DRAFT
ENVIRONMENTAL ASSESSMENT

WALLOPS FLIGHT FACILITY
ALTERNATIVE ENERGY PROJECT

Prepared for

National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, VA 23337

In cooperation with

U.S. Army Corps of Engineers

March 2010

Prepared by

URS

URS Group, Inc.
200 Orchard Ridge Drive, Suite 101
Gaithersburg, MD 20878
15300762

This page intentionally left blank.

DRAFT ENVIRONMENTAL ASSESSMENT
ALTERNATIVE ENERGY PROJECT
WALLOPS FLIGHT FACILITY

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA 23337

Lead Agency: National Aeronautics and Space Administration

Cooperating Agency: U.S. Army Corps of Engineers

Proposed Action: Alternative Energy Project

For Further Information:
Joshua A. Bundick
Code 250.W
Goddard Space Flight Center's Wallops Flight Facility
National Aeronautics and Space Administration
Wallops Island, VA 23337
(757) 824-2319

Date: March 2010

Abstract: This Draft Environmental Assessment has been prepared to evaluate the potential environmental impacts from alternative energy sources that would be capable of generating up to 10 gigawatt-hours per year of electricity at Wallops Flight Facility (WFF). The purpose of the proposed Alternative Energy Project is to generate clean, renewable energy at WFF from a technologically proven source in order to meet the requirements of the 2005 Federal Energy Policy Act and Executive Orders 13423 and 13514. The WFF project would also support the National Aeronautics and Space Administration's goal to set an example of leadership in environmental stewardship and accountability by a Federal agency. The Proposed Action would have both adverse and beneficial impacts to environmental resources. Adverse impacts would be mitigated to the greatest extent practicable to minimize the effects on resources.

This page intentionally left blank.

INTRODUCTION

This Draft Environmental Assessment (EA) has been prepared to evaluate the potential environmental impacts from alternative energy sources that would be capable of generating up to 10 gigawatt-hours per year (GWh/year) of electricity at National Aeronautics and Space Administration's (NASA's) Wallops Flight Facility (WFF). This EA has been prepared in accordance with the National Environmental Policy Act of 1969 (NEPA), as amended (42 United States Code [U.S.C.] 4321–4347), the Council on Environmental Quality (CEQ) regulations for implementing NEPA (40 Code of Federal Regulations [CFR] 1500–1508), the NASA regulations for implementing NEPA (14 CFR Subpart 1216.3), and the NASA Procedural Requirements (NPR): *Implementing NEPA and Executive Order (EO) 12114* (NPR 8580.1).

The U.S. Army Corps of Engineers (USACE) has served as a Cooperating Agency in the preparation of this EA because they possess regulatory authority over the Proposed Action. This EA is being developed to also fulfill the USACE's obligations under NEPA. NASA, as the WFF property owner and project proponent, is the Lead Agency and responsible for ensuring overall compliance with applicable environmental statutes, including NEPA.

PURPOSE AND NEED FOR THE ACTION

The purpose of the proposed Alternative Energy Project is to generate clean, renewable energy at WFF from a technologically proven source in order to meet the requirements of the 2005 Federal Energy Policy Act and EOs 13423 and 13514. The WFF project would also support NASA's goal to set an example of leadership in environmental stewardship and accountability by a Federal agency. Additionally, EO 13423 and NASA Policy Directive 8500.1B require revisions to the NASA Environmental Management System (EMS) procedural requirements, NPR 8553.1, to address the implementation of "sustainable practices" through the EMS, including energy/water conservation, reduction of greenhouse gases (GHGs), fleet management, sustainable acquisition, and development of sustainable facilities. The implementation of proven, renewable energy sources such as wind turbines or solar panels at WFF would meet the facility's goal to reduce GHG emissions by reducing the use of fossil fuels to generate electricity, while also reducing WFF's annual operating costs.

PROPOSED ACTION AND ALTERNATIVES

The Proposed Action and Alternatives consist of developing renewable, self-sufficient energy sources at WFF to supplement the electricity currently supplied to WFF by the local electric cooperative. These alternative energy sources would consist of proven technologies that would assist WFF in meeting its goals of reducing impacts on the natural environment. This EA encompasses a 25-year planning horizon, which is based on the expected life span of the proposed wind turbines and solar panels.

Proposed Action

Under the Proposed Action, NASA's preferred alternative, NASA would construct two 2.0-megawatt (MW) "utility-scale" wind turbines on Wallops Island that would be capable of generating approximately 10 GWh of electricity per year, and up to five 2.4-kilowatt (kW) "residential-scale" wind turbines at the Main Base and Mainland. The utility-scale wind turbines would be located on Wallops Island west of the U.S. Navy V-10/V-20 complex. One of the 2.4

kW wind turbines would be installed near the WFF Visitor Center, and a second one would be installed near the security guard station at the Mainland. The locations of the remaining three residential-scale wind turbines are unknown at this time, but would be placed within the areas that NASA has identified as potential suitable locations at WFF. The residential-scale turbines would not contribute much to the percent of energy generated from renewable sources at WFF because of their small power output; their primary purpose would be to provide outreach and education to WFF employees and the public about wind energy.

New access roads would be constructed to each utility-scale wind turbine. Underground power collection lines would be built to interconnect each wind turbine to the existing Wallops Island electrical distribution system. These power lines would be installed by directional drilling, a trenchless method, to avoid affecting wetlands. Previously disturbed areas, including the cleared area east of the U.S. Navy V-10/V-20 complex, would be used for staging of equipment and materials for the utility-scale turbines, and for construction vehicle parking. The construction period for the two utility-scale wind turbines would be approximately 6 months.

The residential-scale wind turbines would be constructed with a setback distance of 30 meters (100 feet) from existing towers, buildings, and trees. No transformers or interconnection switchgear would be needed.

Alternative One

Under Alternative One, NASA would construct one utility-scale wind turbine on Wallops Island that would be capable of generating 5 GWh of electricity per year. The single 2.0 MW wind turbine would be located west of the U.S. Navy V-10/V-20 complex in the same location as the southern wind turbine under the Proposed Action. The footprint, work space, and staging areas would be the same as described under the Proposed Action, but the construction period would be approximately 4 months. NASA would also install up to five 2.4 kW wind turbines at the Main Base and Mainland as described under the Proposed Action Alternative.

In addition to the wind turbines, NASA would install a system of solar panels at Wallops Main Base that would be capable of generating up to 5 GWh/year (the equivalent of one utility-scale wind turbine). Approximately 19,000-square-meter (15-square-foot) solar panels, equaling an area of approximately 3 hectares (7.5 acres), would be needed to meet this power generating capability. Panel spacing requirements (to avoid shading and allow maintenance) would increase the overall required land area dedicated to solar panels to approximately 16 hectares (40 acres).

The power generated by the solar panels would be connected via underground transmission lines to a set of switchgear that would be enclosed in a small 5-meter by 6-meter (16-foot by 20-foot) pre-fabricated building. Solar panels would be installed in open, grassy areas of Wallops Main Base. The installation period for the solar panels would be approximately 2 months.

Alternative Two

NASA would install up to five 2.4 kW wind turbines at the Main Base and Mainland as described under the Proposed Action Alternative. Alternative Two would also consist of installing a system of solar panels at Wallops Main Base that would be capable of generating 10 GWh/year of power. To produce this amount of energy, WFF would install approximately 38,000-square-meter (15-square-foot) solar panels that would equal an area of approximately 6 hectares (15 acres). Panel spacing requirements (to avoid shading and allow maintenance) would increase the overall required land area dedicated to solar panels to approximately 32 hectares (80 acres).

The power generated by the solar panels would be connected via underground transmission lines to a set of switchgear that would be enclosed in a small 5-meter by 6-meter (16-foot by 20-foot) pre-fabricated building. Solar panels would be installed in open, grassy areas of Wallops Main Base. All solar panels would be located and situated so as not to result in glare that would be a safety hazard to pilots flying in the WFF Aircraft Operating Area. The installation period for the solar panels would be approximately 4 months.

No Action Alternative

Under the No Action Alternative, NASA would not participate in the funding or construction of renewable energy sources at WFF to supplement the current supply of electricity that is provided by the local electric cooperative. The requirements for the implementation of sustainable practices for energy efficiency and reductions in GHG emissions, and for the use of renewable energy set forth in the Federal regulations, would not be met by WFF.

SUMMARY OF ENVIRONMENTAL IMPACTS

Under the No Action Alternative, activities would remain at present levels and there would be no additional impacts on environmental resources. However, there would be no reduction in the use of fossil fuels, which contribute to GHG production and global climate change, during the production of electricity that supplies WFF.

Potential environmental impacts resulting from the Proposed Action and Alternatives are summarized in the Table ES-1 below.

Table ES-1: Summary of Environmental Impacts for the Proposed Action and Alternatives

Resource	Proposed Action	Alternative One	Alternative Two
Topography	Long-term minor adverse impacts from construction of permanent access roads to wind turbines within wetlands. Changes to natural drainage patterns would be minor.	Long-term minor adverse impacts from construction of permanent access road to wind turbine within wetlands. Changes to natural drainage patterns would be minor.	No impacts.
Geology and Soils	Spills or leaks of pollutants would have the potential to adversely affect soils. NASA would implement site-specific Best Management Practices (BMPs) for vehicle and equipment fueling and maintenance, and spill prevention and control measures. Minor long-term	Spills or leaks of pollutants would have the potential to adversely affect soils. NASA would implement site-specific BMPs for vehicle and equipment fueling and maintenance, and spill prevention and control measures. Minor long-term impacts on geology immediately	Spills or leaks of pollutants would have the potential to adversely affect soils. NASA would implement site-specific BMPs for vehicle and equipment fueling and maintenance, and spill prevention and control measures. No impacts on geology.

Resource	Proposed Action	Alternative One	Alternative Two
	impacts on geology immediately around the driven piles.	around the driven piles.	
Land Use	No changes to or impacts on existing or planned land use.	No changes to or impacts on existing or planned land use at Wallops Island. Long-term adverse impacts on land use in areas of Main Base where solar panels would be installed.	Long-term adverse impacts on land use in areas of Main Base where solar panels would be installed.
Surface Waters	Potential adverse impacts from spills or leaks of pollutants. NASA would minimize adverse impacts by acquiring Virginia Stormwater Management Program (VSMP) permits as necessary and implementing BMPs and WFF's Integrated Contingency Plan (ICP).	Potential adverse impacts from spills or leaks of pollutants. NASA would minimize adverse impacts by acquiring VSMP permits as necessary and implementing BMPs and WFF's ICP.	Potential adverse impacts from spills or leaks of pollutants. NASA would minimize adverse impacts by acquiring VSMP permits as necessary and implementing BMPs and WFF's ICP.
Wetlands	Up to 0.36 hectare (0.88 acre) of wetlands would be filled. NASA would obtain necessary permits via the Virginia Marine Resources Commission (VMRC) Joint Permit Application (JPA) process and would implement 0.362 hectare (0.895 acre) of compensatory mitigation at WFF's Mainland.	Up to 0.17 hectare (0.41 acre) of wetlands would be filled. NASA would obtain necessary permits via the VMRC JPA process and would implement 0.17 hectare (0.41 acres) of compensatory mitigation at WFF's Mainland.	No impacts.
Floodplains	The wind turbines would be located within the 100-year and 500-year floodplains. Because Wallops Island is entirely within the floodplain, no practicable alternatives exist. The functionality of the floodplain on Wallops Island would not be adversely impacted.	The wind turbine would be located within the 100-year and 500-year floodplains. Because Wallops Island is entirely within the floodplain, no practicable alternatives exist. The functionality of the floodplain on Wallops Island would not be adversely impacted.	No impacts—the areas of the Main Base where solar panels would be installed are not within the floodplain.

Resource	Proposed Action	Alternative One	Alternative Two
Coastal Zone Management	All activities occur within Virginia's Coastal Management Area (CMA). NASA has determined that the Proposed Action is consistent with the enforceable policies of the Coastal Zone Management (CZM) Program.	All activities occur within Virginia's CMA. Activities under Alternative One would be conducted in a way that was consistent with the enforceable policies of the CZM Program.	All activities occur within Virginia's CMA. Activities under Alternative Two would be conducted in a way that was consistent with the enforceable policies of the CZM Program.
Air Quality and Climate Change	Long-term beneficial impacts on air quality and climate change with reduction in use of fossil-fuel power sources and GHG emissions.	Long-term beneficial impacts on air quality and climate change with reduction in use of fossil-fuel power sources and GHG emissions.	Long-term beneficial impacts on air quality and climate change with reduction in use of fossil-fuel power sources and GHG emissions.
Radar	The wind turbines would be sited in an area that would not impact radar systems at WFF.	The wind turbine would be sited in an area that would not impact radar systems at WFF. No impacts on radar from solar panels.	No impacts.
Noise	Operation of the wind turbines would result in highly localized, long-term, minor impacts on the surrounding environment from noise. Neither the public nor employees and visitors to WFF outside of Wallops Island would be able to hear the wind turbines; therefore, no impacts on either of these two groups would occur. No impacts on the occupational health of construction workers as a result of construction noise with implementation of BMPs.	Operation of the wind turbine would result in highly localized, long-term, minor impacts on the surrounding environment from noise. Neither the public nor employees and visitors to WFF outside of Wallops Island would be able to hear the wind turbines; therefore, no impacts on either of these two groups would occur. No impacts on the occupational health of construction workers as a result of construction noise with implementation of BMPs.	No impacts on the occupational health of construction workers as a result of installation noise with implementation of BMPs. No noise associated with operation of the solar panels.
Hazardous Materials and Hazardous Waste Management	Construction, maintenance, and decommissioning activities for the wind turbines would involve hazardous materials and produce hazardous waste. NASA would ensure implementation of WFF's ICP safety procedures,	Construction, maintenance, and decommissioning activities for the wind turbines and solar panels would involve hazardous materials and produce hazardous waste. NASA would ensure implementation of WFF's	Installation, maintenance, and decommissioning activities would involve hazardous materials and produce hazardous waste. NASA would ensure implementation of WFF's ICP safety procedures, training, and mitigation

Resource	Proposed Action	Alternative One	Alternative Two
	training, and mitigation measures, including spill prevention and response. Therefore, no impacts on human and environmental health due to hazardous materials and wastes are anticipated.	ICP safety procedures, training, and mitigation measures, including spill prevention and response. Therefore, no impacts on human and environmental health due to hazardous materials and wastes are anticipated.	measures, including spill prevention and response. Therefore, no impacts on human and environmental health due to hazardous materials and wastes are anticipated.
Vegetation and Terrestrial Wildlife	Short-term adverse impacts due to excavation and grading to construct the wind turbines, the access roads, and underground cables. Long-term, adverse impacts due to the permanent conversion of 0.36 hectare (0.88 acre) of wetlands to developed land.	Short-term adverse impacts due to excavation and grading to construct the wind turbines, the access roads, and underground cables. Long-term, adverse impacts due to the permanent conversion of 0.08 hectare (0.21 acre) of wetlands to developed land.	Long-term adverse, but highly localized, impacts from the loss of vegetation within the footprint of the support posts for the solar panels.
Birds and Bats	Long-term adverse impacts due to the conversion of wetland habitat to developed land and from operation of the wind turbines. Potential avoidance and/or minimization BMPs would be implemented to reduce the potential long-term (direct and indirect) impacts.	Long-term adverse impacts due to the conversion of wetland habitat to developed land and from operation of the wind turbines. Potential avoidance and/or minimization BMPs would be implemented to reduce the potential long-term (direct and indirect) impacts. Because the installation of solar panels at the Main Base would not alter or remove bat habitat, nor would their operation interfere with bird or bat activities, no impacts are anticipated from solar panels.	Because the installation of solar panels at the Main Base would not alter or remove bat habitat, nor would their operation interfere with bird or bat activities, no impacts are anticipated from solar panels.
Threatened and Endangered Species	NASA determined that the project “may affect, and is likely to adversely affect” the Piping Plover and Red Knot. The project would have “no effect” to federally listed mammals, sea turtles, insects, and plants. NASA submitted a	NASA determined that the project “may affect, and is likely to adversely affect” the Piping Plover and Red Knot. The project would have “no effect” to federally listed mammals, sea turtles, insects, and plants. NASA submitted a Biological	NASA determined that the solar panels would have no affect on State or federally listed species in the project area at the Main Base.

Resource	Proposed Action	Alternative One	Alternative Two
	Biological Assessment to the U.S. Fish and Wildlife Service (USFWS); no response has been received to date.	Assessment to USFWS; no response has been received to date. NASA determined that the solar panels would have no affect on State or federally listed species in the project area at the Main Base.	
Essential Fish Habitat (EFH)	Short-term adverse impacts on EFH from filling wetlands for utility-scale turbine footprints, but impacts are not expected to be substantial. Effects on EFH would be offset by compensatory mitigation at WFF's Mainland.	Short-term adverse impacts on EFH from filling wetlands for utility-scale turbine footprints, but impacts are not expected to be substantial. Effects on EFH would be offset by compensatory mitigation at WFF's Mainland.	No impacts.
Population, Employment, and Income	Construction activities may temporarily increase local employment opportunities and would benefit local stores and businesses.	Construction activities may temporarily increase local employment opportunities and would benefit local stores and businesses.	Construction activities may temporarily increase local employment opportunities and would benefit local stores and businesses.
Environmental Justice	No impacts. Disproportionately high or adverse impacts on low-income or minority populations are not anticipated because there would be no displacement of residences or businesses.	No impacts. Disproportionately high or adverse impacts on low-income or minority populations are not anticipated because there would be no displacement of residences or businesses.	No impacts. Disproportionately high or adverse impacts on low-income or minority populations are not anticipated because there would be no displacement of residences or businesses.
Cultural Resources	All ground disturbances are located outside of areas designated as having moderate or high potential for archeological resources. No adverse effects on archaeological resources are anticipated. Utility-scale turbines are not anticipated to adversely affect historic properties within or outside of WFF given the nature of the viewshed. No adverse effects on aboveground historic properties are anticipated. Residential-scale turbines	All ground disturbances are located outside of areas designated as having moderate or high potential for archeological resources. No adverse effects on archaeological resources are anticipated. Utility-scale turbine is not anticipated to adversely affect historic properties within or outside of WFF given the nature of the viewshed. No adverse effects on aboveground historic properties are anticipated. Solar panels are not	All ground disturbances are located outside of areas designated as having moderate or high potential for archeological resources. No adverse effects on archaeological resources are anticipated. Solar panels are not anticipated to adversely affect aboveground historic properties within WFF. However, solar panels may have indirect adverse effects to aboveground historic properties outside WFF. Residential-scale turbines are not anticipated to adversely affect aboveground historic

Resource	Proposed Action	Alternative One	Alternative Two
	are not anticipated to adversely affect aboveground historic properties within WFF. However, residential-scale turbines may have direct adverse effects on aboveground historic properties in WFF and indirect adverse effects on aboveground historic properties outside WFF.	anticipated to adversely affect aboveground historic properties within WFF. However, solar panels may have indirect adverse effects to aboveground historic properties outside WFF. Residential-scale turbines are not anticipated to adversely affect aboveground historic properties within WFF. However, residential-scale turbines may have direct adverse effects on aboveground historic properties in WFF and indirect adverse effects on aboveground historic properties outside WFF.	properties within WFF. However, residential-scale turbines may have direct adverse effects on aboveground historic properties in WFF and indirect adverse effects on aboveground historic properties outside WFF.
Transportation	Temporary impacts on traffic flow would occur during construction activities. With implementation of mitigation and safety measures related to transportation and traffic closures due to oversize loads, no substantial impacts on transportation are anticipated.	Temporary impacts on traffic flow would occur during construction activities. With implementation of mitigation and safety measures related to transportation and traffic closures due to oversize loads, no substantial impacts on transportation are anticipated.	Temporary impacts on traffic flow would occur during construction activities. With implementation of mitigation and safety measures related to transportation, no substantial impacts on transportation are anticipated.
Aesthetics	No adverse impacts on the public viewshed given the distance of the turbines from surrounding communities. Wind turbines would be white to blend in with sky. Potential adverse impacts on WFF employees and visitors within turbine shadow due to flickering effect of spinning blades on sunny days.	No adverse impacts on the public viewshed given the distance of the turbines from surrounding communities. Wind turbines would be white to blend in with sky. Potential adverse impacts on WFF employees and visitors within turbine shadow due to flickering effect of spinning blades on sunny days. Implementation of solar panels would result in long-term changes to the viewshed at the Main Base. Because WFF is a highly	Implementation of solar panels would result in long-term changes to the viewshed at the Main Base. Because WFF is a highly industrialized setting with numerous antenna arrays and other infrastructure, solar panels should not present a negative impact on the viewshed.

