the 100-year flood hazard zone.

For development in a 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 foundations, access road, and underground cable would not result in a change to topography (or subsequent decrease in storage volume). Only the bases of the turbine towers and the raised transformer pads would contribute to loss in flood storage volume. The wind turbines and supporting elements would be designed to comply with federal regulations for development in flood hazard areas. In particular, the base of each turbine would be installed two feet above the base flood elevation.

Insofar as there is no practicable alternative location completely above the base flood elevation, 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.

3.6 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).

3.6.2 Existing Conditions

The project site is located at the northeast end of Galveston Island. Galveston Island is a barrier formation separating the Gulf of Mexico from the western arm of Galveston Bay. Relatively large portions of the island have been developed and contain residential and commercial buildings and other facilities. Undeveloped habitats on Galveston Island include sand flats and dunes on the sea side, and extensive marshlands on the bay side (Eubanks et al. 2006).

The MARFORRES Center property consists of both developed and naturally vegetated areas. Much of the property is affected by ongoing training activities of the MARFORRES unit, which includes operation of large military vehicles. These activities disturb the ground and alter the vegetation by creating early successional and recently disturbed patches. The remainder of the vegetation at the project site has likewise been disturbed by past activities including land clearing, excavation, and development of a large levee and rock seawall. The developed portion includes facility buildings, paved parking lots, an activity field, and a paved entrance road. These facilities cover the western one-third of the property. The vegetated portion occupies the eastern two-thirds of the property and contains several habitats including shrub-scrub upland and wetland; wet meadow; maintained lawn; and a narrow strip of tidal marsh and low-tide mudflat bordered by a rock seawall. The proposed turbine site at the MARFORRES Center is in upland habitat in an open grassy field. Soils in the vicinity range from sand to loamy fine sand and sandy clay, whereas the vegetation is dominated by Bermuda grass, white clover, bushy seaside tansy, turkey tangle fogfruit, and spotted sandmat (Tetra Tech 2011a).

The Upper Texas Coast has been called “the migration crossroads of North America” (Eubanks *et al.* 2006) as it can host species from any of the four major migratory flyways. Galveston Island is situated in

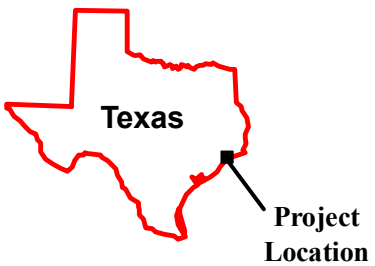
the middle of the Central Flyway, yet migrants associated with the Atlantic and Mississippi Flyway also navigate along the Gulf Coast. This area is an important staging ground for southbound fall migrants, and adverse weather conditions caused by spring cold fronts, such as strong headwinds and rain, force migrants into the Gulf's waters or to ground in coastal woodlots, oak mottes, and cheniers. These habitats provide crucial, lifesaving food and shelter for hundreds of thousands, if not millions, of northbound trans-Gulf migrants (i.e., birds that migrate from the Yucatán and the state of Campeche in Mexico across the Gulf of Mexico to the Gulf Coast of the United States). This phenomenon, when areas on Galveston Island experience unusually high numbers of migrants, is called a "fallout." Even when not stopping over, extremely large numbers of trans-Gulf migrants pass over coastal Texas as part of a broad front of movement that includes the entire Gulf Coast of the United States.

In addition to its importance to summer visitors (nesting species), northbound and southbound migrants, and year-round residents, the varied habitats support innumerable wintering birds. The immediate coast, where the project is located, provides habitat for both water and land birds of diverse taxa. Some of the highest species numbers in North America in the annual National Audubon Society Christmas Bird Counts (CBCs) are recorded along the Upper Texas Coast. For example, on 14 December 2010 during the annual Galveston CBC (covering an approximately 24-kilometer (km) diameter circle including Galveston and vicinity) 44 participants documented 30,586 individuals representing 157 species (National Audubon Society 2011). The ten most recent Galveston CBCs (December 2001–December 2010) recorded a total of 249 species; the high species count during that period was 181 species and the low count was 150 species (National Audubon Society 2011).

The National Audubon Society (2010a) identifies four Important Bird Areas (IBAs) in the region. Jigsaw Island and North Deer Island are located approximately 8 and 10 miles west of the project site, respectively. The Little Pelican Island IBA is located approximately 3.5 miles northwest of the facility. These IBAs have historically held nesting colonies of brown pelican (National Audubon Society 2010a). The fourth IBA, Bolivar Flats (part of the Port Bolivar Bird Sanctuaries), is about 3 miles the northeast across the Houston Ship Channel on Bolivar Peninsula; it has been designated as a Site of International Importance in the Western Hemisphere Shorebird Reserve Network (WHSRN) for its importance to resting, feeding, and breeding shorebirds (WHSRN 2009). Bolivar Flats, as well as Big Reef/East Beach, approximately 1.6 km to the east of the project site, have been designated as critical habitat (e.g., federally-listed as endangered or threatened, based on breeding population) by the USFWS for large populations of wintering piping plover (*Charadrius melodus*) (USFWS 2001).

Federally and state-listed endangered and threatened species and other sensitive species known to occur in Galveston County are listed along with basic information in Appendix D. These are discussed under the relevant analysis items below.

To provide a detailed baseline on bird abundance near the project site, 43 point count surveys were conducted at 10 points on the MARFORRES/USCG property during 6 survey periods beginning in winter 2010, and including the subsequent spring, breeding season, summer, fall, and winter 2010-11 periods (Tetra Tech 2011b). Survey point 2 was nearest the proposed turbine location (Figure 3.6-1), while points 6 and 7 are most similar to the proposed site in terms of habitat. During the same survey periods, 37 point counts were also conducted at 11 reference sites located varying distances from the project site (Figure 3.6-2) (Tetra Tech 2011b). Survey point locations are described in Tables 3.6-1 and 3.6-2.



Source: USDA NAIP Imagery, TetraTech

LEGEND

1.6 MW Turbine

Base Point Count Locations

0 200 400 800 1,200 Feet

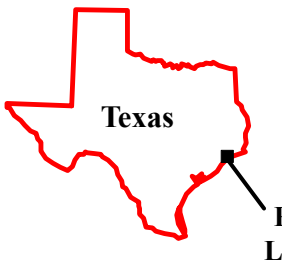
0 50 100 200 300 Meters

Figure 3.6-1. 2010 Bird Survey Base Point Count Locations Galveston, Texas

Prepared For: NAVFAC Naval Facilities Engineering Command

Prepared By: TETRA TECH

Date: 12/2011



Source: ESRI World Imagery Partners, TetraTech

LEGEND

Reference Point Count Locations

0 0.5 1 2 3 4 Miles

0 0.5 1 2 3 4 Kilometers

Figure 3.6-2. 2010 Bird Survey Reference Point Count Locations Galveston, Texas

Prepared For: NAVFAC Naval Facilities Engineering Command

Prepared By: TETRA TECH

Date: 12/2011

Table 3.6-1. Avian Point Count Survey Location Descriptions

Project Site		
Survey Point	**Habitats Observed**	
1	riprapped shoreline; brush; maintained lawn; bay; fenced USMC facility	
2	brush; limited view of shoreline and bay	
3a	open water, flats, and brush in USACE dredge spoil disposal area; brush; scattered trees; bay	
3b	brush; scattered trees; bay; adjacent to but no view of USACE dredge spoil disposal area (birds could be heard but not seen unless flying sufficiently high)	
4	brush; scattered trees; adjacent to but no view of USACE dredge spoil disposal area (birds could be heard but not seen unless flying sufficiently high)	
5a	open water, flats, and brush in USACE dredge spoil disposal area; intermingled brush, grass, and scattered trees	
5b	intermingled brush, grass, and scattered trees; adjacent to but no view of USACE dredge spoil disposal area (birds could be heard but not seen unless flying sufficiently high)	
6	maintained lawn; brush; scattered trees along USACE levee; fenced USMC facility	
7	maintained lawn; brush; scattered trees along USACE levee; fenced USMC facility	
8	riprapped shoreline; brush; maintained lawn; bay; fenced USMC facility	
Reference Points		
Survey Point	**Site Name (Distance from Project Site)**	**Habitats Observed**
A	Corps Woods* (adjacent)	drainage canal; wooded riparian
B1	shoreline W of Seawall end (1.5 mi SE)	shrubland; riprapped shoreline; bay
B2	Seawall end (1.5 miles SE)	bay; shrubland; riprapped shoreline; marsh and beach in middle distance
C	Boddeker Road (1 mile ESE)	narrow tidal beach; shrubland; pond; marsh/wetland
D	East Beach/Big Reef* (2 miles ESE)	beach; tidal sand flats; jetty; open waters of Gulf of Mexico; dunes in distance
E1	NE of Seawall/Apffel Park Road intersection (1.2 miles SSE)	Marsh/wetland; shrubland; canal/pond
E2	Apffel Park Road (1.3 miles S)	marsh; ponds; shrubland
F	8 Mile Road* (10 miles SW)	grassland; seasonal ponds; shrubland
G	Lafitte's Cove* (13 miles SW)	woodland
H	Seawall S of end (0.6 mile SE)	Marsh/wetland; shrubland; canal/pond
I	Seawall *n* of Apffel Park Road (1 mile SSE)	Marsh/wetland; shrubland; canal/pond

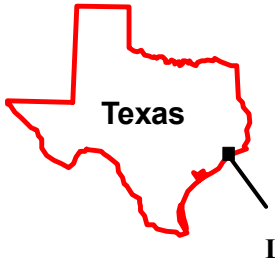
Notes: *Great Texas Coastal Birding Trail site (TPWD, no date).
Source: Tetra Tech 2011b

Table 3.6-2. Avian Point Count Survey Methods

	Winter 1	Spring	Breeding Season	Summer/Early Migration	Fall Migration	Winter 2	
Project Site							
Date Range:	27Jan-21Feb2010	10Mar-6May2010	27May-14Jun2010	9Jul-23Jul2010	1Sep-29Oct2010	20Dec2010-28Jan2011	
Minutes :	~10-30	30	10	10	10	15	
Survey Point	Number of Point Counts at Each Survey Point						Total
1	2	16	3	2	14	6	43
2		14[1]	3	2	14		33
3a	2	16				6	24
3b			3	2	14		19
4	2	16				6	24
5a	2	16				6	24
5b			3	2	14		19
6	2	16	3	2	14	6	43
7	2	16	3	2	14	6	43
8			3	2	14		19
Reference Locations							
Date Range:	27Jan2010	30Mar-6May2010	27May-14Jun2010	no reference site surveys	1Sep-29Oct2010	19Dec2010-27Jan2011	
Minutes:	30	30	30	n/a[2]	10[3]	15	
Survey Point	Number of Point Counts at Each Survey Point						Total
A	1	15	3		14	6	39
B1		15					15
B2		15	3		14	6	38
C	1		3		14	6	24
D	1	15			14	6	36
E1	1	15					16
E2			3		14	6	23
F		15					15
G					14		14
H			3				3
I			3				3

Notes: [1] Location 2 was not surveyed March 10 & 11.
[2] n/a = not applicable.
[3] Extended to a total duration of up to 30 minutes at a few observation points on selected dates when large numbers of birds made it impossible to record all species and individuals within the default time period.
Source: Tetra Tech 2011b.

Of the 32 species of bats that are known to occur in Texas, 11 may occur within the project area. These include the southeastern myotis, silver-haired bat, tri-colored bat, big brown bat, eastern red bat, hoary bat, northern yellow bat, Seminole bat, evening bat, Brazilian free-tailed bat, big free-tailed bat, and the state-listed threatened Rafinesque's big-eared bat. Brazilian free-tailed bat and southeastern myotis are state and federal species of concern (Texas Parks and Wildlife Department [TPWD] 2005). To provide more specific information on bat abundance near the project site, a bat acoustic survey was conducted during 7 months in 2010, spanning the spring and fall migrations and the summer residency period. Acoustic recordings were made of bats at two locations, one approximately 130 ft above ground attached to the guy wire of a meteorological tower, and the other staked approximately 6 ft above ground, as shown in Figure 3.6-3 (Tetra Tech 2011b). Results from the bird and bat surveys are discussed where applicable below.



Source: USDA NAIP Imagery, TetraTech

LEGEND

Bat Acoustic Survey Location

1.6 MW Turbine

0 200 400 800 1,200 Feet

0 50 100 200 300 Meters

Figure 3.6-3. Bat Acoustic Survey Locations Galveston, Texas Spring - Fall 2010

Prepared For: NAVFAC Naval Facilities Engineering Command

Prepared By: TETRA TECH

Date: 11/2010

Z:\projects\100-NEA_T23330.0045_Galvaston_TX\GIS\MXD\TO_11_Wind\100-NEA_T23330.0045_20101110_Figure2.12_2010_WinterBase.mxd, BPA

3.6.3 Environmental Consequences

- *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)?*

The project site does not have an INRMP. CWA jurisdictional wetlands and other waters of the U.S. in the project vicinity were delineated by Tetra Tech (2011a) as shown in Figure 3.5-1. The delineation was reviewed and approved by the USACE. All potential jurisdictional features would be avoided. Designated critical habitat for the piping plover is along the shoreline adjacent to the property but would not be affected. No protected species are known or expected to occur on the project site.

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

Appendix D identifies ESA-listed threatened and endangered species known to occur in Galveston County. State-listed and other species of concern are discussed further under Item BR-4. No listed, proposed, or candidate bat species occur in Galveston County. No proposed or candidate bird species are known to occur in Galveston County. Federally listed species that could occur in Galveston County include the endangered Eskimo curlew and the threatened piping plover (USFWS 2012a). The only federally listed species detected in the vicinity during year-long surveys in 2010-2011 was the piping plover which, however, was not seen on the MARFORRES property during year-long bird surveys (Appendix D).

Although there are historic records of Eskimo curlews and whooping cranes in Galveston County, there were no sightings during the year-long surveys of the USMC property and other areas in the surrounding region (Tetra Tech 2011b), nor are there recent sightings documented on e-Bird or in the Audubon CBCs for 2009-10 and 2010-11. The project site is approximately 130 miles from the whooping crane wintering grounds on Aransas National Wildlife Refuge, and the nearest sightings of whooping cranes reported on eBird (2012) are over 50 miles to the southeast. Similarly, Eskimo curlews were not detected in the bird surveys conducted for the project nor in the Audubon CBCs. The nearest eBird (2012) reported sightings of Eskimo curlews are approximately 50 miles east, along the Brazos River. As a result, whooping cranes and Eskimo curlews are considered not to occur in the project area and would not be affected by the proposed action.

The piping plover inhabits beaches on Galveston Island, including East Beach on the seaward side of the island from the project site, and across the entrance to the bay at Bolivar Flats (Tetra Tech 2011b). Given the lack of habitat on the project site and the fact that the species was not detected in the year-long surveys conducted throughout the property indicates a very low possibility of occurrence on the project site. In addition, since piping plovers are not strong fliers and stay close to the ground, the possibility of a collision with the turbine proposed turbine is considered remote and discountable. In conclusion, the proposed action is not likely to adversely affect or significantly impact the piping plover. On behalf of MARFORRES, Naval Facilities Engineering Command (NAVFAC) Atlantic is consulting with USFWS and has asked for concurrence with this conclusion.

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

Neither bald nor golden eagles are known to occur in Galveston County (Appendix D). Bald and golden eagles were not observed during the year-long avian surveys of the property and adjacent areas, nor were they reported in regional data from e-Bird or Audubon CBCs (Tetra Tech 2011b; Appendix D). Therefore, these species do not occur in the project area and would not be affected.

- *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?*

Birds

Galveston Bay on the whole is a heavily used regional flyway for migratory birds and hosts abundant breeding, roosting, and wintering populations. Results of year-long point-count surveys at various locations on the MARFORRES property and at surrounding reference locations are provided in Appendix D. Table 3.6-3 summarizes data from all survey locations, whereas Table 3.6-4 compares the most abundant species at the sites nearest and most similar to the proposed turbine location with those at other MARFORRES Center sites and regional reference sites.

Table 3.6-3. Avian Point Count Survey Results

Survey Point[2]	Average Number of Birds per Point Count[1]						
	Winter 1	**Spring**	**Summer**	**Summer/Early Migration**	**Fall**	**Winter 2**	**All Surveys**
MARFORRES Property							
1	69	107	122	68	96	287	127
2[3]		60	51	20	38	130	51
3a	22	71				197	82
3b			58	19	24		29
4	12	56		27		56	87
5a	25	55					53
5b					29	57	29
6[3]	94	96	94	86	50		75
7[3]	44	74	64	98	58	63	66
8			78	81	109		101
Reference Sites							
A	14	33	26		38	20	32
B1		55					55
B2			64		76	107	50
C	54	183	74		156	508	344
D	114	154			1185	660	638
E1	33	49					48
E2			22		60	56	54
F		60					60
G		54			33		91
H			30				30
I			35				35

Notes: 1. See Table 3.5-2 for number of point counts at each location.
2. See Figures 3.5-2, 3.5-3
3. Location close to site of proposed action and with similar habitat.

Source: Tetra Tech 2011b.

Table 3.6-4. Comparison of Most Abundant Bird Species Near Turbine Site vs. Other Locations

Sites 2,6 & 7		*Other MARFORRES Center Sites*		*Regional Reference Sites*	
Species	***%***	***Species***	***%***	***Species***	***%***
European Starling	17.4%	Laughing Gull	30.7%	Laughing Gull	33.7%
Laughing Gull	16.7%	Brown Pelican	9.2%	Black Skimmer	10.2%
Great-tailed Grackle	11.4%	Black Skimmer	7.3%	Brown Pelican	7.0%
Brown Pelican	8.2%	Great-tailed Grackle	6.2%	Royal Tern	5.4%
Rock Pigeon	5.8%	European Starling	4.4%	Sanderling	4.3%
Barn Swallow	3.4%	Red-winged Blackbird	2.6%	Unknown Shorebird sp.	2.7%
White-winged Dove	2.9%	Unknown Gull sp.	2.5%	Black Tern	2.3%
Mourning Dove	2.8%	Barn Swallow	2.1%	Ring-billed Gull	2.3%
Cattle Egret	2.7%	Blue-winged Teal	2.0%	Great-tailed Grackle	2.2%
Northern Mockingbird	2.6%	Northern Shoveler	1.7%	European Starling	2.2%
Savannah Sparrow	1.8%	Rock Pigeon	1.7%	Unknown Gull sp.	2.0%
Eastern Meadowlark	1.6%	Unknown Shorebird sp.	1.6%	Western Sandpiper	1.8%

Source: Tetra Tech 2011b.

While moderately large numbers of birds were seen at sites 2, 6, and 7 compared to the other sites (Table 3.6-3), the species composition was markedly different from that of the other MARFORRES Center and regional reference sites (Table 3.6-4). The sites nearest and most similar to the proposed turbine location had a greater representation of upland species including the non-native European starling, which is not protected by the MBTA, whereas more water-associated species (shorebirds, waterfowl, marsh birds) were seen at the other sites (consult Appendix D for a site-by-site and season-by-season breakdown).

Based on Audubon CBC data for the area within a 7.5-mile radius of Galveston (including the project site) from 2009-10 and 2010-11 (Tetra Tech 2011b; Appendix D), the most abundant species at that time of year are (in rough order of abundance) laughing gull, American avocet, European starling, ring-billed gull, northern shoveler, black skimmer, and great-tailed grackle.

All else equal, the risk and frequency of bird fatalities due to collisions should be proportional to the rotor-swept area, which is proportional to energy output. Both the energy output (100 kW) and rotor-swept area of the proposed turbine would be less than one tenth that of a typical large turbine (MARFORRES 2011). Given the coastal location and abundance of birds in the region, the proposed turbine would be expected to result in bird fatalities at the high end of the spectrum observed at wind turbine sites. Bird fatalities have been commonly calculated as a number of individual birds per MW per year, with numbers from medium- to large-turbine sites as reviewed in the Programmatic EA ranging from 0.95 to 11.67 individuals/MW/yr (MARFORRES 2011). During an initial 5-month summer-fall monitoring period, 9 avian fatalities were documented at a 5-turbine, 7.5 MW project on the coast in Atlantic City, New Jersey (New Jersey Audubon 2008). This would equate to 22 over a 12-month period, which is approximately 2.93 birds/MW/yr. Since some fatalities were undoubtedly not detected, the true number was higher. Even if an exceptionally high fatality rate of 20 birds/MW/yr were assumed, adjusting for the size of the proposed project (100 kW = 0.1 MW), the resulting estimate of mortality for the proposed action would be 2 birds per year, probably affecting the commoner species (Table 3.6-4). As such the likelihood of affecting a rare species, much less having any population-level effect, is extremely low, and the impact is considered less than significant.

Bats

Results of the bat acoustic surveys are summarized in Tables 3.6-5 and 3.6-6.

Table 3.6-5. Summary of Acoustic Monitoring Results by Detector at the Project Area – 2010

Detector Location		Period of Operation	Detector-Nights	Number of Minutes with Activity	Total Number of Call Sequences	Overall Index of Activity (Number of Minutes Activity/ Detector-Nights)*100
Met Tower	High	March 10 - April 18, May 5 -May 27, June 2 - July 1, July 9 - July 12, July 24 - October 17	193	1119	1359	*579.8*
Stake	Low	March 11 - March 18, March 20 - August 10, August 25 - October 13	201	620	659	*308.5*
Total			**394**	**1739**	**2018**	***441.4***

Source: Tetra Tech 2011b.

Table 3.6-6. Summary of Bat Call Sequences and Species Recorded at the Project Area – 2010

Call Group	Characteristic Frequencies*	Species/Species Group	Count of Minutes with Activity	Total Call Sequences
Low Frequency	12 kHz–25 kHz	Hoary bat	12	12
		Fc 25 kHz Unknown Species	505	608
Brazilian free-tailed bat	23 kHz–28 kHz	Brazilian Free-tailed / Hoary bat	21	21
		Brazilian Free-tailed / Silver-haired	10	10
		Brazilian Free-tailed / Big brown	69	71
		Brazilian Free-tailed	317	436
Middle Frequency	26 kHz–39 kHz	Big brown bat	94	96
		Evening bat	5	5
		Northern yellow bat	267	292
		Fc 30 kHz Unknown Species	227	236
		Fc 35 kHz Unknown Species	63	68
Eastern red bat	44–45 kHz	Eastern red bat / evening bat	27	29
		Eastern red bat	59	70
High Frequency	40–52 kHz	Tri-colored bat	4	4
		Southeastern myotis	1	1
		Fc 40 Unknown Species	46	47
		Fc 45 Unknown Species	12	12

Note: * Characteristic frequency (Fc) is generally defined as the frequency of the call pulse at the lowest slope, or the lowest frequency of the consistent frequency modulation sweeps. Fc represents the single most useful parameter for species identification.

Source: Tetra Tech 2011b.

The survey results indicate that the bat community of the project area consists of summer resident species as well as migratory species, and overall, the species detected were consistent with existing information on species ranges, the seasonal timing of migration, and the habitat types present. Of the calls identified to species and species groups, 62% were attributed to long distance migratory bats including Brazilian free-tailed bat (the most frequently identified species), hoary bat, and eastern red bat. Of the non-migratory bats, northern yellow bats and big brown bats were recorded most frequently. The Project area is at the edge of the range of southeastern myotis (Bat Conservation International 2010), which may account, in part, for its uncommon occurrence here. Big free-tailed bat is an uncommon species in much of Texas and was not detected during the survey period. Though the seminole bat is a possible species within the project area, call identification is difficult due to the nearly identical eastern red bat calls.

The data in Table 3.6-5 can be used to calculate the number of calls per detector-night, a statistic that has been used to compare relative bat abundances in different locations, although not in coastal Texas (Stantec Consulting 2008a,b). It should be noted that due to variability in individual calling rates and detectability, the number of calls per detector-night is only loosely correlated with the number of bats. With this limitation in mind, the overall average of 5.12 calls/detector-night does not suggest a relatively high abundance of bats compared to other locations surveyed with similar methods (Stantec Consulting 2008a,b; Tetra Tech 2011c).

Given the relatively open coastal location and moderate bat abundance suggested by the survey data, it is reasonable to assume that the proposed location would have fatality rates near the median of fatality spectrum observed at wind turbine sites, which would be roughly 20 bats/MW/yr (MARFORRES 2011). This would correspond to 2 bats/yr for the proposed 100 kW turbine, most likely affecting the more abundant species referred to previously. As for birds, this number is considered less than significant in terms of potential population-level effects.

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

Galveston is within Bird Conservation Region #37, the Gulf Coastal Prairie (USFWS 2008). Of the 43 bird species of conservation concern (including 2 different subspecies of red knot), identified for this region, 27 were observed on either the MARFORRES property or one of the reference sites, and 11 were seen at the 3 point count stations (2, 6 and 7) that were nearest and ecologically most similar to the proposed turbine site. These species included the peregrine falcon, solitary sandpiper, upland sandpiper, marbled godwit, least tern, sandwich tern, black skimmer, loggerhead shrike, sedge wren, painted bunting, and dickcissel. None of these species accounted for more than 0.3% of the individuals detected at the 3 sites, and the combined count of all birds of conservation concern was 1.0% of the total observed at the 3 sites (Appendix D). Given the worst-case estimated mortality of 2 birds/yr, it is unlikely that any of these bird species of conservation concern would experience mortality due to a collision with the proposed turbine, and this impact is considered less than significant.

State-listed bird species that can occur in Galveston County include the endangered brown pelican and the threatened peregrine falcon, bald eagle, reddish egret, white-faced ibis, white-tailed hawk, and wood stork (TPWD 2010). Among these, only the brown pelican and peregrine falcon were seen at point-count stations 2, 6, and 7. The peregrine falcon accounted for 0.05% of the observations (Appendix D), making the likelihood of collision mortality remote, and the potential impact less than significant. The brown pelican was common at all MARFORRES and reference sites (Table 3.6-4), and accounted for 8.2% of the observations at stations 2, 6, and 7. Based on the worst-case estimate of 2 fatalities/yr for all species, and assuming the rate of collisions per species is proportional to relative abundance in the point counts,

the expected mortality to brown pelicans 0.16 individual per year. This would amount to less than 0.001% of the regional population of approximately 12,000 breeding pairs (USFWS 2012b), and as such, the impact is considered less than significant.

3.7 CULTURAL RESOURCES

3.7.1 Definition of Resource

Cultural resources are remnants of past human activity that as a general rule are greater than 50 years of age. Under Section 106 of the NHPA of 1966 as amended, cultural resources are categorized as districts, sites, buildings/structures, objects, and Traditional Cultural Properties. Cultural resources that are currently listed in, that have been determined eligible for listing in, or are considered potentially eligible for listing in the NRHP are termed "historic properties". All historic properties within a project's physical and visual Area of Potential Effect (APE) 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 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. The visual APE is the viewshed of the casual observer from a given location, and includes both the natural and cultural features that are visible. With regards to cultural resources, it is the visible landscape surrounding the location of the proposed action that contains historic properties whose eligibility for the NRHP could be affected by it. The visual APE for cultural resources is defined by the administering federal agency in consultation with the SHPO. The effects on historic properties within the APE from a proposed action can be direct, indirect, and cumulative. Additional information on the definition of this resource can be found in the Programmatic EA for the project (MARFORRES 2011).

In defining the visual APE in the state of Texas, the Texas SHPO generally follows the guidelines for cellular communications towers set forth under a nationwide Programmatic Agreement between the Federal Communications Commission (FCC) and the SHPOs. For towers 100 to 200 ft tall, the visual APE is defined as a radial area of 0.5 miles centered on the tower. However, there are two historic properties that are within 1.0 mile of the proposed turbine that could potentially be affected. Because of the close proximity of these two historic properties that could potentially be affected by the proposed action, the visual APE was expanded to 1.0 mile.

3.7.2 Existing Conditions

The proposed wind turbine and the associated facilities are within the boundaries of a historic archaeological site and within the visual APE of two historic properties. The proposed wind turbine is located within the defined boundaries of the Old Fort San Jacinto archaeological site (41GV119). Site 41GV119 was recorded and evaluated for the NRHP in 1991 by Prewitt and Associates of Austin based on extensive archival research and a site visit (Texas Historical Commission Site Atlas 2012). It encompasses 646 acres on the northeast end of Galveston Island, being bounded on the north by Bolivar Roads, on the east by Seawall Boulevard, and on the south and west by State Highway 87 and the Fort Point Reservation. The site is the location of former military fortifications and structures that date from 1816 to 1959. It is covered with dredged spoil that is up to 10 ft deep, and has also been impacted by numerous major storms that have hit Galveston Island during its period of occupation (1816-1959) and afterwards (1959-Present). The site has also been impacted by more recent construction projects including construction of a jetty and a seawall. The site is currently considered potentially eligible for the NRHP,

and potentially eligible for the Texas State Landmark registry (Texas Historical Commission Site Atlas 2012).

An archaeological survey (Phase I) was conducted at the MARFORRES Center in 2004 by Hardy-Heck-Moore, Inc. (HHM) of Austin for the MARFORRES Center and the Naval Facilities Engineering Command, Engineering Field Division (NAVFAC EFD) South. The Phase I survey included archival research, pedestrian survey, and shovel probing of undisturbed areas of the MARFORRES Center, Galveston. Pedestrian survey was conducted on 25 acres of undeveloped land within the 49.4 acre facility (HHM 2004a). Four shovel tests were excavated in apparent undisturbed portions of the facility between the entrance road and the levee on the east and between the fence and the road on the west. The shovel tests were excavated to depths of 24 to 32 inches below the surface. No archaeological materials were encountered and soils in the excavated probes appear to be highly disturbed (HHM 2004a).

The buildings at the MARFORRES Center, Galveston were inventoried and evaluated for the NRHP in 2004 as well by HHM of Austin for the MARFORRES Center and NAVFAC EFD South (HHM 2004b). A total of eight buildings (Reserve Training Building, LVT Maintenance Building, Ammo/Flammable Storehouse, two General Storage Sheds, Pole Shed, LVT Monument, and Flagpole) constructed between 1968 and 1988 at the center were evaluated for the NRHP. All were considered to be ineligible for the NRHP because they were not 50 years old at the time of survey. Neither did they meet Criteria Consideration G of the NRHP Eligibility Criteria for structures less than 50 years old as they were not considered to be of exceptional significance within the context of the Cold War. It was recommended that they be re-evaluated for the NRHP when they became 50 years old (HHM 2004b).

A total of 92 historic properties are located within Galveston County. Of these, two are located within 1.0 mile of the proposed wind turbine site, and five are located 1.0 to 2.0 miles away. The historic properties within 1.0 mile of the proposed wind turbine include the World War II destroyer USS Stewart and the historic Galveston Seawall. The USS Stewart is a World War II era naval destroyer that was listed on the NRHP in 2007. The Galveston Seawall was constructed along the east side of Galveston to protect the city from future hurricanes after the devastating hurricane of 1900. It is potentially eligible for listing in the NRHP, and is also potentially eligible as a State Historic Landmark. Historic properties located more than 1.0 mile away, but less than 2.0 miles way, include the Ashbel Smith Building, the McKinney-McDonald House, the SS Selma (41GV102), Point Bolivar Lighthouse, and Fort Travis. In addition, the NRHP listed East End Historic District is located approximately 2 miles from the proposed wind turbine location.

3.7.3 Environmental Consequences

- *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 MARFORRES Center Galveston with a footprint of approximately 0.10 acres would be unlikely to have an adverse effect on any known historic properties within the physical APE. While the proposed wind turbine is located within the boundaries of the potential NRHP eligible Old Fort San Jacinto archaeological site, the site has been impacted by a number of natural and manmade factors and is reportedly covered by up to 10 ft of dredged spoil. Previous testing of the site near the proposed wind turbine location indicated a highly disturbed condition to the deposits which are unlikely to contain intact cultural remains. Cultural deposits which lack integrity would not contribute to the potential eligibility of the site to the NRHP. Impacts to cultural remains which do not contribute to the eligibility of the site do not constitute an adverse effect to this historic property under Section 106. Therefore, the construction of the wind turbine and associated facilities in the disturbed soils of the site would not constitute an adverse effect to the property.

The proposed wind turbine is also within the visual APE of the NRHP eligible USS Stewart and the potentially eligible Galveston Seawall. Two Key Observation Points (KOPs) were utilized to evaluate the impacts on these historic properties (Figure 3.7-1). The first KOP (KOP #1) was from the interpretive sign at historic Fort Point at the north end of the seawall. This location is at the very northeast end of the Old Fort San Jacinto archaeological site and north the end of the Galveston Seawall and levee system. It is a location that is frequented by recreational fishermen and birdwatchers. A radio facility with radio towers is located immediately adjacent to the west. Fort Point is located approximately 0.94 miles from the proposed location of the wind turbine.

The second KOP (KOP #2) was from the deck of the NRHP listed USS Stewart at Seawolf Park on Pelican Island across the channel from the proposed location of the wind turbine. Seawolf Park is located on the site of one of the largest 19th and 20th Century immigration stations in the United States. Currently, it is a recreational park containing two World War II naval vessels in addition to a 3-story pavilion, picnic facilities, and a fishing pier. The two World War II vessels consist of an Edsall class destroyer (USS Stewart) and a Gato class submarine (USS Cavalla). Seawolf Park is located approximately 0.65 miles from the location of the proposed wind turbine.

At KOP #1, the proposed wind turbine is largely obscured by vegetation, and is not overly apparent to the casual observer from the seawall (Figure 3.7-2). The radar facilities between the seawall and the wind turbine further serve to obscure it from view. While the proposed wind turbine is more apparent from KOP #2 on the deck of the USS Stewart, it does not impact the setting for the property beyond that which is already present (Figure 3.7-3). The setting for the USS Stewart is not an important aspect of its integrity and not important element of its eligibility to the NRHP. The impacts to the setting from the wind turbine would therefore not constitute an adverse effect on a historic property.

Section 106 consultation with the Texas SHPO, the Comanche Tribal Historic Preservation Officer, and the Tonkawa Tribe were initiated in 26 October 2012. At the time of this submittal, only a response from the Texas SHPO had been received. On 19 November 2012 the Texas SHPO concurred with a finding of No Adverse Effect on any historic properties by the proposed action.

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 view of a casual observer. Impacts to the visual environment are measured by the degree of change that a proposed action causes to the view of an observer from a vantage point referred to as a key observation point (KOP). The degree of change referred to as the degree of contrast is measured in terms of changes to the forms, lines, textures, and colors present in the landscape. 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.

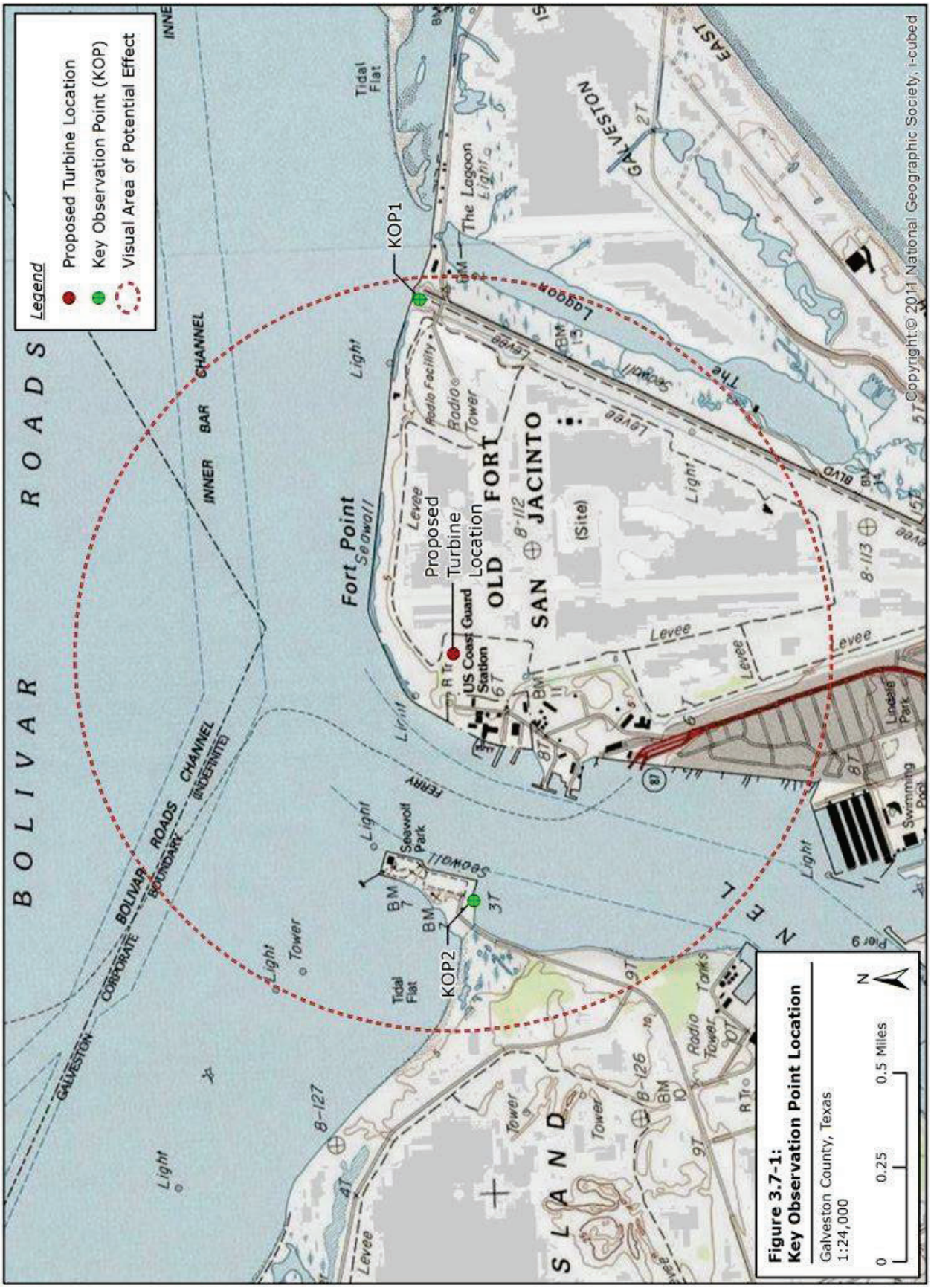

Legend
Proposed Turbine Location
Key Observation Point (KOP)
Visual Area of Potential Effect
KOP1
KOP2
Proposed Turbine Location
BOLIVAR ROADS
GALVESTON
FORT SAN JACINTO
OLD (Site)
Fort Point Seawall
INNER BAR CHANNEL
BOLIVAR ROADS CHANNEL (INDEFINITE)
CORPORATE BOUNDARY
GALVESTON ISLAND
EAST BEACH
Seawolf Park
US Coast Guard Station
Radio Facility
Radio Tower
The Lagoon Light
Lagoon
Levee
Tidal Flat
Tower
Light
Lincoln Park
Swimming Pool
Pier 9
Radio Tanks
Figure 3.7-1:
Key Observation Point Location
Galveston County, Texas
1:24,000
0 0.25 0.5 Miles
N
Copyright © 2011 National Geographic Society, i-cubed

Figure 3.7-2: Visual Simulation of Proposed Turbine from Old Fort San Jacinto, Galveston, Texas

Figure 3.7-3. Visual Simulation of Proposed Turbine from USS Stewart at Seawolf Park, Galveston, Texas

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 topography surrounding the MARFORRES Center is flat with large expanses of water. The Bolivar Roads water channel separates Galveston Island from neighboring Bolivar Island to the north with Point Bolivar visible in the distance. A narrow water channel separates Galveston Island from Pelican Island to the west. Low-lying marshes are located to the south, and a lagoon is located to the east. The viewshed to the north from the turbine location includes communications towers and small structures in the foreground, and the low lying buildings of Point Bolivar in the distance across the channel. The viewshed to the southwest is dominated by the low buildings of the USCG Station and MARFORRES Center in foreground. The skyline of Galveston is visible beyond with numerous large buildings associated with University of Texas Medical School dominant in the middle ground. Tall cranes adjacent to the piers, more large buildings, tank batteries, and tall flaring towers associated with the oil refineries are visible in the distance beyond. The buildings are blocky in form and largely rectangular and square in shape with strong, definitive lines. Tanks have a cylindrical form but blocky shape. The cranes and flaring towers have a linear shape with strong, vertical lines. The overall texture of the landscape is bumpy. Colors on the landscape are dominated by different shades of browns, tans, whites, and grays with some reds.

There are four receptors that are potentially sensitive to shadow flicker within 690 ft of the proposed turbine location. With respect to the proposed turbine location, these are the Reserve Center's main office building 300 ft to the north, the Reserve Center's two auxiliary office buildings 300 ft to the northwest, and a USCG Reserve auxiliary office building approximately 530 ft to the southwest of the proposed turbine location.

3.8.3 Environmental Consequences

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

The two KOPs utilized to evaluate the impact on the two historic properties within the visual APE were also utilized to evaluate the degree of contrast in the landscape between the existing landscape conditions and that of the landscape with implementation of the proposed action (see Figure 3.7-1).

The visual impacts of the turbine from KOP #1 would vary from weak to strong with a moderate cumulative impact. The symmetrical, vertical form of the wind turbine would contrast strongly with the flat, horizontal topography, and the irregular, asymmetrical form of the vegetation (see Figure 3.7-2). It would contrast strongly with the blocky, square forms of the buildings to the southwest in the foreground and background, as well as the irregular form of the levee in the foreground. The contrast would be strong with the radio towers in the foreground to the southwest, and moderate with the radio towers in the background to the west. The offset of the turbine from the highly visible radio towers in the foreground and its higher visibility than the radio towers in the background due to its larger size and the rotating blades would draw the eye of the casual observer. The regular, straight lines of the turbine would contrast strongly with the irregular, undulating lines of the vegetation, but the contrast would be weak with the strong, straight lines of the buildings in the foreground and the background. The white color of the turbine would contrast strongly with the greens, yellows and blues of the vegetation, but the contrast would be weak with the white/tan color of the levee rocks and the sand in the foreground, and the brown, white and gray colors of the buildings and towers in the foreground and background. The spikey texture of the wind turbine would contrast strongly with the smooth texture of the land and the rough, prickly texture of the

vegetation. The contrast with the bumpy and spikey texture of the buildings and radio towers would be weak. The overall visual impact from KOP #1 would be moderate and less than significant.

The visual impacts of the turbine from KOP #2 would also vary from weak to strong with a moderate cumulative impact. The position of the turbine between the radio towers, and the presence of the vertical flagpoles and utility poles in the foreground decreases the overall contrast and does not overtly draw the attention of the casual observer (see Figure 3.7-3). The vertical, symmetrical form of the turbine would contrast strongly with the flat, horizontal topography of the land and water, but the contrasts with the, vertical and symmetrical form of the palm trees in the foreground is weak. The turbine would contrast strongly with the blocky, square and polygonal forms of the building, but contrasts with the vertical forms of the communications towers in the background and the flagpoles and utility poles in the foreground would be weak. The strong vertical line of the turbine would contrast strongly with the gentle, undulating line of the levee. However, the contrast with the strong vertical lines of the communications towers in the background, and the flagpoles and utility poles in the foreground would be weak. The white color of the turbine would contrast strongly with the greens, blues, and reds of the vegetation, water, building roofs, and torpedo display. The contrast with the whites and grays of the buildings and communications towers in the background, and the flagpoles, walking paths, and seawall in the foreground would be weak. The spikey texture of the wind turbine would contrast strongly with the smooth texture of the land and water, but would contrast weakly with the bumpy texture of the buildings and the spikey texture of the communications towers, flagpoles, and palm trees. The overall visual impact from KOP #2 would be moderate and less than significant.

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

The implementation of the proposed action would not cause any shadow flicker to fall on the Reserve Center's main office building or the Reserve Center's northern auxiliary office building. However, a limited amount of shadow flicker could fall on the Reserve Center's southern auxiliary office building and the USCG Reserve's auxiliary office building; refer to Appendix C, *Shadow Flicker Analysis*, for the full results. In the worst-case scenario, in which clouds never obscure the sun, the wind is always blowing, and the wind is in line with the sun as it moves through the sky throughout the day, the southern side of the Reserve Center's southern auxiliary office building would receive no more than 52 minutes of flicker per day from 11 November through 31 January. All flicker received would be in the morning, between approximately 8:19 and 9:55. The actual occurrence of shadow flicker on the Reserve Center's southern auxiliary office building's south side, however, is expected to be minimal, if any, because the sun only shines an average of 52% of the time from November through January (National Climate Data Center 2008) and because the wind would have to simultaneously be blowing to or from the southeast or the northwest in the middle of the morning.

Similarly, in the worst case scenario, the northern and eastern sides of the USCG Reserve's auxiliary office building would receive no more than 32 minutes of flicker per day from 19 April through 24 August. All flicker received would be in the early morning, between approximately 7:06 and 7:58. The actual occurrence of shadow flicker on the USCG Reserve auxiliary office building's northern or eastern sides, however, is expected to be minimal, if any, because the sun only shines an average of 69% of the time from April through August (National Climate Data Center 2008) and because the wind would have to simultaneously be blowing to or from the northeast or the southwest in the early morning. Therefore, operation of the proposed wind turbines would not result in significant impacts to nearby 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

Galveston County has a population of 295,747, with 66.7% in the labor force, and a median income of $58,317 (U.S. Census Bureau 2012). Galveston County has a minority population of 19.9%, a population of 12.8% below the poverty level, and a population of 25.3% under the age of 18 (U.S. Census Bureau 2012).

3.9.3 Environmental Consequences

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

The proposed action 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, the proposed action 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, 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.

3.10 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_2), nitrogen dioxide (NO_2), ozone (O_3), suspended particulate matter less than or equal to 10 microns in diameter (PM_{10}), fine particulate matter less than or equal to 2.5 microns in diameter ($PM_{2.5}$), and lead (Pb). SO_2 and NO_2 are

commonly referred to and reported as oxides of sulfur (SO_x) and oxides of nitrogen (NO_x), respectively. Volatile organic compounds (VOCs) and NO_x do not have established ambient standards but are important as precursors to O_3. 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_2), methane (CH_4), and nitrous oxide (N_2O). Each GHG is assigned a global warming potential (GWP). Total GHG emissions from a source are often reported as a CO_2 equivalent (CO_2e). The CO_2e 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

The Reserve Center is located within Galveston County, and is part of Air Quality Control Region (AQCR) 216 - Metropolitan Houston-Galveston Intrastate for determining conformance with the NAAQS (USEPA 2012a). This area is in severe nonattainment for O_3, but attains the NAAQS for all other criteria pollutants. For conformity rule applicability, *de minimis* thresholds only apply to nonattainment or maintenance areas. Therefore, only project emissions of O_3 (or its precursors, VOCs and NO_x) are analyzed for conformity rule applicability.

The annual *de minimis* levels for this region are listed in Table 3.10-1. Federal actions may be exempt from conformity determinations if they do not exceed designated *de minimis* levels (40 CFR Part 1, Section 51.853[b]). There are no Class I areas within 100 km of the project area.

Table 3.10-1. *De minimis* Levels for Criteria Pollutants in the Project Area

Criteria Pollutant	*de minimis Level (tons/year)*
Volatile Organic Compounds (VOC)	25
Oxides of Nitrogen (NO_x)	25

3.10.3 Environmental Consequences

- *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 100-kW wind turbine. Consistent with the Programmatic EA for the *MARFORRES Wind Energy Program,* the construction footprint for one 100-kW turbine would be approximately 0.10 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 (Table 3.10-2) would be below conformity *de minimis* levels, even for criteria pollutants within attainment. Appendix A includes a Record of Non-Applicability (RONA) for CAA Conformity for this project (Appendix A).

Table 3.10-2. Estimated Emissions Resulting from Implementation of the Proposed Action

Estimated Construction Emissions (duration 1 month)	*Emissions (tons/year)*					
	CO	***VOCs***	***NO_x***	***SO_x***	***PM_{10}***	***$PM_{2.5}$***
One 100-kV Turbine	0.53	0.13	1.14	0.00	0.09	0.06
de minimis threshold[1]	NA	25	25	NA	NA	NA
Exceeds *de minimis* threshold?	No	No	No	No	No	No

Note: [1] Galveston County is considered a severe nonattainment area for the 8-hour O_3 NAAQS (VOCs and NO_x are precursors to the formation of O_3), and attains the NAAQS for all other criteria pollutants. NA = Not Applicable; *de minimis* thresholds do not apply to attainment areas.

Sources: 40 CFR Part 81 § 81.344 – Texas; USEPA 2012b.

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 3.10-3 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 3.10-3. Range of Energy Output under the Proposed Action

Proposed Action	*Energy Output (MWh/yr)*
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 are shown in Table 3.10-4.

Table 3.10-4. Estimated GHG Emissions under the Proposed Action

Proposed Action Scenario	*Metric Tons*[1]			
	CO_2	CH_4	N_2O	CO_2e
One 100-kW Turbine	103.33	0.01	0.10	134

Notes: [1]$CO_2e = (CO_2 * 1) + (CH_4 * 21) + (N_2O * 310)$

Compared with the estimated 7,054 million metric tons of GHG emissions from all construction in the United States in 2006 (USEPA 2012c), 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 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 1 areas?*

There are no Class I areas within 100 km of the project area; therefore, the proposed action 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

The existing utilities at this Reserve Center are owned and/or operated by Southern Union Gas (natural gas lines), CenterPoint Energy (electrical lines), AT&T Texas (telephone lines) and The City of Galveston's Public Works Department (water and sewer lines). There are no overhead power lines and no known underground utilities in the area.

3.11.3 Environmental Consequences

- *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 the proposed action, 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. Furthermore, a direct electrical connection to the Reserve Center is preferred, which would allow for only the excess power generated to reach the electrical grid and would generally occur only at night. Therefore, with implementation of the procedures discussed above, only minor 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 the proposed action, 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 Consumers Energy Company. 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.

3.12 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 project location is approximately 5.8 nautical miles from Scholes Field International Airport, which is outside of the 3.0 nautical miles limit for FAA determination of DNH. The proposed turbine location is not within line-of-sight of any air defense or next generation radar (NEXRAD) Doppler weather radar site (http://radar.weather.gov/). There is no special use airspace for military operations in the immediate vicinity.

3.12.3 Environmental Consequences

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

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 B) **[Pending]**.

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

As the project has been cleared with FAA and the turbine is of relatively low height, there would be no impacts on VFR or IFR aviation.

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

Because the proposed action is a single turbine of relatively small size and because of its relative isolation, there would be no impacts on NEXRAD operations. Furthermore, the blades are predominately fiberglass and resin, which do not create electromagnetic interference and would not affect NEXRAD operations. Similarly, the single small turbine is not expected to have any effect on other radars or the transmission or reception of television, radio, or cellular communications.

In conclusion, the proposed action would not have a significant impact on airspace.

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 project site is located on the north end of Galveston Island. The nearest potential site that may contain children is a residential area approximately 0.7 mile south. A park is located 0.6 mile west; however, it is separated from the project site by a portion of Galveston Bay. There are no other schools are parks in the immediate vicinity and the USCG Reserve's boundary is bordered by a fence. The nearest publically accessible area is the USCG Reserve Center's entrance, approximately 1,200 ft to the southwest of the proposed turbine location.

3.13.3 Environmental Consequences

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 be automatically engaged and would shut down the turbine to prevent failure. Similarly, should ice form on the blades, the sensors would detect the resulting imbalance and would shut down the turbine, eliminating the possibility of ice-throw. 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 removed from the proposed turbine location. Therefore, the public would not be exposed to health or safety hazards from the construction or operation of the proposed action.

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

According to the USEPA Enviromapper, no superfund sites occur in the immediate vicinity of the project site; however a superfund site is located approximately 0.6 mile south of the project site.

3.14.3 Environmental Consequences

- *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 Resource Conservation and Recovery Act and other applicable federal, state, and local regulations. These would include preparation of a site-specific Storm Water Pollution Prevention Plan 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?*

The superfund site located approximately 0.6 mile south of the project would not be disturbed by construction. However, 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.

3.15 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

Transportation resources near the project site consist mainly of two-lane roads. Ferry Road is located approximately 0.2 mile south of the site and is the only public road that leads to the site. This road connects to State Highway 87, a four lane road that provides direct access to Interstate 45 and a ferry terminal, both of which provide access to and from the mainland. Except for State Highway 275, a four lane road that parallels State Highway 87, all other roads in the vicinity are primarily residential. The project site is also located approximately 0.4 mile northeast of several docks (USCG and commercial), which may be used in delivering the components to the project site.

3.15.3 Environmental Consequences

- *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, which is not expected to be a problem given existing access to the Reserve Center. Construction-related traffic would amount to approximately 15 vehicles, which is negligible in relation to traffic on the surrounding highways and roads. 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 single 100-kW wind turbine at MARFORRES Center, Galveston in Galveston County, Texas, 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, Galveston (Section 4.2.2), and the existing, under construction, approved, or proposed wind energy projects within the state, neighboring counties, and Galveston County (Section 4.2.3).

4.2.1 Regional Setting

Galveston Island is approximately 45 miles southeast of Houston and is one of a string of barrier beach islands along the Texas gulf coast. The Reserve Center is located on a USCG Reserve installation at the northeast end of Galveston Island known as Fort Point. The USACE Galveston Office is also a tenant at the site.

The City of Galveston recently updated its Comprehensive Plan, available online at http://www.progressgalveston.com/sites/default/files/documents/GALV_Comp_Plan_Adopted_Final_11_1027_webres.pdf.

The 1994 Galveston Bay Plan identifies the majority of the marine areas surrounding Pelican Island and the northeast portion of Galveston Island as a polluted area with respect to shellfish fishing. Furthermore the Plan does not indicate these areas as having submerged vegetation. The best indication in the Plan of the potential for quality marine habitat in the project area is the allowance of pier fishing at Seawolf Park. The Galveston Bay Plan can be found at http://gbic.tamug.edu/GBPlan/GBPlan.html.