Resource	Proposed Action	Alternative One	Alternative Two
		industrialized setting with numerous antenna arrays and other infrastructure, solar panels should not present a negative impact on the viewshed.	
Cumulative Effects	There would be adverse cumulative impacts on avifauna from construction and operation of the wind turbines. Cumulative impacts on wetlands would be mitigated. There would be beneficial impacts on air quality due to reduced GHG emissions and lowered use of fossil fuels during the production of electricity.	There would be adverse cumulative impacts on avifauna from construction and operation of the wind turbines. Cumulative impacts on wetlands would be mitigated. There would be beneficial impacts on air quality from the use of wind turbines and solar panels due to reduced GHG emissions and lowered use of fossil fuels during the production of electricity.	Beneficial impacts on regional air quality would result from the operation of the solar panels, which are a fossil fuel-free power source. No other cumulative impacts from installation of solar panels are anticipated.

This page intentionally left blank.

TABLE OF CONTENTS

Photographs

Tables

Figures

This page intentionally left blank.

ACHP	Advisory Council on Historic Preservation
ACUA	Atlantic County Utilities Authority
amsl	above mean sea level
APE	Area of Potential Effect
APWRA	Altamont Pass Wind Resource Area
AST	aboveground storage tank
ASR	Archive Search Report
BA	Biological Assessment
BBSH	Big brown/Silver-haired bat Guild
BMP	Best Management Practice
CAA	Clean Air Act
CBC	Christmas Bird Counts
CBRA	Coastal Barrier Resources Act
CBRS	Coastal Barrier Resources System
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CH_4	methane
CMA	Coastal Management Area
CNWR	Chincoteague National Wildlife Refuge
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CRA	Cultural Resources Assessment
CRMP	Cultural Resources Management Plan
CWA	Clean Water Act
CZM	Coastal Zone Management (Program)
dB	decibel
dBA	decibel weighted to the A-scale
DCR	Virginia Department of Conservation and Recreation
E&SC	Erosion and Sediment Control
EA	Environmental Assessment
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EJIP	Environmental Justice Implementation Plan
EMS	Environmental Management System
EO	Executive Order
EPA	Environmental Protection Agency
EPAct	Federal Energy Policy Act
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FERC	Federal Energy Regulatory Commission

FIRM	Flood Insurance Rate Map
FONSI	Finding of No Significant Impact
GAO	Government Accountability Office
GHG	greenhouse gas
GPS	Global Positioning System
GSFC	Goddard Space Flight Center
GWh	gigawatt-hours
GWP	global warming potential
HAP	Hazardous Air Pollutant
HVAC	heating, ventilation and air conditioning
ICP	Integrated Contingency Plan
IEC	International Electrotechnical Commission
JD	jurisdictional determination
JPA	Joint Permit Application
kph	kilometers per hour
kW	kilowatt
L_{01}	sound level exceeded 1 percent of the time
L_{10}	sound level exceeded 10 percent of the time
L_{90}	sound level exceeded 90 percent of the time
L_{eq}	time-averaged sound level
lbs	pounds
MARS	Mid-Atlantic Regional Spaceport
MBTA	Migratory Bird Treaty Act
MW	megawatt
MWh	megawatt-hours
MSDS	Material Safety Data Sheet
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act of 1969
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
NPDES	National Pollutant Discharge Elimination System
NPR	NASA Procedural Requirements

NPS	National Park Service
NRHP	National Register of Historic Places
NWR	National Wildlife Refuge
O_3	ozone
OSHA	Occupational Safety and Health Administration
Pb	lead
PM	particulate matter
$PM_{2.5}$	particulate matter less than or equal to 2.5 microns
PM_{10}	particulate matter less than or equal to 10 microns
ppm	parts per million
PTE	potential to emit
PV	photovoltaic
RBEP	Eastern red bats, Eastern pipistrelles, Evening bats Guild
RCRA	Resource Conservation and Recovery Act
SHPO	State Historic Preservation Office
SO_2	sulfur dioxide
SO_X	sulfur oxides
SRIPP	Shoreline Restoration and Infrastructure Protection Program
SWPPP	Stormwater Pollution Prevention Plan
TREC	Tom Ridge Environmental Center
UAS	Unmanned Aerial System
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USDOE	U.S. Department of Energy
USFWS	U.S. Fish and Wildlife Service
UST	underground storage tank
VAC	Virginia Administrative Code
VDGIF	Virginia Department of Game and Inland Fisheries
VDEQ	Virginia Department of Environmental Quality
VDHR	Virginia Department of Historic Resources
VEC	Virginia Employment Commission
VMRC	Virginia Marine Resources Commission
VOC	volatile organic compound
VPDES	Virginia Pollutant Discharge Elimination System
VSMP	Virginia Stormwater Management Program
WFF	Wallops Flight Facility
WRP	Wallops Research Park

This page intentionally left blank.

SECTION ONE: MISSION, PURPOSE AND NEED, BACKGROUND INFORMATION

1.1 INTRODUCTION

This Draft Environmental Assessment (EA) has been prepared to evaluate the potential environmental impacts from alternative energy sources that would be capable of generating up to 10 gigawatt-hours per year (GWh/year) of electricity at the National Aeronautics and Space Administration's (NASA's) Wallops Flight Facility (WFF). This EA has been prepared in accordance with the National Environmental Policy Act of 1969 (NEPA), as amended (42 United States Code [U.S.C.] 4321–4347), the Council on Environmental Quality (CEQ) regulations for implementing NEPA (40 Code of Federal Regulations [CFR] 1500–1508), the NASA regulations for implementing NEPA (14 CFR Subpart 1216.3), and the NASA Procedural Requirements (NPR): *Implementing NEPA and Executive Order (EO) 12114* (NPR 8580.1). NEPA requires the preparation of an EA for Federal actions that do not qualify for a Categorical Exclusion and may not require an Environmental Impact Statement (EIS). If this EA determines that the environmental effects of the Proposed Action are not significant, a Finding of No Significant Impact (FONSI) will be issued. Otherwise, a Notice of Intent to prepare an EIS will be published in the Federal Register.

The U.S. Army Corps of Engineers (USACE) has served as a Cooperating Agency in the preparation of this EA because they possess regulatory authority over the Proposed Action. This EA is being developed to also fulfill the USACE's obligations under NEPA. NASA, as the WFF property owner and project proponent, is the Lead Agency and responsible for ensuring overall compliance with applicable environmental statutes, including NEPA.

This EA encompasses a 25-year planning horizon, which is based on the expected life span of the proposed wind turbines and solar panels. This EA will be reviewed for adequacy at any time if major changes to the Proposed Action are under consideration, or substantial changes to the environmental conditions occur. As such, the document may be supplemented in the future to assess new proposals or to address changes in existing conditions, impacts, and mitigation measures.

1.2 WALLOPS FLIGHT FACILITY

1.2.1 Mission

During its early history, the mission of the NASA Goddard Space Flight Center's (GSFC's) WFF was primarily to serve as a test site for aerospace technology experiments. Over the last several decades, the WFF mission has evolved toward a focus of supporting scientific research through carrier systems (i.e., airplanes, balloons, rockets, and uninhabited aerial vehicles) and mission services.

NASA is the land owner at WFF, but WFF also consists of multiple NASA tenants and partners, including the U.S. Navy, U.S. Coast Guard, Marine Science Consortium, Mid-Atlantic Regional Spaceport (MARS), and the National Oceanic and Atmospheric Administration (NOAA). Each tenant partially relies on NASA for institutional and programmatic services, but also has its own missions. WFF is a national resource with the facilities, personnel, core competencies, and low cost of operations to provide world-class, end-to-end services for small- to medium-sized missions. It is a fully capable launch range for rockets and balloons, and is also a research airport. In addition, Wallops personnel provide mobile range capabilities, range instrumentation engineering, range safety, flight hardware engineering, and mission operations support.

The strategic vision for WFF is that "Wallops Flight Facility will be a national resource for enabling low-cost aerospace-based science and technology research" (NASA, 2008a).

1.2.2 Environmental Management System

NASA is committed to carrying out its research and projects at WFF in an environmentally sustainable manner. The Wallops Environmental Office (Code 250) ensures that the facility obtains the appropriate environmental permits, prepares documentation for compliance with NEPA and other environmental regulations and EOs, conducts employee and supervisor training, and implements the facility's Environmental Management System (EMS). WFF's EMS is a coherent, integrated approach to environmental management. WFF manages environmental risks through the application of the WFF EMS, which covers such topics as pollution prevention, energy and water management, maintenance of natural (green) infrastructure, and sustainable building practices.

1.2.3 Location

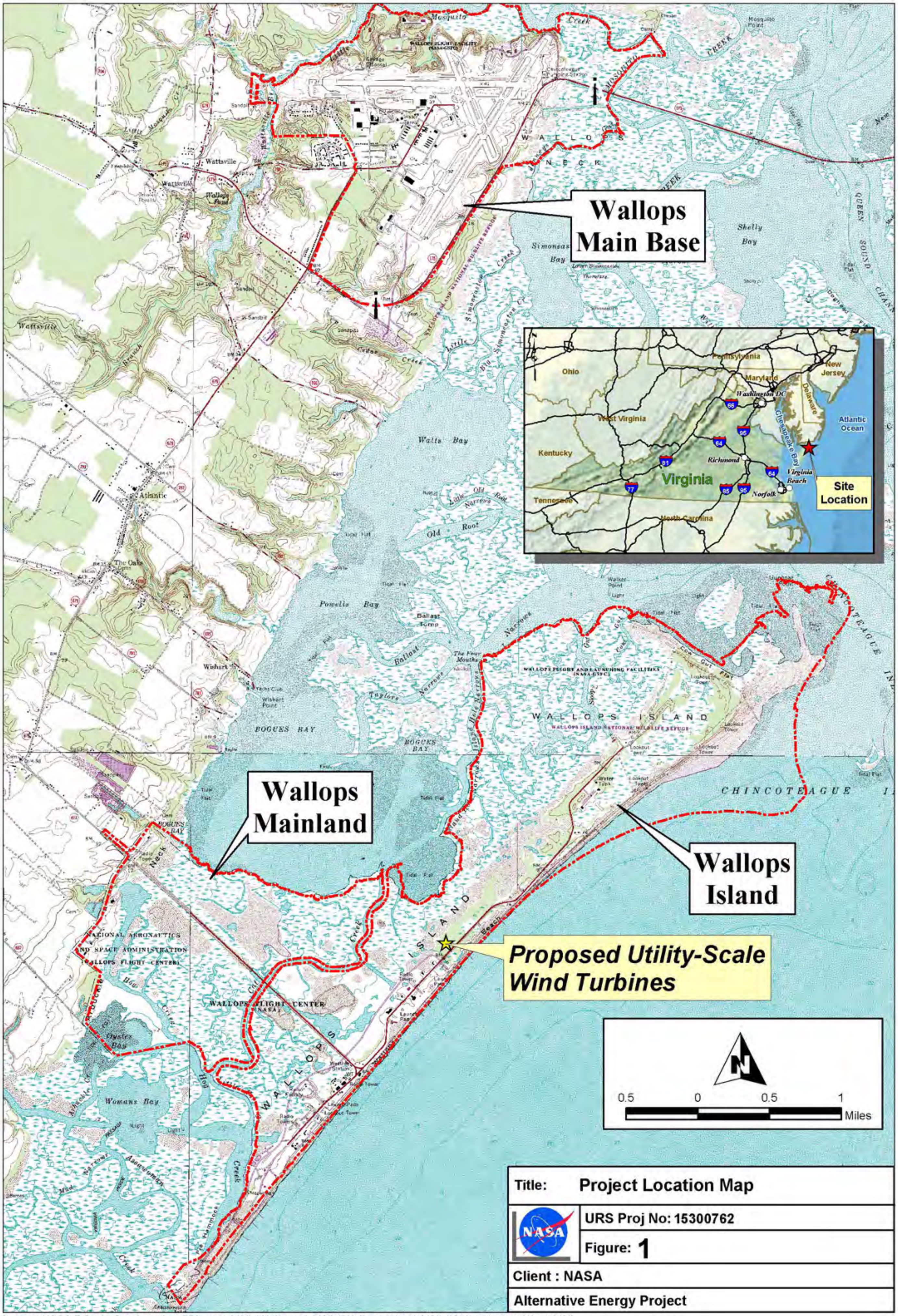
WFF is located in the northeastern portion of Accomack County, VA, on the Delmarva Peninsula, and is comprised of three separate land masses: the Main Base, Wallops Mainland, and Wallops Island (Figure 1). The Main Base comprises 720 hectares (1,800 acres), Wallops Mainland comprises 40.5 hectares (100 acres), and Wallops Island comprises 1,680 hectares (4,600 acres).

The Main Base is located off Virginia Route 175, approximately 3.2 kilometers (2 miles) east of U.S. Route 13. The entrance gate for Wallops Mainland and Wallops Island is approximately 11 kilometers (7 miles) south of the Main Base at the easternmost terminus of County Route 803.

1.3 BACKGROUND

EO 13423, *Strengthening Federal Environmental, Energy, and Transportation Management* (effective January 24, 2007), instructs Federal agencies to "conduct their environmental, transportation, and energy-related activities under the law in support of their respective missions in an environmentally, economically, and fiscally sound, integrated, continuously improving, efficient, and sustainable manner." EO 13514, *Federal Leadership in Environmental, Energy, and Economic Performance* (effective October 8, 2009), sets sustainability goals for Federal agencies and focuses on making improvements in their environmental, energy, and economic performance.

Both EO 13423 and EO 13514 direct Federal agencies to implement sustainable practices for energy efficiency and reductions in greenhouse gas (GHG) emissions, and for the use of renewable energy. Section 3 of EO 13423 states that a Federal agency's EMS objectives shall include the goals identified in Section 2 of EO 13423. EO 13514 requires Federal agencies to set a 2020 GHG emissions reduction target, increase energy efficiency, and reduce fleet petroleum consumption.



Source: USGS 7.5 min Quadrangles: "Bloxom, VA", "Hallwood, VA", "Wallops Island, VA", "Chincoteague West, VA"

This page intentionally left blank.

The Federal Energy Policy Act (EPAct), effective August 8, 2005, requires Federal agencies to lower electricity consumption and cost, and to increase the use of renewable sources by 3 percent between 2007 and 2009, 5 percent between 2010 and 2012, and by 7.5 percent for 2013 and beyond.

WFF has identified several goals that meet its mission while promoting environmental stewardship and accountability:

- Reducing impacts on the natural environment by consuming energy from a source that provides zero GHG emissions;
- Reducing WFF's annual operating cost by consuming continual, low-cost power from a renewable and sustainable natural resource; and
- Supporting NASA's goal to set an example for responsible stewardship of natural resources by a Federal agency.

1.3.1 Current WFF Energy Sources

WFF currently obtains all of its electricity from the local electric cooperative, which generates electricity primarily from coal and nuclear power. In 2008, the local electric cooperative generated 21.5 percent of its energy from the combustion of coal, 12.4 percent from nuclear power, and 2.6 percent from gas and diesel combined. The remaining 63.5 percent was purchased by the local electric cooperative from a combination of coal and nuclear power sources (ODEC, 2008). WFF also has a backup system of diesel-fired generators for use in the event of a power outage and one large generator that is permitted for load shedding.

Adverse environmental effects result from the production and combustion of coal and the generation of nuclear power. Although new technologies are currently reducing these effects, combustion of coal still results in release of GHGs to the atmosphere, the generation of waste products such as heavy metals and contaminants (fly ash), and destruction of habitat if mountain-top removal methods are used to mine coal. Nuclear power results in the generation of hazardous nuclear waste and uses large quantities of water for cooling compared to wind and solar power sources (AWEA, 2009).

1.4 PURPOSE AND NEED FOR THE PROPOSED ACTION

1.4.1 Purpose

The purpose of the proposed Alternative Energy Project is to implement a technologically proven renewable energy source that would enable NASA to meet the requirements of the 2005 EPAct, EO 13423, and EO 13514 while supporting its own goal of setting an example in environmental stewardship by a Federal agency.

The project would also stabilize or reduce WFF's institutional costs. It is expected that as fossil fuels become scarcer, the costs of generating electricity from them would be passed on to the user in the form of higher electricity rates. Having on-site power generation would buffer a portion of WFF's costs from future increases associated with variables in the electricity market (e.g., tariff adjustments).

1.4.2 Need

As the Federal renewable energy requirements continue to increase, the Alternative Energy Project is needed at both an Agency and Center level. Agency-wide, NASA met the 3 percent target specified by the EPAct in fiscal years 2007 and 2008, generating 3.57 percent and 3.55 percent, respectively, of the agency's electricity from renewable sources (Smith, pers. comm., 2009). However, NASA did not meet the 3 percent target in fiscal year 2009 (FY09), when 2.2 percent of its electricity was obtained from renewable sources, and the target is increasing to 5 percent for FY10. Also, WFF did not use renewable electricity during either year. Table 1 shows the contribution of the Proposed Action to the percentage of energy generated from renewable sources for NASA, GSFC, and WFF.

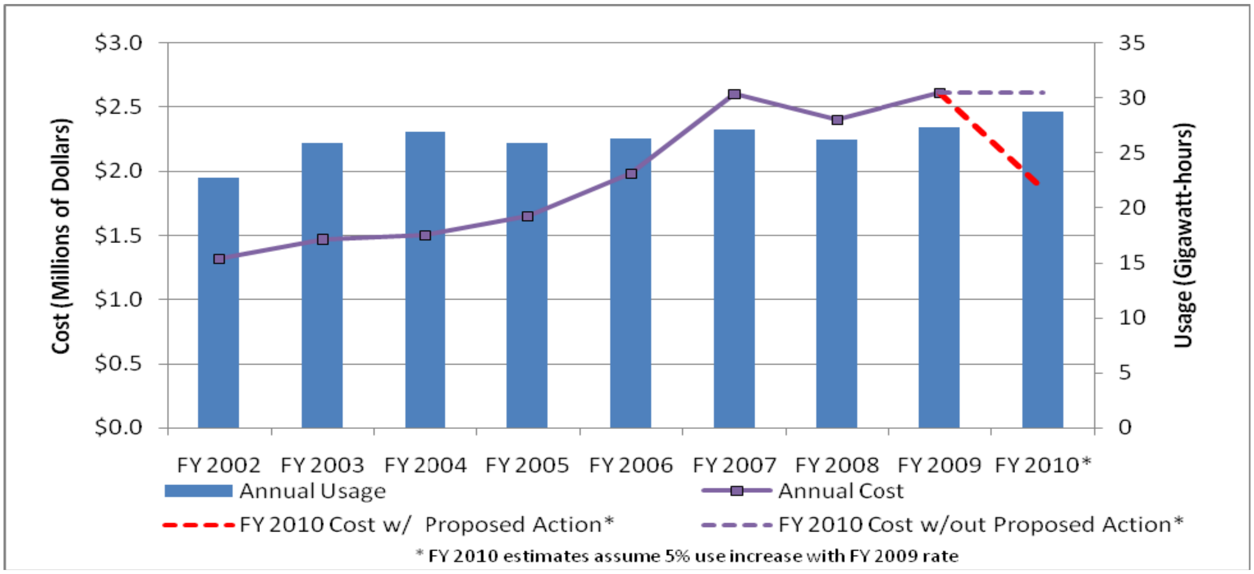
Table 1: Use of Renewable Energy in FY08 and FY09, Predicted Contribution of Alternative Energy Project in FY10

	% Obtained from Renewable Sources FY08	% Obtained from Renewable Sources FY09	Predicted Contribution of Renewable Energy from Alternative Energy Project (%)
NASA	3	2.2	1
GSFC	3	3	13
WFF	0	0	66[1]

[1]Two turbines represent 66 percent of NASA's electricity as it applies to the Federal requirements (two times actual production for on-site generation) - two utility-scale wind turbines actually represent 33 percent of NASA's electricity consumption from renewable energy sources at WFF.