The northern edge of the Corps Woods Nature Sanctuary, a small wooded area, is located approximately 1,000 ft to the south of the proposed turbine location. Southeast of the project site lies the Federally-owned 605-acre Galveston East End Flats, which will likely be transferred to the City of Galveston for development sometime between 2016 and 2046 (see Section 3.2.2). Apffel Park and East Beach are located directly east of the Galveston East End Flats, the nearest portion of which is approximately 3,000 ft from the proposed turbine location. The City of Galveston was home to approximately 291,000 people in 2010 (U.S. Census Bureau 2012); the northeastern edge of the urban core lies approximately one mile to the south of the proposed project site.

Galveston beach, 1.5 miles southeast of the proposed project, is lined with four condominium towers. Two of these towers constitute the Palisade Palms Condominiums; at 27 stories tall, these are the tallest buildings in the project's vicinity and are likely the tallest buildings in Galveston. More information about the Palisade Palms can be found at http://www.palisadepalms.com/index.php.

Seawolf Park, on Pelican Island, is located approximately 3,000 ft to the west of the proposed turbine location and is home to the USS Cavalla, a World War II submarine, and the USS Stewart, a destroyer escort (http://www.galveston.com/seawolfpark/). Portions of Pelican Island are also used to dispose of dredged material. Port Bolivar, an unincorporated area in the southern portion of the Bolivar Peninsula, is located approximately 3 miles to the north, on the opposite side of the Galveston Shipping Channel. Texas City to the northwest is the nearest incorporated city outside of Galveston, located on the mainland approximately 8 miles to the northwest of the proposed turbine location.

4.2.2 Ongoing Activity at MARFORRES Center, Galveston

With the exception of the potential future transferal of the Galveston East End Flats to the City of Galveston for development sometime between 2016 and 2046 (see Section 3.2.2), no major development projects or changes in operations at the MARFORRES Center or the USCG Reserve Center are planned at this time. [**To be confirmed.]**

4.2.3 Other Wind Energy Projects within Texas

With 10,929 MW of operational wind turbines spanning at least 39 counties, Texas is home to more than one fifth (21.2%) of all installed wind energy capacity in the United States and is continuing to rapidly develop new capacity, particularly in its northwestern area (American Wind Energy Association [AWEA] 2012a, Wind Today 2011). One goal of the Texas Public Utility Commission is to eventually transmit 18,500 MW of wind power from northwest Texas to population centers in southeast Texas (Public Utility Commission of Texas 2012). Within the state, 1,573 MW and 22,239 MW of new generating capacity are currently under construction or in queue, respectively (AWEA 2012b). Much of this rapid development is attributed to Texas's vast wind resources, which are estimated at more than 1.9 million MW at 80 m; the 1999 passage of Senate Bill 7 that created the state's first Renewable Portfolio Standard; and the use of Renewable Energy Credits (Texas State Energy Conservation Office 2012, AWEA 2012a). Notably, Texas met its 2025 goal of 10,000 MW generation capacity for all renewable power sources in 2010.

While most of this development is in Texas's western half, particularly within the southern portion of the Texas pan-handle, there are considerable wind resources along Texas's Gulf coast. Importantly, unlike the panhandle's winds, the coast's winds generally rise in the afternoon when the electricity is needed most (ERCOT 2006). These resources, combined with Texas's unique political status as the only state with the ability to develop offshore out to 10.3 miles without approval from the US Department of the Interior, make on- and off-shore wind energy development in Texas's Gulf coast particularly attractive. The area with the greatest average offshore wind speeds is the area east of the barrier islands between Corpus Christi and Port Isabel, more than 100 miles south and southwest of the proposed project. Table 4-1 summarizes the status of the ten existing or proposed gulf coast wind projects.

Since 2005, the Public Utility Commission of Texas has worked to identify and develop Competitive Renewable Energy Zones, or geographic areas with optimal conditions for the economic development of wind power generation facilities, and associated transmission lines. One initial zone encompassed much of the Texas coastline and was selected for initial analysis, although it did not include any portion of Galveston County or its neighboring counties and ultimately was not carried forward as part of the current planning process (ERCOT 2006, Public Utility Commission of Texas 2012).

Table 4-1. Status of Texas Gulf Coast Wind Energy Projects

Project Name	On/Off-Shore	Size (MW)	Approximate Distance from Proposed Project	Status
Galveston Offshore Wind (Phases I and II)	Off	300	9 miles South	Approved by Texas General Land Office, requires additional NEPA review and permitting by USACE
Jefferson Offshore Wind	Off	300	50 miles Northeast	Proposed
Brazoria Offshore Wind	Off	500	50 miles Southwest	Proposed
Corpus Christi Offshore Wind	Off	500	130 miles Southwest	Proposed
Brownsville Offshore Wind	Off	500	250 miles Southwest	Proposed
Mustang	Off	1,200	180 miles Southwest	Approved by Texas General Land Office, requires additional NEPA review and permitting by USACE
Rio Grande (North and South)	Off	2,000	250 miles Southwest	Approved by Texas General Land Office, requires additional NEPA review and permitting by USACE
Papalote Creek Wind Farm (Phases I and II)	On	380	180 miles southwest	Existing
Penascal Wind Farm	On	201.6	220 miles southwest	Existing
Gulf Wind Project	On	283.2	240 miles southwest	Existing

Sources: Texas General Land Office 2010, U.S. Offshore Wind Collaborative 2010, Coastal Point Energy 2012, Baryonyx Corporation 2012, San Patricio Municipal Water District 2011.

4.3 RESOURCE SPECIFIC IMPACTS

4.3.1 Land Use

Land use impacts from the proposed action would be relatively small (approximately 0.10 acre permanent; there would be no additional temporary construction footprint) within the boundaries of the Reserve Center, would not adversely impact the facility's mission or essential activities, and would be insignificant. Since the proposed project would be completed well before 2016, the earliest possible date that the East End Flats ownership could be transferred to the City of Galveston, any potential land use impacts from implementation of the proposed project would be understood well before land ownership is transferred, and with a 161% setback from the nearest edge of the 605-acre East End Flats, no potential land use impact is expected. Development of the site would have no potential to affect other public or private lands or activities, and other 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 for a cumulative impact to land use.

4.3.2 Noise

Since the proposed project would be completed well before 2016, the earliest possible date that the East End Flats ownership could be transferred to the City of Galveston, any potential noise from the implementation of the proposed project would be understood well before land ownership is transferred. However, the noise level at the northwest corner of the 605-acre East End Flats, the nearest corner of which is located 250 ft southeast of the proposed turbine location, would respectively be 48, 51, and 58 dBA with 13.4, 18, and 29 mph wind. As such, noise levels at the northwest corner of the flats would be well below the maximum normally acceptable L_{dn} of 75 dBA for office buildings and 65 dBA for residential or recreational areas (Figure 3.3-1 in MARFORRES 2011). Based on the minimal impacts of the proposed action on noise (Section 3.3), the previous level of development in and around Galveston, 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. As a result, the effect on local water resources would be negligible or minor, with minor cumulative impacts.

4.3.5 Biological Resources

The scale of existing and proposed wind energy development along the Texas coast and in the offshore waters, potentially amounting to thousands of large (> 1 MW) turbines, indicates the potential for cumulative impacts on migratory birds and bats. Given the number and size of turbines, the numbers of bird and bat fatalities associated with the proposed wind farms would be 3-4 orders of magnitude greater than those of the proposed MARFORRES wind energy project, with a corresponding potential for cumulative effects on populations of migratory birds and bats, including species of concern. Most projects are still undergoing review, including analyses of project-specific and cumulative impacts, and projects may be modified or required to mitigate (avoid, reduce, or compensate) these impacts. As a result, it is speculative to assume that these levels of mortality and population-level effects would occur.

The incremental effects of the proposed action on habitats and species (Section 3.6), would be minuscule in comparison to those of a large wind farm, and as a result, would be unlikely to have an adverse cumulative impact. Species of concern, whose populations are already low, would be most vulnerable to cumulative impacts, but as noted in Section 3.6, the proposed action would have negligible effects on these species and hence would not contribute to cumulative impacts. It is likely that individuals of the same species would be impacted by wind energy or other projects elsewhere within the region, but the proportional effect of the proposed action would be very small. 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

The proposed action would not have a significant cumulative impact on the cultural resources of the area. While the turbine and its associated facilities would be located within the boundaries of the Old Fort San Jacinto archaeological site, the site is covered by 10 feet of highly disturbed, dredged soils and testing of nearby areas indicates a highly disturbed condition to the soils present. The impacts from the proposed action are therefore unlikely to disturb any intact cultural remains on this archaeological site, and would by extension have no impact on the larger archaeological record of the region.

The proposed wind turbine would be visible from two historic properties located within 1 mile of it. While the proposed action would be visible from the Galveston Seawall historic site, it is largely obscured by existing vegetation and radar facilities from the only publicly accessible location along its extent. The proposed action is highly visible from the USS Stewart at Sea Wolf Park located across the channel from the proposed location. However, the setting for this NRHP listed Naval Destroyer has already been impacted by the numerous existing features on the landscape, and the proposed action would not diminish it further. The proposed action would therefore not have a significant cumulative impact upon these two historic properties.

4.3.7 Visual Resources

The proposed action would not have a significant impact on the visual resources of the area. While contrasts with the surrounding terrain and vegetation are strong to moderate, the contrasts to the existing built landscape are only moderate and the net cumulative impact upon the existing landscape would be moderate and less than significant. Although no significant shadow flicker impact to the future Galveston East End Flats development is expected, any potential impact could be minimized during the East End Flats development process. For example, development plans could include strategically placed trees. Therefore, cumulative visual resource impacts would be less than 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 discussed in Section 4.2.3. 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.

EO 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 16 October 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 22 January 2010 the DoN and the Department of Agriculture signed a Memorandum of Understanding 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 Consumers Energy Company. This coordination with the local utility provider 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 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 MARFORRES Center, Galveston, minimizes the potential for impacts consistent with the Programmatic EA (MARFORRES 2011). BMPs as presented in Section 2.3 further reduce the potential short-term impacts of construction.

CHAPTER 6
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CHAPTER 7
PERSONS AND AGENCIES CONTACTED

Kate Zultner, Planning & Policy Coordinator, Texas General Land Office

Others to be added (wildlife agency contacts by Bird & Bat Study Team)

CHAPTER 8
PREPARERS

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

Project Oversight: NAVFAC ESC

Kevin Frantz, Project Oversight

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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

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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, Galveston, 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.

Galveston, TX is located within Galveston County, and is part of AQCR 216 - Metropolitan Houston-Galveston Intrastate. This area is in severe nonattainment for ozone (O_3), but attains the NAAQS for all other criteria pollutants. For conformity rule applicability, *de minimis* thresholds only apply to nonattainment or maintenance areas. Therefore, only project emissions of O_3 (or its precursors, volatile organic compounds [VOCs] and oxides of nitrogen [NO_x]) are analyzed for conformity rule applicability.

The annual *de minimis* levels for this region are listed in Table 1. Federal actions may be exempt from conformity determinations if they do not exceed designated *de minimis* levels (40 CFR Part 1, Section 51.853[b]).

Table 1. *De minimis* Levels for Criteria Pollutants in the Project Area

Criteria Pollutant	*de minimis* Level (tons/year)
Volatile Organic Compounds (VOC)	100
Oxides of Nitrogen (NO_x)	100

PROPOSED ACTION

Action Proponent: United States Marine Corps Forces Reserve

Location: Marine Forces Reserve Center, Galveston, TX

Proposed Action Name: United States Marine Corps Forces Reserve Wind Energy Program Site: Marine Forces Reserve Center, Galveston, 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, Galveston, 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 0.10 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 2. 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 2. Estimated Emissions Resulting from Implementation of the Proposed Action

Estimated Construction Emissions (duration 1 month)	***Emissions (tons/year)***					
	CO	***VOCs***	***NO_x***	***SO_x***	***PM_{10}***	***$PM_{2.5}$***
One 100-kV Turbine	0.53	0.13	1.14	0.00	0.09	0.06
de minimis threshold[1]	NA	25	25	NA	NA	NA
Exceeds *de minimis* threshold?	No	No	No	No	No	No

Note: [1] Galveston County is considered a severe nonattainment area for the 8-hour O_3 NAAQS (VOCs and NO_x are precursors to the formation of O_3), and attains the NAAQS for all other 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. The typical energy output under the proposed action would range from 88 to 440 megawatt-hours per year, 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).

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 216 - Metropolitan Houston-Galveston Intrastate, Galveston County

Date RONA prepared: 26 November 2012

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

ATTAINMENT AREA STATUS AND EMISSIONS EVALUATION CONCLUSION

Galveston County is a severe nonattainment area for the O_3 NAAQS; VOCs and NO_x are precursors to the formation of O_3, and attains the NAAQS for all other criteria pollutants. The United States Marine Corps Forces Reserve concludes that *de minimis* thresholds for applicable 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 2, 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.

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

SMALL TURBINE: CONSTRUCTION EMISSIONS SUMMARY

Emissions	Emissions (tons)							
	CO	**VOC**	**NO_X**	**SO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**
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_2	**CH_4**	**N_20**	**CO_{2e}**
One Small Turbine	103.33	0.01	0.10	134

Notes:

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

N_20 = NOx * 0.095

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

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	Hrs/day	Months	Emissions, lbs/day								Emissions, tons/year							
Equipment				CO	VOC	NOx	SOx	PM10	PM2.5	CO2	CH4				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
												TOTAL for 1 Small Turbine			**30.81**	**8.75**	**71.82**	**0.07**	**4.02**	**3.58**	**6469.49**	**0.78**	**0.40**	**0.11**	**0.93**	**0.00**	**0.05**	**0.05**	**84.10**	**0.01**

Small Turbine

Proj. Construction Trucks	No. of Trucks	Speed (mph)	VMT (mi/vehicle-day)	CO Running Exhaust (g/mi)	NO_X Running Exhaust (g/mi)	VOC Running Exhaust (g/mi)	SOx Running Exhaust (g/mi)	PM10 Running Exhaust (g/mi)	PM10 Tire Wear (g/mi)	PM10 Brake Wear (g/mi)	PM2.5 Running Exhaust (g/mi)	PM2.5 Tire Wear (g/mi)	PM2.5 Brake Wear (g/mi)	CO2 Running Exhaust (g/mi)	CH4 Running Exhaust (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

Emissions, lbs/day								Emissions, tons/year							
CO	NOx	VOCs	SOx	PM10	PM2.5	CO2	CH4	CO	NOx	VOCs	SOx	PM10	PM2.5	CO2	CH4
5.56	**15.18**	**1.11**	**0.02**	**0.69**	**0.60**	**1757.24**	**0.05**	**0.07**	**0.20**	**0.01**	**0.00**	**0.01**	**0.01**	**22.84**	**0.00**
						Total 1 Small Turbine =		**0.07**	**0.20**	**0.01**	**0.00**	**0.01**	**0.01**	**22.84**	**0.00**

Unpaved Road Emissions		**PM10**	**PM2.5**
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
1 Small Turbine (emissions, tons/year) =		**0.03**	**0.00**

Small Turbine

Vehicle Class	No. POVs	Speed (mph)	VMT (mi/vehicle day)	CO		NO_X		VOCs					
				Running Exhaust (g/mi)	Start-Up (g/start)[a]	Running Exhaust (g/mi)	Start-Up (g/start)[a]	Running Exhaust (g/mi)	Start-Up (g/start)[a]	Hot-Soak (g/trip)	Resting Loss (g/hr)	Running Evaporative (g/mi)	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	SOx		PM10				PM2.5				CO2		CH4	
	Running Exhaust (g/mi)	Start-Up (g/start)[a]	Running Exhaust (g/mi)	Start-Up (g/start)[a]	Tire Wear (g/mi)	Brake Wear (g/mi)	Running Exhaust (g/mi)	Start-Up (g/start)[a]	Tire Wear (g/mi)	Brake Wear (g/mi)	Running Exhaust (g/mi)	Start-Up (g/start)[a]	Running Exhaust (g/mi)	Start-Up (g/start)[a]
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	NOx	VOCs	SOx	PM10	PM2.5	CO2	CH4	CO	NOx	VOCs	SOx	PM10	PM2.5	CO2	CH4
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**	**6.96**	**0.00**
Total 1 Small Turbine =								**0.06**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**6.96**	**0.00**

APPENDIX B
CORRESPONDENCE

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. 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	PROJECT CITY	PROJECT ZIP CODE(S)
Marine Corps Reserve Center	Galveston	77550

PROJECT COUNTY OR COUNTIES
Galveston

PROJECT TYPE (Check all that apply)

- ☐ Road/Highway Construction or Improvement
- ☐ Site Excavation
- ☒ Utilities & Infrastructure
- ☐ New Construction
- ☐ Repair, Rehabilitation or Renovation of Structure(s)
- ☐ Addition to Existing Structure(s)
- ☐ Demolition or Relocation of Existing Structure(s)
- ☐ 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 one 100 kilowatt wind turbine (155 feet total height) and the associated foundation, access road, and electrical infrastructure for the operation of the wind turbine.

2. Project Contact Information

PROJECT CONTACT NAME	TITLE	ORGANIZATION
Alain Flexer	Energy Manager	MARFORRES

ADDRESS	CITY	STATE	ZIP
2000 Opelousas Ave., Bldg. 1, Rm. 2W4700	New Orleans	LA	70146-5400

PHONE	EMAIL
(504) 697-9571	alain.flexer.ctr@usmc.mil

For SHPO Use Only — **Date Stamp Below:**

Track Review to:

☐ Archeology Division: Reviewer:

☐ History Programs Division: Reviewer:

☐ Architecture Division: Reviewer:

NO ADVERSE EFFECT
On National Register-eligible or listed properties
PROJECT MAY PROCEED
by A. Elizabeth Brummett
for Mark Wolfe
State Historic Preservation Officer
Date 11/19/2012

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

Aeronautical Study No.
2010-WTW-13656-OE

Issued Date: 11/04/2010

Alain D. 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 Marines WTG1
Location:	Galveston, TX
Latitude:	29-20-05.93N NAD 83
Longitude:	94-45-56.50W
Heights:	414 feet above ground level (AGL)
	434 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:

As a condition to this Determination, the structure is marked and/or lighted in accordance with FAA Advisory circular 70/7460-1 K Change 2, Obstruction Marking and Lighting, white paint/synchronized red lights - Chapters 4,12&13(Turbines).

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)
__X__ Within 5 days after the construction reaches its greatest height (7460-2, Part II)

This determination expires on 05/04/2012 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 (847) 294-7520. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2010-WTW-13656-OE.

Signature Control No: 131395419-132868511 (DNE -WT)
Brenda Mumper
Specialist

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

Aeronautical Study No.
2010-WTW-13657-OE

Issued Date: 11/04/2010

Alain D. 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 Coast Guard WTG2
Location:	Galveston, TX
Latitude:	29-19-55.84N NAD 83
Longitude:	94-46-06.60W
Heights:	414 feet above ground level (AGL)
	434 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:

As a condition to this Determination, the structure is marked and/or lighted in accordance with FAA Advisory circular 70/7460-1 K Change 2, Obstruction Marking and Lighting, white paint/synchronized red lights - Chapters 4,12&13(Turbines).

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)
__X__ Within 5 days after the construction reaches its greatest height (7460-2, Part II)

This determination expires on 05/04/2012 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 (847) 294-7520. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2010-WTW-13657-OE.

Signature Control No: 131395421-132868665 (DNE -WT)
Brenda Mumper
Specialist

APPENDIX C
SHADOW FLICKER ANALYSIS

Project:
Galveston

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Licensed user:
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5101
Chris Noddings / Chris.Noddings@cardnotec.com

Calculated:
10/16/2012 3:49 PM/2.8.552

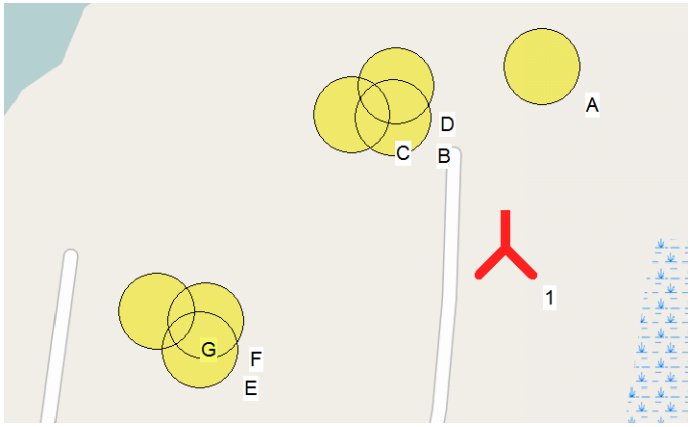
SHADOW - Main Result

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



Scale 1:4,000
New WTG Shadow receptor

WTGs

	Geo [deg,min,sec]-WGS84				WTG type							Shadow data	
	Longitude	Latitude	Z [m]	Row data/Description	Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM [RPM]
1	-94°46'05.22" West	29°20'03.89" North	0.0	Wind Turbine	Yes	Nothern Power	Northwind 100-100	100	21.0	36.9	370	59.0

Shadow receptor-Input

No.	Geo [deg,min,sec]-WGS84 Longitude	Latitude	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
A	-94°46'04.51" West	29°20'06.97" North	0.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
B	-94°46'07.43" West	29°20'06.10" North	0.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
C	-94°46'08.23" West	29°20'06.16" North	0.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
D	-94°46'07.37" West	29°20'06.65" North	0.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
E	-94°46'11.22" West	29°20'02.14" North	0.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
F	-94°46'11.11" West	29°20'02.64" North	0.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
G	-94°46'12.06" West	29°20'02.79" North	0.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

Shadow, worst case

No.	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]
A	0:00	0	0:00
B	46:10	66	0:52
C	57:26	82	0:49
D	0:00	0	0:00
E	36:56	82	0:31
F	25:16	62	0:32
G	15:16	43	0:28

Project:
Galveston

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Calculated:
10/16/2012 3:49 PM/2.8.552

SHADOW - Main Result

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

No.	Name	Worst case [h/year]	Expected [h/year]
1	Wind Turbine	152:41	

Project:
Galveston

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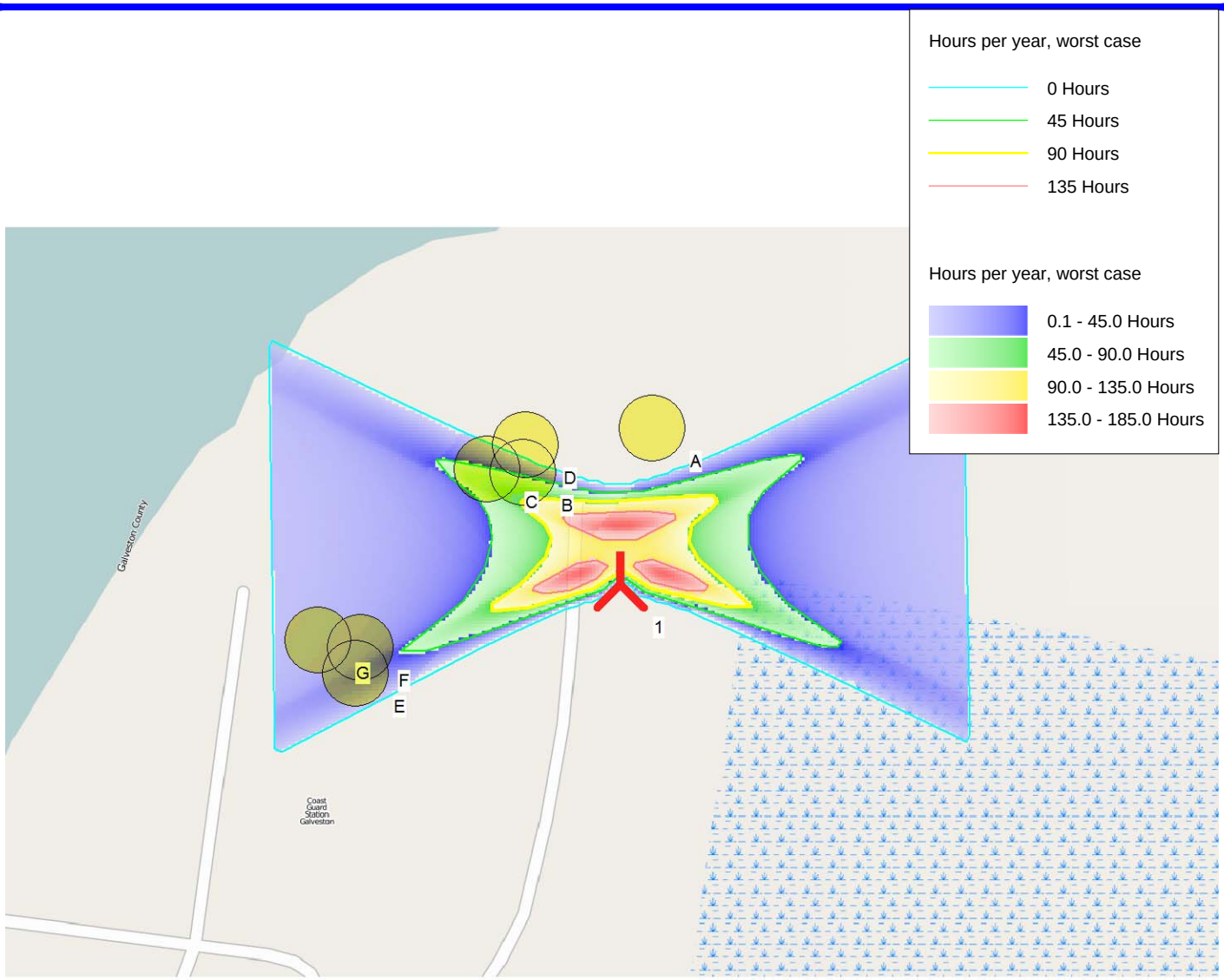
Calculated:
10/16/2012 3:49 PM/2.8.552

SHADOW - Map



0 50 100 150 200 m

Map: WindPRO map , Print scale 1:4,000, Map center Geo WGS84 West: -94°46'05.24" West North: 29°20'03.87" North

New WTG Shadow receptor

Flicker map level: 0 m above sea level

Project:
Galveston

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Calculated:
10/16/2012 3:49 PM/2.8.552

SHADOW - Calendar per WTG

WTG: 1 - Wind Turbine

Assumptions for shadow calculations

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
1	07:14 08:32-09:21/49 17:32 09:21-09:54/33	07:09 17:57	06:46 18:18	07:10 19:37	06:38 07:20-07:46/26 19:55	06:21 07:06-07:37/31 20:14
2	07:14 08:32-09:21/49 17:33 09:21-09:54/33	07:09 17:58	06:45 18:19	07:09 19:38	06:37 07:20-07:45/25 19:56	06:20 07:07-07:37/30 20:14
3	07:14 08:33-09:22/49 17:34 09:22-09:55/33	07:08 17:59	06:44 18:19	07:08 19:38	06:37 07:19-07:45/26 19:56 07:45-07:46/1	06:20 07:07-07:37/30 20:15
4	07:15 08:34-09:23/49 17:34 09:23-09:54/31	07:07 18:00	06:43 18:20	07:07 19:39	06:36 07:19-07:45/26 19:57 07:45-07:47/2	06:20 07:07-07:38/31 20:15
5	07:15 08:34-09:23/49 17:35 09:23-09:54/31	07:07 18:00	06:42 18:21	07:05 19:39	06:35 07:18-07:44/26 19:57 07:44-07:47/3	06:20 07:08-07:38/30 20:16
6	07:15 08:34-09:23/49 17:36 09:23-09:54/31	07:06 18:01	06:40 18:21	07:04 19:40	06:34 07:17-07:43/26 19:58 07:43-07:47/4	06:20 07:08-07:38/30 20:16
7	07:15 08:35-09:24/49 17:37 09:24-09:54/30	07:06 18:02	06:39 18:22	07:03 19:41	06:33 07:17-07:42/25 19:59 07:42-07:47/5	06:20 07:08-07:38/30 20:17
8	07:15 08:35-09:24/49 17:37 09:24-09:54/30	07:05 18:02	07:38 18:23	07:02 19:41	06:33 07:17-07:41/24 19:59 07:41-07:48/7	06:20 07:09-07:38/29 20:17
9	07:15 08:36-09:24/48 17:38 09:24-09:54/30	07:04 18:03	07:37 19:23	07:01 19:42	06:32 07:16-07:38/22 20:00 07:38-07:48/10	06:19 07:09-07:38/29 20:18
10	07:15 08:36-09:24/48 17:39 09:24-09:54/30	07:03 18:04	07:36 19:24	07:00 19:42	06:31 07:16-07:47/31 20:01	06:19 07:10-07:38/28 20:18
11	07:15 08:37-09:25/48 17:40 09:25-09:54/29	07:03 18:05	07:35 19:25	06:59 19:43	06:30 07:16-07:48/32 20:01	06:19 07:10-07:38/28 20:19
12	07:15 08:37-09:25/48 17:41 09:25-09:53/28	07:02 18:06	07:34 19:25	06:58 19:43	06:30 07:16-07:47/31 20:02	06:19 07:10-07:38/28 20:19
13	07:15 08:38-09:25/47 17:41 09:25-09:53/28	07:01 18:06	07:33 19:26	06:56 19:44	06:29 07:14-07:47/33 20:02	06:19 07:10-07:38/28 20:19
14	07:15 08:38-09:25/47 17:42 09:25-09:53/28	07:00 18:07	07:31 19:26	06:55 19:45	06:28 07:13-07:47/34 20:03	06:20 07:11-07:38/27 20:20
15	07:15 08:39-09:25/46 17:43 09:25-09:52/27	06:59 18:08	07:30 19:27	06:54 19:45	06:28 07:11-07:46/35 20:04	06:20 07:11-07:38/27 20:20
16	07:15 08:39-09:25/46 17:44 09:25-09:51/26	06:58 18:09	07:29 19:28	06:53 19:46	06:27 07:11-07:47/36 20:04	06:20 07:11-07:38/27 20:20
17	07:15 08:40-09:25/45 17:45 09:25-09:50/25	06:58 18:09	07:28 19:28	06:52 19:46	06:27 07:09-07:46/37 20:05	06:20 07:11-07:38/27 20:21
18	07:15 08:41-09:25/44 17:46 09:25-09:49/24	06:57 18:10	07:27 19:29	06:51 19:47	06:26 07:08-07:45/37 20:06	06:20 07:11-07:38/27 20:21
19	07:14 08:42-09:25/43 17:46 09:25-09:48/23	06:56 18:11	07:26 19:29	06:50 07:29-07:40/11 19:48	06:26 07:08-07:45/37 20:06	06:20 07:11-07:38/27 20:21
20	07:14 08:43-09:25/42 17:47 09:25-09:47/22	06:55 18:12	07:24 19:30	06:49 07:27-07:43/16 19:48	06:25 07:08-07:44/36 20:07	06:20 07:12-07:39/27 20:22
21	07:14 08:43-09:23/40 17:48 09:24-09:45/21	06:54 18:12	07:23 19:31	06:48 07:25-07:44/19 19:49	06:25 07:07-07:44/37 20:07	06:20 07:13-07:39/26 20:22
22	07:14 08:44-09:22/38 17:49 09:27-09:43/16	06:53 18:13	07:22 19:31	06:47 07:24-07:45/21 19:49	06:24 07:07-07:43/36 20:08	06:21 07:12-07:39/27 20:22
23	07:13 08:45-09:22/37 17:50 09:31-09:40/9	06:52 18:14	07:21 19:32	06:46 07:23-07:46/23 19:50	06:24 07:06-07:42/36 20:09	06:21 07:12-07:39/27 20:22
24	07:13 08:46-09:21/35 17:51	06:51 18:15	07:20 19:32	06:45 07:22-07:46/24 19:51	06:23 07:07-07:42/35 20:09	06:21 07:13-07:40/27 20:22
25	07:13 08:48-09:20/32 17:52	06:50 18:15	07:18 19:33	06:44 07:22-07:48/26 19:51	06:23 07:06-07:40/34 20:10	06:21 07:13-07:40/27 20:23
26	07:12 08:48-09:19/31 17:52	06:49 18:16	07:17 19:34	06:43 07:21-07:48/27 19:52	06:22 07:06-07:39/33 20:10	06:22 07:13-07:40/27 20:23
27	07:12 08:50-09:18/28 17:53	06:48 18:17	07:16 19:34	06:42 07:21-07:48/27 19:52	06:22 07:06-07:38/32 20:11	06:22 07:13-07:40/27 20:23
28	07:11 08:51-09:17/26 17:54	06:47 18:17	07:15 19:35	06:41 07:20-07:48/28 19:53	06:22 07:06-07:36/30 20:12 07:36-07:37/1	06:22 07:14-07:41/27 20:23
29	07:11 08:54-09:15/21 17:55		07:14 19:35	06:40 07:20-07:47/27 19:54	06:21 07:06-07:37/31 20:12	06:23 07:14-07:41/27 20:23
30	07:10 08:55-09:13/18 17:56		07:12 19:36	06:39 07:20-07:47/27 19:54	06:21 07:06-07:37/31 20:13	06:23 07:13-07:41/28 20:23
31	07:10 08:59-09:10/11 17:57		07:11 19:36		06:21 07:07-07:38/31 20:13	
Potential sun hours	326	312	371	386	422	420
Sum of minutes with flicker	1879	0	0	276	1004	841

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

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

Project:
Galveston

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Chris Noddings / Chris.Noddings@cardnotec.com

Calculated:
10/16/2012 3:49 PM/2.8.552

SHADOW - Calendar per WTG

WTG: 1 - Wind Turbine

Assumptions for shadow calculations

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

	July	August	September	October	November	December
1	06:23 07:14-07:42/28 20:23	06:39 07:27-07:58/31 20:13	06:57 19:43	07:12 19:07	06:32 17:34	06:56 08:19-09:07/48 17:21 09:07-09:36/29
2	06:24 07:14-07:42/28 20:23	06:40 07:26-07:58/32 20:12	06:57 19:42	07:13 19:06	06:33 17:33	06:57 08:19-09:07/48 17:21 09:07-09:37/30
3	06:24 07:14-07:43/29 20:23	06:41 07:27-07:46/19 20:11 07:46-07:58/12	06:58 19:41	07:13 19:05	06:34 17:32	06:57 08:20-09:08/48 17:21 09:08-09:38/30
4	06:25 07:14-07:43/29 20:23	06:41 07:26-07:49/23 20:11 07:49-07:57/8	06:58 19:40	07:14 19:04	06:34 17:32	06:58 08:19-09:08/49 17:21 09:08-09:38/30
5	06:25 07:14-07:43/29 20:23	06:42 07:27-07:51/24 20:10 07:51-07:58/7	06:59 19:39	07:15 19:02	06:35 17:31	06:59 08:20-09:09/49 17:21 09:09-09:39/30
6	06:25 07:14-07:44/30 20:23	06:42 07:26-07:52/26 20:09 07:52-07:57/5	06:59 19:38	07:15 19:01	06:36 17:30	07:00 08:20-09:09/49 17:21 09:09-09:40/31
7	06:26 07:14-07:44/30 20:23	06:43 07:27-07:53/26 20:08 07:53-07:57/4	07:00 19:36	07:16 19:00	06:37 17:30	07:01 08:21-09:10/49 17:21 09:10-09:41/31
8	06:26 07:15-07:45/30 20:23	06:43 07:28-07:54/26 20:08 07:54-07:57/3	07:00 19:35	07:16 18:58	06:37 17:29	07:01 08:21-09:10/49 17:21 09:10-09:41/31
9	06:27 07:14-07:45/31 20:23	06:44 07:28-07:54/26 20:07 07:54-07:56/2	07:01 19:34	07:17 18:57	06:38 17:28	07:02 08:21-09:11/50 17:21 09:11-09:43/32
10	06:27 07:15-07:45/30 20:22	06:45 07:29-07:55/26 20:06	07:01 19:33	07:18 18:56	06:39 17:28	07:03 08:22-09:11/49 17:22 09:11-09:44/33
11	06:28 07:14-07:45/31 20:22	06:45 07:29-07:54/25 20:05	07:02 19:32	07:18 18:54	06:40 08:30-08:41/11 17:27	07:03 08:22-09:11/49 17:22 09:11-09:44/33
12	06:28 07:15-07:46/31 20:22	06:46 07:28-07:55/27 20:04	07:02 19:30	07:19 18:53	06:41 08:27-08:45/18 17:27	07:04 08:23-09:12/49 17:22 09:12-09:45/33
13	06:29 07:15-07:46/31 20:22	06:46 07:28-07:55/27 20:03	07:03 19:29	07:19 18:52	06:41 08:25-08:48/23 17:26	07:05 08:24-09:13/49 17:22 09:13-09:46/33
14	06:29 07:15-07:46/31 20:22	06:47 07:28-07:55/27 20:02	07:03 19:28	07:20 18:51	06:42 08:24-08:50/26 17:25	07:05 08:23-09:12/49 17:23 09:12-09:46/34
15	06:30 07:15-07:46/31 20:21	06:47 07:27-07:54/27 20:01	07:04 19:27	07:21 18:50	06:43 08:23-08:51/28 17:25	07:06 08:24-09:13/49 17:23 09:13-09:47/34
16	06:30 07:16-07:46/30 20:21	06:48 07:28-07:55/27 20:00	07:04 19:26	07:21 18:49	06:44 08:21-08:52/31 17:25	07:07 08:25-09:14/49 17:23 09:14-09:47/33
17	06:31 07:15-07:48/33 20:21	06:49 07:27-07:54/27 19:59	07:05 19:24	07:22 18:48	06:45 08:21-08:53/32 17:24	07:07 08:25-09:14/49 17:24 09:14-09:47/33
18	06:31 07:16-07:50/34 20:20	06:49 07:28-07:54/26 19:58	07:05 19:23	07:22 18:47	06:45 08:20-08:55/35 17:24	07:08 08:26-09:15/49 17:24 09:15-09:48/33
19	06:32 07:16-07:50/34 20:20	06:50 07:29-07:53/24 19:57	07:06 19:22	07:23 18:46	06:46 08:19-08:56/37 17:23 09:05-09:14/9	07:08 08:26-09:15/49 17:25 09:15-09:48/33
20	06:32 07:16-07:52/36 20:19	06:50 07:29-07:52/23 19:56	07:07 19:21	07:24 18:45	06:47 08:19-08:57/38 17:23 09:02-09:18/16	07:09 08:27-09:16/49 17:25 09:16-09:49/33
21	06:33 07:16-07:52/36 20:19	06:51 07:30-07:51/21 19:55	07:07 19:19	07:24 18:44	06:48 08:19-08:59/40 17:23 09:00-09:21/21	07:09 08:27-09:16/49 17:25 09:16-09:49/33
22	06:34 07:17-07:53/36 20:19	06:51 07:30-07:49/19 19:54	07:08 19:18	07:25 18:43	06:49 08:19-09:01/42 17:22 09:01-09:23/22	07:10 08:28-09:17/49 17:26 09:17-09:50/33
23	06:34 07:17-07:54/37 20:18	06:52 07:32-07:47/15 19:53	07:08 19:17	07:26 18:42	06:49 08:18-09:01/43 17:22 09:01-09:24/23	07:10 08:28-09:17/49 17:26 09:17-09:50/33
24	06:35 07:18-07:55/37 20:18	06:52 07:34-07:44/10 19:52	07:09 19:16	07:26 18:41	06:50 08:18-09:02/44 17:22 09:02-09:26/24	07:11 08:29-09:18/49 17:27 09:18-09:51/33
25	06:35 07:19-07:56/37 20:17	06:53 19:51	07:09 19:15	07:27 18:40	06:51 08:18-09:03/45 17:22 09:03-09:28/25	07:11 08:29-09:18/49 17:28 09:18-09:51/33
26	06:36 07:19-07:56/37 20:17	06:54 19:50	07:10 19:13	07:28 18:39	06:52 08:18-09:04/46 17:21 09:04-09:30/26	07:12 08:29-09:18/49 17:28 09:18-09:51/33
27	06:36 07:20-07:57/37 20:16	06:54 19:49	07:10 19:12	07:28 18:38	06:53 08:18-09:04/46 17:21 09:04-09:31/27	07:12 08:30-09:19/49 17:29 09:19-09:52/33
28	06:37 07:21-07:57/36 20:15	06:55 19:48	07:11 19:11	07:29 18:37	06:54 08:18-09:05/47 17:21 09:05-09:33/28	07:13 08:30-09:19/49 17:29 09:19-09:52/33
29	06:38 07:22-07:57/35 20:15	06:55 19:47	07:11 19:10	07:30 18:36	06:54 08:18-09:05/47 17:21 09:05-09:33/28	07:13 08:30-09:19/49 17:30 09:19-09:53/34
30	06:38 07:23-07:57/34 20:14	06:56 19:46	07:12 19:08	07:31 18:36	06:55 08:18-09:06/48 17:21 09:06-09:34/28	07:13 08:31-09:21/50 17:31 09:21-09:54/33
31	06:39 07:25-07:58/33 20:14	06:56 19:45		07:31 18:35		07:14 08:32-09:21/49 17:31 09:21-09:54/33
Potential sun hours	429	409	371	356	321	319
Sum of minutes with flicker	1011	625	0	0	1004	2521

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:
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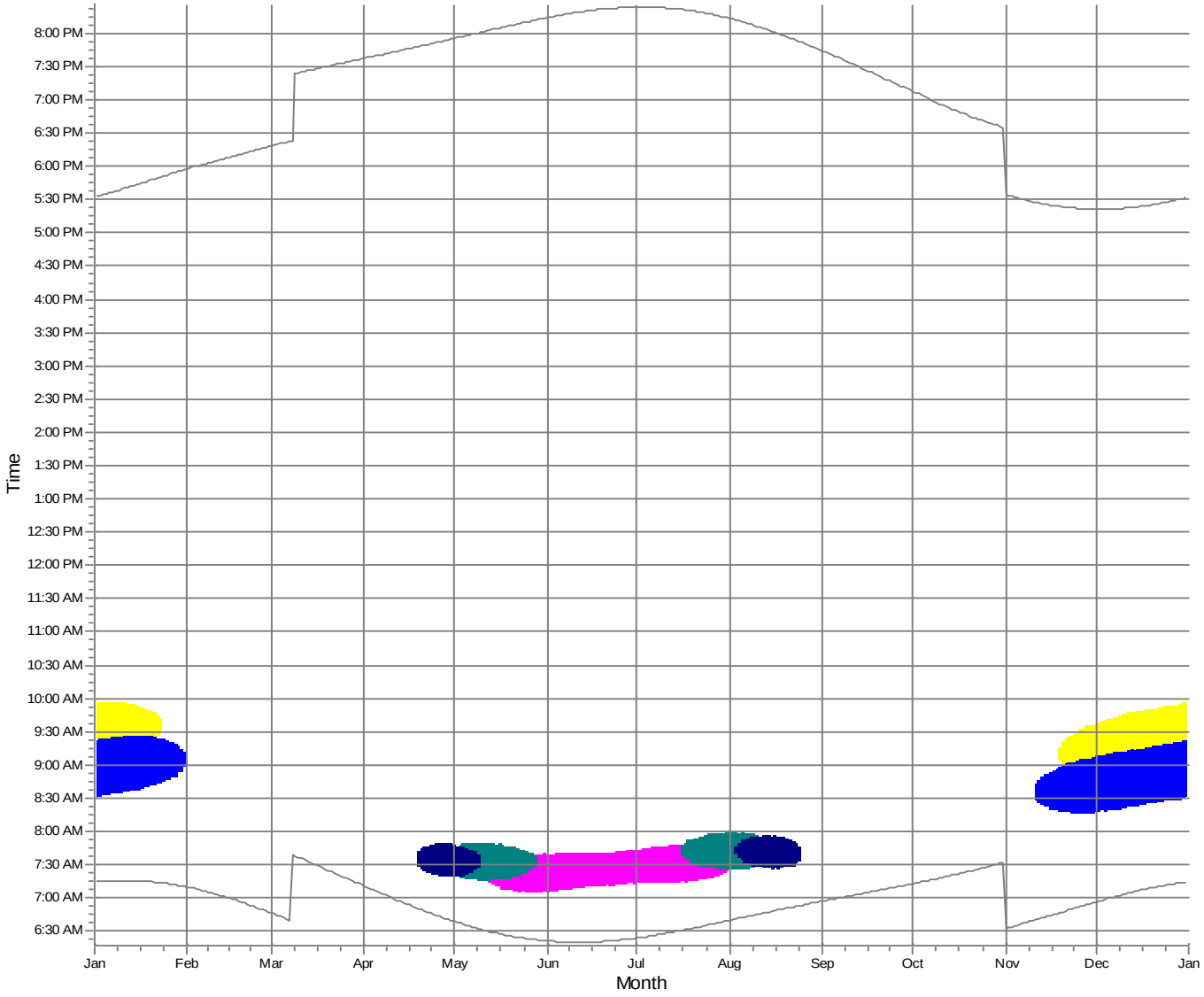
Calculated:
10/16/2012 3:49 PM/2.8.552

SHADOW - Calendar per WTG, graphical

WTG: 1 - Wind Turbine

1: Wind Turbine



Shadow receptors

- B: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (2)
- C: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (3)
- E: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (5)
- F: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (6)
- G: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (7)

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10/16/2012 3:49 PM/2.8.552

SHADOW - Calendar

Shadow receptor: A - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (1)

Assumptions for shadow calculations

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	07:14	07:09	06:46	07:10	06:38	06:21	06:23	06:39	06:57	07:12	06:32	06:56
	17:32	17:57	18:18	19:37	19:55	20:14	20:23	20:13	19:43	19:07	17:34	17:21
2	07:14	07:09	06:45	07:09	06:37	06:20	06:24	06:40	06:57	07:13	06:33	06:57
	17:33	17:58	18:19	19:38	19:56	20:14	20:23	20:12	19:42	19:06	17:33	17:21
3	07:14	07:08	06:44	07:08	06:37	06:20	06:24	06:41	06:58	07:13	06:34	06:57
	17:34	17:59	18:19	19:38	19:56	20:15	20:23	20:11	19:41	19:05	17:32	17:21
4	07:15	07:07	06:43	07:07	06:36	06:20	06:25	06:41	06:58	07:14	06:34	06:58
	17:34	18:00	18:20	19:39	19:57	20:15	20:23	20:11	19:40	19:04	17:32	17:21
5	07:15	07:07	06:42	07:05	06:35	06:20	06:25	06:42	06:59	07:15	06:35	06:59
	17:35	18:00	18:21	19:39	19:57	20:16	20:23	20:10	19:39	19:02	17:31	17:21
6	07:15	07:06	06:40	07:04	06:34	06:20	06:25	06:42	06:59	07:15	06:36	07:00
	17:36	18:01	18:21	19:40	19:58	20:16	20:23	20:09	19:38	19:01	17:30	17:21
7	07:15	07:06	06:39	07:03	06:33	06:20	06:26	06:43	07:00	07:16	06:37	07:01
	17:37	18:02	18:22	19:41	19:59	20:17	20:23	20:08	19:36	19:00	17:30	17:21
8	07:15	07:05	07:38	07:02	06:33	06:20	06:26	06:43	07:00	07:16	06:37	07:01
	17:37	18:02	18:23	19:41	19:59	20:17	20:23	20:08	19:35	18:58	17:29	17:21
9	07:15	07:04	07:37	07:01	06:32	06:19	06:27	06:44	07:01	07:17	06:38	07:02
	17:38	18:03	19:23	19:42	20:00	20:18	20:23	20:07	19:34	18:57	17:28	17:21
10	07:15	07:03	07:36	07:00	06:31	06:19	06:27	06:45	07:01	07:18	06:39	07:03
	17:39	18:04	19:24	19:42	20:01	20:18	20:22	20:06	19:33	18:56	17:28	17:22
11	07:15	07:03	07:35	06:59	06:30	06:19	06:28	06:45	07:02	07:18	06:40	07:03
	17:40	18:05	19:25	19:43	20:01	20:19	20:22	20:05	19:32	18:54	17:27	17:22
12	07:15	07:02	07:34	06:58	06:30	06:19	06:28	06:46	07:02	07:19	06:41	07:04
	17:41	18:06	19:25	19:43	20:02	20:19	20:22	20:04	19:30	18:53	17:27	17:22
13	07:15	07:01	07:33	06:56	06:29	06:19	06:29	06:46	07:03	07:19	06:41	07:05
	17:41	18:06	19:26	19:44	20:02	20:19	20:22	20:03	19:29	18:52	17:26	17:22
14	07:15	07:00	07:31	06:55	06:28	06:20	06:29	06:47	07:03	07:20	06:42	07:05
	17:42	18:07	19:26	19:45	20:03	20:20	20:22	20:02	19:28	18:51	17:25	17:23
15	07:15	06:59	07:30	06:54	06:28	06:20	06:30	06:47	07:04	07:21	06:43	07:06
	17:43	18:08	19:27	19:45	20:04	20:20	20:21	20:01	19:27	18:50	17:25	17:23
16	07:15	06:58	07:29	06:53	06:27	06:20	06:30	06:48	07:04	07:21	06:44	07:07
	17:44	18:09	19:28	19:46	20:04	20:20	20:21	20:00	19:26	18:49	17:25	17:23
17	07:15	06:58	07:28	06:52	06:27	06:20	06:31	06:49	07:05	07:22	06:45	07:07
	17:45	18:09	19:28	19:46	20:05	20:21	20:21	19:59	19:24	18:48	17:24	17:24
18	07:15	06:57	07:27	06:51	06:26	06:20	06:31	06:49	07:05	07:22	06:45	07:08
	17:46	18:10	19:29	19:47	20:06	20:21	20:20	19:58	19:23	18:47	17:24	17:24
19	07:14	06:56	07:26	06:50	06:26	06:20	06:32	06:50	07:06	07:23	06:46	07:08
	17:46	18:11	19:29	19:48	20:06	20:21	20:20	19:57	19:22	18:46	17:23	17:25
20	07:14	06:55	07:24	06:49	06:25	06:20	06:32	06:50	07:07	07:24	06:47	07:09
	17:47	18:12	19:30	19:48	20:07	20:22	20:19	19:56	19:21	18:45	17:23	17:25
21	07:14	06:54	07:23	06:48	06:25	06:20	06:33	06:51	07:07	07:24	06:48	07:09
	17:48	18:12	19:31	19:49	20:07	20:22	20:19	19:55	19:19	18:44	17:23	17:25
22	07:14	06:53	07:22	06:47	06:24	06:21	06:34	06:51	07:08	07:25	06:49	07:10
	17:49	18:13	19:31	19:49	20:08	20:22	20:19	19:54	19:18	18:43	17:22	17:26
23	07:13	06:52	07:21	06:46	06:24	06:21	06:34	06:52	07:08	07:26	06:49	07:10
	17:50	18:14	19:32	19:50	20:09	20:22	20:18	19:53	19:17	18:42	17:22	17:26
24	07:13	06:51	07:20	06:45	06:23	06:21	06:35	06:52	07:09	07:26	06:50	07:11
	17:51	18:15	19:32	19:51	20:09	20:22	20:18	19:52	19:16	18:41	17:22	17:27
25	07:13	06:50	07:18	06:44	06:23	06:21	06:35	06:53	07:09	07:27	06:51	07:11
	17:52	18:15	19:33	19:51	20:10	20:23	20:17	19:51	19:15	18:40	17:22	17:28
26	07:12	06:49	07:17	06:43	06:22	06:22	06:36	06:54	07:10	07:28	06:52	07:12
	17:52	18:16	19:34	19:52	20:10	20:23	20:17	19:50	19:13	18:39	17:21	17:28
27	07:12	06:48	07:16	06:42	06:22	06:22	06:36	06:54	07:10	07:28	06:53	07:12
	17:53	18:17	19:34	19:52	20:11	20:23	20:16	19:49	19:12	18:38	17:21	17:29
28	07:11	06:47	07:15	06:41	06:22	06:22	06:37	06:55	07:11	07:29	06:54	07:13
	17:54	18:17	19:35	19:53	20:12	20:23	20:15	19:48	19:11	18:37	17:21	17:29
29	07:11		07:14	06:40	06:21	06:23	06:38	06:55	07:11	07:30	06:54	07:13
	17:55		19:35	19:54	20:12	20:23	20:15	19:47	19:10	18:36	17:21	17:30
30	07:10		07:12	06:39	06:21	06:23	06:38	06:56	07:12	07:31	06:55	07:13
	17:56		19:36	19:54	20:13	20:23	20:14	19:46	19:08	18:36	17:21	17:31
31	07:10		07:11		06:21		06:39	06:56		07:31		07:14
	17:57		19:36		20:13		20:14	19:45		18:35		17:31
Potential sun hours	326	312	371	386	422	420	429	409	371	356	321	319
Total, worst case												

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

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

Project:
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Calculated:
10/16/2012 3:49 PM/2.8.552

SHADOW - Calendar

Shadow receptor: B - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (2)