Additionally, NASA's electricity costs have increased substantially in recent years. Table 2 shows that since Fiscal Year 2002, NASA's annual electrical expenditures have nearly doubled (an increase of 98 percent), although electrical usage has only increased approximately 20 percent. With WFF's current cost of electricity at 7.5 cents per kilowatt-hour, the proposed project could result in avoided electrical costs of at least $750,000 per year.

Table 2: NASA Annual Electricity Usage and Cost, FY02 to FY10



SECTION TWO: PROPOSED ACTION AND ALTERNATIVES

A study conducted for WFF (James Madison University, 2005) found that a single 1.5 MW wind turbine would produce approximately 15 percent of the electricity required to operate WFF and would easily interconnect to WFF's distribution system. Following this study, NASA performed its own electrical system evaluation and determined that based on its average electrical load, WFF could likely support two of the 1.5 MW wind turbines. Further investigation also led to the conclusion that NASA could obtain 2.0 MW wind turbines for approximately the same cost. WFF estimates that each 2.0 MW wind turbine would generate approximately 5 GWh/year of electricity, for a total of 10 GWh produced annually. Therefore, to establish a means for reasonable comparison among renewable energy alternatives in this EA, NASA standardized each alternative as having to produce an equivalent amount of electricity that would be generated by two 2.0 MW wind turbines (10 GWh/year).

In addition, CEQ regulations require that an agency "include the alternative of no action" as one of the alternatives it considers (40 CFR 1502.14[d]). The No Action Alternative serves as a baseline against which the impacts of the Proposed Action and Alternatives are compared.

2.1 RANGE OF ALTERNATIVES CONSIDERED FOR RENEWABLE ENERGY

Several sources of renewable energy were considered for the Alternative Energy Project including wind, solar, tidal, wave, and geothermal power.

2.1.1 Wind Power

Currently the world's fastest growing renewable power source, wind energy is the transformation of wind into mechanical power through a turbine, which is then converted into electricity through a generator. Generation of electricity by wind energy has the potential to reduce environmental impacts caused by use of fossil fuels to generate electricity because, unlike fossil fuels, wind energy does not generate atmospheric contaminants or thermal pollution.

Figure 2 shows the major components of a typical wind turbine. The nacelle is the housing for the gear box and generator that is mounted on top of the tower. Electronic controls rotate the nacelle to face into the wind, and adjust the angle of the blades to regulate rotor speed.

According to studies performed by JMU (2005) and Iberdrola Engineering (2009), the average annual wind speed at Wallops Island in the location of the proposed turbines at a height of 48 meters (157 feet) is 6.25 meters per second, and the prevailing wind direction is from the south and southwest.

The International Electrotechnical Commission (IEC), an international standards development organization, has developed a classification system for the design conditions of wind turbine systems. There are 3 classes: Class I, II, and III, which specify the design wind speeds for a specific turbine product. The wind resource classification at Wallops Island is Class IIa.

Based on the measured wind speeds and predicted long-term wind speeds, direction of the wind resource, the IEC wind classification (IIa), and other factors such as air density, Iberdrola (2009) determined that Wallops Island has adequate wind resources for operation of utility-scale wind turbines.

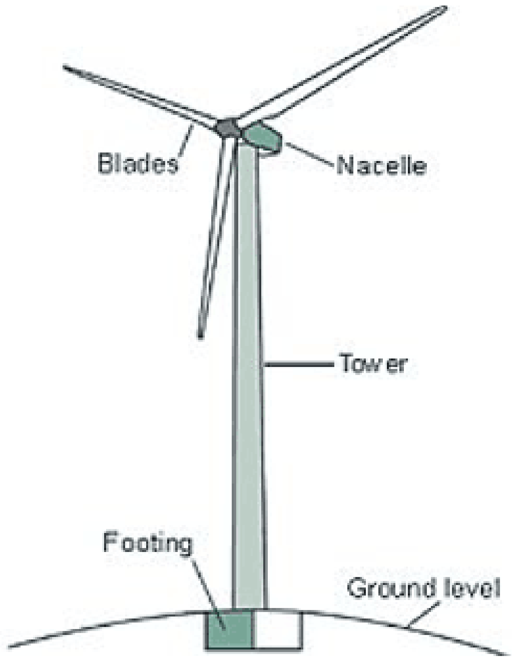


Figure 2: Diagram of Major Wind Turbine Components

Although modern utility-scale wind turbines typically operate 65 to 90 percent of the time, they often run at less than full capacity. Capacity factor, which compares the turbine's actual production over a given period of time with the amount of power the turbine would have produced if it had run at full capacity for the same amount of time, is one element in measuring the productivity of a wind turbine (or any other power production facility). Iberdrola (2009) determined that the capacity factor of potential wind turbines initially evaluated for installation at Wallops Island (based on one 1.5 MW and two 2.0 MW models) was between 25 and 30 percent. Higher capacity factors may be achieved during windy weeks or months.

2.1.1.1 Wind Turbine Specifications

Utility-Scale Turbines

Based on the classification the wind resource at WFF (Class IIa) and the appropriate level of electrical generation, either a 1.5 MW or 2.0 MW wind turbine would be suited to WFF's needs (Iberdrola, 2009). NASA initially evaluated both 1.5 MW and 2.0 MW wind turbine models and determined that they were very similar in their design, configuration, and cost—the primary difference being the amount of power generated. Therefore, NASA would install a wind turbine that would produce up to the electrical output of a 2.0 MW wind turbine.

General specifications of a 2.0 MW turbine commonly available in the United States are shown in Table 3 to provide representative information for evaluation of environmental impacts in this EA. Any 2.0 MW wind turbine model NASA would use would have very similar specifications to those shown in Table 3.

Table 3: Basic Data for 2.0 MW Wind Turbine

Representative 2.0 MW Wind Turbine Model[1]	
Rated power, single turbine	2.0 MW
Rated power, 2 turbines	4.0 MW
Cut-in wind speed	3.5 meters/second
Cut-out wind speed	25 meters/second – 10 minutes
Rated wind speed	14 meters/second
Wind class	IIa
Blade length	42.5 meters (139.5 feet)
Total height (to tip of blade)	120.5 meters (395.3 feet)
Capacity factor[2]	25 to 30%
Equipment life expectancy	25 years
Annual production at WFF	5 GWh/year

[1]Gamesa, 2009; [2]Iberdrola, 2009

Residential-Scale Turbines

General specifications for the smallest wind turbine commercially available in the United States, a 2.4 kW model, are shown in Table 4. As opposed to the utility-scale wind turbines, these residential-scale turbines would not contribute substantially to the percent of energy generated from renewable sources at WFF because of their small power output. They would help offset power use at individual buildings, but their primary purpose would be to provide outreach and education to WFF employees and the public about wind energy.

Table 4: Basic Data for 2.4 kW Wind Turbine

Representative 2.4 kW Wind Turbine Model[1]	
Rated power	2.4 kW
Cut-in wind speed	3.5 meters/second
Rated wind speed	13 meters/second
Blade diameter	3.72 meters (12 feet)
Total height (to tip of blade)	22 meters (72 feet)
Capacity factor	25 to 30%
Equipment life expectancy	25 years
Annual production at WFF, single turbine	6 MWh/year[2]

[1]Southwest Windpower, 2010
[2]MWh = megawatt-hours

2.1.1.2 Potential Locations for Wind Turbines at Wallops Flight Facility

Utility-Scale Turbines

Based on wind studies and compatibility with mission-related activities (JMU, 2005; Iberdrola, 2009), Wallops Island was identified as the preferred location for siting a wind turbine to maximize the wind resource available at WFF.

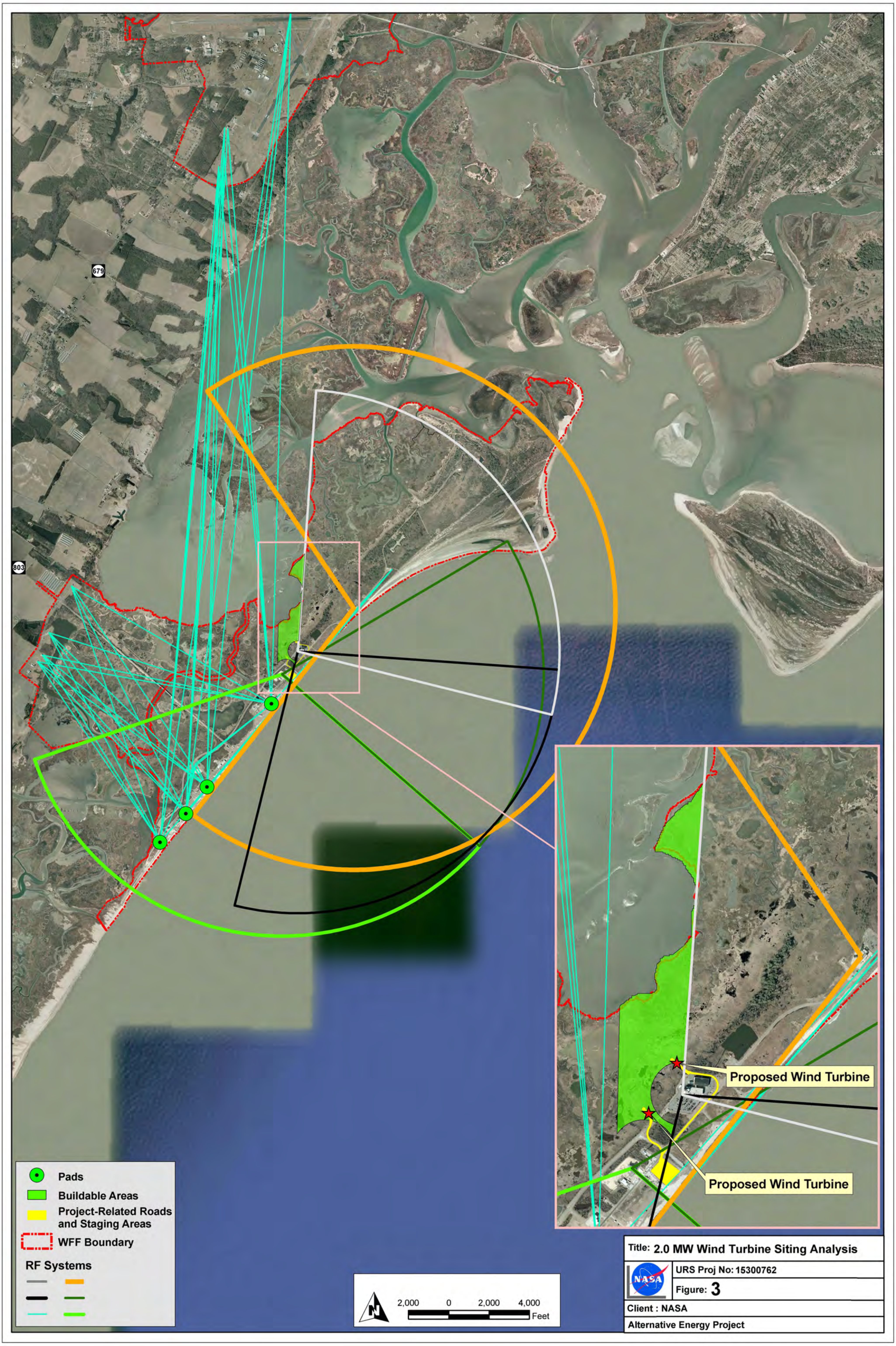
Other locations at WFF were considered for construction of one or two wind turbines. Wind turbines have the potential to interfere with WFF's active airfields and tracking/telemetry systems; therefore, the area available for their construction is extremely limited.

The entire Wallops Main Base was dismissed due to height restrictions to maintain Federal Aviation Administration (FAA) Part 77 airfield obstruction requirements. The available locations for turbine(s) installation at the Main Base would result in a violation of the FAA height restrictions of objects within a specified distance of a public or military runway; therefore siting of the turbines at the Main Base was dismissed.

The entire Wallops Mainland was dismissed due to impacts on the performance of radar frequency systems (QinetiQ Inc., 2004). In addition, NASA undertook a rigorous internal siting exercise to identify a location for the proposed wind turbines that would not interfere with existing or planned mission activities on Wallops Island. This exercise was led by the WFF Facility Director with assistance from the Radio Frequency Spectrum Manager, Facilities Management Branch, and Environmental Office. The team evaluated all lines of sight for the NASA telemetry systems and U.S. Navy radar viewsheds. On Wallops Island, all areas north and east of the proposed wind turbine site were dismissed due to impacts on U.S. Navy radar systems (Figure 3). Areas south and west of the proposed wind turbine site were dismissed due to impacts on NASA launch range radars and radar frequency systems (QinetiQ Inc., 2004). The final proposed location of the utility-scale wind turbines at Wallops Island was approved by both the NASA Center Director and the U.S. Navy Surface Combat Systems Center Commanding Officer.

NASA also considered locating wind turbines in the ocean immediately east of Wallops Island. This alternative was dismissed based on the much higher cost of installation and maintenance compared to siting the wind turbines on land, potential interference of the turbines with radar, as well as interference with NASA's launch range activities such as Unmanned Aerial Systems (UAS), rockets, and drones that are launched over the Atlantic Ocean.

The only available mission-compatible area at WFF for placement of wind turbines is restricted to the "Buildable Area" shown on Figure 3.


679
803
Proposed Wind Turbine
Proposed Wind Turbine
Pads
Buildable Areas
Project-Related Roads and Staging Areas
WFF Boundary
RF Systems
2,000
0
2,000
4,000
Feet
Title: 2.0 MW Wind Turbine Siting Analysis
URS Proj No: 15300762
Figure: 3
Client : NASA
Alternative Energy Project

This page intentionally left blank.

Residential-Scale Turbines

The residential-scale turbines would not be expected to interfere with WFF's tracking/telemetry systems. Other considerations, listed below, were taken into account in identifying potentially suitable areas for these wind turbines. The following areas were excluded from the Main Base for installation of residential-scale turbines:

- Areas having moderate and high sensitivity for cultural resources
- Wetlands
- Roads
- Radio frequency hazard areas
- Buildable heights greater than 25 meters (80 feet)
- Areas within 30 meters (100 feet) of forest
- Areas within 30 meters (100 feet) of existing structures
- Areas greater than 152 meters (500 feet) from electrical transformers

Figure 4 shows the potentially suitable areas for installation of residential-scale wind turbines. The total area identified is 48 hectares (119 acres).

2.1.1.3 Solar Power

Solar panels are made of up photovoltaic (PV) cells composed of silicon that convert sunlight into electricity; when sunlight is reduced or absent, such as an overcast day or at night, the conversion process slows down or stops completely. Solar panels by themselves do not constitute a PV system—a system includes structures to hold the arrays and point them toward the sun and components that take the direct-current electricity produced by the modules or arrays and condition the electricity so that it may be utilized. PV cells were first developed in the United States in the 1950s, and solar technology has been constantly improving since (USDOE, 2005). PV cells are an environmentally low-impact source of energy, as their use generates no air pollution or hazardous wastes, and they do not require fuel. The use of solar power has been expanding at an average rate of 40 percent per year since the year 2000, and solar panels are expected to provide up to 10 percent of the electricity in the United States by the year 2025 (USDOE, 2008).

The amount of energy produced by a PV device depends not only on available solar energy (i.e., how many sunny days occur) but on how well the solar cell converts sunlight to useful electrical energy. Today's commercial PV systems can convert from 5 percent to 15 percent of sunlight into electricity, with recent PV cells achieving percentages of efficiency nearing 20 percent (IMEC, 2009; Mitsubishi, 2009).They are highly reliable and typically last 20 years or longer. Due to loss of sunlight during the nighttime and cloud cover, solar energy typically has a capacity factor (the ratio of average production to the rated capability of production) between 15 and 25 percent.

Many sizes and types of modules are commercially available from a number of different companies—NASA is currently considering use of a 200-watt solar panel for WFF. Using a commonly available U.S.–made panel as a representative model, each panel would have a width of 0.84 meter (2.75 feet) and a length of 1.7 meters (5.5 feet), which results in a total surface are of 1.4 square meters (15.13 square feet) per panel (BP Solar, 2009; Table 5). Factory recycling (i.e., the partial reuse of discarded solar panel raw materials), which has been introduced by most manufacturers, can save up to 80 percent of production energy (Earthscan, 2008). As with the silicon cells, the glass and aluminum components can be reused.