Assumptions for shadow calculations

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	07:14	09:03 (1)	07:09	06:46	07:10	06:38	06:21	06:23	06:39	06:57	07:12	06:32		06:56	08:53 (1)
	17:32	51 09:54 (1)	17:57	18:18	19:37	19:55	20:14	20:23	20:13	19:43	19:07	17:34		17:21	43 09:36 (1)
2	07:14	09:04 (1)	07:09	06:45	07:09	06:37	06:20	06:24	06:40	06:57	07:13	06:33		06:57	08:53 (1)
	17:33	50 09:54 (1)	17:58	18:19	19:38	19:56	20:14	20:23	20:12	19:42	19:06	17:33		17:21	44 09:37 (1)
3	07:14	09:05 (1)	07:08	06:44	07:08	06:37	06:20	06:24	06:41	06:58	07:13	06:34		06:57	08:53 (1)
	17:34	50 09:55 (1)	17:59	18:19	19:38	19:56	20:15	20:23	20:11	19:41	19:05	17:32		17:21	45 09:38 (1)
4	07:15	09:06 (1)	07:07	06:43	07:07	06:36	06:20	06:25	06:41	06:58	07:14	06:34		06:58	08:52 (1)
	17:34	48 09:54 (1)	18:00	18:20	19:39	19:57	20:15	20:23	20:11	19:40	19:04	17:32		17:21	46 09:38 (1)
5	07:15	09:06 (1)	07:07	06:42	07:05	06:35	06:20	06:25	06:42	06:59	07:15	06:35		06:59	08:53 (1)
	17:35	48 09:54 (1)	18:00	18:21	19:39	19:57	20:16	20:23	20:10	19:39	19:02	17:31		17:21	46 09:39 (1)
6	07:15	09:07 (1)	07:06	06:40	07:04	06:34	06:20	06:25	06:42	06:59	07:15	06:36		07:00	08:53 (1)
	17:36	47 09:54 (1)	18:01	18:21	19:40	19:58	20:16	20:23	20:09	19:38	19:01	17:30		17:21	47 09:40 (1)
7	07:15	09:08 (1)	07:06	06:39	07:03	06:33	06:20	06:26	06:43	07:00	07:16	06:37		07:01	08:53 (1)
	17:37	46 09:54 (1)	18:02	18:22	19:41	19:59	20:17	20:23	20:08	19:36	19:00	17:30		17:21	48 09:41 (1)
8	07:15	09:08 (1)	07:05	07:38	07:02	06:33	06:20	06:26	06:43	07:00	07:16	06:37		07:01	08:53 (1)
	17:37	46 09:54 (1)	18:02	18:23	19:41	19:59	20:17	20:23	20:08	19:35	18:58	17:29		17:21	48 09:41 (1)
9	07:15	09:09 (1)	07:04	07:37	07:01	06:32	06:19	06:27	06:44	07:01	07:17	06:38		07:02	08:53 (1)
	17:38	45 09:54 (1)	18:03	19:23	19:42	20:00	20:18	20:23	20:07	19:34	18:57	17:28		17:21	50 09:43 (1)
10	07:15	09:10 (1)	07:03	07:36	07:00	06:31	06:19	06:27	06:45	07:01	07:18	06:39		07:03	08:54 (1)
	17:39	44 09:54 (1)	18:04	19:24	19:42	20:01	20:18	20:22	20:06	19:33	18:56	17:28		17:22	50 09:44 (1)
11	07:15	09:11 (1)	07:03	07:35	06:59	06:30	06:19	06:28	06:45	07:02	07:18	06:40		07:03	08:53 (1)
	17:40	43 09:54 (1)	18:05	19:25	19:43	20:01	20:19	20:22	20:05	19:32	18:54	17:27		17:22	51 09:44 (1)
12	07:15	09:12 (1)	07:02	07:34	06:58	06:30	06:19	06:28	06:46	07:02	07:19	06:41		07:04	08:54 (1)
	17:41	41 09:53 (1)	18:06	19:25	19:43	20:02	20:19	20:22	20:04	19:30	18:53	17:27		17:22	51 09:45 (1)
13	07:15	09:13 (1)	07:01	07:33	06:56	06:29	06:19	06:29	06:46	07:03	07:19	06:41		07:05	08:55 (1)
	17:41	40 09:53 (1)	18:06	19:26	19:44	20:02	20:19	20:22	20:03	19:29	18:52	17:26		17:22	51 09:46 (1)
14	07:15	09:14 (1)	07:00	07:31	06:55	06:28	06:20	06:29	06:47	07:03	07:20	06:42		07:05	08:54 (1)
	17:42	39 09:53 (1)	18:07	19:26	19:45	20:03	20:20	20:22	20:02	19:28	18:51	17:25		17:23	52 09:46 (1)
15	07:15	09:16 (1)	06:59	07:30	06:54	06:28	06:20	06:30	06:47	07:04	07:21	06:43		07:06	08:55 (1)
	17:43	36 09:52 (1)	18:08	19:27	19:45	20:04	20:20	20:21	20:01	19:27	18:50	17:25		17:23	52 09:47 (1)
16	07:15	09:16 (1)	06:58	07:29	06:53	06:27	06:20	06:30	06:48	07:04	07:21	06:44		07:07	08:56 (1)
	17:44	35 09:51 (1)	18:09	19:28	19:46	20:04	20:20	20:21	20:00	19:26	18:49	17:25		17:23	51 09:47 (1)
17	07:15	09:17 (1)	06:58	07:28	06:52	06:27	06:20	06:31	06:49	07:05	07:22	06:45		07:07	08:56 (1)
	17:45	33 09:50 (1)	18:09	19:28	19:46	20:05	20:21	20:21	19:59	19:24	18:48	17:24		17:24	51 09:47 (1)
18	07:15	09:19 (1)	06:57	07:27	06:51	06:26	06:20	06:31	06:49	07:06	07:22	06:45		07:08	08:57 (1)
	17:46	30 09:49 (1)	18:10	19:29	19:47	20:06	20:21	20:20	19:58	19:23	18:47	17:24		17:24	51 09:48 (1)
19	07:14	09:20 (1)	06:56	07:26	06:50	06:26	06:20	06:32	06:50	07:06	07:23	06:46	09:05 (1)	07:08	08:56 (1)
	17:46	28 09:48 (1)	18:11	19:29	19:48	20:06	20:21	20:20	19:57	19:22	18:46	17:23	9 09:14 (1)	17:25	52 09:48 (1)
20	07:14	09:22 (1)	06:55	07:24	06:49	06:25	06:20	06:32	06:50	07:07	07:24	06:47	09:02 (1)	07:09	08:57 (1)
	17:47	25 09:47 (1)	18:12	19:30	19:48	20:07	20:22	20:19	19:56	19:21	18:45	17:23	16 09:18 (1)	17:25	52 09:49 (1)
21	07:14	09:24 (1)	06:54	07:23	06:48	06:25	06:20	06:33	06:51	07:07	07:24	06:48	09:00 (1)	07:09	08:57 (1)
	17:48	21 09:45 (1)	18:12	19:31	19:49	20:07	20:22	20:19	19:55	19:19	18:44	17:23	21 09:21 (1)	17:25	52 09:49 (1)
22	07:14	09:27 (1)	06:53	07:22	06:47	06:24	06:21	06:34	06:51	07:08	07:25	06:49	08:58 (1)	07:10	08:58 (1)
	17:49	16 09:43 (1)	18:13	19:31	19:49	20:08	20:22	20:19	19:54	19:18	18:43	17:22	25 09:23 (1)	17:26	52 09:50 (1)
23	07:13	09:31 (1)	06:52	07:21	06:46	06:24	06:21	06:34	06:52	07:08	07:26	06:49	08:57 (1)	07:10	08:58 (1)
	17:50	9 09:40 (1)	18:14	19:32	19:50	20:09	20:22	20:18	19:53	19:17	18:42	17:22	27 09:24 (1)	17:26	52 09:50 (1)
24	07:13		06:51	07:20	06:45	06:23	06:21	06:35	06:52	07:09	07:26	06:50	08:56 (1)	07:11	08:59 (1)
	17:51		18:15	19:32	19:51	20:09	20:22	20:18	19:52	19:16	18:41	17:22	30 09:26 (1)	17:27	52 09:51 (1)
25	07:13		06:50	07:18	06:44	06:23	06:21	06:35	06:53	07:09	07:27	06:51	08:55 (1)	07:11	09:00 (1)
	17:52		18:15	19:33	19:51	20:10	20:23	20:17	19:51	19:15	18:40	17:22	33 09:28 (1)	17:28	51 09:51 (1)
26	07:12		06:49	07:17	06:43	06:22	06:22	06:36	06:54	07:10	07:28	06:52	08:55 (1)	07:12	09:00 (1)
	17:52		18:16	19:34	19:52	20:10	20:23	20:17	19:50	19:13	18:39	17:21	35 09:30 (1)	17:28	51 09:51 (1)
27	07:12		06:48	07:16	06:42	06:22	06:22	06:36	06:54	07:10	07:28	06:53	08:55 (1)	07:12	09:01 (1)
	17:53		18:17	19:34	19:52	20:11	20:23	20:16	19:49	19:12	18:38	17:21	36 09:31 (1)	17:29	51 09:52 (1)
28	07:11		06:47	07:15	06:41	06:22	06:22	06:37	06:55	07:11	07:29	06:54	08:54 (1)	07:13	09:01 (1)
	17:54		18:17	19:35	19:53	20:12	20:23	20:15	19:48	19:11	18:37	17:21	39 09:33 (1)	17:29	51 09:52 (1)
29	07:11			07:14	06:40	06:21	06:23	06:38	06:55	07:11	07:30	06:54	08:53 (1)	07:13	09:01 (1)
	17:55			19:35	19:54	20:12	20:23	20:15	19:47	19:10	18:36	17:21	40 09:33 (1)	17:30	52 09:53 (1)
30	07:10			07:12	06:39	06:21	06:23	06:38	06:56	07:12	07:31	06:55	08:53 (1)	07:13	09:03 (1)
	17:56			19:36	19:54	20:13	20:23	20:14	19:46	19:08	18:36	17:21	41 09:34 (1)	17:31	51 09:54 (1)
31	07:10			07:11		06:21		06:39	06:56		07:31			07:14	09:03 (1)
	17:57			19:36		20:13		20:14	19:45		18:35			17:31	51 09:54 (1)
Potential sun hours	326		312	371	386	422	420	429	409	371	356	321		319	
Total, worst case		871											352		1547

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

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

Project:
Galveston

Printed/Page
10/16/2012 3:52 PM / 3

Licensed user:
TEC Inc.
2496 Old Ivy Road, Suite 300
US-CHARLOTTESVILLE, VA 22903
5101
Chris Noddings / Chris.Noddings@cardnotec.com

Calculated:
10/16/2012 3:49 PM/2.8.552

SHADOW - Calendar

Shadow receptor: C - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (3)

Assumptions for shadow calculations

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	07:14	08:32 (1)	07:09	06:46	07:10	06:38	06:21	06:23	06:39	06:57	07:12	06:32		06:56		08:19 (1)
	17:32	48 09:20 (1)	17:57	18:18	19:37	19:55	20:14	20:23	20:13	19:43	19:07	17:34		17:21	47	09:06 (1)
2	07:14	08:32 (1)	07:09	06:45	07:09	06:37	06:20	06:24	06:40	06:57	07:13	06:33		06:57		08:19 (1)
	17:33	48 09:20 (1)	17:58	18:19	19:38	19:56	20:14	20:23	20:12	19:42	19:06	17:33		17:21	47	09:06 (1)
3	07:14	08:33 (1)	07:08	06:44	07:08	06:37	06:20	06:24	06:41	06:58	07:13	06:34		06:57		08:20 (1)
	17:34	48 09:21 (1)	17:59	18:19	19:38	19:56	20:15	20:23	20:11	19:41	19:05	17:32		17:21	47	09:07 (1)
4	07:15	08:34 (1)	07:07	06:43	07:07	06:36	06:20	06:25	06:41	06:58	07:14	06:34		06:58		08:19 (1)
	17:34	48 09:22 (1)	18:00	18:20	19:39	19:57	20:15	20:23	20:11	19:40	19:04	17:32		17:21	48	09:07 (1)
5	07:15	08:34 (1)	07:07	06:42	07:05	06:35	06:20	06:25	06:42	06:59	07:15	06:35		06:59		08:20 (1)
	17:35	48 09:22 (1)	18:00	18:21	19:39	19:57	20:16	20:23	20:10	19:39	19:02	17:31		17:21	48	09:08 (1)
6	07:15	08:34 (1)	07:06	06:40	07:04	06:34	06:20	06:25	06:42	06:59	07:15	06:36		07:00		08:20 (1)
	17:36	48 09:22 (1)	18:01	18:21	19:40	19:58	20:16	20:23	20:09	19:38	19:01	17:30		17:21	48	09:08 (1)
7	07:15	08:35 (1)	07:06	06:39	07:03	06:33	06:20	06:26	06:43	07:00	07:16	06:37		07:01		08:21 (1)
	17:37	48 09:23 (1)	18:02	18:22	19:41	19:59	20:17	20:23	20:08	19:36	19:00	17:30		17:21	48	09:09 (1)
8	07:15	08:35 (1)	07:05	07:38	07:02	06:33	06:20	06:26	06:43	07:00	07:16	06:37		07:01		08:21 (1)
	17:37	48 09:23 (1)	18:02	18:23	19:41	19:59	20:17	20:23	20:08	19:35	18:58	17:29		17:21	48	09:09 (1)
9	07:15	08:36 (1)	07:04	07:37	07:01	06:32	06:19	06:27	06:44	07:01	07:17	06:38		07:02		08:21 (1)
	17:38	47 09:23 (1)	18:03	19:23	19:42	20:00	20:18	20:23	20:07	19:34	18:57	17:28		17:21	49	09:10 (1)
10	07:15	08:36 (1)	07:03	07:36	07:00	06:31	06:19	06:27	06:45	07:01	07:18	06:39		07:03		08:22 (1)
	17:39	47 09:23 (1)	18:04	19:24	19:42	20:01	20:18	20:22	20:06	19:33	18:56	17:28		17:22	48	09:10 (1)
11	07:15	08:37 (1)	07:03	07:35	06:59	06:30	06:19	06:28	06:45	07:02	07:18	06:40	08:30 (1)	07:03		08:22 (1)
	17:40	47 09:24 (1)	18:05	19:25	19:43	20:01	20:19	20:22	20:05	19:32	18:54	17:27	11 08:41 (1)	17:22	48	09:10 (1)
12	07:15	08:37 (1)	07:02	07:34	06:58	06:30	06:19	06:28	06:46	07:02	07:19	06:41	08:27 (1)	07:04		08:23 (1)
	17:41	47 09:24 (1)	18:06	19:25	19:43	20:02	20:19	20:22	20:04	19:30	18:53	17:27	18 08:45 (1)	17:22	48	09:11 (1)
13	07:15	08:38 (1)	07:01	07:33	06:56	06:29	06:19	06:29	06:46	07:03	07:19	06:41	08:25 (1)	07:05		08:24 (1)
	17:41	46 09:24 (1)	18:06	19:26	19:44	20:02	20:19	20:22	20:03	19:29	18:52	17:26	23 08:48 (1)	17:22	48	09:12 (1)
14	07:15	08:38 (1)	07:00	07:31	06:55	06:28	06:20	06:29	06:47	07:03	07:20	06:42	08:24 (1)	07:05		08:23 (1)
	17:42	46 09:24 (1)	18:07	19:26	19:45	20:03	20:20	20:22	20:02	19:28	18:51	17:25	26 08:50 (1)	17:23	48	09:11 (1)
15	07:15	08:39 (1)	06:59	07:30	06:54	06:28	06:20	06:30	06:47	07:04	07:21	06:43	08:23 (1)	07:06		08:24 (1)
	17:43	45 09:24 (1)	18:08	19:27	19:45	20:04	20:20	20:21	20:01	19:27	18:50	17:25	28 08:51 (1)	17:23	48	09:12 (1)
16	07:15	08:39 (1)	06:58	07:29	06:53	06:27	06:20	06:30	06:48	07:04	07:21	06:44	08:21 (1)	07:07		08:25 (1)
	17:44	45 09:24 (1)	18:09	19:28	19:46	20:04	20:20	20:21	20:00	19:26	18:49	17:25	31 08:52 (1)	17:23	48	09:13 (1)
17	07:15	08:40 (1)	06:58	07:28	06:52	06:27	06:20	06:31	06:49	07:05	07:22	06:45	08:21 (1)	07:07		08:25 (1)
	17:45	44 09:24 (1)	18:09	19:28	19:46	20:05	20:21	20:21	19:59	19:24	18:48	17:24	32 08:53 (1)	17:24	48	09:13 (1)
18	07:15	08:41 (1)	06:57	07:27	06:51	06:26	06:20	06:31	06:49	07:06	07:22	06:45	08:20 (1)	07:08		08:26 (1)
	17:46	43 09:24 (1)	18:10	19:29	19:47	20:06	20:21	20:20	19:58	19:23	18:47	17:24	35 08:55 (1)	17:24	48	09:14 (1)
19	07:14	08:42 (1)	06:56	07:26	06:50	06:26	06:20	06:32	06:50	07:06	07:23	06:46	08:19 (1)	07:08		08:26 (1)
	17:46	42 09:24 (1)	18:11	19:29	19:48	20:06	20:21	20:20	19:57	19:22	18:46	17:23	37 08:56 (1)	17:25	48	09:14 (1)
20	07:14	08:43 (1)	06:55	07:24	06:49	06:25	06:20	06:32	06:50	07:07	07:24	06:47	08:19 (1)	07:09		08:27 (1)
	17:47	41 09:24 (1)	18:12	19:30	19:48	20:07	20:22	20:19	19:56	19:21	18:45	17:23	38 08:57 (1)	17:25	48	09:15 (1)
21	07:14	08:43 (1)	06:54	07:23	06:48	06:25	06:20	06:33	06:51	07:07	07:24	06:48	08:19 (1)	07:09		08:27 (1)
	17:48	40 09:23 (1)	18:12	19:31	19:49	20:07	20:22	20:19	19:55	19:19	18:44	17:23	40 08:59 (1)	17:25	48	09:15 (1)
22	07:14	08:44 (1)	06:53	07:22	06:47	06:24	06:21	06:34	06:51	07:08	07:25	06:49	08:19 (1)	07:10		08:28 (1)
	17:49	38 09:22 (1)	18:13	19:31	19:49	20:08	20:22	20:19	19:54	19:18	18:43	17:22	41 09:00 (1)	17:26	48	09:16 (1)
23	07:13	08:45 (1)	06:52	07:21	06:46	06:24	06:21	06:34	06:52	07:08	07:26	06:49	08:18 (1)	07:10		08:28 (1)
	17:50	37 09:22 (1)	18:14	19:32	19:50	20:09	20:22	20:18	19:53	19:17	18:42	17:22	42 09:00 (1)	17:26	48	09:16 (1)
24	07:13	08:46 (1)	06:51	07:20	06:45	06:23	06:21	06:35	06:52	07:09	07:26	06:50	08:18 (1)	07:11		08:29 (1)
	17:51	35 09:21 (1)	18:15	19:32	19:51	20:09	20:22	20:18	19:52	19:16	18:41	17:22	43 09:01 (1)	17:27	48	09:17 (1)
25	07:13	08:48 (1)	06:50	07:18	06:44	06:23	06:21	06:35	06:53	07:09	07:27	06:51	08:18 (1)	07:11		08:29 (1)
	17:52	32 09:20 (1)	18:15	19:33	19:51	20:10	20:23	20:17	19:51	19:15	18:40	17:22	44 09:02 (1)	17:28	48	09:17 (1)
26	07:12	08:48 (1)	06:49	07:17	06:43	06:22	06:22	06:36	06:54	07:10	07:28	06:52	08:18 (1)	07:12		08:29 (1)
	17:52	31 09:19 (1)	18:16	19:34	19:52	20:10	20:23	20:17	19:50	19:13	18:39	17:21	45 09:03 (1)	17:28	48	09:17 (1)
27	07:12	08:50 (1)	06:48	07:16	06:42	06:22	06:22	06:36	06:54	07:10	07:28	06:53	08:18 (1)	07:12		08:30 (1)
	17:53	28 09:18 (1)	18:17	19:34	19:52	20:11	20:23	20:16	19:49	19:12	18:38	17:21	45 09:03 (1)	17:29	48	09:18 (1)
28	07:11	08:51 (1)	06:47	07:15	06:41	06:22	06:22	06:37	06:55	07:11	07:29	06:54	08:18 (1)	07:13		08:30 (1)
	17:54	26 09:17 (1)	18:17	19:35	19:53	20:12	20:23	20:15	19:48	19:11	18:37	17:21	46 09:04 (1)	17:29	48	09:18 (1)
29	07:11	08:54 (1)		07:14	06:40	06:21	06:23	06:38	06:55	07:11	07:30	06:54	08:18 (1)	07:13		08:30 (1)
	17:55	21 09:15 (1)		19:35	19:54	20:12	20:23	20:15	19:47	19:10	18:36	17:21	46 09:04 (1)	17:30	48	09:18 (1)
30	07:10	08:55 (1)		07:12	06:39	06:21	06:23	06:38	06:56	07:12	07:31	06:55	08:18 (1)	07:13		08:31 (1)
	17:56	18 09:13 (1)		19:36	19:54	20:13	20:23	20:14	19:46	19:08	18:36	17:21	47 09:05 (1)	17:31	49	09:20 (1)
31	07:10	08:59 (1)		07:11		06:21		06:39	06:56		07:31			07:14		08:32 (1)
	17:57	11 09:10 (1)		19:36		20:13		20:14	19:45		18:35			17:31	48	09:20 (1)
Potential sun hours	326		312	371	386	422	420	429	409	371	356	321		319		
Total, worst case		1241											718		1487	

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

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

Project:
Galveston

Printed/Page
10/16/2012 3:52 PM / 4

Licensed user:
TEC Inc.
2496 Old Ivy Road, Suite 300
US-CHARLOTTESVILLE, VA 22903
5101
Chris Noddings / Chris.Noddings@cardnotec.com
Calculated:
10/16/2012 3:49 PM/2.8.552

SHADOW - Calendar

Shadow receptor: D - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (4)

Assumptions for shadow calculations

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	07:14	07:09	06:46	07:10	06:38	06:21	06:23	06:39	06:57	07:12	06:32	06:56
	17:32	17:57	18:18	19:37	19:55	20:14	20:23	20:13	19:43	19:07	17:34	17:21
2	07:14	07:09	06:45	07:09	06:37	06:20	06:24	06:40	06:57	07:13	06:33	06:57
	17:33	17:58	18:19	19:38	19:56	20:14	20:23	20:12	19:42	19:06	17:33	17:21
3	07:14	07:08	06:44	07:08	06:37	06:20	06:24	06:41	06:58	07:13	06:34	06:57
	17:34	17:59	18:19	19:38	19:56	20:15	20:23	20:11	19:41	19:05	17:32	17:21
4	07:15	07:07	06:43	07:07	06:36	06:20	06:25	06:41	06:58	07:14	06:34	06:58
	17:34	18:00	18:20	19:39	19:57	20:15	20:23	20:11	19:40	19:04	17:32	17:21
5	07:15	07:07	06:42	07:05	06:35	06:20	06:25	06:42	06:59	07:15	06:35	06:59
	17:35	18:00	18:21	19:39	19:57	20:16	20:23	20:10	19:39	19:02	17:31	17:21
6	07:15	07:06	06:40	07:04	06:34	06:20	06:25	06:42	06:59	07:15	06:36	07:00
	17:36	18:01	18:21	19:40	19:58	20:16	20:23	20:09	19:38	19:01	17:30	17:21
7	07:15	07:06	06:39	07:03	06:33	06:20	06:26	06:43	07:00	07:16	06:37	07:01
	17:37	18:02	18:22	19:41	19:59	20:17	20:23	20:08	19:36	19:00	17:30	17:21
8	07:15	07:05	07:38	07:02	06:33	06:20	06:26	06:43	07:00	07:16	06:37	07:01
	17:37	18:02	18:23	19:41	19:59	20:17	20:23	20:08	19:35	18:58	17:29	17:21
9	07:15	07:04	07:37	07:01	06:32	06:19	06:27	06:44	07:01	07:17	06:38	07:02
	17:38	18:03	19:23	19:42	20:00	20:18	20:23	20:07	19:34	18:57	17:28	17:21
10	07:15	07:03	07:36	07:00	06:31	06:19	06:27	06:45	07:01	07:18	06:39	07:03
	17:39	18:04	19:24	19:42	20:01	20:18	20:22	20:06	19:33	18:56	17:28	17:22
11	07:15	07:03	07:35	06:59	06:30	06:19	06:28	06:45	07:02	07:18	06:40	07:03
	17:40	18:05	19:25	19:43	20:01	20:19	20:22	20:05	19:32	18:54	17:27	17:22
12	07:15	07:02	07:34	06:58	06:30	06:19	06:28	06:46	07:02	07:19	06:41	07:04
	17:41	18:06	19:25	19:43	20:02	20:19	20:22	20:04	19:30	18:53	17:27	17:22
13	07:15	07:01	07:33	06:56	06:29	06:19	06:29	06:46	07:03	07:19	06:41	07:05
	17:41	18:06	19:26	19:44	20:02	20:19	20:22	20:03	19:29	18:52	17:26	17:22
14	07:15	07:00	07:31	06:55	06:28	06:20	06:29	06:47	07:03	07:20	06:42	07:05
	17:42	18:07	19:26	19:45	20:03	20:20	20:22	20:02	19:28	18:51	17:25	17:23
15	07:15	06:59	07:30	06:54	06:28	06:20	06:30	06:47	07:04	07:21	06:43	07:06
	17:43	18:08	19:27	19:45	20:04	20:20	20:21	20:01	19:27	18:50	17:25	17:23
16	07:15	06:58	07:29	06:53	06:27	06:20	06:30	06:48	07:04	07:21	06:44	07:07
	17:44	18:09	19:28	19:46	20:04	20:20	20:21	20:00	19:26	18:49	17:25	17:23
17	07:15	06:58	07:28	06:52	06:27	06:20	06:31	06:49	07:05	07:22	06:45	07:07
	17:45	18:09	19:28	19:46	20:05	20:21	20:21	19:59	19:24	18:48	17:24	17:24
18	07:15	06:57	07:27	06:51	06:26	06:20	06:31	06:49	07:06	07:22	06:45	07:08
	17:46	18:10	19:29	19:47	20:06	20:21	20:20	19:58	19:23	18:47	17:24	17:24
19	07:14	06:56	07:26	06:50	06:26	06:20	06:32	06:50	07:06	07:23	06:46	07:08
	17:46	18:11	19:29	19:48	20:06	20:21	20:20	19:57	19:22	18:46	17:23	17:25
20	07:14	06:55	07:24	06:49	06:25	06:20	06:32	06:50	07:07	07:24	06:47	07:09
	17:47	18:12	19:30	19:48	20:07	20:22	20:19	19:56	19:21	18:45	17:23	17:25
21	07:14	06:54	07:23	06:48	06:25	06:20	06:33	06:51	07:07	07:24	06:48	07:09
	17:48	18:12	19:31	19:49	20:07	20:22	20:19	19:55	19:19	18:44	17:23	17:25
22	07:14	06:53	07:22	06:47	06:24	06:21	06:34	06:51	07:08	07:25	06:49	07:10
	17:49	18:13	19:31	19:49	20:08	20:22	20:19	19:54	19:18	18:43	17:22	17:26
23	07:13	06:52	07:21	06:46	06:24	06:21	06:34	06:52	07:08	07:26	06:49	07:10
	17:50	18:14	19:32	19:50	20:09	20:22	20:18	19:53	19:17	18:42	17:22	17:26
24	07:13	06:51	07:20	06:45	06:23	06:21	06:35	06:52	07:09	07:26	06:50	07:11
	17:51	18:15	19:32	19:51	20:09	20:22	20:18	19:52	19:16	18:41	17:22	17:27
25	07:13	06:50	07:18	06:44	06:23	06:21	06:35	06:53	07:09	07:27	06:51	07:11
	17:52	18:15	19:33	19:51	20:10	20:23	20:17	19:51	19:15	18:40	17:22	17:28
26	07:12	06:49	07:17	06:43	06:22	06:22	06:36	06:54	07:10	07:28	06:52	07:12
	17:52	18:16	19:34	19:52	20:10	20:23	20:17	19:50	19:13	18:39	17:21	17:28
27	07:12	06:48	07:16	06:42	06:22	06:22	06:36	06:54	07:10	07:28	06:53	07:12
	17:53	18:17	19:34	19:52	20:11	20:23	20:16	19:49	19:12	18:38	17:21	17:29
28	07:11	06:47	07:15	06:41	06:22	06:22	06:37	06:55	07:11	07:29	06:54	07:13
	17:54	18:17	19:35	19:53	20:12	20:23	20:15	19:48	19:11	18:37	17:21	17:29
29	07:11		07:14	06:40	06:21	06:23	06:38	06:55	07:11	07:30	06:54	07:13
	17:55		19:35	19:54	20:12	20:23	20:15	19:47	19:10	18:36	17:21	17:30
30	07:10		07:12	06:39	06:21	06:23	06:38	06:56	07:12	07:31	06:55	07:13
	17:56		19:36	19:54	20:13	20:23	20:14	19:46	19:08	18:36	17:21	17:31
31	07:10		07:11		06:21		06:39	06:56		07:31		07:14
	17:57		19:36		20:13		20:14	19:45		18:35		17:31
Potential sun hours	326	312	371	386	422	420	429	409	371	356	321	319
Total, worst case												