Table 5: Basic Data for Representative Solar Panels

Specifications for Representative Solar Panel[1]	
Electricity generation per panel	200 Watts
Spacing requirements due to shading and maintenance	4 hectares (10 acres) of space per 1.0 MW of power
Length, single panel	1.7 meters (5.5 feet)
Width, single panel	0.84 meter (2.75 feet)
Capacity factor	15%
Equipment life expectancy	25 years
Annual production at WFF with a 4.0 MW system	5 GWh/year
Number of panels required for 4.0 MW system	19,000

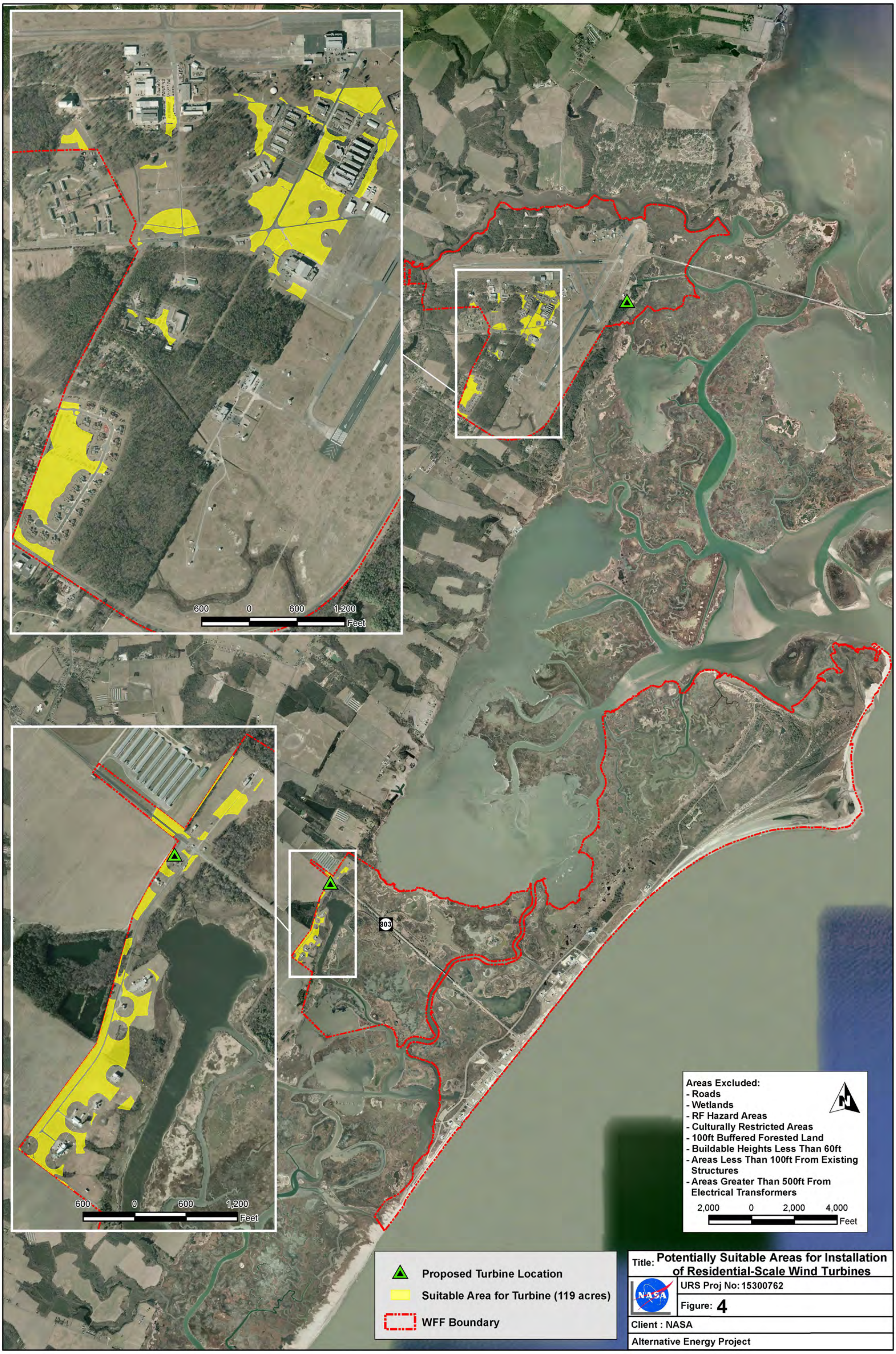
[1]BP Solar, 2009

Locations for Solar Panels

Installation of solar panels at Wallops Mainland and Wallops Island was considered but dismissed due to the area required for installation of the amount of solar panels needed to generate 5 or 10 GWh/year of power (equivalent power generated by one and two 2.0 MW wind turbines, respectively). In addition to the space occupied by the solar panels themselves, there are spacing requirements around each solar panel to prevent shading and to perform maintenance. Four hectares (10 acres) are estimated to be needed for each planned MW of power (Caudle, pers. comm.); therefore, a 4.0 MW solar panel system, which would generate 5 GWh/year of power, would require a total area of approximately 16 hectares (40 acres).

Reasons that this amount of area, or partial amounts of this area (i.e., installation of half of the solar panels) would not be suitable at Wallops Mainland or Wallops Island are listed below:

1. Most areas of Wallops Mainland and Wallops Island are obligated for existing and planned mission operations; therefore, enough space to install an amount of solar panels equivalent to the energy output of one 2.0 MW wind turbine (which would require 16 hectares [40 acres]) is not feasible.
2. Based on the siting constraints for mission operations, and that the remaining open areas of Wallops Mainland and Wallops Island are comprised of large areas of wetlands (79 percent of Wallops Island is classified as wetlands), ground disturbance and construction over 16 hectares (40 acres) would create unacceptable adverse impacts on wetlands.



600 0 600 1,200 Feet
600 0 600 1,200 Feet
303
Areas Excluded:
- Roads
- Wetlands
- RF Hazard Areas
- Culturally Restricted Areas
- 100ft Buffered Forested Land
- Buildable Heights Less Than 60ft
- Areas Less Than 100ft From Existing Structures
- Areas Greater Than 500ft From Electrical Transformers
2,000 0 2,000 4,000 Feet
Proposed Turbine Location
Suitable Area for Turbine (119 acres)
WFF Boundary
Title: Potentially Suitable Areas for Installation of Residential-Scale Wind Turbines
URS Proj No: 15300762
Figure: 4
Client : NASA
Alternative Energy Project

This page intentionally left blank.

3. Additionally, the potentially available areas of Wallops Mainland and Wallops Island, primarily within wetlands, are within the 100-year floodplain and are subject to flooding and the corrosive effects of nearby marine waters, which would result in additional maintenance on the solar panels.
4. There is an insufficient amount of buildings, and therefore rooftop area, at Wallops Mainland and Wallops Island to allow for a majority of the panels to be installed on rooftops.

Therefore, NASA has determined that the solar panels should be installed at the WFF Main Base. The solar panels would not be expected to interfere with WFF's tracking/telemetry systems. Other considerations, listed below, were taken into account in identifying potentially suitable areas for these wind turbines. The following areas were excluded from the Main Base for installation of solar panels:

- Areas having moderate and high sensitivity for cultural resources
- Wetlands
- Impervious surfaces (i.e., buildings, roads, parking lots)
- Airfield, runways, taxiways
- Areas within a 174-meter (570-foot) buffer adjacent to runways and taxiways (due to glare and pilot safety)
- Areas planned for future structures

Figure 5 shows the potentially suitable areas for installation of solar panels. The total area identified is 70 hectares (172 acres).

2.1.1.4 Hydrokinetic Power

Tidal and wave power generation are in their technological infancy compared to wind and solar power, and numerous operational limitations exist as a result. Some of these limitations include the need to develop equipment and technology that can withstand destructive factors such as heavy storms and corrosion, the cost-benefit of materials and installation versus energy output, and the relatively undocumented effects on ocean life.

Description of Tidal Power

Tidal power utilizes the movement of water caused by tidal currents, and uses equipment similar to wind turbines, turning like windmills in the current. Water's greater density means fewer and smaller turbines are needed to produce the same amount of electricity as wind turbines. Although tidal power is more predictable than wind and solar power, it is a relatively unproven technology with questionable economic viability on a small scale, which would be the case at WFF.

Description of Wave Power

Wave power differs from tidal power in that electricity generators are placed on the surface of the ocean. Energy output is determined by wave height, wave speed, wavelength, and water density. Two of the three basic methods to harness wave power include the buoy method and the hinged contour device, which use a special floating device that rises and falls along with the movement of the waves, and the mechanical energy that is created is then converted to electricity using specially designed generators. A third basic method is the oscillating water column method, which is used on shore and must be fixed to the seabed. This method works by using a column of water as a piston to pump air and drive a turbine to generate power. Wave power is a relatively unproven technology with questionable economic viability on a small scale, which would be the case at WFF.

U.S. Licensed or Permitted Tidal and Wave Power Projects

To date there are only a handful of experimental wave generator plants in operation around the world. In December 2007, plans were announced to build the first commercial wave power plant in the United States, located off the coast of northern California (FERC, 2009). A wave energy pilot project off the shore of Washington State obtained the first Federal Energy Regulatory Commission (FERC) license for a hydrokinetic power (includes both wave and tidal power) project in December 2007; however, this license was surrendered in April 2009. No FERC licenses for wave energy projects are pending as of September 2009 (FERC, 2009). As of November 2009, there are several pending FERC permits—five for tidal energy projects (four in Alaska and one in California) and one for a wave energy project in Hawaii. FERC has issued permits to 42 projects in various coastal States: 29 permits for tidal projects in Maine, New York, Washington, Massachusetts, Alaska, Delaware, New Hampshire, and New Jersey, and 12 permits for wave projects in California, Oregon, and Washington (FERC, 2009).

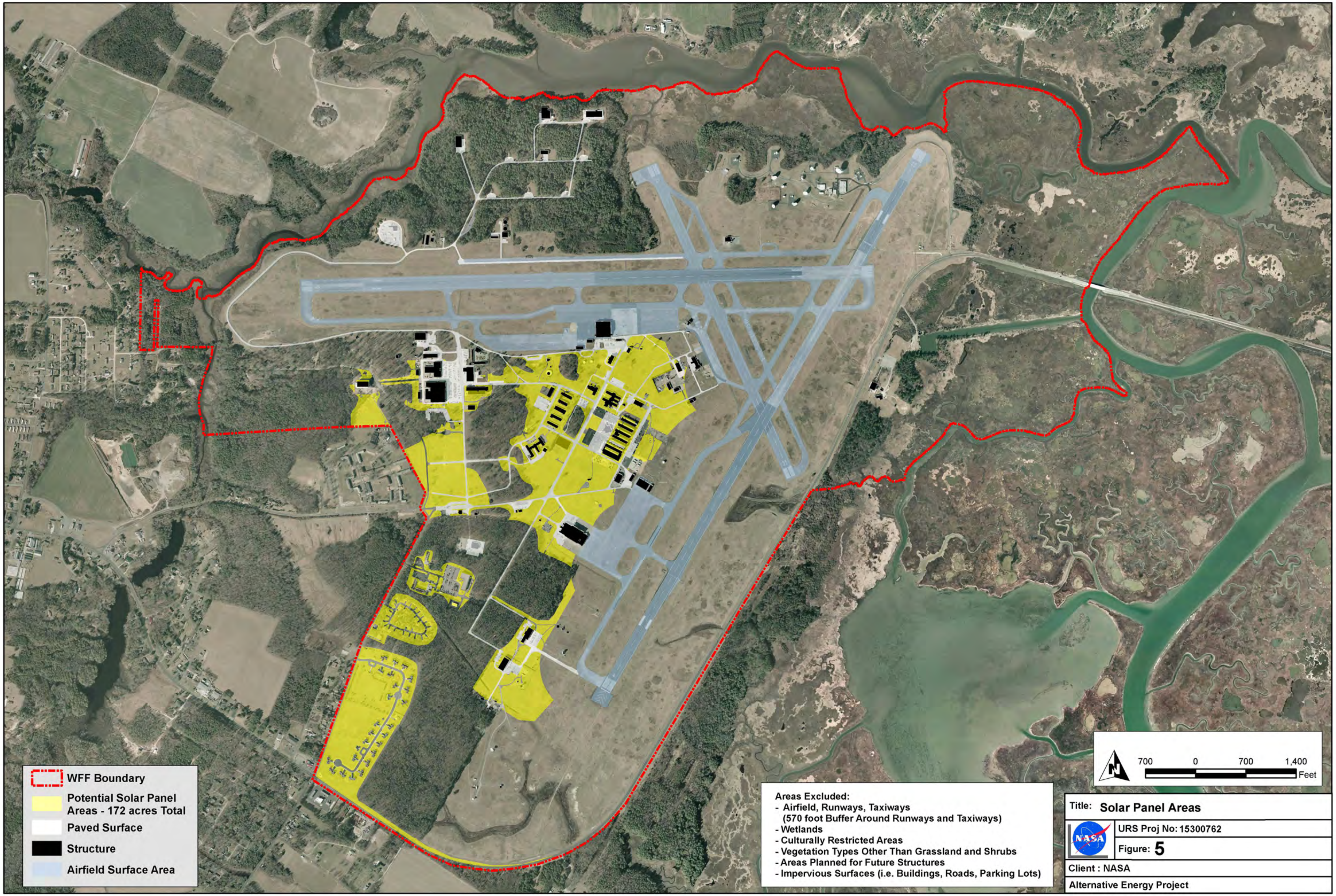
2.1.1.5 Geothermal Power

Geothermal power, which is energy generated by heat stored beneath the Earth's surface or the collection of absorbed heat in the atmosphere and oceans, is available 24 hours a day, 365 days a year, making it a dependable energy resource. Geothermal reservoirs are most numerous in the Western United States, Alaska, Hawaii, and in the Gulf Coast areas of Texas and Louisiana (USDOE, 2006). Areas in central Texas, Arkansas, the Dakotas, and parts of the East Coast demonstrate moderate geothermal reservoirs as well (USDOE, 2006). Current research is concentrating on discovery methods for other hidden and deeper deposits, as well as better techniques for more efficient and economical extraction (Maryland Energy Administration, 2007). An unknown, but likely low potential for a geothermal reservoir exists within WFF property due to its geographic location.

2.2 ALTERNATIVES CONSIDERED AND DISMISSED

The tidal, wave, and geothermal power alternatives as renewable energy sources for WFF were dismissed because currently they are not practicable or feasible from a technical and/or economic standpoint. However, as these and other renewable energy sources become more technically mature, such sources may be proposed, and as such, their environmental impacts would be addressed in future NEPA documentation.

Siting constraints, as described above, for both the wind turbines and solar panels limited their placement to the locations described in Section 2.3 below.



WFF Boundary
Potential Solar Panel Areas - 172 acres Total
Paved Surface
Structure
Airfield Surface Area
Areas Excluded:
- Airfield, Runways, Taxiways (570 foot Buffer Around Runways and Taxiways)
- Wetlands
- Culturally Restricted Areas
- Vegetation Types Other Than Grassland and Shrubs
- Areas Planned for Future Structures
- Impervious Surfaces (i.e. Buildings, Roads, Parking Lots)
N
700 0 700 1,400
Feet
Title: Solar Panel Areas
URS Proj No: 15300762
Figure: 5
Client : NASA
Alternative Energy Project

This page intentionally left blank.

2.3 PROPOSED ACTION AND ALTERNATIVES

The Proposed Action and Alternatives consist of developing renewable, self-sufficient energy sources at WFF to supplement the electricity currently supplied to WFF by the local electric cooperative. These alternative energy sources would consist of proven wind and/or solar technologies to assist WFF in meeting its goals of reducing impacts on the natural environment. The wind and solar sources would consume energy from a source that provides zero GHG emissions, reduce WFF's annual operating costs, and set an example for responsible stewardship of natural resources by a Federal agency.

2.3.1 Proposed Action: Utility-Scale Wind Turbines and Residential-Scale Wind Turbines

Under the Proposed Action, NASA's preferred alternative, NASA would construct two 2.0 MW "utility-scale" wind turbines on Wallops Island that would be capable of generating approximately 10 GWh/year, and up to five 2.4 kW "residential-scale" wind turbines at the Main Base and Mainland.

2.3.1.1 Utility-Scale Turbines

The 2.0 MW wind turbines would be located on Wallops Island west of the U.S. Navy V-10/V-20 complex (Figure 6). A depiction of the wind turbines is shown on Figure 7. The general specifications of a representative 2.0 MW wind turbine (Gamesa, 2009) include:

- Three composite (non-metal) rotor blades
- The diameter of the rotor blades is 87 meters (285 feet)
- A height of 120.5 meters (395 feet) at the top of the blade
- A rotation speed of 9 to 19 revolutions per minute
- Independent pitch control that allows rotor blades to automatically turn to face oncoming wind
- The generator and gearbox are supported by elastomeric elements to minimize noise emissions
- Braking system

The wind turbines would be constructed with a setback distance of 153 meters (500 feet) from existing towers and buildings. The finished subsurface footprint of each wind turbine would be approximately 13 meters (42 feet) in diameter, with a 4.6-meter-diameter (15-foot-diameter) surface foundation. The foundation of the turbines would be pre-cast concrete piles installed to a depth of approximately 30 meters (100 feet) below the ground surface.

A corridor 9.7 meters (32 feet) wide would be constructed for access roads to each wind turbine, including approximately 4.9 meters (16 feet) for a permanent gravel road surface and an additional 2.4 meters (8 feet) on each side for road shoulders.

Previously disturbed areas, including the cleared area east of the U.S. Navy V-10/V-20 complex, would be used for staging of equipment and materials, and for construction vehicle parking. The construction period for two wind turbines would be approximately 6 months.

The workspace radius required around each turbine tower during construction activities would be approximately 45.7 meters (150 feet). Clearing of existing vegetation beyond the foundation and crane pad footprints would not be required. A crane pad would be installed within the 45.7-meter (150-foot) radius of the wind turbine and would be approximately 15.2 meters (50 feet) by 15.2 meters (50 feet). The orientation and size of the crane pad could vary depending on the requirements of the wind turbine construction contractor.

Underground power collection lines would be built to interconnect each wind turbine to the existing Wallops Island 12.47-kilovolt electrical distribution system (see Figure 6). These power lines would be installed in conduit via horizontal directional drilling, which is a trenchless method of installing underground pipes, conduits, and cables in a shallow arc along a prescribed bore path, to minimize wetland disturbance. Step-up transformers for each wind turbine would be air-insulated and installed inside the base of the each tower. Additionally, interconnection switchgear would be installed inside the tower assemblies. All electrical equipment would be installed inside and out of the weather to minimize potential corrosion on the equipment and potential wetland disturbance.

2.3.1.2 Residential-Scale Turbines

Up to five residential-scale (2.4 kW) wind turbines would be installed under the Proposed Action. The representative residential-scale wind turbine described in Section 2.1.1.1 and Table 4 would be used. One of the 2.4 kW wind turbines would be installed near the WFF Visitor Center, and a second would be installed near the security guard station at the Mainland (Figure 4). The locations of the remaining three wind turbines are unknown at this time, but would be placed within the areas that NASA has identified as potential suitable locations at WFF (see Section 2.1.1.2 for a description of the methodology used to determine potentially suitable locations). Figure 4 shows the potentially suitable areas where three of the 2.4 kW wind turbines could be installed.

The wind turbines would be constructed with a setback distance of 30 meters (100 feet) from existing towers, buildings, and trees. The finished subsurface footprint of each 2.4 kW wind turbine would be approximately 1 meter (3 feet) in diameter, with a foundation depth of 6 meters (20 feet). No transformers or interconnection switchgear would be needed. Standard home electric wiring (10 gauge) would be buried in a trench from the wind turbine to the desired facility.