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

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

Project:
Galveston

Printed/Page
10/16/2012 3:52 PM / 5

Licensed user:
TEC Inc.
2496 Old Ivy Road, Suite 300
US-CHARLOTTESVILLE, VA 22903
5101
Chris Noddings / Chris.Noddings@cardnotec.com
Calculated:
10/16/2012 3:49 PM/2.8.552

SHADOW - Calendar

Shadow receptor: E - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (5)

Assumptions for shadow calculations

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	07:14	07:09	06:46	07:10	06:38		06:21		06:23		06:39		06:57	07:12	06:32	06:56
	17:32	17:57	18:18	19:37	19:55		20:14	31	07:37 (1)	28	07:42 (1)	4	07:34 (1)	19:43	19:07	17:34	17:21
2	07:14	07:09	06:45	07:09	06:38		06:20		07:07 (1)		06:24		07:14 (1)	06:40	06:57	07:13	06:33	06:57
	17:33	17:58	18:19	19:38	19:56		20:14	30	07:37 (1)	28	07:42 (1)		20:12	19:42	19:06	17:33	17:21
3	07:14	07:08	06:44	07:08	06:37		06:20		07:07 (1)		06:24		07:14 (1)	06:41	06:58	07:14	06:34	06:57
	17:34	17:59	18:19	19:38	19:56		20:15	30	07:37 (1)	29	07:43 (1)		20:11	19:41	19:05	17:32	17:21
4	07:15	07:07	06:43	07:07	06:36		06:20		07:07 (1)		06:25		07:14 (1)	06:41	06:58	07:14	06:34	06:58
	17:34	18:00	18:20	19:39	19:57		20:15	31	07:38 (1)	29	07:43 (1)		20:11	19:40	19:04	17:32	17:21
5	07:15	07:07	06:42	07:05	06:35		06:20		07:08 (1)		06:25		07:14 (1)	06:42	06:59	07:15	06:35	06:59
	17:35	18:00	18:21	19:39	19:57		20:16	30	07:38 (1)	29	07:43 (1)		20:10	19:39	19:02	17:31	17:21
6	07:15	07:06	06:40	07:04	06:34		06:20		07:08 (1)		06:25		07:14 (1)	06:42	06:59	07:15	06:36	07:00
	17:36	18:01	18:21	19:40	19:58		20:16	30	07:38 (1)	30	07:44 (1)		20:09	19:38	19:01	17:30	17:21
7	07:15	07:06	06:39	07:03	06:33		06:20		07:08 (1)		06:26		07:14 (1)	06:43	07:00	07:16	06:37	07:01
	17:37	18:02	18:22	19:41	19:59		20:17	30	07:38 (1)	30	07:44 (1)		20:08	19:36	19:00	17:30	17:21
8	07:15	07:05	07:38	07:02	06:33		06:20		07:09 (1)		06:26		07:15 (1)	06:43	07:00	07:16	06:37	07:01
	17:37	18:02	18:23	19:41	19:59		20:17	29	07:38 (1)	30	07:45 (1)		20:08	19:35	18:58	17:29	17:21
9	07:15	07:04	07:37	07:01	06:32		06:19		07:09 (1)		06:27		07:14 (1)	06:44	07:01	07:17	06:38	07:02
	17:38	18:03	19:23	19:42	20:00		20:18	29	07:38 (1)	31	07:45 (1)		20:07	19:34	18:57	17:28	17:21
10	07:15	07:03	07:36	07:00	06:31		06:19		07:10 (1)		06:27		07:15 (1)	06:45	07:01	07:18	06:39	07:03
	17:39	18:04	19:24	19:42	20:01		20:18	28	07:38 (1)	30	07:45 (1)		20:06	19:33	18:56	17:28	17:22
11	07:15	07:03	07:35	06:59	06:30		06:19		07:10 (1)		06:28		07:14 (1)	06:45	07:02	07:18	06:40	07:03
	17:40	18:05	19:25	19:43	20:01		20:19	28	07:38 (1)	31	07:45 (1)		20:05	19:32	18:54	17:27	17:22
12	07:15	07:02	07:34	06:58	06:30	07:17 (1)	06:19		07:10 (1)		06:28		07:15 (1)	06:46	07:02	07:19	06:41	07:04
	17:41	18:06	19:25	19:43	20:02	8 07:25 (1)	20:19	28	07:38 (1)	31	07:46 (1)		20:04	19:30	18:53	17:27	17:22
13	07:15	07:01	07:33	06:56	06:29	07:14 (1)	06:19		07:10 (1)		06:29		07:15 (1)	06:46	07:03	07:19	06:41	07:05
	17:41	18:06	19:26	19:44	20:02	13 07:27 (1)	20:19	28	07:38 (1)	31	07:46 (1)		20:03	19:29	18:52	17:26	17:22
14	07:15	07:00	07:31	06:55	06:28	07:13 (1)	06:20		07:11 (1)		06:29		07:15 (1)	06:47	07:03	07:20	06:42	07:05
	17:42	18:07	19:26	19:45	20:03	17 07:30 (1)	20:20	27	07:38 (1)	31	07:46 (1)		20:02	19:28	18:51	17:25	17:23
15	07:15	06:59	07:30	06:54	06:28	07:11 (1)	06:20		07:11 (1)		06:30		07:15 (1)	06:47	07:04	07:21	06:43	07:06
	17:43	18:08	19:27	19:45	20:04	20 07:31 (1)	20:20	27	07:38 (1)		20:21	31	07:46 (1)	20:01	19:27	18:50	17:25	17:23
16	07:15	06:58	07:29	06:53	06:27	07:11 (1)	06:20		07:11 (1)		06:30		07:16 (1)	06:48	07:04	07:21	06:44	07:07
	17:44	18:09	19:28	19:46	20:04	22 07:33 (1)	20:20	27	07:38 (1)		20:21	30	07:46 (1)	20:00	19:26	18:49	17:25	17:23
17	07:15	06:58	07:28	06:52	06:27	07:09 (1)	06:20		07:11 (1)		06:31		07:15 (1)	06:49	07:05	07:22	06:45	07:07
	17:45	18:09	19:28	19:46	20:05	24 07:33 (1)	20:21	27	07:38 (1)		20:21	31	07:46 (1)	19:59	19:24	18:48	17:24	17:24
18	07:15	06:57	07:27	06:51	06:26	07:08 (1)	06:20		07:11 (1)		06:31		07:16 (1)	06:49	07:06	07:22	06:45	07:08
	17:46	18:10	19:29	19:47	20:06	25 07:33 (1)	20:21	27	07:38 (1)		20:20	30	07:46 (1)	19:58	19:23	18:47	17:24	17:24
19	07:14	06:56	07:26	06:50	06:26	07:08 (1)	06:20		07:11 (1)		06:32		07:16 (1)	06:50	07:06	07:23	06:46	07:08
	17:46	18:11	19:29	19:48	20:06	26 07:34 (1)	20:21	27	07:38 (1)		20:20	30	07:46 (1)	19:58	19:22	18:46	17:23	17:25
20	07:14	06:55	07:24	06:49	06:25	07:08 (1)	06:20		07:12 (1)		06:32		07:16 (1)	06:50	07:07	07:24	06:47	07:09
	17:47	18:12	19:30	19:48	20:07	27 07:35 (1)	20:22	27	07:39 (1)		20:19	30	07:46 (1)	19:56	19:21	18:45	17:23	17:25
21	07:14	06:54	07:23	06:48	06:25	07:07 (1)	06:20		07:13 (1)		06:33		07:16 (1)	06:51	07:07	07:24	06:48	07:09
	17:48	18:12	19:31	19:49	20:07	28 07:35 (1)	20:22	26	07:39 (1)		20:19	30	07:46 (1)	19:55	19:19	18:44	17:23	17:25
22	07:14	06:53	07:22	06:47	06:24	07:07 (1)	06:21		07:12 (1)		06:34		07:17 (1)	06:51	07:08	07:25	06:49	07:10
	17:49	18:13	19:31	19:49	20:08	29 07:36 (1)	20:22	27	07:39 (1)		20:19	29	07:46 (1)	19:54	19:18	18:43	17:22	17:26
23	07:13	06:52	07:21	06:46	06:24	07:06 (1)	06:21		07:12 (1)		06:34		07:17 (1)	06:52	07:08	07:26	06:49	07:10
	17:50	18:14	19:32	19:50	20:09	30 07:36 (1)	20:22	27	07:39 (1)		20:18	28	07:45 (1)	19:53	19:17	18:42	17:22	17:26
24	07:13	06:51	07:20	06:45	06:23	07:07 (1)	06:21		07:13 (1)		06:35		07:18 (1)	06:52	07:09	07:26	06:50	07:11
	17:51	18:15	19:32	19:51	20:09	30 07:37 (1)	20:22	27	07:40 (1)		20:18	27	07:45 (1)	19:52	19:16	18:41	17:22	17:27
25	07:13	06:50	07:18	06:44	06:23	07:06 (1)	06:21		07:13 (1)		06:35		07:19 (1)	06:53	07:09	07:27	06:51	07:11
	17:52	18:15	19:33	19:51	20:10	30 07:36 (1)	20:23	27	07:40 (1)		20:17	26	07:45 (1)	19:51	19:15	18:40	17:22	17:28
26	07:12	06:49	07:17	06:43	06:22	07:06 (1)	06:22		07:13 (1)		06:36		07:19 (1)	06:54	07:10	07:28	06:52	07:12
	17:52	18:16	19:34	19:52	20:10	31 07:37 (1)	20:23	27	07:40 (1)		20:17	25	07:44 (1)	19:50	19:13	18:39	17:21	17:28
27	07:12	06:48	07:16	06:42	06:22	07:06 (1)	06:22		07:13 (1)		06:36		07:20 (1)	06:54	07:10	07:28	06:53	07:12
	17:53	18:17	19:34	19:52	20:11	31 07:37 (1)	20:23	27	07:40 (1)		20:16	23	07:43 (1)	19:49	19:12	18:38	17:21	17:29
28	07:11	06:47	07:15	06:41	06:22	07:06 (1)	06:22		07:14 (1)		06:37		07:21 (1)	06:55	07:11	07:29	06:54	07:13
	17:54	18:17	19:35	19:53	20:12	31 07:37 (1)	20:23	27	07:41 (1)		20:15	21	07:42 (1)	19:48	19:11	18:37	17:21	17:29
29	07:11		07:14	06:40	06:21	07:06 (1)	06:23		07:14 (1)		06:38		07:22 (1)	06:55	07:11	07:30	06:54	07:13
	17:55		19:35	19:54	20:12	31 07:37 (1)	20:23	27	07:41 (1)		20:15	19	07:41 (1)	19:47	19:10	18:36	17:21	17:30
30	07:10		07:12	06:39	06:21	07:06 (1)	06:23		07:13 (1)		06:38		07:23 (1)	06:56	07:12	07:31	06:55	07:13
	17:56		19:36	19:54	20:13	31 07:37 (1)	20:23	28	07:41 (1)		20:14	16	07:39 (1)	19:46	19:08	18:36	17:21	17:31
31	07:10		07:11		06:21	07:07 (1)					06:39		07:25 (1)	06:56		07:31		07:14
	17:57		19:36		20:13	31 07:38 (1)					20:14	12	07:37 (1)	19:45		18:35		17:31
Potential sun hours	326	312	371	386	422		420		429		409		371	356	321	319
Total, worst case						515		841		856		4				

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

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

Project:
Galveston

Printed/Page
10/16/2012 3:52 PM / 6

Licensed user:
TEC Inc.
2496 Old Ivy Road, Suite 300
US-CHARLOTTESVILLE, VA 22903
5101
Chris Noddings / Chris.Noddings@cardnotec.com

Calculated:
10/16/2012 3:49 PM/2.8.552

SHADOW - Calendar

Shadow receptor: F - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (6)

Assumptions for shadow calculations

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	07:14	07:09	06:46	07:10			06:38		07:22 (1)	06:21	06:23			06:39		07:27 (1)	06:57	07:12	06:32	06:56
	17:32	17:57	18:18	19:37			19:55	22	07:44 (1)	20:14	20:23			20:13	31	07:58 (1)	19:43	19:07	17:34	17:21
2	07:14	07:09	06:45	07:09			06:38		07:20 (1)	06:20	06:24			06:40		07:26 (1)	06:57	07:13	06:33	06:57
	17:33	17:58	18:19	19:38			19:56	25	07:45 (1)	20:14	20:23			20:12	32	07:58 (1)	19:42	19:06	17:33	17:21
3	07:14	07:08	06:44	07:08			06:37		07:19 (1)	06:20	06:24			06:41		07:27 (1)	06:58	07:14	06:34	06:57
	17:34	17:59	18:19	19:38			19:56	27	07:46 (1)	20:15	20:23			20:11	31	07:58 (1)	19:41	19:05	17:32	17:21
4	07:15	07:07	06:43	07:07			06:36		07:19 (1)	06:20	06:25			06:41		07:26 (1)	06:58	07:14	06:34	06:58
	17:34	18:00	18:20	19:39			19:57	28	07:47 (1)	20:15	20:23			20:11	31	07:57 (1)	19:40	19:04	17:32	17:21
5	07:15	07:07	06:42	07:05			06:35		07:18 (1)	06:20	06:25			06:42		07:27 (1)	06:59	07:15	06:35	06:59
	17:35	18:00	18:21	19:39			19:57	29	07:47 (1)	20:16	20:23			20:10	31	07:58 (1)	19:39	19:02	17:31	17:21
6	07:15	07:06	06:40	07:04			06:34		07:17 (1)	06:20	06:25			06:42		07:26 (1)	06:59	07:15	06:36	07:00
	17:36	18:01	18:21	19:40			19:58	30	07:47 (1)	20:16	20:23			20:09	31	07:57 (1)	19:38	19:01	17:30	17:21
7	07:15	07:06	06:39	07:03			06:33		07:17 (1)	06:20	06:26			06:43		07:27 (1)	07:00	07:16	06:37	07:01
	17:37	18:02	18:22	19:41			19:59	30	07:47 (1)	20:17	20:23			20:08	30	07:57 (1)	19:36	19:00	17:30	17:21
8	07:15	07:05	07:38	07:02			06:33		07:17 (1)	06:20	06:26			06:43		07:28 (1)	07:00	07:16	06:37	07:01
	17:37	18:02	18:23	19:41			19:59	31	07:48 (1)	20:17	20:23			20:08	29	07:57 (1)	19:35	18:58	17:29	17:21
9	07:15	07:04	07:37	07:01			06:32		07:16 (1)	06:19	06:27			06:44		07:28 (1)	07:01	07:17	06:38	07:02
	17:38	18:03	19:23	19:42			20:00	32	07:48 (1)	20:18	20:23			20:07	28	07:56 (1)	19:34	18:57	17:28	17:21
10	07:15	07:03	07:36	07:00			06:31		07:16 (1)	06:19	06:27			06:45		07:29 (1)	07:01	07:18	06:39	07:03
	17:39	18:04	19:24	19:42			20:01	31	07:47 (1)	20:18	20:22			20:06	26	07:55 (1)	19:33	18:56	17:28	17:22
11	07:15	07:03	07:35	06:59			06:30		07:16 (1)	06:19	06:28			06:45		07:29 (1)	07:02	07:18	06:40	07:03
	17:40	18:05	19:25	19:43			20:01	32	07:48 (1)	20:19	20:22			20:05	24	07:53 (1)	19:32	18:54	17:27	17:22
12	07:15	07:02	07:34	06:58			06:30		07:16 (1)	06:19	06:28			06:46		07:31 (1)	07:02	07:19	06:41	07:04
	17:41	18:06	19:25	19:43			20:02	31	07:47 (1)	20:19	20:22			20:04	22	07:53 (1)	19:30	18:53	17:27	17:22
13	07:15	07:01	07:33	06:56			06:29		07:16 (1)	06:19	06:29			06:46		07:31 (1)	07:03	07:19	06:41	07:05
	17:41	18:06	19:26	19:44			20:02	31	07:47 (1)	20:19	20:22			20:03	19	07:50 (1)	19:29	18:52	17:26	17:22
14	07:15	07:00	07:31	06:55			06:28		07:17 (1)	06:20	06:29			06:47		07:33 (1)	07:03	07:20	06:42	07:05
	17:42	18:07	19:26	19:45			20:03	30	07:47 (1)	20:20	20:22			20:02	15	07:48 (1)	19:28	18:51	17:25	17:23
15	07:15	06:59	07:30	06:54			06:28		07:17 (1)	06:20	06:30			06:47		07:36 (1)	07:04	07:21	06:43	07:06
	17:43	18:08	19:27	19:45			20:04	29	07:46 (1)	20:20	20:21			20:01	9	07:45 (1)	19:27	18:50	17:25	17:23
16	07:15	06:58	07:29	06:53			06:27		07:17 (1)	06:20	06:30		07:38 (1)	06:48			07:04	07:21	06:44	07:07
	17:44	18:09	19:28	19:46			20:04	30	07:47 (1)	20:20	20:21	8	07:46 (1)	20:00			19:26	18:49	17:25	17:23
17	07:15	06:58	07:28	06:52			06:27		07:17 (1)	06:20	06:31		07:36 (1)	06:49			07:05	07:22	06:45	07:07
	17:45	18:09	19:28	19:46			20:05	29	07:46 (1)	20:21	20:21	12	07:48 (1)	19:59			19:24	18:48	17:24	17:24
18	07:15	06:57	07:27	06:51			06:26		07:17 (1)	06:20	06:31		07:35 (1)	06:49			07:06	07:22	06:45	07:08
	17:46	18:10	19:29	19:47			20:06	28	07:45 (1)	20:21	20:20	15	07:50 (1)	19:58			19:23	18:47	17:24	17:24
19	07:14	06:56	07:26	06:50			06:26		07:18 (1)	06:20	06:32		07:33 (1)	06:50			07:06	07:23	06:46	07:08
	17:46	18:11	19:29	19:48			20:06	27	07:45 (1)	20:21	20:20	17	07:50 (1)	19:58			19:22	18:46	17:23	17:25
20	07:14	06:55	07:24	06:49			06:25		07:19 (1)	06:20	06:32		07:32 (1)	06:50			07:07	07:24	06:47	07:09
	17:47	18:12	19:30	19:48			20:07	25	07:44 (1)	20:22	20:19	20	07:52 (1)	19:56			19:21	18:45	17:23	17:25
21	07:14	06:54	07:23	06:48			06:25		07:20 (1)	06:20	06:33		07:31 (1)	06:51			07:07	07:24	06:48	07:09
	17:48	18:12	19:31	19:49			20:07	24	07:44 (1)	20:22	20:19	21	07:52 (1)	19:55			19:19	18:44	17:23	17:25
22	07:14	06:53	07:22	06:47			06:24		07:21 (1)	06:21	06:34		07:30 (1)	06:51			07:08	07:25	06:49	07:10
	17:49	18:13	19:31	19:49			20:08	22	07:43 (1)	20:22	20:19	23	07:53 (1)	19:54			19:18	18:43	17:22	17:26
23	07:13	06:52	07:21	06:46			06:24		07:21 (1)	06:21	06:34		07:29 (1)	06:52			07:08	07:26	06:49	07:10
	17:50	18:14	19:32	19:50			20:09	21	07:42 (1)	20:22	20:18	25	07:54 (1)	19:53			19:17	18:42	17:22	17:26
24	07:13	06:51	07:20	06:45			06:23		07:23 (1)	06:21	06:35		07:29 (1)	06:52			07:09	07:26	06:50	07:11
	17:51	18:15	19:32	19:51			20:09	19	07:42 (1)	20:22	20:18	26	07:55 (1)	19:52			19:16	18:41	17:22	17:27
25	07:13	06:50	07:18	06:44			06:23		07:24 (1)	06:21	06:35		07:29 (1)	06:53			07:09	07:27	06:51	07:11
	17:52	18:15	19:33	19:51			20:10	16	07:40 (1)	20:23	20:17	27	07:56 (1)	19:51			19:15	18:40	17:22	17:28
26	07:12	06:49	07:17	06:43			06:22		07:26 (1)	06:22	06:36		07:28 (1)	06:54			07:10	07:28	06:52	07:12
	17:52	18:16	19:34	19:52			20:10	13	07:39 (1)	20:23	20:17	28	07:56 (1)	19:50			19:13	18:39	17:21	17:28
27	07:12	06:48	07:16	06:42			06:22		07:28 (1)	06:22	06:36		07:28 (1)	06:54			07:10	07:28	06:53	07:12
	17:53	18:17	19:34	19:52			20:11	10	07:38 (1)	20:23	20:16	29	07:57 (1)	19:49			19:12	18:38	17:21	17:29
28	07:11	06:47	07:15	06:41		07:28 (1)	06:22		07:30 (1)	06:22	06:37		07:27 (1)	06:55			07:11	07:29	06:54	07:13
	17:54	18:17	19:35	19:53	11	07:39 (1)	20:12	5	07:35 (1)	20:23	20:15	30	07:57 (1)	19:48			19:11	18:37	17:21	17:29
29	07:11		07:14	06:40		07:25 (1)	06:21			06:23	06:38		07:27 (1)	06:55			07:11	07:30	06:54	07:13
	17:55		19:35	19:54	16	07:41 (1)	20:12			20:23	20:15	30	07:57 (1)	19:47			19:10	18:36	17:21	17:30
30	07:10		07:12	06:39		07:23 (1)	06:21			06:23	06:38		07:26 (1)	06:56			07:12	07:31	06:55	07:13
	17:56		19:36	19:54	20	07:43 (1)	20:13			20:23	20:14	31	07:57 (1)	19:46			19:08	18:36	17:21	17:31
31	07:10		07:11				06:21				06:39		07:27 (1)	06:56				07:31		07:14
	17:57		19:36				20:13				20:14	31	07:58 (1)	19:45				18:35		17:31
Potential sun hours	326	312	371	386			422			420	429			409			371	356	321	319
Total, worst case					47			707				373			389					

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

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

Project:
Galveston

Printed/Page
10/16/2012 3:52 PM / 7

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US-CHARLOTTESVILLE, VA 22903
5101
Chris Noddings / Chris.Noddings@cardnotec.com

Calculated:
10/16/2012 3:49 PM/2.8.552

SHADOW - Calendar

Shadow receptor: G - Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (7)