2.3.1.3 Operation, Maintenance, and Decommissioning

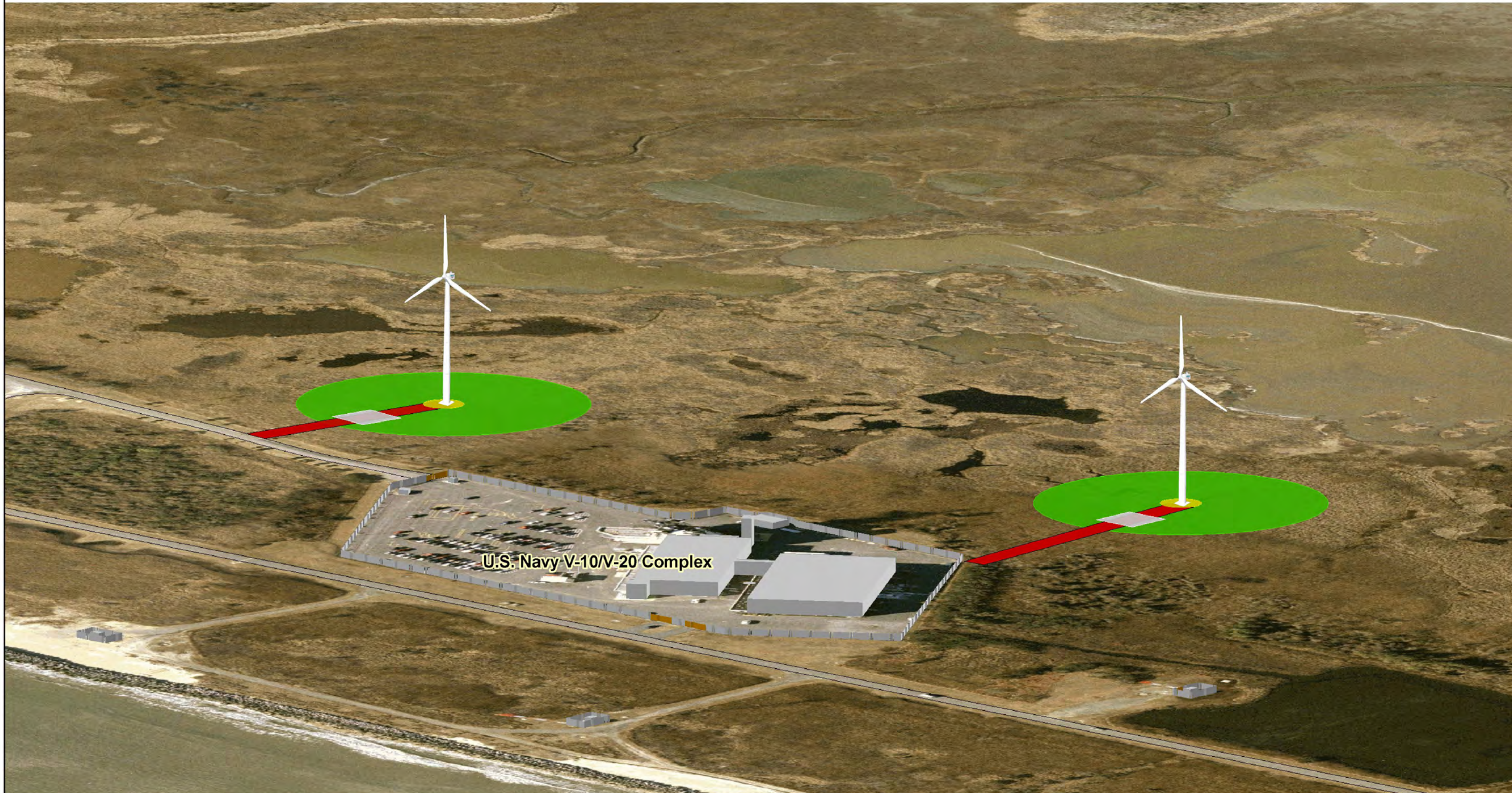
Operation and Maintenance

NASA would utilize data currently collected at various locations/towers on Wallops Island to monitor wind speed and direction, rather than building a new meteorological tower specifically for the Proposed Action. Existing WFF maintenance staff along with on-call manufacturer maintenance support staff would be used to maintain the turbines and transmission system; no new staff would be hired for the operation and maintenance of the turbines. Operations and maintenance staff and equipment would be housed in existing NASA facilities, negating the need to construct any new buildings for operations and maintenance.

- Surface Foundation Radius - 7.5 feet
- Subsurface Foundation Radius - 21 feet
- Turbine Workspace Radius - 150 feet
- New Road Width - 30 feet
- Crane Pad - 50 ft x 50 feet
- Staging Area

Title:	Proposed Location of 2.0 MW Wind Turbines and Staging Areas
URS Proj No:	15300762
Figure:	6
Client :	NASA
Alternative Energy Project	

This page intentionally left blank.



NOT TO SCALE

Surface Foundation Radius - 7.5 ft	
Subsurface Foundation Radius - 21 ft	
Turbine Workspace Radius - 150 ft	
New Road Width - 30 ft	
Crane Pad - 50 ft x 50 ft	

Title: Oblique Aerial View of Wallops Island Viewed from the South End of the Island Looking North

URS Proj No: 15300762

Figure: 7

Client : NASA

Alternative Energy Project

This page intentionally left blank.

Decommissioning

After the approximate 25-year useful life of a wind turbine, it would be decommissioned. Because the wind energy industry is still rather young, there are currently no industry-wide standards for disposing of wind turbine parts. At present, there are three possible options for dismantled wind turbine blades: landfill, incineration, or recycling. NASA would not dispose of the blades in a landfill. For incineration, currently the most popular method of disposal, turbine blades must be dismantled and crushed before being transported to incineration plants. After incineration, approximately 60 percent of the blades are left behind as ash, some of which can be recycled as construction materials. Recycling of either the synthetic composite material that makes up the turbine blades or entire parts of the turbine (if the parts are still in good working order) is another option for decommissioned turbine parts. There are several companies (primarily on the west coast, where wind technology has been around the longest) that specialize in rebuilding turbines with refurbished parts (Runyon, 2008; Nexion DG, 2009). Additionally, some of the metal parts may be recycled as scrap metal.

2.3.1.4 Cooperating Agency Action

The USACE is a cooperating Federal agency for this EA. The only suitable location for the two utility-scale wind turbines would result in the filling of wetlands. A USACE permit under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbor Act for dredging and the placement of fill in waters of the U.S. would be required. Therefore, in issuing the permit, the USACE would undertake a "connected action" (40 CFR 1508.25) that is related to, but unique from NASA's proposed action, the construction of the project.

2.3.2 Alternative One: Utility-Scale Wind Turbine, Residential-Scale Wind Turbines, and Solar Panels

Under Alternative One, NASA would construct one 2.0 MW wind turbine on Wallops Island that would be capable of generating 5 GWh/year. The specifications for the 2.0 MW wind turbine would be the same as described in Section 2.1.1.1 and the Proposed Action Alternative. The single 2.0 MW wind turbine would be constructed west of the U.S. Navy V-10/V-20 complex in the same location as the southern wind turbine shown on Figures 6 and 7. The footprint, work space, and staging areas would be the same as under the Proposed Action, but the construction period would be approximately 4 months.

NASA would also install up to five 2.4 kW wind turbines at the Main Base and Mainland as described under the Proposed Action Alternative.

In addition to the wind turbines, NASA would install a 4.0 MW system of solar panels at Wallops Main Base that would be capable of generating up to 5 GWh/year (the equivalent of one 2.0 MW wind turbine). Because the capacity factor of solar power is lower than that of wind turbines, at WFF, a 4.0 MW solar panel system would be required to produce an equal amount of energy as a 2.0 MW wind turbine. Based on the size of the solar panel described in Section 2.1.1.1 of this EA, approximately 19,000 1.4-square-meter (15-square-foot) solar panels equaling an area of approximately 3 hectares (7.5 acres) would be needed to meet the 2.0 MW power-generating capability. Panel spacing requirements would increase the overall required land area dedicated to solar panels to approximately 16 hectares (40 acres).

The power generated by the solar panels would be connected via underground distribution lines to a set of switchgear that would be enclosed in a small 5-meter by 6-meter (16-foot by 20-foot) pre-fabricated building. Solar panels would be installed in open, grassy areas of the Main Base (Figure 5). All solar panels would be installed facing south to maximize their power generating capability. All solar panels would be located and situated to have no effect on cultural resources, wetlands, or on pilots flying in the Aircraft Operating Area. The installation period for the solar panels would be approximately 2 months.

Operation, Maintenance, and Decommissioning

Operation, maintenance, and decommissioning for wind turbines would be the same as described under the Proposed Action Alternative. Maintenance and operation of solar panels would primarily consist of mirror washing every few weeks or mirror replacement as necessary. Existing WFF maintenance staff would be used to monitor and maintain the solar panels and transmission system; no new staff would be hired for the operation and maintenance of the solar panels.

After the expected 25-year life span of the solar panels, the PV cell systems would be decommissioned. NASA would recycle the solar panels by sending the spent cells to a smelting or refining facility that specializes in reclaiming materials such as glass, aluminum frames, and semiconductor materials.

2.3.3 Alternative Two: Residential-Scale Wind Turbines and Solar Panels

Under Alternative Two, NASA would install up to five 2.4 kW wind turbines at the Main Base and Mainland as described under the Proposed Action Alternative. In addition, NASA would install a system of solar panels at Wallops Main Base that would be capable of generating 10 GWh/year of power. To produce this amount of energy, WFF would install approximately 38,000 1.4-square-meter (15-square-foot) panels that would equal an area of approximately 6 hectares (15 acres). Panel spacing requirements (to avoid shading and allow maintenance) would increase the overall required land area dedicated to solar panels to approximately 32 hectares (80 acres).

The power generated by the solar panels would be connected via underground distribution lines to a set of switchgears that would be enclosed in a small 5-meter by 6-meter (16-foot by 20-foot) pre-fabricated building. All solar panels would be installed facing south in open, grassy areas of the Main Base (Figure 5). All solar panels would be located and situated to have no effect on cultural resources, wetlands, or on pilots flying in the WFF Aircraft Operating Area. The installation period for the solar panels would be approximately 4 months. Operation, maintenance, and decommissioning of solar panels would be the same as described under the Alternative One.

2.3.4 Comparison of Costs Among Alternatives

A primary reason for NASA’s preference for employing wind energy at WFF is its cost and relatively fast payback; it would be the most economically feasible of the alternatives. Table 6 below presents a summary of estimated savings or costs that would be realized for each alternative. It does not include costs for the installation of up to five residential-scale wind turbines because these costs would be the same for each alternative since all three alternatives include an identical proposal for the installation of the residential-scale turbines.

Table 6: Comparison of Costs Among the Action Alternatives

	Proposed Action	Alternative One	Alternative Two
Annual energy production at WFF	10 GWh/year	10 GWh/year	10 GWh/year
Total Installed Cost[1]	$10.1 million	$31.0 million	$52.0 million
Estimated 25-year Savings (*Cost*)[1, 2]	$14.4 million	(*$5.1 million*)	(*$24.8 million*)

[1]All costs are in 2010 dollars

[2]Assumes $0.075/kWh at Year 1 with 3 percent annual escalation

2.4 NO ACTION ALTERNATIVE

Under the No Action Alternative, NASA would not fund or construct renewable energy sources at WFF to supplement the current supply of electricity that is provided by the local electric cooperative. The requirements for the implementation of sustainable practices for energy efficiency and reductions in GHG emissions, and for the use of renewable energy set forth in the 2005 EPAct, EO 13423, and EO 13514 would not be met by WFF.

WFF would not meet its own goals of reducing GHG emissions and supporting NASA's goal to set an example for environmental stewardship and accountability by a Federal agency. Additionally, WFF would not work towards its goal of reducing annual operating costs by investing in self-sufficient, renewable energy generation. The cost of electricity would continue to depend on the cost of the traditional, non-renewable energy sources used to produce it; as the supply and availability of fossil-fuel burning energy sources decreases, fuel costs are expected to continue to rise and ultimately the cost of electricity to the end user, WFF, would increase.

This page intentionally left blank.

SECTION THREE: AFFECTED ENVIRONMENT

Section 3 describes existing resources at WFF that may be affected by the proposed alternatives. Resources are discussed under three main categories: Physical Environment, Biological Environment, and Social and Economic Environment. Because the Proposed Action activities that could affect the environment would take place on Wallops Island and the Main Base, and not on Wallops Mainland, this section does not provide a comprehensive description of conditions (soil types, air emissions, etc.) for Wallops Mainland. For more information about the existing conditions at Wallops Mainland, please refer to the 2008 WFF Environmental Resources Document (NASA, 2008a).

3.1 PHYSICAL ENVIRONMENT

3.1.1 Land Resources

Information on land resources is taken from the 1994 soil survey for Accomack County, VA (USDA, 1994); the 2005 WFF Site-Wide EA (NASA, 2005); and the 2008 WFF Environmental Resources Document (NASA, 2008a). Land resources include topography and drainage, geology, soil, and land use within the WFF operating area.

3.1.1.1 Topography

The topography at WFF is typical of the Mid-Atlantic coastal region, generally low-lying and near sea level with elevations ranging from sea level to 15 meters (50 feet) above mean sea level (amsl). The majority of the WFF Main Base is located on a high terrace landform (7.6 to 12.2 meters [25 to 40 feet] amsl), with the northern and eastern portions located on low terraces (0 to 7.6 meters [0 to 25 feet] amsl) and tidal marsh.

Wallops Island is a barrier island separated from the Main Base and Wallops Mainland by numerous inlets, marshes, bays, creeks, and tidal estuaries. During storms, flood water from the Atlantic Ocean moves through these inlets and across the marshes to low-lying areas along the coast (NASA, 2005). Wallops Island is approximately 11 kilometers (7 miles) long and 807 meters (2,650 feet) wide. Presently, the highest elevation on Wallops Island is approximately 4.6 meters (15 feet) amsl. Most of the island is below 3.0 meters (10 feet) amsl (NASA, 2005).

3.1.1.2 Geology and Soil

Located within the Atlantic Coastal Plain Physiographic Province, WFF is underlain by approximately 2,133 meters (7,000 feet) of sediment. The sediment lies atop crystalline basement rock. The sedimentary section, ranging in age from Cretaceous to Quaternary (approximately 145.5 to 2.5 million years ago), consists of a thick sequence of terrestrial, continental deposits overlain by a much thinner sequence of marine sediments. These sediments are generally unconsolidated and consist of clay, silt, sand, and gravel.

The regional dip of the soil units is eastward, toward the Atlantic Ocean. The two uppermost stratigraphic units on Wallops Island are the Yorktown Formation and the Columbia Group, which is not subdivided into formations. The Yorktown Formation is the uppermost unit in the Chesapeake Group and was deposited during the Pliocene epoch of the Tertiary Period (approximately 5.3 to 1.8 million years ago). The Yorktown Formation generally consists of fine to coarse glauconite quartz sand, which is greenish gray, clayey, silty, and in part, shelly. The Yorktown Formation occurs at depths of 18 to 43 meters (60 to 140 feet) in Accomack County (Commonwealth of Virginia, 1975).

The Coastal Plain soils of the Eastern Shore are generally very level, and many soil types are considered to be prime farmland by the U.S. Department of Agriculture (USDA). The dominant agricultural soils in the region are high in sand content, which results in a highly leached condition, an acidic pH, and a low natural fertility (USDA, 1994). No prime or unique soils are found on Wallops Island, but some of the area surrounding WFF, as well as a small part of the Main Base, is designated as prime or unique farmland as classified by Natural Resources Conservation Service (USDA, 1994). Because the entire Main Base is zoned for industrial use by Accomack County, the Farmland Protection Policy Act (7 U.S.C. 4201 et seq.) does not apply to the soils at WFF. The shoreline beaches consist mostly of fine-grained sand deposited by wave action and subjected to daily tidal fluctuations.

3.1.1.3 Land Use

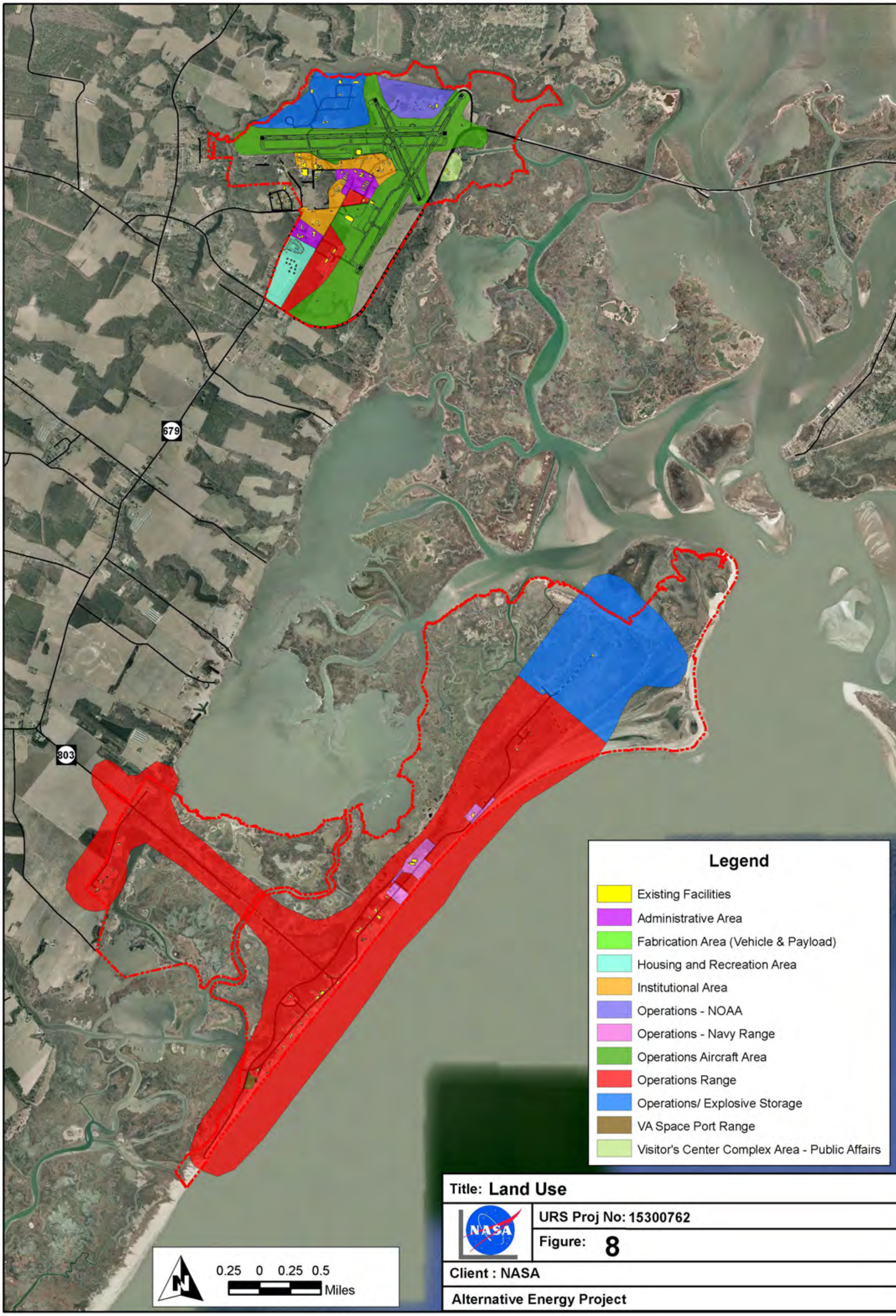
The Main Base and most of Wallops Island are zoned for industrial use by Accomack County, VA (Figure 8). The marsh area between Wallops Mainland and Wallops Island is classified as marshland in the County's Comprehensive Plan. Rural farmland and small villages are scattered throughout the surrounding areas.

Wallops Island consists of 1,680 hectares (4,150 acres), most of which is marshland, and includes launch and testing facilities, blockhouses, rocket storage buildings, assembly shops, dynamic balancing facilities, tracking facilities, U.S. Navy facilities, and other related support structures.

Area businesses include fuel stations, retail stores, markets, and restaurants. Horntown is located 4 kilometers (2.5 miles) north of the Main Base; Wattsville is located 1.6 kilometers (1 mile) to the west of the Main Base; and Atlantic is located 4.4 kilometers (2.75 miles) to the southwest of the Main Base. Each of these towns has a population of less than 500 people.

The Town of Chincoteague, located approximately 24 kilometers (15 miles) northeast of Wallops Island, on Chincoteague Island, VA, is the largest of the surrounding communities, with approximately 4,300 year-round residents. The island attracts a large tourist population during the summer months to visit the public beaches and attend the annual Assateague Island pony swim and roundup. Therefore, hotels and motels, as well as other summer-season tourist businesses, can be found on Chincoteague Island.

The Wallops Island National Wildlife Refuge is located south of the Visitor Information Center and is under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS). This refuge is not open to the general public. South of Wallops Island is Assawoman Island, a 576-hectare (1,424-acre) island managed as part of the Chincoteague National Wildlife Refuge (CNWR) by the USFWS. A string of undeveloped barrier islands, managed by the Nature Conservancy as part of the Virginia Coast Reserve, extends down the coast to the mouth of Chesapeake Bay.


679
803
Legend
Existing Facilities
Administrative Area
Fabrication Area (Vehicle & Payload)
Housing and Recreation Area
Institutional Area
Operations - NOAA
Operations - Navy Range
Operations Aircraft Area
Operations Range
Operations/ Explosive Storage
VA Space Port Range
Visitor's Center Complex Area - Public Affairs
0.25 0 0.25 0.5
Miles
Title: Land Use
URS Proj No: 15300762
Figure: 8
Client : NASA
Alternative Energy Project

This page intentionally left blank.

3.1.2 Water Resources

Water resources include surface waters, wetlands, floodplains, coastal zone management, and groundwater.

The southern and eastern portions of Wallops Island are part of the Eastern Lower Delmarva watershed. The western portion of Wallops Island and the entire Main Base are part of the Chincoteague Bay watershed, while the remaining Wallops Island surface waters flow into many small unnamed watersheds. The Chincoteague Bay watershed has a relatively small population, with an average density of less than 105 people per square kilometer (40 per square mile), little topographic relief, and a high water table. Large areas of the watersheds on Wallops Island are comprised of tidal wetlands.

3.1.2.1 Surface Waters

Chincoteague Inlet forms the northern boundary of Wallops Island and its western side is bounded by water bodies that include (from north to south) Ballast Narrows, Bogues Bay, Cat Creek, and Hog Creek. Little Mosquito Creek forms the northwest and northern boundary of the Main Base (Figure 9). A section of the Virginia Inside Passage, a federally maintained navigational channel frequently used by commercial and recreational boaters, is located west of Wallops Island and east of the Main Base. The Atlantic Ocean lies to the east of Wallops Island.

Surface waters in the vicinity of WFF are saline to brackish and are influenced by the tides. Outgoing tidal flow is generally north and east to Chincoteague Inlet and out to the Atlantic Ocean; incoming tides flow in the reverse direction. No wild or scenic rivers are located on or adjacent to Wallops Island; therefore, the Wild and Scenic Rivers Act (16 U.S.C. 1271–1287) does not apply to this project.

Stormwater

The Main Base has both natural drainage patterns and stormwater swales and drains to intercept and divert flow; all stormwater at WFF eventually flows to the Atlantic Ocean. On the northern portion of the Main Base, stormwater drains to Little Mosquito Creek, the eastern and southeastern portions of the Main Base have a natural drainage pattern that flows to Simoneaston Bay, and the natural drainage pattern on the western and southwestern portions of the Main Base is toward Wattsville Branch and Little Mosquito Creek. The marshes at WFF flood regularly with the tides and are drained by an extensive system of meandering creeks. Surface water on Wallops Island flows through numerous tidal tributaries that subsequently flow to the Atlantic Ocean. Additionally, Wallops Island has storm drains that divert stormwater flow to several individual discharge locations.

The Clean Water Act (CWA) (33 U.S.C. §1251 et seq.), as amended in 1977, established the basic framework for regulating discharges of pollutants into the waters of the United States.

The CWA National Pollutant Discharge Elimination System (NPDES) (33 U.S.C. 1342) requires permits for stormwater discharges associated with industrial activities. VDEQ is authorized to carry out NPDES permitting under the Virginia Pollutant Discharge Elimination System (VPDES) (9 Virginia Administrative Code [VAC] 25-151). NASA maintains a Stormwater Pollution Prevention Plan (SWPPP) to ensure that its operations have minimal impact on stormwater quality.

The Virginia Stormwater Management Program (VSMP) regulations (4 VAC 3-20), administered by the Virginia Department of Conservation and Recreation (DCR), require that construction and land development activities incorporate measures to protect aquatic resources from the effects of increased volume, frequency, and peak rate of stormwater runoff and from increased non-point source pollution carried by stormwater runoff. The VSMP also requires that land-disturbing activities of 0.4 hectare (1 acre) or greater develop a SWPPP and acquire a permit from the Virginia DCR prior to construction. Construction and demolition activities at WFF are subject to VSMP permitting. NASA and its tenants develop SWPPPs and acquire the necessary permits as part of early project planning.

3.1.2.2 Wetlands

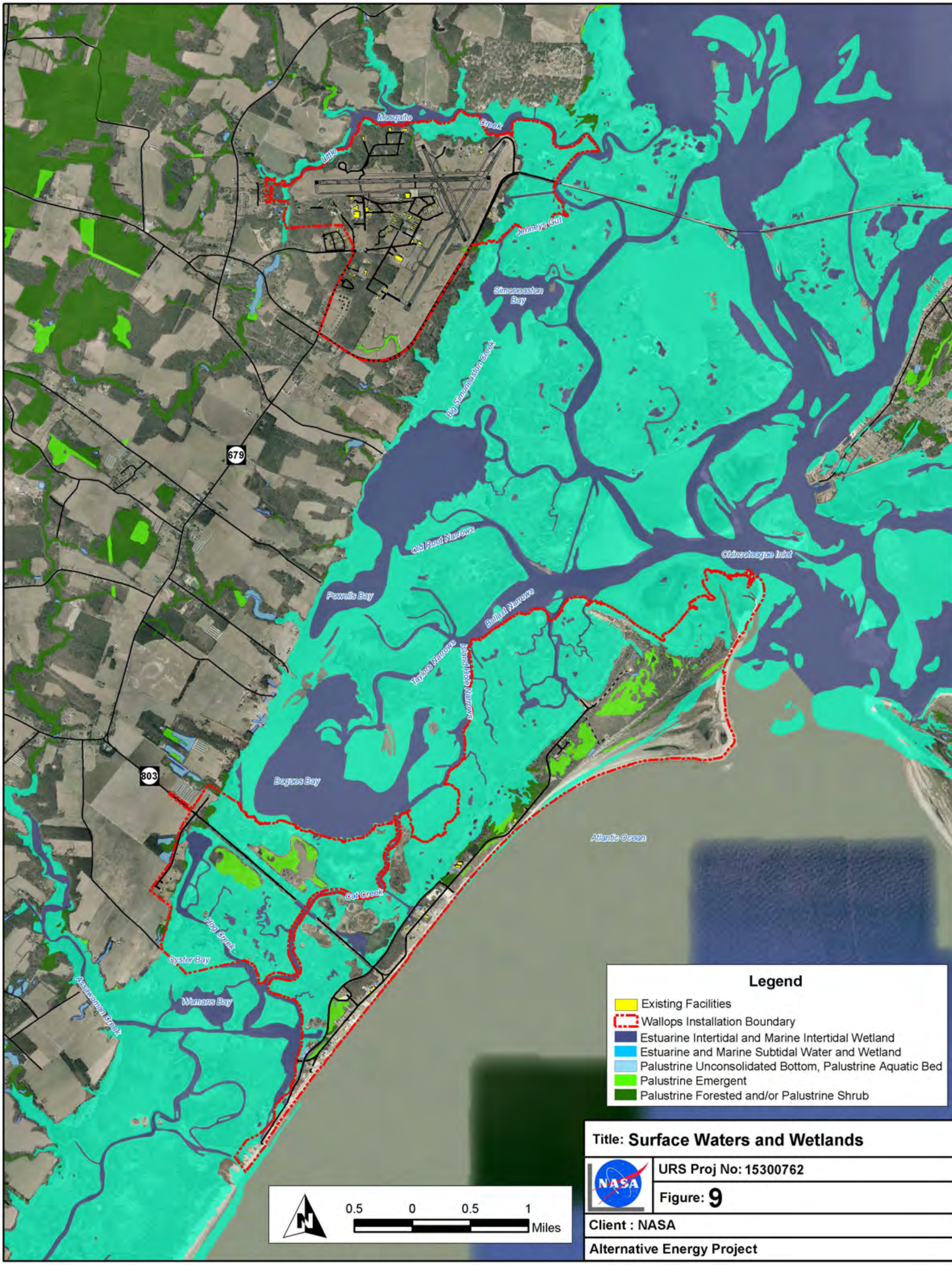
EO 11990, *Protection of Wetlands*, directs Federal agencies to minimize the destruction, loss, and degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetland communities. In accordance with the CWA, Section 404 permits from the USACE are required for projects at WFF that involve dredging or filling wetlands. Title 14 of CFR Part 1216.2 (NASA regulations on Floodplain and Wetland Management) directs WFF and its tenants to minimize wetland impacts.

In addition, permits may be required from the Virginia Marine Resources Commission (VMRC), the Accomack County Wetlands Board, and the VDEQ for work that may impact wetlands. A Joint Permit Application (JPA), filed with VMRC, is used to apply for permits for work in the waters of the United States, including wetlands, within Virginia. The VMRC plays a central role as an information clearinghouse for local, State, and Federal levels of review; JPAs submitted to VMRC receive independent yet concurrent review by local wetland boards, VMRC, VDEQ, and USACE.

The Main Base has tidal and nontidal wetlands along its perimeter in association with Little Mosquito Creek, Jenneys Gut, Simoneaston Bay, and Simoneaston Creek. Extensive tidal wetland systems border Wallops Island. The island has non-tidal freshwater emergent wetlands and several small freshwater ponds in its interior and freshwater forested/shrub wetlands, estuarine intertidal emergent wetlands, and maritime forests on its northern and western edges**.** Figure 9 provides further details on the types and locations of wetland communities present on Wallops Main Base and Wallops Island.

3.1.2.3 Floodplains

EO 11988, *Floodplain Management*, requires Federal agencies to take action to minimize occupancy and modification of the floodplain. Specifically, EO 11988 prohibits Federal agencies from funding construction in the 100-year floodplain unless there are no practicable alternatives. As shown on the Flood Insurance Rate Maps (FIRMs) produced by the Federal Emergency Management Agency, the 100-year floodplain designates the area inundated during a storm having a 1 percent chance of occurring in any given year. The 500-year floodplain designates the area inundated during a storm having a 0.2-percent chance of occurring in any given year.



Title: **Surface Waters and Wetlands**

URS Proj No: 15300762

Figure: 9

Client : NASA

Alternative Energy Project

This page intentionally left blank.

FIRM Community Panels 510001 0070 B and 510001 0100 C indicate that Wallops Island is located entirely within the 100-year and 500-year floodplains (see Figure 10). In addition, the same FIRM Community Panels show that the 100-year and 500-year floodplains surround the perimeter of the Main Base, and occur along Mosquito Creek, Jenneys Gut, and Simoneaston Creek.

3.1.2.4 Coastal Zone Management

Wallops Island is one of a limited number of barrier islands along the Atlantic Coast of the United States. Barrier islands are elongated, narrow landforms that consist largely of unconsolidated and shifting sand, and lie parallel to the shoreline between the open ocean and the mainland. Barrier islands provide protection to the mainland, prime recreational resources, important natural habitats for unique species, and valuable economic opportunities to the country. Wallops Island also contains coastal primary sand dunes that serve as protective barriers from the effects of flooding and erosion caused by coastal storms (NASA, 2008a).

The Coastal Barrier Resources Act (CBRA [P.L. 97-348], 16 U.S.C. 3501-3510), enacted in 1982, designated various undeveloped coastal barrier islands as units in the Coastal Barrier Resources System (CBRS). Designated units are ineligible for direct or indirect Federal financial assistance programs that could support development on coastal barrier islands; exceptions are made for certain emergency and research activities. Wallops Island is not included in the CBRS; therefore, the CBRA does not apply.

VDEQ is the lead agency for the Virginia Coastal Zone Management (CZM) Program, which is authorized by NOAA to administer the Coastal Zone Management Act of 1972. Any Federal agency development in Virginia’s Coastal Management Area (CMA) must be consistent with the enforceable policies of the CZM Program. Although Federal lands are excluded from Virginia’s CMA, any activity on Federal land that has reasonably foreseeable coastal effects must be consistent with the CZM Program (VDEQ, 2008b). Enforceable policies of the CZM Program that must be considered when making a Federal Consistency Determination include:

- **Fisheries Management.** Administered by VMRC, this program stresses the conservation and enhancement of shellfish and finfish resources and the promotion of commercial and recreational fisheries.
- **Subaqueous Lands Management.** Administered by VMRC, this program establishes conditions for granting permits to use State-owned bottomlands.
- **Wetlands Management.** Administered by VMRC and VDEQ, the wetlands management program preserves and protects tidal wetlands.
- **Dunes Management.** Administered by VMRC, the purpose of this program is to prevent the destruction or alteration of primary dunes.
- **Non-Point Source Pollution Control.** Administered by the Virginia DCR, the Virginia Erosion and Sediment Control Law is intended to minimize non-point source pollution entering Virginia’s waterways.
- **Point Source Pollution Control.** Administered by VDEQ, the VPDES permit program regulates point source discharges to Virginia’s waterways.

- **Shoreline Sanitation.** Administered by the Virginia Department of Health, this program regulates the installation of septic tanks to protect public health and the environment.
- **Air Pollution Control.** Administered by VDEQ, this program implements the Federal Clean Air Act (CAA) through a legally enforceable State Implementation Plan.
- **Coastal Lands Management.** Administered by the Chesapeake Bay Local Assistance Department, the Chesapeake Bay Preservation Act guides land development in coastal areas to protect the Chesapeake Bay and its tributaries.

Because WFF is within Virginia's CMA, its activities are subject to the Federal Consistency requirement.

3.1.3 Air Quality

The CAA (P.L. 108-201, 42 U.S.C. 85 et seq.), as amended, requires EPA to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. The CAA established two types of NAAQS: primary and secondary standards. Primary standards set limits to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly. Secondary standards protect public welfare, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

The EPA has set NAAQS for six principal pollutants that are called criteria pollutants. They are: carbon monoxide (CO), nitrogen oxides (NO_X), ozone (O_3) for which volatile organic compounds (VOCs) and NO_X are the main precursors, lead (Pb), sulfur dioxide (SO_2) and particulate matter (PM). EPA divides PM into two categories: inhalable coarse particles (i.e., PM less than 10 micrometers [PM_{10}] but larger than 2.5 micrometers) and fine particles (i.e., PM less than or equal to 2.5 micrometer [$PM_{2.5}$]). Although States have the authority to adopt stricter standards, the Commonwealth of Virginia has accepted the Federal standards and has incorporated them by reference in 9 VAC 5-30 (VDEQ, 2008c; see Table 7).

679
803
Legend
Existing Facilities
Wallops Installation Boundary
100 Year Flood Zone
500 Year Flood Zone
0.5
0
0.5
1
Miles
Title: Floodplains
NASA
URS Proj No: 15300762
Figure: 10
Client : NASA
Alternative Energy Project

This page intentionally left blank.

Table 7: National Ambient Air Quality Standards

Pollutant	Averaging Time	Primary/Secondary NAAQS	NAAQS Violation Determination
O_3	8 hour	0.075 ppm [b]	3-year average of the annual 4th highest daily maximum 8-hour average concentration
CO	8 hour	9.0 ppm	Not to be exceeded more than once per calendar year
	1 hour	35.0 ppm	Not to be exceeded more than once per calendar year
NO_2	Annual arithmetic mean	0.053 ppm	Annual average
SO_2	Annual arithmetic mean	0.03 ppm	Not to be exceeded more than once per calendar year
	24 hour	0.14 ppm	Not to be exceeded more than once per calendar year
	3 hour	0.5 ppm	Not to be exceeded more than once per calendar year
PM_{10}	Annual arithmetic mean	Revoked[c]	Expected number of days per calendar year with a 24-hour average concentration above 150 µg/m^3 cannot be exceeded more than once per year on average over a 3-year period
	24 hours	150 µg/m^3	
$PM_{2.5}$	Annual arithmetic mean	15 µg/m^3	3-year average of annual arithmetic mean
	24 hour	65 µg/m^3	3-year average of 98th percentile of the 24-hour values determined for each year
Pb	Quarterly average	1.5 µg/m^3	Quarterly arithmetic mean

[a]A NAAQS violation results in the re-designation of an area; however, an exceedance of the NAAQS does not always mean a violation has occurred.
[b]New O_3 8-hour standard effective May 30, 2008.
[c]Revoked annual PM_{10} standard December 2006.
µg/m^3 = micrograms per cubic meter
ppm = parts per million
NA = not applicable
NO_2 = nitrogen dioxide
Source: Derived from EPA, 2008a

Federal regulations designate Air Quality Control Regions, or airsheds, that cannot attain compliance with the NAAQS as non-attainment areas. Areas meeting the NAAQS are designated as attainment areas. Wallops Island and Mainland are located in Accomack County, an attainment area for all criteria pollutants; therefore, a General Conformity Review (under Section 176(c) of the CAA) does not apply to the facilities prior to implementing a Federal action.

Wallops Island and Wallops Mainland are considered a synthetic minor source, and the two land masses are combined into a single facility-wide State operating air permit for stationary emission sources (Permit Number 40909, amended September 8, 2009). Wallops Main Base is also considered a synthetic minor source and has its own facility-wide State operating air permit for stationary sources (Permit Number 40217, amended February 5, 2009). A facility is considered a major source in an attainment area if all of its sources together have a potential to emit (PTE) greater than or equal to 90.7 metric tonnes (100 tons) per year of the criteria pollutants, or greater than or equal to 9.1 metric tonnes (10 tons) per year of a single Hazardous Air Pollutant (HAP) or 23 metric tonnes (25 tons) per year of combined HAPs. Table 8 provides the actual emissions of criteria pollutants for calendar year 2008 at WFF based on the 2008 Annual Update Forms (NASA, 2009c).

Table 8: Calendar Year 2008 Air Emissions at WFF

Pollutant	Emissions (metric tonnes per year/tons per year)
CO	0.46 / 0.51
NO_X	1.93 / 2.13
SO_2	2.98 / 3.28
VOC	0.05 / 0.06
PM_{10}	0.20 / 0.22
PM	0.18 / 0.20

3.1.4 Climate Change

There is scientific evidence that the chemical composition of the Earth's atmosphere is being changed by human activities, such as fossil fuel combustion, deforestation, and other land use changes, resulting in the accumulation of trace GHGs in the atmosphere (NASA, 2010a). By absorbing the radiative energy from the sun and earth, GHGs trap heat in the atmosphere and such accumulation in the atmosphere may be contributing to an increase in the Earth's average surface temperature, which in turn is expected to affect weather patterns and severity of storms/droughts, average sea levels, and increased intrusion of seawater into estuaries. Other effects are changes in precipitation rates, an increase in O_3 levels due in part to changes in atmospheric photochemistry, and decreased water availability and quality (Jones & Stokes, 2007).

GHGs include water vapor, CO_2, methane (CH_4), nitrous oxide (N_2O), O_3, and several hydro- and chlorofluorocarbons. These emissions occur from both natural processes and human activities. Water vapor occurs naturally and accounts for the largest percentage of GHGs, and CO_2 is the second-most abundant GHG. Some GHGs are directly emitted from human processes (CO_2, chlorofluorocarbons, and water vapor), while other gases (e.g., NO_X and VOCs) emitted from these processes contribute indirectly by forming tropospheric (ground-level) O_3 and other reactive species. Those compounds then react with GHGs and control the amount of radiation penetrating through the troposphere.

As GHGs are relatively stable in the atmosphere and are essentially uniformly mixed throughout the troposphere and stratosphere, the impact of GHG emissions on the climate does not depend upon the source location. Therefore, regional climate impacts are likely a function of global emissions.

Each GHG is assigned a global warming potential (GWP), which is the ability to trap heat, and is standardized to CO_2, which has a GWP value of one. For example, N_2O has a GWP of 310, meaning it has a global warming effect 310 times greater than CO_2 on an equal-mass basis. For simplification, total GHG emissions are often expressed as a CO_2 equivalent (CO_2e). The CO_2e is calculated by multiplying each GHG emission by its GWP and adding the results to produce a combined rate to represent all GHGs.