Assumptions for shadow calculations

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	07:14		07:09		06:46		07:10			06:38		07:20 (1)	06:21		06:23		06:39			06:57		07:12		06:32		06:56	
	17:32		17:57		18:18		19:37			19:55	26	07:46 (1)	20:14		20:23		20:13			19:43		19:07		17:34		17:21	
2	07:14		07:09		06:45		07:09			06:38		07:20 (1)	06:20		06:24		06:40			06:57		07:13		06:33		06:57	
	17:33		17:58		18:19		19:38			19:56	25	07:45 (1)	20:14		20:23		20:12			19:42		19:06		17:33		17:21	
3	07:14		07:08		06:44		07:08			06:37		07:20 (1)	06:20		06:24		06:41		07:41 (1)	06:58		07:14		06:34		06:57	
	17:34		17:59		18:19		19:38			19:56	24	07:44 (1)	20:15		20:23		20:11	4	07:45 (1)	19:41		19:05		17:32		17:21	
4	07:15		07:08		06:43		07:07			06:36		07:21 (1)	06:20		06:25		06:41		07:37 (1)	06:58		07:14		06:34		06:58	
	17:34		18:00		18:20		19:39			19:57	23	07:44 (1)	20:15		20:23		20:11	11	07:48 (1)	19:40		19:04		17:32		17:21	
5	07:15		07:07		06:42		07:05			06:35		07:22 (1)	06:20		06:25		06:42		07:35 (1)	06:59		07:15		06:35		06:59	
	17:35		18:00		18:21		19:39			19:57	21	07:43 (1)	20:16		20:23		20:10	15	07:50 (1)	19:39		19:02		17:31		17:21	
6	07:15		07:06		06:40		07:04			06:34		07:23 (1)	06:20		06:25		06:42		07:33 (1)	06:59		07:15		06:36		07:00	
	17:36		18:01		18:21		19:40			19:58	19	07:42 (1)	20:16		20:23		20:09	18	07:51 (1)	19:38		19:01		17:30		17:21	
7	07:15		07:06		06:39		07:03			06:33		07:24 (1)	06:20		06:26		06:43		07:32 (1)	07:00		07:16		06:37		07:01	
	17:37		18:02		18:22		19:41			19:59	17	07:41 (1)	20:17		20:23		20:08	20	07:52 (1)	19:36		19:00		17:30		17:21	
8	07:15		07:05		07:38		07:02			06:33		07:26 (1)	06:20		06:26		06:43		07:31 (1)	07:00		07:16		06:37		07:01	
	17:37		18:02		18:23		19:41			19:59	14	07:40 (1)	20:17		20:23		20:08	22	07:53 (1)	19:35		18:58		17:29		17:21	
9	07:15		07:04		07:37		07:01			06:32		07:28 (1)	06:20		06:27		06:44		07:30 (1)	07:01		07:17		06:38		07:02	
	17:38		18:03		19:23		19:42			20:00	9	07:37 (1)	20:18		20:23		20:07	23	07:53 (1)	19:34		18:57		17:28		17:21	
10	07:15		07:03		07:36		07:00			06:31			06:19		06:27		06:45		07:30 (1)	07:01		07:18		06:39		07:03	
	17:39		18:04		19:24		19:42			20:01			20:18		20:22		20:06	24	07:54 (1)	19:33		18:56		17:28		17:22	
11	07:15		07:03		07:35		06:59			06:30			06:19		06:28		06:45		07:29 (1)	07:02		07:18		06:40		07:03	
	17:40		18:05		19:25		19:43			20:01			20:19		20:22		20:05	25	07:54 (1)	19:32		18:54		17:27		17:22	
12	07:15		07:02		07:34		06:58			06:30			06:19		06:28		06:46		07:28 (1)	07:02		07:19		06:41		07:04	
	17:41		18:06		19:25		19:43			20:02			20:19		20:22		20:04	27	07:55 (1)	19:30		18:53		17:27		17:22	
13	07:15		07:01		07:33		06:56			06:29			06:19		06:29		06:46		07:28 (1)	07:03		07:19		06:41		07:05	
	17:41		18:06		19:26		19:44			20:02			20:19		20:22		20:03	27	07:55 (1)	19:29		18:52		17:26		17:22	
14	07:15		07:00		07:31		06:55			06:28			06:20		06:29		06:47		07:28 (1)	07:03		07:20		06:42		07:05	
	17:42		18:07		19:26		19:45			20:03			20:20		20:22		20:02	27	07:55 (1)	19:28		18:51		17:25		17:23	
15	07:15		06:59		07:30		06:54			06:28			06:20		06:30		06:47		07:27 (1)	07:04		07:21		06:43		07:06	
	17:43		18:08		19:27		19:45			20:04			20:20		20:21		20:01	27	07:54 (1)	19:27		18:50		17:25		17:23	
16	07:15		06:58		07:29		06:53			06:27			06:20		06:30		06:48		07:28 (1)	07:04		07:21		06:44		07:07	
	17:44		18:09		19:28		19:46			20:04			20:20		20:21		20:00	27	07:55 (1)	19:26		18:49		17:25		17:23	
17	07:15		06:58		07:28		06:52			06:27			06:20		06:31		06:49		07:27 (1)	07:05		07:22		06:45		07:07	
	17:45		18:09		19:28		19:46			20:05			20:21		20:21		19:59	27	07:54 (1)	19:24		18:48		17:24		17:24	
18	07:15		06:57		07:27		06:51			06:26			06:20		06:31		06:49		07:28 (1)	07:06		07:22		06:45		07:08	
	17:46		18:10		19:29		19:47			20:06			20:21		20:20		19:58	26	07:54 (1)	19:23		18:47		17:24		17:24	
19	07:14		06:56		07:26		06:50		07:29 (1)	06:26			06:20		06:32		06:50		07:29 (1)	07:06		07:23		06:46		07:08	
	17:46		18:11		19:29		19:48	11	07:40 (1)	20:06			20:21		20:20		19:58	24	07:53 (1)	19:22		18:46		17:23		17:25	
20	07:14		06:55		07:24		06:49		07:27 (1)	06:25			06:20		06:32		06:50		07:29 (1)	07:07		07:24		06:47		07:09	
	17:47		18:12		19:30		19:48	16	07:43 (1)	20:07			20:22		20:19		19:56	23	07:52 (1)	19:21		18:45		17:23		17:25	
21	07:14		06:54		07:23		06:48		07:25 (1)	06:25			06:20		06:33		06:51		07:30 (1)	07:07		07:24		06:48		07:09	
	17:48		18:12		19:31		19:49	19	07:44 (1)	20:07			20:22		20:19		19:55	21	07:51 (1)	19:19		18:44		17:23		17:25	
22	07:14		06:53		07:22		06:47		07:24 (1)	06:24			06:21		06:34		06:51		07:30 (1)	07:08		07:25		06:49		07:10	
	17:49		18:13		19:31		19:49	21	07:45 (1)	20:08			20:22		20:19		19:54	19	07:49 (1)	19:18		18:43		17:22		17:26	
23	07:13		06:52		07:21		06:46		07:23 (1)	06:24			06:21		06:34		06:52		07:32 (1)	07:08		07:26		06:49		07:10	
	17:50		18:14		19:32		19:50	23	07:46 (1)	20:09			20:22		20:18		19:53	15	07:47 (1)	19:17		18:42		17:22		17:26	
24	07:13		06:51		07:20		06:45		07:22 (1)	06:23			06:21		06:35		06:52		07:34 (1)	07:09		07:26		06:50		07:11	
	17:51		18:15		19:32		19:51	24	07:46 (1)	20:09			20:22		20:18		19:52	10	07:44 (1)	19:16		18:41		17:22		17:27	
25	07:13		06:50		07:18		06:44		07:22 (1)	06:23			06:21		06:35		06:53			07:09		07:27		06:51		07:11	
	17:52		18:15		19:33		19:51	26	07:48 (1)	20:10			20:23		20:17		19:51			19:15		18:40		17:22		17:28	
26	07:12		06:49		07:17		06:43		07:21 (1)	06:22			06:22		06:36		06:54			07:10		07:28		06:52		07:12	
	17:52		18:16		19:34		19:52	27	07:48 (1)	20:10			20:23		20:17		19:50			19:13		18:39		17:21		17:28	
27	07:12		06:48		07:16		06:42		07:21 (1)	06:22			06:22		06:36		06:54			07:10		07:28		06:53		07:12	
	17:53		18:17		19:34		19:52	27	07:48 (1)	20:11			20:23		20:16		19:49			19:12		18:38		17:21		17:29	
28	07:11		06:47		07:15		06:41		07:20 (1)	06:22			06:22		06:37		06:55			07:11		07:29		06:54		07:13	
	17:54		18:17		19:35		19:53	28	07:48 (1)	20:12			20:23		20:15		19:48			19:11		18:37		17:21		17:29	
29	07:11				07:14		06:40		07:20 (1)	06:21			06:23		06:38		06:55			07:11		07:30		06:54		07:13	
	17:55				19:35		19:54	27	07:47 (1)	20:12			20:23		20:15		19:47			19:10		18:36		17:21		17:30	
30	07:10				07:12		06:39		07:20 (1)	06:21			06:23		06:38		06:56			07:12		07:31		06:55		07:13	
	17:56				19:36		19:54	27	07:47 (1)	20:13			20:23		20:14		19:46			19:08		18:36		17:21		17:31	
31	07:10				07:11					06:21					06:39		06:56					07:31				07:14	
	17:57				19:36					20:13					20:14		19:45					18:35				17:31	
Potential sun hours	326		312		371		386			422			420		429		409			371		356		321		319	
Total, worst case								276			178							462									

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

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

Project:
Galveston

Printed/Page
10/16/2012 3:53 PM / 1

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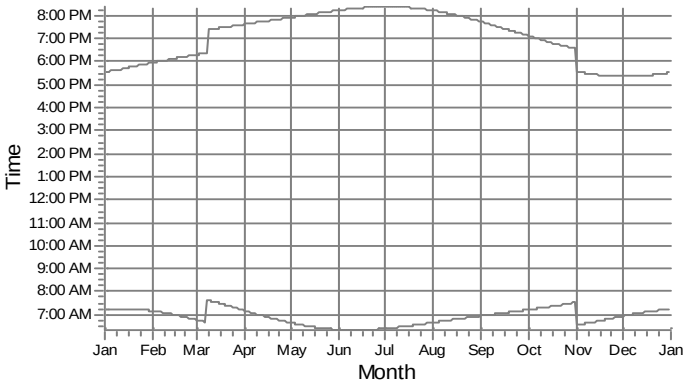
Calculated:
10/16/2012 3:49 PM/2.8.552

SHADOW - Calendar, graphical

A: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (1)



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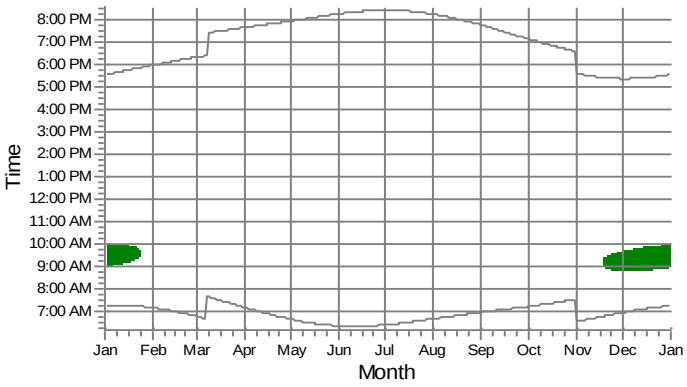

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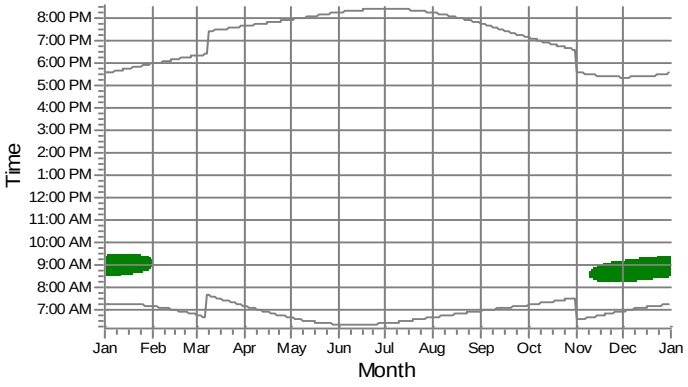

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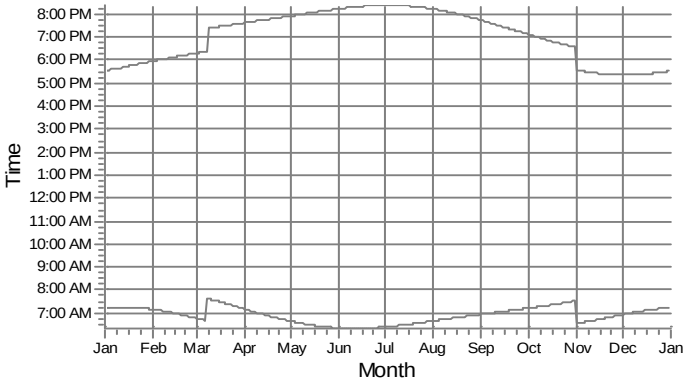

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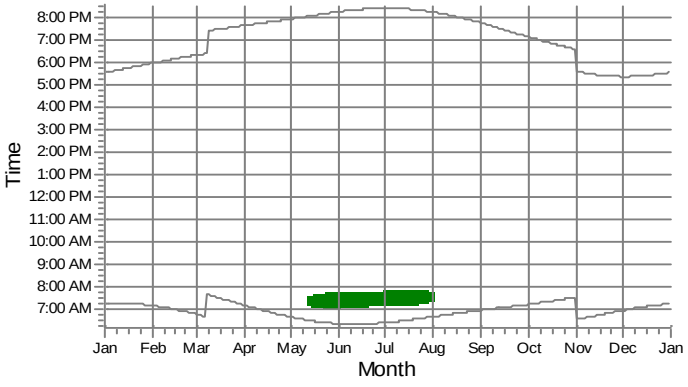

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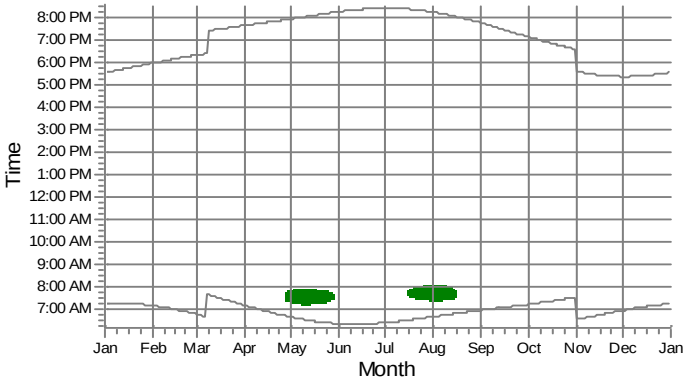


WTGs

1: Wind Turbine

Project:
Galveston

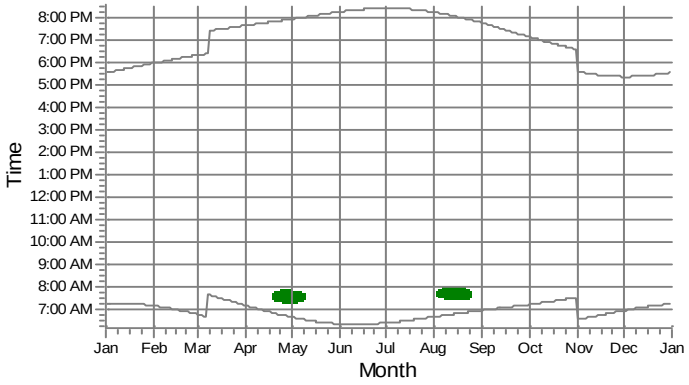
Printed/Page
10/16/2012 3:53 PM / 2

Licensed user:
TEC Inc.
2496 Old Ivy Road, Suite 300
US-CHARLOTTESVILLE, VA 22903
5101
Chris Noddings / Chris.Noddings@cardnotec.com

Calculated:
10/16/2012 3:49 PM/2.8.552

SHADOW - Calendar, graphical

G: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (7)



WTGs

1: Wind Turbine

APPENDIX D
ENDANGERED SPECIES AND BIRD SURVEY DATA

Ecological Services

Southwest Region

Back to Start

List of species by county for Texas:

Counties Selected: Galveston

Select one or more counties from the following list to view a county list:

Anderson
Andrews
Angelina
Aransas
Archer

View County List

Galveston County

Common Name	Scientific Name	Species Group	Listing Status	Species Image	Species Distribution Map	Critical Habitat	More Info
Attwater's greater prairie-chicken	*Tympanuchus cupido attwateri*	Birds	E				P
brown pelican	*Pelecanus occidentalis*	Birds	DM				P
Eskimo curlew	*Numenius borealis*	Birds	E				P
green sea turtle	*Chelonia mydas*	Reptiles	E, T				P
hawksbill sea turtle	*Eretmochelys imbricata*	Reptiles	E				P
Kemp's ridley sea turtle	*Lepidochelys kempii*	Reptiles	E				P
leatherback sea turtle	*Dermochelys coriacea*	Reptiles	E				P
loggerhead sea turtle	*Caretta caretta*	Reptiles	T				P
piping Plover	*Charadrius melodus*	Birds	E, T			Final	P

Ecological Services
Endangered Species
Electronic Library
Environmental Contaminants
Energy
Partners Program
Texas Coastal Program
National Wetlands Inventory
Field Offices

Last Updated: September 20, 2012

The mission of the U.S. Fish and Wildlife Service is working with others to conserve, protect, and enhance fish, wildlife, plants and their habitats for the continuing benefit of the American people.

Last Revision: 8/7/2012 4:08:00 PM

GALVESTON COUNTY

BIRDS

		Federal Status	State Status
American Peregrine Falcon	*Falco peregrinus anatum*	DL	T

year-round resident and local breeder in west Texas, nests in tall cliff eyries; also, migrant across state from more northern breeding areas in US and Canada, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Arctic Peregrine Falcon	*Falco peregrinus tundrius*	DL	

migrant throughout state from subspecies' far northern breeding range, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Attwater's Greater Prairie-Chicken	*Tympanuchus cupido attwateri*	LE	E

this county within historic range; endemic; open prairies of mostly thick grass one to three feet tall; from near sea level to 200 feet along coastal plain on upper two-thirds of Texas coast; males form communal display flocks during late winter-early spring; booming grounds important; breeding February-July

Bald Eagle	*Haliaeetus leucocephalus*	DL	T

found primarily near rivers and large lakes; nests in tall trees or on cliffs near water; communally roosts, especially in winter; hunts live prey, scavenges, and pirates food from other birds

Black Rail	*Laterallus jamaicensis*		

salt, brackish, and freshwater marshes, pond borders, wet meadows, and grassy swamps; nests in or along edge of marsh, sometimes on damp ground, but usually on mat of previous year's dead grasses; nest usually hidden in marsh grass or at base of Salicornia

Brown Pelican	*Pelecanus occidentalis*	DL	

largely coastal and near shore areas, where it roosts and nests on islands and spoil banks

Eskimo Curlew	*Numenius borealis*	LE	E

historic; nonbreeding: grasslands, pastures, plowed fields, and less frequently, marshes and mudflats

Henslow's Sparrow	*Ammodramus henslowii*		

wintering individuals (not flocks) found in weedy fields or cut-over areas where lots of bunch grasses occur along with vines and brambles; a key component is bare ground for running/walking

Mountain Plover	*Charadrius montanus*		

breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous

GALVESTON COUNTY

BIRDS

		Federal Status	State Status
Peregrine Falcon	*Falco peregrinus*	DL	T

both subspecies migrate across the state from more northern breeding areas in US and Canada to winter along coast and farther south; subspecies (F. p. anatum) is also a resident breeder in west Texas; the two subspecies' listing statuses differ, F.p. tundrius is no longer listed in Texas; but because the subspecies are not easily distinguishable at a distance, reference is generally made only to the species level; see subspecies for habitat.

Piping Plover	*Charadrius melodus*	LT	T

wintering migrant along the Texas Gulf Coast; beaches and bayside mud or salt flats

Reddish Egret	*Egretta rufescens*		T

resident of the Texas Gulf Coast; brackish marshes and shallow salt ponds and tidal flats; nests on ground or in trees or bushes, on dry coastal islands in brushy thickets of yucca and prickly pear

Snowy Plover *Charadrius alexandrinus*

formerly an uncommon breeder in the Panhandle; potential migrant; winter along coast

Southeastern Snowy Plover *Charadrius alexandrinus tenuirostris*

wintering migrant along the Texas Gulf Coast beaches and bayside mud or salt flats

Sprague's Pipit	*Anthus spragueii*	C	

only in Texas during migration and winter, mid September to early April; short to medium distance, diurnal migrant; strongly tied to native upland prairie, can be locally common in coastal grasslands, uncommon to rare further west; sensitive to patch size and avoids edges.

White-faced Ibis	*Plegadis chihi*		T

prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats

White-tailed Hawk	*Buteo albicaudatus*		T

near coast on prairies, cordgrass flats, and scrub-live oak; further inland on prairies, mesquite and oak savannas, and mixed savanna-chaparral; breeding March-May

Whooping Crane	*Grus americana*	LE	E

potential migrant via plains throughout most of state to coast; winters in coastal marshes of Aransas, Calhoun, and Refugio counties

Wood Stork	*Mycteria americana*		T

forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960

GALVESTON COUNTY

FISHES

		Federal Status	State Status
American eel	*Anguilla rostrata*		

coastal waterways below reservoirs to gulf; spawns January to February in ocean, larva move to coastal waters, metamorphose, then females move into freshwater; most aquatic habitats with access to ocean, muddy bottoms, still waters, large streams, lakes; can travel overland in wet areas; males in brackish estuaries; diet varies widely, geographically, and seasonally

Smalltooth sawfish	*Pristis pectinata*	LE	E

different life history stages have different patterns of habitat use; young found very close to shore in muddy and sandy bottoms, seldom descending to depths greater than 32 ft (10 m); in sheltered bays, on shallow banks, and in estuaries or river mouths; adult sawfish are encountered in various habitat types (mangrove, reef, seagrass, and coral), in varying salinity regimes and temperatures, and at various water depths, feed on a variety of fish species and crustaceans

MAMMALS

		Federal Status	State Status
Louisiana black bear	*Ursus americanus luteolus*	LT	T

possible as transient; bottomland hardwoods and large tracts of inaccessible forested areas

Plains spotted skunk	*Spilogale putorius interrupta*		

catholic; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie

Red wolf	*Canis rufus*	LE	E

extirpated; formerly known throughout eastern half of Texas in brushy and forested areas, as well as coastal prairies

West Indian manatee	*Trichechus manatus*	LE	E

Gulf and bay system; opportunistic, aquatic herbivore

REPTILES

		Federal Status	State Status
Alligator snapping turtle	*Macrochelys temminckii*		T

perennial water bodies; deep water of rivers, canals, lakes, and oxbows; also swamps, bayous, and ponds near deep running water; sometimes enters brackish coastal waters; usually in water with mud bottom and abundant aquatic vegetation; may migrate several miles along rivers; active March-October; breeds April-October

Atlantic hawksbill sea turtle	*Eretmochelys imbricata*	LE	E

Gulf and bay system, warm shallow waters especially in rocky marine environments, such as coral reefs and jetties, juveniles found in floating mats of sea plants; feed on sponges, jellyfish, sea urchins, molluscs, and crustaceans, nests April through November

GALVESTON COUNTY

REPTILES		Federal Status	State Status
Green sea turtle	*Chelonia mydas*	LT	T

Gulf and bay system; shallow water seagrass beds, open water between feeding and nesting areas, barrier island beaches; adults are herbivorous feeding on sea grass and seaweed; juveniles are omnivorous feeding initially on marine invertebrates, then increasingly on sea grasses and seaweeds; nesting behavior extends from March to October, with peak activity in May and June

Gulf Saltmarsh snake *Nerodia clarkii*

saline flats, coastal bays, and brackish river mouthss

Kemp's Ridley sea turtle	*Lepidochelys kempii*	LE	E

Gulf and bay system, adults stay within the shallow waters of the Gulf of Mexico; feed primarily on crabs, but also snails, clams, other crustaceans and plants, juveniles feed on sargassum and its associated fauna; nests April through August

Leatherback sea turtle	*Dermochelys coriacea*	LE	E

Gulf and bay systems, and widest ranging open water reptile; omnivorous, shows a preference for jellyfish; in the US portion of their western Atlantic nesting territories, nesting season ranges from March to August

Loggerhead sea turtle	*Caretta caretta*	LT	T

Gulf and bay system primarily for juveniles, adults are most pelagic of the sea turtles; omnivorous, shows a preference for mollusks, crustaceans, and coral; nests from April through November

Texas diamondback terrapin *Malaclemys terrapin littoralis*

coastal marshes, tidal flats, coves, estuaries, and lagoons behind barrier beaches; brackish and salt water; burrows into mud when inactive; may venture into lowlands at high tide

Texas horned lizard	*Phrynosoma cornutum*	T

open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September

Timber/Canebrake rattlesnake	*Crotalus horridus*	T

swamps, floodplains, upland pine and deciduous woodlands, riparian zones, abandoned farmland; limestone bluffs, sandy soil or black clay; prefers dense ground cover, i.e. grapevines or palmetto

PLANTS		Federal Status	State Status
Coastal gay-feather	*Liatris bracteata*		

Texas endemic; coastal prairie grasslands of various types, from salty prairie on low- lying somewhat saline clay loams to upland prairie on nonsaline clayey to sandy loams; flowering in fall

Correll's false dragon-head *Physostegia correllii*

wet, silty clay loams on streamsides, in creek beds, irrigation channels and roadside drainage ditches; or seepy, mucky, sometimes gravelly soils along riverbanks or small islands in the Rio Grande; or underlain by Austin Chalk limestone along gently flowing spring-fed creek in central Texas; flowering May-September

GALVESTON COUNTY

PLANTS

Federal Status State Status

Grand Prairie evening primrose *Oenothera pilosella ssp sessilis*

known in Texas from a single historic collection from Galveston Island; elsewhere known from remnant moist to dry tallgrass prairies on sandy or silty Alfisols over claypan on ancient river terraces of the Mississippi Alluvial Plain, and fragipan flatwoods; flowering May-June

Houston daisy *Rayjacksonia aurea*

Texas endemic; on and around naturally barren or sparsely vegetated saline slick spots or pimple mounds on coastal prairies, usually on sandy to sandy loam soils, occasionally in pastures and on roadsides in similar soil types where mowing may mimic natural prairie disturbance regimes; flowering late September-November (-December)

Texas ladies'-tresses *Spiranthes brevilabris var. brevilabris*

Sandy soils in moist prairies, incl. blackland/Fleming prairies, calcareous prairie pockets surrounded by pines, pine-hardwood forest, open pinelands, wetland pine savannahs/flatwoods, and dry to moist fields, meadows, and roadsides. Delicate, nearly ephemeral orchid, producing winter rosettes, flowers Feb-Apr. Historically endemic to SE coastal plain.

Texas windmill-grass *Chloris texensis*

Texas endemic; sandy to sandy loam soils in relatively bare areas in coastal prairie grassland remnants, often on roadsides where regular mowing may mimic natural prairie fire regimes; flowering in fall

Threeflower broomweed *Thurovia triflora*

Texas endemic; near coast in sparse, low vegetation on a veneer of light colored silt or fine sand over saline clay along drier upper margins of ecotone between between salty prairies and tidal flats; further inland associated with vegetated slick spots on prairie mima mounds; flowering September-November

Table H-3. Overall Species totals, richness, frequency and abundance per point at USMC Site – 2010 and 2011.													
	1	2	3a	3b	4	5a	5b	6	7	8	Total	Frequency	Abundance
American Goldfinch		1	1		7	1		33	1		44	60.00%	4.40
American Green-winged Teal			1		12						13	20.00%	1.30
American Kestrel	2							3	3	1	9	40.00%	0.90
American Pipit	1				1				3		5	30.00%	0.50
American Robin				1		2					3	20.00%	0.30
American White Pelican	11		37			13		1			62	40.00%	6.20
Baltimore Oriole		4						2	1		7	30.00%	0.70
Bank Swallow				1							1	10.00%	0.10
Barn Swallow	143	57	56	12	15	48	3	140	69	18	561	100.00%	56.10
Belted Kingfisher	6		1	1				1	2	4	15	60.00%	1.50
Black Skimmer	2	4			1000						1006	30.00%	100.60
Black Tern								1			1	10.00%	0.10
Black Vulture					2	2			1		5	30.00%	0.50
Black-bellied Plover	7	2	1				1				11	40.00%	1.10
Black-bellied Whistling-Duck			2	10	4	5	6	2	72		101	70.00%	10.10
Black-billed Cuckoo			1								1	10.00%	0.10
Black-crowned Night-Heron	1		1		5						7	30.00%	0.70
Black-necked Stilt	4	2	8	17	16						47	50.00%	4.70
Blue Grosbeak				3				2	1		6	30.00%	0.60
Blue Jay								2			2	10.00%	0.20
Blue-winged Teal			187		81	2		6	2		278	50.00%	27.80
Boat-tailed Grackle									2		2	10.00%	0.20
Bonaparte's Gull					1						1	10.00%	0.10
Broad-winged Hawk									4		4	10.00%	0.40
Brown Pelican	607	250	165	99	81	76	55	228	155	183	1899	100.00%	189.90
Brown Thrasher		1	1	5				3	2		12	50.00%	1.20
Brown-headed Cowbird	72	40	27	8	26	18	12	15	11	22	251	100.00%	25.10
Caspian Tern	19	1	8						3	7	38	50.00%	3.80
Cattle Egret	6	25				4		80	107	1	223	60.00%	22.30
Cedar Waxwing		4	3		3	4					14	40.00%	1.40
Chestnut-sided Warbler			1								1	10.00%	0.10
Chimney Swift				3		4		7	4		18	40.00%	1.80
Chipping Sparrow		1						3	3		7	30.00%	0.70

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	1	2	3a	3b	4	5a	5b	6	7	8	Total	Frequency	Abundance
Clapper Rail	1										1	10.00%	0.10
Cliff Swallow	17	17	16		15	18		17	10		110	70.00%	11.00
Common Grackle		5						4	2		11	30.00%	1.10
Common Ground-Dove		3			1						4	20.00%	0.40
Common Loon	3										3	10.00%	0.30
Common Moorhen						2					2	10.00%	0.20
Common Tern								1			1	10.00%	0.10
Common Yellowthroat	5	16	7	8	12	9	15	22	36	5	135	100.00%	13.50
Cooper's Hawk								1			1	10.00%	0.10
Crested Caracara					1						1	10.00%	0.10
Dickcissel		6	2	6		2	3	2		1	22	70.00%	2.20
Double-crested Cormorant	49	3	21			1		1		6	81	60.00%	8.10
Downy Woodpecker									1		1	10.00%	0.10
Eastern Kingbird	7	10	15		15	14	3	24	11		99	80.00%	9.90
Eastern Meadowlark	10					6	1	72	55	4	148	60.00%	14.80
Eastern Phoebe	4		7	3	4	4	3	3	8	1	37	90.00%	3.70
Eastern Wood-Pewee		2			1						3	20.00%	0.30
Eurasian Collared-Dove	6	3		12			12	10	13	7	63	70.00%	6.30
European Starling	252	44	15		23	151	8	549	755	156	1953	90.00%	195.30
Forster's Tern	109	6	4							5	124	40.00%	12.40
Fulvous Whistling-Duck					2						2	10.00%	0.20
Golden-crowned Kinglet		1		3			3				7	30.00%	0.70
Gray Catbird		1		1	3	2		4	5		16	60.00%	1.60
Great Blue Heron	12	1	6	3	29	52		2	2	4	111	90.00%	11.10
Great Crested Flycatcher				1			1				2	20.00%	0.20
Great Egret	9	9	6	2	6	3	3	5	6	2	51	100.00%	5.10
Great Kiskadee		1									1	10.00%	0.10
Greater Yellowlegs	1		2	1	2	7			1	1	15	70.00%	1.50
Great-tailed Grackle	417	114	62	22	64	86	54	371	395	145	1730	100.00%	173.00
Gull-billed Tern	5										5	10.00%	0.50
Herring Gull	11	1	1		4			2			19	50.00%	1.90
Horned Lark	2		6								8	20.00%	0.80
House Sparrow	1			2				6	2	3	14	50.00%	1.40
House Wren	5	3	4	9	2	4	7	29	12	1	76	100.00%	7.60
Indigo Bunting		5	7	28	3		6	14	8	1	72	80.00%	7.20

Table H-3. Overall Species totals, richness, frequency and abundance per point at USMC Site – 2010 and 2011.													
	1	2	3a	3b	4	5a	5b	6	7	8	Total	Frequency	Abundance
Killdeer	4	5	31	13	44	20	11	11	24	3	166	100.00%	16.60
King Rail					1						1	10.00%	0.10
Laughing Gull	2173	460	812	118	178	120	39	487	347	796	5530	100.00%	553.00
Le Conte's Sparrow			1								1	10.00%	0.10
Least Bittern			1		1						2	20.00%	0.20
Least Sandpiper	13	2								2	17	30.00%	1.70
Least Tern	4	2	2							3	11	40.00%	1.10
Lesser Yellowlegs			1								1	10.00%	0.10
Lincoln's Sparrow	1	1	1	6	1	1	10	6	4		31	90.00%	3.10
Little Blue Heron	13	1	5		4	1				3	27	60.00%	2.70
Loggerhead Shrike	3	2		1		9	4	9	8	7	43	80.00%	4.30
Magnificent Frigatebird	7	18	1	3			6	13	10	14	72	80.00%	7.20
Marbled Godwit		3		1					1		5	30.00%	0.50
Marsh Wren	1	12	10		9	10		1			43	60.00%	4.30
Monk Parakeet								2			2	10.00%	0.20
Mottled Duck	3		4	2	26	22	4	5			66	70.00%	6.60
Mourning Dove	26	34	11	8	23	28	40	96	90	15	371	100.00%	37.10
Nashville Warbler		2		3				1			6	30.00%	0.60
Neotropic Cormorant	93	47	39	1		2	4	5	10	46	247	90.00%	24.70
Northern Cardinal		4	5	3	4	3	1	9	7		36	80.00%	3.60
Northern Flicker		1	1	1	1	1		3			8	60.00%	0.80
Northern Harrier	1	3	2		2	4	3	2	3		20	80.00%	2.00
Northern Mockingbird	41	48	27	7	27	47	22	72	78	8	377	100.00%	37.70
Northern Rough-winged Swallow	3				4	7	2	3	2		21	60.00%	2.10
Northern Shoveler	1		58		65	112		4	3		243	60.00%	24.30
Northern Waterthrush									1		1	10.00%	0.10
Orange-crowned Warbler	2		5	1	10	4	1	11	2		36	80.00%	3.60
Orchard Oriole		5	2	6				2	1		16	50.00%	1.60
Osprey	10	1	4		6	1	1	4	3	3	33	90.00%	3.30
Painted Bunting								1			1	10.00%	0.10
Pectoral Sandpiper					2						2	10.00%	0.20
Peregrine Falcon	1	1	1		2	2	1	1	2		11	80.00%	1.10
Purple Martin			5			1		2	12		20	40.00%	2.00
Red-breasted Merganser	2										2	10.00%	0.20

Table H-3. Overall Species totals, richness, frequency and abundance per point at USMC Site – 2010 and 2011.													
	1	2	3a	3b	4	5a	5b	6	7	8	Total	Frequency	Abundance
Reddish Egret	3			1	1					1	6	40.00%	0.60
Red-shouldered Hawk						1		3	1		5	30.00%	0.50
Red-tailed Hawk	1		3		4	3					11	40.00%	1.10
Red-winged Blackbird	132	42	51	27	71	53	14	55	26	14	485	100.00%	48.50
Ring-billed Gull	11	7	6		2	2		4	1	3	36	80.00%	3.60
Rock Pigeon	106	55	7	2	7	87	7	268	124	17	680	100.00%	68.00
Roseate Spoonbill	3		1		1		2		1		8	50.00%	0.80
Royal Tern	66	37	11	15	3	10	5	18	49	51	265	100.00%	26.50
Ruby-crowned Kinglet		1	2		3		1	2	4		13	60.00%	1.30
Ruby-throated Hummingbird		4	8		2	1		1	1		17	60.00%	1.70
Ruddy Turnstone	74	5	2							2	83	40.00%	8.30
Rusty Blackbird	2										2	10.00%	0.20
Sanderling	27										27	10.00%	2.70
Sandwich Tern	7	8	2							11	28	40.00%	2.80
Savannah Sparrow	22	5	3	2	16	37	3	58	73	17	236	100.00%	23.60
Scissor-tailed Flycatcher	1	10	3	3	1		2	14	27	5	66	90.00%	6.60
Seaside Sparrow	1			1							2	20.00%	0.20
Sedge Wren	1		2	1		2	1	1	1		9	70.00%	0.90
Short-billed Dowitcher	5				1						6	20.00%	0.60
Snow Goose			2		0						2	20.00%	0.20
Snowy Egret	30	22	19	4	24	7		1		4	111	80.00%	11.10
Solitary Sandpiper						4		4			8	20.00%	0.80
Song Sparrow	2	1	4		1	6		9	23		46	70.00%	4.60
Spotted Sandpiper	9	1	1	1		1				2	15	60.00%	1.50
Summer Tanager									1		1	10.00%	0.10
Swainson's Hawk								1			1	10.00%	0.10
Swamp Sparrow	4	6	15	2	14	10	2	7	9		69	90.00%	6.90
Tennessee Warbler		1	2								3	20.00%	0.30
Tree Swallow		15	3		6	4		9			37	50.00%	3.70
Tricolored Heron	3	1			2						6	30.00%	0.60
Unknown Blackbird sp.		7								27	34	20.00%	3.40
Unknown Cormorant sp.	44	20	16	4	3	3	1	26	3	2	122	100.00%	12.20
Unknown Dove sp.		2		1	0		10	10	9		32	60.00%	3.20
Unknown Duck sp.			1	1		45		10		50	107	50.00%	10.70

Table H-3. Overall Species totals, richness, frequency and abundance per point at USMC Site – 2010 and 2011.													
	1	2	3a	3b	4	5a	5b	6	7	8	Total	Frequency	Abundance
Unknown Flycatcher sp.			1	1							2	20.00%	0.20
Unknown Gull sp.	266		3	5	1	8		4	1	58	346	80.00%	34.60
Unknown Heron/Egret sp.								2			2	10.00%	0.20
Unknown Hummingbird sp.		2		1				1			4	30.00%	0.40
Unknown Ibis sp.									1		1	10.00%	0.10
Unknown Passerine sp.	3	10		12			15	18	11	4	73	70.00%	7.30
Unknown Plover sp.										1	1	10.00%	0.10
Unknown Rail sp.					1						1	10.00%	0.10
Unknown Sandpiper sp.	12										12	10.00%	1.20
Unknown Shorebird sp.	209		2	5				3		10	229	50.00%	22.90
Unknown Sparrow sp.	5	8	4		1	3	7	31	5	1	65	90.00%	6.50
Unknown Swallow sp.	17			0			18			2	37	40.00%	3.70
Unknown Tern sp.	21	20	2			4	9	3	4	9	72	80.00%	7.20
Unknown Vireo sp							1				1	10.00%	0.10
Unknown Warbler sp.		1		3	2			32			38	40.00%	3.80
Unknown Waterbird sp.								2			2	10.00%	0.20
Upland Sandpiper	39							8	16		63	30.00%	6.30
Vermilion Flycatcher					1						1	10.00%	0.10
Western Kingbird							1				1	10.00%	0.10
Western Sandpiper	1										1	10.00%	0.10
White Ibis	77		2			9			16	130	234	50.00%	23.40
White-crowned Sparrow								2			2	10.00%	0.20
White-faced Ibis							45				45	10.00%	4.50
White-rumped Sandpiper					1						1	10.00%	0.10
White-tailed Kite	1	4			1	3			1		10	50.00%	1.00
White-throated Sparrow	1		2		7			3	4		17	50.00%	1.70
White-winged Dove		13		7			58	172	43	2	295	60.00%	29.50
Willet	50	42	33	4	26	12		3		9	179	80.00%	17.90
Wilson's Plover	1		1								2	20.00%	0.20
Wilson's Snipe		1					1				2	20.00%	0.20
Yellow Palm Warbler		13	15	1	13	3		5	1	1	52	80.00%	5.20
Yellow Warbler		5	5	2	1			1	2		16	60.00%	1.60

Table H-3. Overall Species totals, richness, frequency and abundance per point at USMC Site – 2010 and 2011.													
	1	**2**	**3a**	**3b**	**4**	**5a**	**5b**	**6**	**7**	**8**	**Total**	**Frequency**	**Abundance**
Yellow-bellied Sapsucker		1			1						2	20.00%	0.20
Yellow-breasted Chat			3								3	10.00%	0.30
Yellow-crowned Night-Heron	1										1	10.00%	0.10
Yellow-rumped warbler	1	8	17	1	25	13	1	13	7	5	91	100.00%	9.10
Number of Individuals	**5468**	**1673**	**1965**	**542**	**2094**	**1266**	**549**	**3222**	**2841**	**1916**	**21536**		**2153.60**
Species Richness	**82**	**78**	**84**	**56**	**77**	**66**	**47**	**84**	**77**	**49**	**152**		

Table H-6. Overall Species totals, richness, frequency and abundance per point at reference locations – 2010 and 2011*														
Species	**A**	**B1**	**B2**	**C**	**D**	**E1**	**E2**	**F**	**G**	**H**	**I**	**Total**	**Frequency**	**Abundance**
American Avocet					2							2	9.09%	0.18
American Coot			1									1	9.09%	0.09
American Goldfinch	7		1						1			9	27.27%	0.82
American Green-winged Teal						3		1	1			5	27.27%	0.45
American Kestrel	2						3					5	18.18%	0.45
American Oystercatcher			2	6	9							17	27.27%	1.55
American Pipit					1							1	9.09%	0.09
American Redstart	12								17			29	18.18%	2.64
American Robin	6											6	9.09%	0.55
American White Pelican				2	127		2					131	27.27%	11.91
American Wigeon						1						1	9.09%	0.09
Baird's Sandpiper								3				3	9.09%	0.27
Baltimore Oriole	2								4			6	18.18%	0.55
Barn Swallow	42	41	6	3	13	24	4	87	28			248	81.82%	22.55
Bay-breasted Warbler									1			1	9.09%	0.09
Belted Kingfisher	2		1	2			6		2			13	45.45%	1.18
Black Skimmer				2748	1298							4046	18.18%	367.82
Black Tern				3	900							903	18.18%	82.09
Black-and-White Warbler	9							1	17			27	27.27%	2.45
Black-bellied Plover			5	30	98							133	27.27%	12.09
Black-bellied Whistling-Duck	7					4	3		4	2		20	45.45%	1.82
Black-billed Cuckoo	1											1	9.09%	0.09

Table H-6. Overall Species totals, richness, frequency and abundance per point at reference locations – 2010 and 2011*														
Species	**A**	**B1**	**B2**	**C**	**D**	**E1**	**E2**	**F**	**G**	**H**	**I**	**Total**	**Frequency**	**Abundance**
Blackburnian Warbler									3			3	9.09%	0.27
Black-crowned Night-Heron	13					4	4	1	2			24	45.45%	2.18
Black-necked Stilt	2		30	55	4	23	15	23	13			165	72.73%	15.00
Blackpoll Warbler									1			1	9.09%	0.09
Black-throated Green Warbler									5			5	9.09%	0.45
Blue Grosbeak	1	1							7			9	27.27%	0.82
Blue Jay	1								13			14	18.18%	1.27
Blue-gray Gnatcatcher	8	1						1	23			33	36.36%	3.00
Blue-headed Vireo	1								2			3	18.18%	0.27
Blue-winged Teal						79		77	28			184	27.27%	16.73
Boat-tailed Grackle				1								1	9.09%	0.09
Bonaparte's Gull				9	7							16	18.18%	1.45
Brown Pelican	39	150	166	613	1622	37	43	36	7	14	29	2756	100.00%	250.55
Brown Thrasher	11							1	9			21	27.27%	1.91
Brown-headed Cowbird	17	30	2	1	5	5	4	13	24	3	2	106	100.00%	9.64
Carolina Wren	7											7	9.09%	0.64
Caspian Tern	1	2	10	30	19			1				63	54.55%	5.73
Cassin's Sparrow				1								1	9.09%	0.09
Cattle Egret		7			80			12				99	27.27%	9.00
Chestnut-sided Warbler									1			1	9.09%	0.09
Chimney Swift	3					4		2	1			10	36.36%	0.91
Chipping Sparrow									2			2	9.09%	0.18
Clapper Rail			3	11			31					45	27.27%	4.09
Cliff Swallow	15	2				5		31	3			56	45.45%	5.09
Common Grackle	8							3		3		14	27.27%	1.27
Common Loon				3								3	9.09%	0.27
Common Moorhen						1						1	9.09%	0.09
Common Snipe									1			1	9.09%	0.09
Common Tern		1		11	513							525	27.27%	47.73
Common Yellowthroat	22	2	1				5		6	1	1	38	63.64%	3.45
Cooper's Hawk	2						1					3	18.18%	0.27
Cordilleran Flycatcher	1											1	9.09%	0.09
Dickcissel	1	2					1		2			6	36.36%	0.55
Double-crested Cormorant		1	12	16	5	6						40	45.45%	3.64
Downy Woodpecker	5							1	7			13	27.27%	1.18
Dunlin				48	93				3			144	27.27%	13.09

Table H-6. Overall Species totals, richness, frequency and abundance per point at reference locations – 2010 and 2011*														
Species	**A**	**B1**	**B2**	**C**	**D**	**E1**	**E2**	**F**	**G**	**H**	**I**	**Total**	**Frequency**	**Abundance**
Eastern Kingbird	16	1							7			24	27.27%	2.18
Eastern Meadowlark				1								1	9.09%	0.09
Eastern Phoebe	6			1			3					10	27.27%	0.91
Eastern Wood-Pewee	1								11			12	18.18%	1.09
Eurasian Collared-Dove			2			2	3	2	3			12	45.45%	1.09
European Starling	233	28	18	51	7	72	237	157	33	3	19	858	100.00%	78.00
Forster's Tern		2	50	45	306	2	1					406	54.55%	36.91
Franklin's Gull		1		0	23							24	27.27%	2.18
Fulvous Whistling-Duck						4						4	9.09%	0.36
Gadwall								1				1	9.09%	0.09
Golden-crowned Kinglet	1											1	9.09%	0.09
Gray Catbird	7								22			29	18.18%	2.64
Great Blue Heron	2		2	10	6	10	12	1				43	63.64%	3.91
Great Crested Flycatcher	2								2			4	18.18%	0.36
Great Egret			16	22	24	17	24	5	1	4	2	115	81.82%	10.45
Great Horned Owl									1			1	9.09%	0.09
Greater Yellowlegs			6	45	2	4	5		4			66	54.55%	6.00
Great-tailed Grackle	93	29	237	112	62	53	168	83	28	14	11	890	100.00%	80.91
Green Heron	1								1			2	18.18%	0.18
Gull-billed Tern				3	2							5	18.18%	0.45
Herring Gull		1	4	39	87	5						136	45.45%	12.36
Hooded Warbler	4							1	17			22	27.27%	2.00
House Sparrow	1							5	16			22	27.27%	2.00
House Wren	18	1					1		11			31	36.36%	2.82
Hudsonian Godwit				1								1	9.09%	0.09
Inca Dove	2								11			13	18.18%	1.18
Indigo Bunting	22	8	1				1		53			85	45.45%	7.73
Kentucky Warbler									2			2	9.09%	0.18
Killdeer	17	2	6	10	3	2	18	1	4			63	81.82%	5.73
King Rail							4					4	9.09%	0.36
Ladder-backed Woodpecker									3			3	9.09%	0.27
Lark Sparrow	1											1	9.09%	0.09
Laughing Gull	58	265	630	1435	10586	88	128	92	17	21	16	13336	100.00%	1212.36
Least Sandpiper			19	12	8		4		6			49	45.45%	4.45
Least Tern			6	47	46							99	27.27%	9.00
Lesser Black-backed Gull					2							2	9.09%	0.18

Table H-6. Overall Species totals, richness, frequency and abundance per point at reference locations – 2010 and 2011*														
Species	**A**	**B1**	**B2**	**C**	**D**	**E1**	**E2**	**F**	**G**	**H**	**I**	**Total**	**Frequency**	**Abundance**
Lesser Scaup			3		50							53	18.18%	4.82
Lesser Yellowlegs				7		8	5	1	8			29	45.45%	2.64
Lincoln's Sparrow	10	1			1				3			15	36.36%	1.36
Little Blue Heron	4		1	2		4	6	2				19	54.55%	1.73
Loggerhead Shrike	1		3	3		3	10		1			21	54.55%	1.91
Long-billed Curlew				18								18	9.09%	1.64
Long-billed Dowitcher									3			3	9.09%	0.27
Magnificent Frigatebird			6									6	9.09%	0.55
Magnolia Warbler									4			4	9.09%	0.36
Marbled Godwit			6	159	3							168	27.27%	15.27
Marsh Wren							17					17	9.09%	1.55
Mottled Duck				2	2	18	48	8	8	6		92	63.64%	8.36
Mourning Dove	46	35	10	24	13	42	72	40	39		4	325	90.91%	29.55
Nashville Warbler									2			2	9.09%	0.18
Neotropic Cormorant		23	60	112	76	4	28			1	3	307	72.73%	27.91
Northern Cardinal	33	1						1	35			70	36.36%	6.36
Northern Harrier	2			2	1	1	6	2		1	1	16	72.73%	1.45
Northern Mockingbird	60	21	3		1		14	24	42	1	2	168	81.82%	15.27
Northern Parula	7								8			15	18.18%	1.36
Northern Rough-winged Swallow			5				4		2			11	27.27%	1.00
Northern Shoveler				6		48	7	41	2			104	45.45%	9.45
Orange-crowned Warbler	10		1						6			17	27.27%	1.55
Orchard Oriole	11	1							22			34	27.27%	3.09
Osprey	1	1	4	3	1		4	2	1			17	72.73%	1.55
Ovenbird									1			1	9.09%	0.09
Painted Bunting	4								6			10	18.18%	0.91
Pectoral Sandpiper								1	5			6	18.18%	0.55
Peregrine Falcon					2							2	9.09%	0.18
Pied-billed Grebe			5			3						8	18.18%	0.73
Pileated Woodpecker	2											2	9.09%	0.18
Piping Plover			1	56	129							186	27.27%	16.91
Prothonotary Warbler	8								10			18	18.18%	1.64
Purple Martin	3	10							8		6	27	36.36%	2.45

Table H-6. Overall Species totals, richness, frequency and abundance per point at reference locations – 2010 and 2011*														
Species	**A**	**B1**	**B2**	**C**	**D**	**E1**	**E2**	**F**	**G**	**H**	**I**	**Total**	**Frequency**	**Abundance**
Red Knot				1	8							9	18.18%	0.82
Red-breasted Merganser				21								21	9.09%	1.91
Reddish Egret			27	17	13	7	2			1		67	54.55%	6.09
Red-eyed Vireo	1								11			12	18.18%	1.09
Red-shouldered Hawk	1											1	9.09%	0.09
Red-tailed Hawk			3				5		1			9	27.27%	0.82
Red-winged Blackbird	28	15	67		2	37	25	12	5	3	2	196	90.91%	17.82
Ring-billed Gull		4	20	526	345	2		3				900	54.55%	81.82
Rock Pigeon		12	88	41	1	5	23	16	42	2	5	235	90.91%	21.36
Roseate Spoonbill			3	24	14	19	13	1	2	1		77	72.73%	7.00
Rose-breasted Grosbeak	6								9			15	18.18%	1.36
Royal Tern	8	10	10	272	1820	4	7		2		1	2134	81.82%	194.00
Ruby-crowned Kinglet	9								4			13	18.18%	1.18
Ruby-throated Hummingbird	6	3							5			14	27.27%	1.27
Ruddy Turnstone		21	6	103	220			1				351	45.45%	31.91
Sanderling			37	364	1289							1690	27.27%	153.64
Sandwich Tern			14	142	497		2					655	36.36%	59.55
Savannah Sparrow		17	3		1	1	6	19	4			51	63.64%	4.64
Scarlet Tanager	1								7			8	18.18%	0.73
Scissor-tailed Flycatcher	4	2					3	4	3		1	17	54.55%	1.55
Seaside Sparrow							7					7	9.09%	0.64
Sedge Wren			1	2			5					8	27.27%	0.73
Semipalmated Plover				48	29				2			79	27.27%	7.18
Semipalmated Sandpiper				4	5							9	18.18%	0.82
Short-billed Dowitcher				2					4			6	18.18%	0.55
Snowy Egret	1	22	12	32	25	49	23	44	5	4		217	90.91%	19.73
Snowy Plover				31	64							95	18.18%	8.64
Solitary Sandpiper			1			6		13	16			36	36.36%	3.27
Song Sparrow	1						1		1			3	27.27%	0.27
Spotted Sandpiper					1				3			4	18.18%	0.36
Stilt Sandpiper				2					7			9	18.18%	0.82
Summer Tanager	10								19			29	18.18%	2.64
Surf Scoter				1								1	9.09%	0.09
Swainson's Thrush	2								8			10	18.18%	0.91
Swamp	1		2				11					14	27.27%	1.27

Table H-6. Overall Species totals, richness, frequency and abundance per point at reference locations – 2010 and 2011*														
Species	**A**	**B1**	**B2**	**C**	**D**	**E1**	**E2**	**F**	**G**	**H**	**I**	**Total**	**Frequency**	**Abundance**
Sparrow														
Tennessee Warbler	3								13			16	18.18%	1.45
Tree Swallow	31							9	10			50	27.27%	4.55
Tricolored Heron				7	1	1	2	2				13	45.45%	1.18
Unknown Blackbird sp.	30											30	9.09%	2.73
Unknown Cormorant sp.			63	3	13							79	27.27%	7.18
Unknown Dove sp.	30					1			21			52	27.27%	4.73
Unknown Dowitcher sp.			21	19			4					44	27.27%	4.00
Unknown Duck sp.				2	2		25					29	27.27%	2.64
Unknown Flycatcher sp.									1			1	9.09%	0.09
Unknown Gull sp.			35	1	748		1					785	36.36%	71.36
Unknown Heron/Egret sp.			1	10			2					13	27.27%	1.18
Unknown Hummingbird sp.									5			5	9.09%	0.45
Unknown Night Heron sp.	4											4	9.09%	0.36
Unknown Passerine sp.	12		1		1		7		7			28	45.45%	2.55
Unknown Raptor sp.	1											1	9.09%	0.09
Unknown Sandpiper sp.			21	16	1							38	27.27%	3.45
Unknown Shorebird sp.			3	110	950							1063	27.27%	96.64
Unknown Sparrow sp.			2			1	2					5	27.27%	0.45
Unknown Swallow sp.	5						16		2			23	27.27%	2.09
Unknown Tern sp.	2	1	4	60	201	10	2					280	63.64%	25.45
Unknown Warbler sp.	3					1	1		4			9	36.36%	0.82
Unknown Waterthrush						1						1	9.09%	0.09
Unknown Wren sp.							1					1	9.09%	0.09
Western Kingbird							1					1	9.09%	0.09
Western Sandpiper			8	390	326				3			727	36.36%	66.09
Western Tanager	1											1	9.09%	0.09
Whimbrel				1								1	9.09%	0.09
White Ibis	4		52	10			7					73	36.36%	6.64
White-crowned Sparrow			1									1	9.09%	0.09
White-eyed Vireo	8								10			18	18.18%	1.64
White-faced							2					2	9.09%	0.18

Table H-6. Overall Species totals, richness, frequency and abundance per point at reference locations – 2010 and 2011*														
Species	**A**	**B1**	**B2**	**C**	**D**	**E1**	**E2**	**F**	**G**	**H**	**I**	**Total**	**Frequency**	**Abundance**
Ibis														
White-rumped Sandpiper									2			2	9.09%	0.18
White-tailed Kite		1					1		1			3	27.27%	0.27
White-throated Sparrow	18											18	9.09%	1.64
White-winged Dove	18						70		225	4		317	36.36%	28.82
Willet		35	49	114	121	26	4	15	8			372	72.73%	33.82
Wilson's Phalarope						6			24			30	18.18%	2.73
Wilson's Plover				55	36							91	18.18%	8.27
Wilson's Snipe	1								4			5	18.18%	0.45
Wilson's Warbler									2			2	9.09%	0.18
Wood Thrush									1			1	9.09%	0.09
Worm-eating Warbler									1			1	9.09%	0.09
Yellow Palm Warbler	1	2			2				14			19	36.36%	1.73
Yellow Warbler	2								11			13	18.18%	1.18
Yellow-bellied Sapsucker									2			2	9.09%	0.18
Yellow-billed Cuckoo									1			1	9.09%	0.09
Yellow-breasted Chat									1			1	9.09%	0.09
Yellow-crowned Night-Heron	9			1		6	4					20	36.36%	1.82
Yellow-rumped warbler	36	11	1		1				23			72	45.45%	6.55
Yellow-throated Vireo	4								9			13	18.18%	1.18
Yellow-throated Warbler									2			2	9.09%	0.18
Number of Individuals	**1237**	**827**	**1901**	**8253**	**22976**	**769**	**1237**	**903**	**1274**	**89**	**105**	**39571**		**3597.36**
Species Richness	**89**	**43**	**59**	**72**	**74**	**46**	**61**	**49**	**115**	**19**	**16**	**193**		

*Abundance and frequency based on 14 surveys. September 15, no survey of location B2. September 16, one AM survey at location B2. September 28, no survey at location G. September 29, location G surveyed in AM. October 6, additional survey at location G. October 7, AM survey at location G. October 8, no survey of location G. October 29, additional AM survey of location A.