There are a multitude of State and regional regulatory programs requiring GHG emissions reductions. Although Virginia has no current GHG legislation, the Governor issued Executive Order 59 in 2007, which established the "Governor's Commission on Climate Change" (Bryant, 2008). Since then, VDEQ created a Climate Change Steering Committee and GHG Emissions Workgroup who have focused on possible regional reduction targets, among other items. In addition to State programs, there is emerging Federal climate change-related legislation such as EO 13514. In 2007, the U.S. Supreme Court determined that the EPA had the regulatory authority to include GHGs as pollutants under the CAA. On October 30, 2009, EPA issued a new rule (Mandatory Reporting of GHGs) that adds substantial additional requirements, such as measurement, monitoring, and reporting for many industries. Most recently, the EPA released a statement on December 7, 2009 announcing that the current levels of GHG threaten public health and the environment, prompting further requests for regulations to reduce GHGs (EPA, 2009).

GHG emissions were calculated for both WFF Mainland/Wallops Island and the Main Base to estimate NASA's contribution in calendar year 2008. These emissions resulting from mobile (government-owned vehicles and rocket launches) and stationary source operations at WFF in 2008 will be referred to as the "baseline" condition for the analysis in this EA.

Table 9 lists the GHG emissions for WFF based on the 2008 Annual Update Forms (NASA, 2009c). Emission factors from the EPA's AP-42 (EPA, 2009) and Environment Canada's National Inventory Report Annex 13 (Environment Canada, 2006) were used in conjunction with the WFF fuel consumption rates to calculate annual GHG emissions for boilers/heating equipment and emergency generators. Total baseline CO_2e emissions for WFF are 10,206 metric tonnes per year.

Table 9: Calendar Year 2008 Greenhouse Gas Emissions at WFF by Pollutant

Pollutant	Emissions (metric tonnes per year)	
	WFF Main Base	**WFF Mainland/Wallops Island**
CO_2	8,794	1,392
CH_4	<1	<1
N_2O	<1	<1
CO_2e	8,811	1,398

3.1.5 Climate

WFF is located in the climatic region known as the humid continental warm summer climate zone. Large temperature variations during the course of a single year and lesser variations in average monthly temperatures typify the region. The climate is tempered by the proximity of the Atlantic Ocean to the east and the Chesapeake Bay to the west. Also affecting the climate is an oceanic current, known as the Labrador Current, which originates in the polar latitudes and moves southward along the Delmarva coastline. The current creates a wedge between the warm Gulf Stream offshore and the Atlantic Coast. The climate of the region is dominated in winter by polar continental air masses and in summer by tropical maritime air masses. Clashes between these two air masses create frontal systems, resulting in thunderstorms, high winds, and precipitation. Precipitation in this climate zone varies seasonally.

Four distinct seasons are discernible in the region. In winter, sustained snowfall events are rare. Spring is wet with increasing temperatures. Summer is hot and humid with precipitation occurring primarily from thunderstorm activity. Autumn is characterized by slightly decreasing temperatures and strong frontal systems with rain and sustained winds.

Wind

For Wallops Island, prevailing winds in the fall and winter tend to be from the northwest, but stormy nor'easters can occur. These 2- to 3-day storms produce severe conditions offshore, with high winds, cold rain, and steep seas due to the open distance of water over which wind can blow from the northeast. Prevailing winds in the summer are southerly, increasing in mid-morning to typically lower than 37 kilometers per hour (kph) (20 knots) and usually dying down at dusk. Offshore fog is uncommon, but can be produced during the spring when a warm, moist, southerly flow of air passes over the cold ocean water.

Wind speeds are the strongest during the fall and winter months, with winds exceeding 55 kph (30 knots) more than 5 percent of the time from November through February. Wind speeds peak in December, when winds exceed 55 kph (30 knots) more than 6 percent of the time. During these months, the predominant wind direction is from the northwest. During March and April, winds are more southerly but still strong. March winds exceed 55 kph (30 knots) nearly 5 percent of the time.

3.1.6 Radar

Radar systems provide space position and/or target characteristic information for a variety of applications, including surveillance, tracking, weather observation, and scientific remote sensing. The radar functions are performed by a variety of ground-based and airborne systems in support of the Wallops Research Range and Earth Science programs. Three surveillance radars and up to seven (three fixed and four mobile) tracking radars provide data for range safety and mission requirements. These systems are located on the Main Base, Wallops Mainland, and Wallops Island. The targets that are tracked include aircraft, balloons, drones, expendable launch vehicles, reusable launch vehicles, satellites, and sounding rockets.

Radar is used to monitor the altitudes that are used for air traffic to prevent airplane collisions. All the objects that are illuminated in the radar field reflect some energy back to the radar. The energy is modified by the reflection process, but radar can use these modifications to differentiate between different types of objects. The motion of wind turbine blades has a similar velocity band as aircraft, so if the blades are visible to the radar then they cannot be distinguished from a moving aircraft. This could cause aircraft near wind turbines to be identified in the wrong position or be lost in the vicinity of the wind turbine(s). As wind turbine technology changes, modifications to radar or turbines and blades are being explored (BWEA, 2008).

3.1.7 Noise

The EPA's Noise Control Act of 1972 (42 U.S.C. 4901 to 4918) as amended by the Quiet Communities Act of 1978, states that the policy of the United States is to promote an environment for all Americans free from noise that jeopardizes their health or welfare.

3.1.7.1 Noise Standards and Criteria

Noise is defined as any loud or undesirable sound. The standard measurement unit of noise is the decibel (dB), generally weighted to the A-scale (dBA), corresponding to the range of human hearing (Table 10). Since sounds in the outdoor environment are usually not continuous, a common unit of measurement is the L_{eq}, which is the time-averaged sound energy level. The L_{10} is the sound level exceeded 10 percent of the time and is typically used to represent peak noise levels. Similarly, the L_{01} and L_{90} are the noise levels exceeded 1 percent and 90 percent of the time, respectively. The 1-hour L_{eq} is the measurement unit used to describe monitored baseline noise levels in the vicinity of WFF. It conforms to the requirements in 23 CFR 772 and is a descriptor recommended by the Federal Highway Administration for describing noise levels during peak traffic periods. EPA guidelines, and those of many other Federal agencies, state that outdoor sound levels in excess of 55 dB night level are "normally unacceptable" for noise-sensitive land uses such as residences, schools, or hospitals.

The U.S. Occupational Safety and Health Administration (OSHA) regulates noise impacts on workers. OSHA regulations on noise standards ensure that workers are not exposed to noise levels higher than 115 dBA. Exposure to 115 dBA is limited to 15 minutes or less during an 8-hour work shift. Exposure to impulsive or impact noise (loud, short duration sounds) is not to exceed 140 dB peak sound pressure level.

Table 10: Typical Noise Levels of Familiar Noise Sources and Public Responses

Thresholds/Noise Sources	Sound Level (dBA)	Subjective Evaluation[a]	Possible Effects on Humans[a]
Human threshold of pain	140	Deafening	Continuous exposure to levels above 70 dBA can cause hearing loss in the majority of the population
Siren at 100 feet Loud rock band	130		
Jet takeoff at 200 feet Auto horn at 3 feet	120		
Chain saw Noisy snowmobile	110		
Lawn mower at 3 feet Noisy motorcycle at 50 feet	100	Very Loud	
Heavy truck at 50 feet	90		
Pneumatic drill at 50 feet Busy urban street, daytime	80	Loud	
Normal automobile at 50 mph Vacuum cleaner at 3 feet	70		Speech interference
Air conditioning unit at 20 feet Conversation at 3 feet	60	Moderate	
Quiet residential area Light auto traffic at 100 feet	50		Sleep interference
Library Quiet home	40	Faint	
Soft whisper at 15 feet	30		
Slight rustling of leaves	20	Very Faint	
Broadcasting studio	10		
Threshold of Human Hearing	0		

[a]Both the subjective evaluations and the physiological responses are continuums without true threshold boundaries. Consequently, there are overlaps among categories of response that depend on the sensitivity of the noise receivers.
Source: EPA, 1974

The Accomack County code states that "...any loud, disturbing, or unreasonable noise in the county, which noise is of such character, intensity, or duration as to be detrimental to the life, health, or safety of any person, or to disturb the quiet, comfort, or response of any reasonable person" is prohibited (Accomack County, 2001). Table 11 shows the specific noise limitations by land use as regulated by Accomack County.

Table 11: Accomack County Noise Guidelines by Land Use

District/Land Use	Daytime Level (dBA)	Nighttime Level (dBA)
Residential	65	55
Agricultural	65	55
Business	70	60
Industrial	70	60
Barrier Island	65	55

Source: Accomack County, 2001

As a general rule, the above levels should not be exceeded; however, exceptions to the rule exist. According to Article II, Section 38-35 of the Accomack County code, "This article shall not apply to noises generated by commercial or industrial operations except for those noises that emanate from the boundaries of such commercial or industrial site and affect persons who are not working onsite at such commercial or industrial operation."

Noise sources associated with activities at WFF include vehicular and air traffic, and noise at Wallops Island also includes target and rocket launches. In general, vehicular traffic at WFF, and especially Wallops Island, is minimal, and rocket launches are relatively infrequent and of short duration. WFF and U.S. Navy air traffic from the Main Base flies over Wallops Mainland and Wallops Island. Wind, wildlife, and wave action are the predominant sources of naturally occurring noise on Wallops Island.

During a 1992 noise monitoring program at Wallops Island, a wide range of background noise levels was found. At the northern portion of Wallops Island, natural sounds of wind, trees, and birds are the predominant source of the 53-dBA noise level. At the southern end of the island, as well as along the eastern seawall, the sounds of water and waves generate a noise level of about 64 dBA. In the interior of the island, near roads and buildings, noise levels are about 61 dBA during off-peak traffic periods and 64 to 65 dBA during peak a.m. and p.m. traffic (NASA, 2005).

3.1.8 Hazardous Materials and Hazardous Waste

3.1.8.1 Hazardous Materials Management

The WFF Integrated Contingency Plan (ICP), developed to meet the requirements of 40 CFR 112 (Oil Pollution Prevention and Response), 40 CFR 265 Subparts C and D (Hazardous Waste Contingency Plan), and 9 VAC 25-91-10 (Oil Discharge Contingency Plan), serves as the facility's primary guidance document for the prevention and management of oil, hazardous material, and hazardous waste releases. The ICP includes the following procedures:

- Each container of hazardous material is labeled in English with the following minimal description: name of chemical and all appropriate hazard warnings.
- Each work area has Material Safety Data Sheets (MSDSs) on file for each hazardous material used onsite. Each MSDS is in English and contains all required information. WFF utilizes an online electronic chemical inventory that contains links to appropriate MSDSs and is accessible to all WFF personnel through the GSFC intranet. Individual WFF support contractor offices train their personnel in the applicable hazardous communication pertinent to the requirements for each employee.
- Spill contingency and response procedures are prepared and implemented.
- The WFF Environmental Office offers annual ICP training to all Wallops and tenant personnel as well as to all visiting project teams.

3.1.8.2 Hazardous Waste Management

The regulations that govern hazardous waste management are the Resource Conservation and Recovery Act (RCRA, 42 U.S.C. 6901 et seq.) and Virginia's Hazardous Waste Management Regulations (9 VAC 20-60). A solid waste is any material that is disposed, incinerated, treated, or recycled except those exempted under 40 CFR 261.4. All hazardous wastes are classified as solid wastes. Wallops Main Base is separated from Wallops Island and Wallops Mainland by approximately 11.2 kilometers (7 miles) of public roadway. As they are not contiguous, each has been assigned its own EPA hazardous waste generator number. Shipment of hazardous waste between the two sites is illegal except by a licensed hazardous waste transporter. To facilitate the transportation of rocket motors declared hazardous waste from the Main Base to the Wallops Island, NASA has its own hazardous waste transporter license. NASA uses licensed hazardous waste transporters to transport hazardous waste off site to licensed treatment, storage, and disposal facilities.

3.2 BIOLOGICAL ENVIRONMENT

3.2.1 Vegetation

Wallops Island

Wallops Island is a barrier island that contains various ecological succession stages, including beaches, dunes, swales, maritime forests, and marsh. These natural vegetative zones form a series of finger-like stands that merge or grow into each other. The northern and southern dune vegetation on Wallops Island directly borders salt marshes.

Dominant species within the dune system include seabeach orach (*Atriplex arenaria*), common saltwort (*Salsola kali*), sea rocket (*Cakile edentula*), American beachgrass (*Ammonphila breviligulata*), seaside goldenrod (*Solidago sempervirens*), and common reed (*Phragmites australis*) (Koltz, 1986). Because of the dynamics of wave action, few plants exist in the subtidal zone, which extends from the lower limit of low tide seaward, and the intertidal zone, a transition zone exposed during low tide and submerged at high tide. On Wallops Island, beaches and dune systems are found on the northern and extreme southern sections of the island only. Plants such as sea rocket and beachgrass are scattered on the northern part of the island.

On the southern part of Wallops Island, the dune and swale zone extends to the tidal marsh on the western side of Wallops Island with no maritime forest present. In the central and northern areas, the dune and swale zone extends to the maritime zone that starts where the secondary dune line once existed. The central portion of Wallops Island is dominated by common reed, an invasive undesirable species, and maintained lawn areas. Due to its successful competition with many other plant species, the common reed has virtually taken over much of the area in the center of Wallops Island. A small area of maritime forest dominated by loblolly pine (*Pinus taeda*) and cherry trees (*Prunus* spp.), with an understory of northern bayberry, wax myrtle, and groundsel-tree, exists on the central portion of the island. The northern part of Wallops Island within the dune and swale zone is in an almost natural state, and is dominated by northern bayberry (*Morella pensylvanica*), wax myrtle (*Morella cerifera*), groundsel-tree (*Baccharis halimifolia*), and American beachgrass.

An area of tidal marsh encompasses 1,130 hectares (2,800 acres) between Wallops Island and Wallops Mainland. As the marshes provide suitable habitat for both foraging and reproduction, these areas are of tremendous importance to marine life and many terrestrial and avian species.

Wallops Main Base

The vegetative zones from east to west on Wallops Main Base are marsh, thicket, and upland forest. Inland communities such as fresh and brackish marsh, xeric and mesic shrub, patches of open ground, areas completely covered by pine, and pine-deciduous mixed woodlands are often separated from one another by a sharp topographic change. Small rich remnants of upland forests and swamps occur on the Main Base. Dominant species in the upland forest include loblolly pine, various oaks (*Quercus* sp.), hickory (*Carya* sp.), tulip-poplar (*Liriodendron tulipifera*), dogwood (*Cornus florida*), sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), and sassafras (*Sassafras albidum*). Black willow (*Salix nigra*) and red maple are dominant species in the swamps. The tidal marsh found on Wallops Main Base is similar to the tidal marsh on Wallops Island. Fields, pine forests, lawns, buildings, and pavement are present throughout the Main Base.

3.2.2 Terrestrial Wildlife

Wallops Island and Wallops Main Base host both terrestrial and aquatic forms of fauna that comprise their biotic communities. Terrestrial and aquatic species are particularly concentrated in the tidal marsh areas, which provide abundant habitat.

3.2.2.1 Invertebrates

Wallops Island, particularly the tidal marsh area, has an extensive variety of invertebrates. Saltmarsh cordgrass marshes have herbivorous (plant-eating) insects such as the saltmarsh grasshopper (*Orchelium fidicinium*) and the tiny plant hopper (*Megamelus* spp.). Plant hopper eggs are in turn preyed upon by a variety of arthropods, the group of animals that includes insects, spiders, and crustaceans. The tidal marshes are inhabited by a number of parasitic flies, wasps, spiders, and mites. The spiders prey mostly on herbivorous insects, and mites prey primarily on microarthropods (small invertebrates) found in dead smooth cordgrass. Saltmarsh mosquitoes (*Ochlerotatus sollicitans*) and greenhead flies (*Tabanus nigrovittatus*) are prevalent insects on Wallops Island. Periwinkle snails (*Littorina irrorata*) and mud snails (*Ilyanassa obsoleta*) are found on the marsh surface.

3.2.2.2 Amphibians and Reptiles

Amphibians and reptiles use the dune and swale zones of Wallops Island for foraging. Fowler's toad (*Bufo woodhoussei*) can be found under stands of bayberry. The green tree frog (*Hyla cinerea*) can be found in the wetter areas in the northern portion of Wallops Island. Some species of reptiles such as the black rat snake (*Elapha obsoleta*), hognose snake (*Heterodon platirhinos*), snapping turtle (*Chelydra serpentina*), box turtle (*Terrapene carolina*), and northern fence lizard (*Sceloporus undulatus*) can be found in low-lying shrubby areas. Diamondback terrapin (*Malaclemys terrapin*) can be found in saltmarsh estuaries, tidal flats, and lagoons.

3.2.2.3 Mammals

Mammals such as white-tailed deer (*Odocoileus virginianus*), opossum (*Didelphis marsupialis*), raccoon (*Procyon lotor*), and gray squirrel (*Sciurus carolinensis*) are plentiful at WFF. Raccoon and red fox (*Vulpes vulpes*) are occasionally found in the upper beach zone and the intertidal zone. River otters (*Lontra Canadensis)* have been observed on the marsh/upland interface of Wallops Island. These mammals use the maritime forest and other sections of the island for forage and shelter.

Mammals such as raccoon, red fox, white-footed mouse (*Peromyscus leucopus*), meadow vole (*Microtus pennsylvanicus*), rice rat (*Oryzomys palustris*), white-tailed deer, and Eastern cottontail rabbit (*Sylvilagus floridanus*) are found in the dune and swale zone.

3.2.3 Avifauna

3.2.3.1 Birds

Vaughn (1993) reported in the *Birds of Wallops Island, Virginia 1970–1992* that a total of 244 species have been recorded for Wallops Island and Wallops Mainland. This includes those birds that have been seen over the ocean, saltmarshes, thickets and forests, dunes, and urbanized land habitats associated with WFF. Of these, approximately 61 species have been documented breeding since 1970. Vaughn (1993) provides detailed species accounts for the occurrence of all 244 species, including information on the listed species discussed in this report: Bald Eagle, Peregrine Falcon, Piping Plover, Upland Sandpiper, and Wilson's Plover. This list is a subset of the 324 species that have been identified at the CNWR and includes shorebirds, gulls/terns, songbirds, raptors and other groups of birds as discussed below.

During spring and fall migrations, approximately 15 species of shorebirds feed on microscopic plants and animals in the intertidal zone. Abundant among these are the Sanderling (*Calidris alba*), Semi-palmated Plover (*Charadrius semipalmatus*), Red Knot (*Calidris canutus rufa*), Short-billed Dowitcher (*Limnodromus griseus*), and Dunlin (*Calidris alpina*). The Willet (*Catoptrophorus semipalmutus*) is very common during the breeding season. Royal Tern (*Sterna maxima*), Common Tern (*S. antillarum*), and Least Tern (*S. hirundo*) can be observed during the summer months. In addition, the Piping Plover (*Charadrius melodus*) and Wilson's Plover (*Charadrius wilsonia)* sometimes nest on the northern and southern ends of Wallops Island.

Laughing Gulls (*Larus atricilla*), Herring Gulls (*L. argentatus*), and Great Black-backed Gulls (*L. marinus*) commonly forage in the upper beach zone and the intertidal zone. Forster's Terns (*S. foresteri*) are common in the marshes and on occasion may winter on Wallops Island. Birds that use the shrub zones include various species of Sparrows, Red-winged Blackbirds (*Agelaius* *phoeniceus*), Boat-tailed Grackles (*Quiscalus major*), and Fish Crows (*Corvus ossifragus*). Birds common in the shrub zone include the Song Sparrow (*Melopiza melodia*), Gray Catbird (*Dumetella carolinensis*), Yellowthroat (*Geothlypis trichas*), and Mourning Dove (*Zenaida macroura*). Resident Canada Geese (*Branta canadensis*) are found year-round in open upland portions of the property.

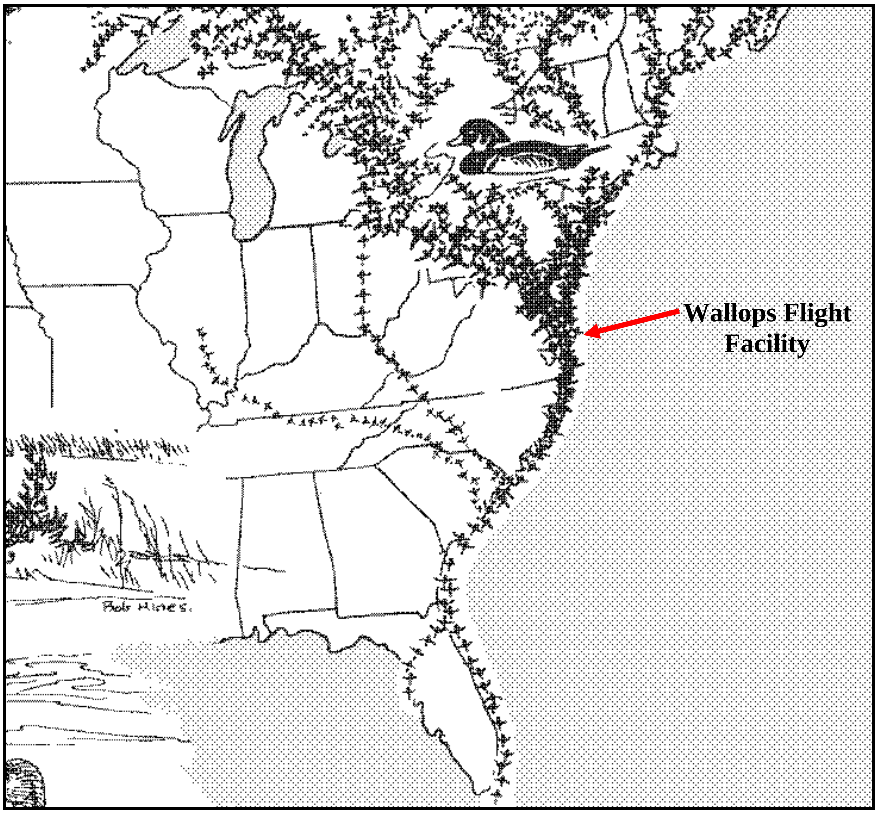
Numerous songbirds and other avian species can be found on the Main Base. Some of these, such as Barn Swallows (*Hirundo rustica*), are migratory and occur only during the spring, summer, and early fall. Northern Mockingbirds (*Mimus polyglottos*), Robins (*Turdus migratorius*), and Starlings (*Sturnus vulgaris*) are prevalent throughout the year.

Raptors, including Peregrine Falcons (*Falco peregrinus*), Northern Harriers (*Circus cyaneus*), and Osprey (*Pandion haliaetus*), inhabit the marsh areas west of Wallops Island. Great Horned Owls (*Bubo virginianus*) can be found in the maritime forest, and Bald Eagles (*Haliaeetus leucocephalus*) can often be seen flying over the facility although they do not nest on Wallops Island. There is an active Bald Eagle nest just north of the WFF Main Base, and recently another nest was discovered on the northern end of Wallops Island.

Migratory Birds

The Migratory Bird Treaty Act (MBTA, 16 U.S.C. 703-712) was enacted to ensure the protection of shared migratory bird resources. The MBTA prohibits the take and possession of any migratory bird, their eggs, or nests, except as authorized by a valid permit or license. The statutory definition of “take” is “to harass, hunt, capture, or kill, or attempt to harass, hunt, capture or kill.” A migratory bird is any species that lives, reproduces, or migrates within or across international borders at some point during its annual life cycle.

The coastal route of the Atlantic Flyway, which in general follows the eastern seaboard, is a regular avenue of travel for migrating land and water birds that winter on the waters and marshes—several routes converge just north of WFF, resulting in the Eastern Shore of Virginia and parts of Accomack County hosting large migrations of a diversity of bird species (see Figure 11). Waterfowl, other waterbirds, shorebirds, songbirds, and raptors stopover in or migrate through portions of Virginia and Maryland’s eastern shore along the Atlantic Flyway in numbers that are globally significant. Some species use Wallops Island as a stopover point, while others use the island and surrounding habitats as an overwintering area.



Source: USFWS, 2009a

Figure 11: Atlantic Flyway Migration Routes

Wintering Birds

Moderate to large numbers of birds winter successfully in coastal Virginia. The National Audubon Society Christmas Bird Counts (CBCs) are the primary sources of information on birds wintering in and adjacent to Accomack County and the project site. The CBCs are conducted by dozens of birders in Accomack County over a 10-day period in December of each year. Two locations of CBCs contain similar habitat to Wallops Island: the CNWR at Assateague Island and Hog Island, VA, which is a barrier island approximately 29 kilometers (18 miles) south-southwest of Wallops Island (National Audubon Society, 2010). The diversity and number of birds varies between years and sites, but both CBC sites regularly record more than 100 species and in some years report more than 150 species of birds. The reason for the large number of species and individuals found in these CBC sites is related to the diversity of habitats and the presence of excellent winter forage and cover for these species. During the 10-year count period between 1999 and 2009 at CNWR, one Piping Plover was observed in 1999, and one Piping Plover was observed in 2001. One Red Knot, a Federal candidate species, was observed in 2003. No other federally endangered species were observed.

Designated Wildlife Areas in the Vicinity of WFF

Several areas in the vicinity of WFF have been set aside as conservation and/or wildlife management areas, including for use as bird habitat, and when combined, make the Eastern Shore of Virginia a desirable stopover or permanent home for birds. These areas include:

- The Saxis Wildlife Management Area and the Saxis Waterfowl Management Area and Refuge, owned by the Commonwealth of Virginia, is located on the western side of the eastern shore of Virginia, approximately 12.9 kilometers (8 miles) west of Wallops Island on Pocomoke Sound.
- The Nature Conservancy's Virginia Coast Reserve, which includes 14 of 18 islands along the entire Virginia coast to the south of Wallops Island.
- The CNWR units located approximately 3.2 kilometers (2 miles) northeast of Wallops Island, on Assawoman Island, and within the Wallops Island National Wildlife Refuge.
- The Assateague National Seashore, which is located approximately 16.6 kilometers (10 miles) northeast of Wallops Island.
- The Pocomoke State Forest in Maryland is located approximately 17.6 kilometers (11 miles) northwest of Wallops Island.

Avian Study at Wallops Island, 2008–2009

NASA conducted an avian field pre-construction study between October 1, 2008, and October 1, 2009 (Appendix A). The overall objective of this study was to assess the potential risk to birds from operation of the two proposed 2.0 MW wind turbines.[1] The specific objectives of the field study were:

- Perform a pre-construction inventory of resident avian species and habitat in the vicinity of the proposed turbine sites.
- Identify pre-construction migratory, nesting, and winter avian use (abundance and behavior) of the project site, including use of migration stopover, resting, or feeding areas in the vicinity of the development site.
- Assess potential risk from wind turbine operation to avian species, primarily through monitoring of avian fatality at existing tall structures on Wallops Island.

To specifically address these objectives, the field study included diurnal avian surveys and fatality searches near existing towers in the general vicinity of the proposed wind turbines. Searcher efficiency and carcass removal tests were also incorporated into the fatality surveys. Radar surveillance was not a component of the avian study.

Methods

Avian Field Observations

The avian field observations included two components: 1) avian observations conducted once per week at two point count locations ("Avian Survey Observation Points" on Figure 12) throughout the 52-week study duration; and 2) avian observations for a period of 15 minutes at least twice per week during migration seasons (September 1–October 31 and April 15–June 15) at the same observation sites.

[1] The potential risk to birds from the five proposed 2.4 kW wind turbines was not assessed as part of this study. See Section 4.3.3 for a qualitative assessment.

Title: Bat Detector and Avian Observation Locations

URS Proj No: 15300762

Figure: 12

Client : NASA

Alternative Energy Project

This page intentionally left blank.

For the once-per-week observations throughout the 52-week period, biologists visited both observation sites at least once per week for a minimum of 15 minutes per day between 7:00 a.m. and 9:00 a.m. at each location to record avian activity. Data were recorded for birds observed within a 1-kilometer (0.62-mile) radius of the point count locations. Data for each avian observation included: species, number of individuals, and behavior of individuals (to include altitude, flight direction, feeding vs. flying/migrating, resting, etc.).

During migration seasons, the biologists conducted 15-minute avian observations at least twice weekly between 7:00 a.m. and 9:00 a.m. at each location at the same two observation points referenced above. During peak migration days, biologists supplemented these data by conducting observations at the U.S. Navy building mast tower, which offers unobstructed, panoramic views of the Wallops Island air space (including the rotor sweep areas of the proposed turbines). The survey team targeted fall and spring days when weather front movement was conducive to migratory activity and conducted their spot observations during daytime hours (between 9:00 a.m. and 4:00 p.m.). Data collected during migration season surveys included the date and times of observations, species observed, numbers of individuals, and behavior. Behavioral information includes the path where birds were flying in relation to the proposed turbine area(s), height of flight (below, within, or above the rotor height zone), perching behavior, hunting behavior, etc. Local weather data, including temperature, sky conditions, wind direction, and wind speed, were also recorded.

Avian Fatality Searches at Existing Towers

NASA used three existing towers on Wallops Island as surrogates for wind turbines to study avian fatalities. By studying fatalities at these tall structures, an understanding of the nocturnal and diurnal birds that use the airspace above Wallops Island was acquired. One guyed (North Boresight, 47 meters [155 feet] tall) and two unguyed towers (South Boresight, 47 meters [155 feet] tall and South Meteorological Tower, 102 meters [335 feet] tall) were used for observations (see Figure 12).

Fatality searches were conducted as soon as possible after sunrise between October 1, 2008, and September 30, 2009. The intensity of searches was greater during the peak spring (April to early June) and fall (August to October) bird migration seasons. Searches took place three times per week during the migration seasons and one time per week during the remainder of the year; the length of time for each search was not reported. At the North Boresight Tower, the search area extended outward to the full extent of guy wires (approximately 18 meters [60 feet]). At the South Boresight Tower and South Meteorological Tower, which have no guy wires, the search areas extended from the tower base outward to 80 percent of the tower height (approximately 38-meter [125-foot] and 82-meter [268-foot] radii, respectively). The maximum area searched was a rectangle with transects separated by 7 meters (23 feet). All 335 square meters (3,600 square feet) was searched at the North Boresight Tower; a portion of the areas for the South Boresight Tower and the South Meteorological Tower was searched as shown on Figure 4 in Appendix A. All carcasses (i.e., feathers or clumps of feathers with flesh attached or loose tail or primary feathers not expected to come from molt) were recorded as fatalities.

In addition to fatality searches for bird carcasses beneath the existing towers, searcher efficiency and carcass removal trials were also conducted. The Avian Study Final Report (Appendix A) contains more detailed explanation of the searcher efficiency and carcass removal trials.

To estimate how many birds were likely killed at the existing towers, the numbers of carcasses found were multiplied by a factor of four. This factor includes a general searcher efficiency rate of 50 percent and a carcass removal rate of 50 percent. The factor is calculated by multiplying 0.5 by 0.5 for a combined rate of 0.25, the factor of four used to calculate fatality rate. Studies of bird carcasses at communication towers indicate that the factor of four is likely to reflect searcher efficiency and carcass removal at a wide variety of habitats beneath communication towers (Gehring et al., 2009).

Findings

The following is a summary of the data collected during the avian surveys described above; detailed results are presented in the Avian Study Final Report (Appendix A). Although the surveys officially started on October 1, 2008, some data collected prior to this date are included in the report, particularly diurnal point count observations that began on September 12, 2008, and one migration survey on September 22, 2008. Fatality searches began on October 3, 2008, and ended on October 2, 2009.

Avian Field Observations

Species observed during the 79 surveys include almost 100 species of birds typical of the avifauna community expected to occur at Wallops Island (Table 12). With the exception of snow goose, which was 72.4 percent of the total number of observations, almost 30 percent of the bird community observed was comprised of native species typically found in Virginia's coastal habitats (e.g., Tree Swallow, Canada Goose, Red-winged Blackbird and Great Egret, in order of frequency of occurrence) as well as a common non-native species (European Starling) that frequently occur in disturbed/urbanized habitats.

Table 12: Species Abundance Summary October 2008–October 2009

Species	Number Observed	Percent of Total With 20,000 Snow Geese Recorded on Single Day	Percent of Total Without 20,000 Snow Geese Recorded on Single Day
Snow Goose	23,321	72.4	27.2
Tree Swallow	1,569	4.8	12.8
European Starling	708	2.2	5.8
Canada Goose	501	1.6	4.1
Red-winged Blackbird	500	1.6	4.1
Great Egret	495	1.5	4.0
All other species	5,132	15.9	42
Total	32,226	100	100

A flock of 20,000 Snow Geese was observed on the far western side of the marsh adjacent to the observation point on one day in November 2008. Table 13 shows the percentage of the total number of birds observed excluding the 20,000-member flock of Snow Geese.

Waterfowl were the dominant class of birds observed (76.8 percent of all observations) (Table 13). Passerines, blackbirds, waders, gulls and terns, raptors, shorebirds and others were much less common, with each less than 9 percent of the total number of birds observed. Excluding the single observation of 20,000 Snow Geese from the total, waterfowl were still the most frequently observed group of birds at 38.9 percent of total individuals. Table 13 shows the percentage of the total number of birds observed excluding the 20,000-member flock of Snow Geese.

Table 13: Avian Observations by Class of Species

Class of Species	Number Observed	Percent of Total With 20,000 Snow Geese Recorded on Single Day	Percent of Total Without 20,000 Snow Geese Recorded on Single Day
Waterfowl[1]	24,759	76.8	38.9
Passerines[2]	2,864	8.9	23.4
Blackbirds[3]	1,554	4.8	12.7
Waders[4]	986	3.1	8.1
Gulls and Terns	951	3.0	7.8
Shorebirds	588	1.8	4.8
Raptors	60	<0.1	<0.1
Other[5]	464	1.4	0.5
Total	32,226	100	100

Notes:
1 Waterfowl – includes geese, ducks, cormorants, and mergansers.
2 Passerines – include all songbirds.
3 Blackbirds – include crows, grackles, blackbirds, starlings, and cowbirds.
4 Waders – include herons, egrets, and ibis.
5 Other – includes all other species, including but not limited to, owls, woodpeckers, doves, and pelicans.

The greatest concentrations (i.e., flocks) of birds documented were wintering waterfowl and flocks of certain passerines passing through during migration. Migratory Snow Goose are common and abundant winter residents in the lower mid-Atlantic States, including Virginia, and were observed multiple times in large flocks numbering up to 20,000. Other large flocks observed were up to 250 Tree Swallow, 100 to 200 Northern Flicker, 120 Brant, and groups of 90 to 120 Yellow-rumped Warbler during the fall migration period. Several other species were observed during migration in concentrations above 50 individuals including waterfowl, passerines, gulls, shorebirds, and wading birds. No large concentrations of raptors were recorded migrating during the survey period.

There is a seasonal component to bird activity at Wallops Island. The observational data for the year-long study indicate that bird activity was highest during fall migration (50 percent higher than spring) and decreased from mid-December through the winter months in January and February (Table 14). Average daily avian observations more than doubled in March and sustained similar levels through June before increasing again approximately 50 percent in July and maintaining similar levels through October 1. The data collected from this study also demonstrate that the winter and summer bird communities vary and some of the migrants that were observed may spend minimal time in the area heading to other geographic areas to winter and/or breed. Finally, the data indicate that the morning bird counts conducted during migration seasons resulted in a 50-percent higher incidence of birds in fall versus spring migration months.

Table 14: Number of Bird Observations by Month and Survey Effort

Month	Number of Surveys	Number of Birds Observed	Average Birds Observed Per Day
September 2008	5	741	148
October 2008	6	2,745	458
November 2008	4	20,665	5,166[2]
December 2008	3	1,833	611
January 2009	5	419	84
February 2009	4	191	48
March 2009	5	543	108
April 2009	12	752	63
May 2009	11	1,070	97
June 2009	7	627	90
July 2009	4	531	133
August 2009	4	682	171
September 2009	8	1,283	160
October 2009	1	154	154

No federally listed endangered or threatened species were observed during the field surveys. Three species listed as threatened by the Commonwealth of Virginia were observed, including 10 Bald Eagles, one Gull-billed Tern, and two Peregrine Falcons. All of the eagles were located west or northwest of the wind turbine sites and the Gull-billed Tern was observed south of the project site. Also documented were 15 Red Knot, a USFWS candidate species and Virginia Tier IV (moderate conservation need) species, observed on one occasion in September 2009. Other listed species that may occur in the area but were not observed during the surveys include Piping Plover, Wilson's Plover, and Upland Sandpiper.

The number of birds recorded within the wind turbine rotor-sweep zone, which would occur between approximately 43 meters (140 feet) and 120 meters (395 feet) above ground level, was 598 or 1.9 percent of all observed birds. Of these birds, 188 were Tree Swallows (31.4 percent), 130 were Great Egrets (21.7 percent), 57 were European Starlings (9.5 percent) and 50 were Snowy Egrets (8.4 percent). Flight direction was predominantly to the west (65 percent), followed by south (25 percent), east (5 percent) and north (5 percent). The majority of these birds were hunting or feeding (46 percent) or resting (43 percent). These birds were all observed in the August and September fall migration months.

Avian Fatality Study

Carcass searches were conducted on 83 days between October 3, 2008, and October 2, 2009, and resulted in 18 recorded fatalities. Eleven observations were located near the 102-meter (335-foot) tall unguyed South Meteorological Tower. Single/small clumps of feathers of seven individuals

[2] Includes a single daily observation of 20,000 snow geese on November 20, 2008.

were also observed, but not recorded as collision fatalities. Seven dead birds were located near the 47-meter (155-foot) tall guyed North Boresight Tower. Carcasses that could be identified to species include:

- American Robin (MT[1])
- Clapper Rail (MT)
- Common Grackle (NB[2])
- Double Crested Cormorant (NB)
- European Starling (NB, MT)
- Marsh Wren (MT)
- Northern Flicker (MT)
- Red-winged Blackbird (NB, MT)
- Salt Marsh Sharp-tailed Sparrow (NB)
- Tree Swallow (MT)
- Unidentified gull (MT)
- Unidentified sparrow (NB)
- Yellow-rumped Warbler (NB)

[1] MT=Meteorological Tower
[2] NB=North Boresight Tower

Carcasses were recovered during most months of the year.

Few generalizations can be made about what types of birds were most susceptible to colliding with the towers. Both night-flying and diurnal migrant birds were observed, including waterfowl, waterbirds, passerines, and raptors. No State or federally listed endangered or threatened species were among the fatalities. No bird carcasses or remnants were located in the vicinity of the South Boresight Tower; the presence of guy wires may have been responsible for all or nearly all fatalities that were found at the North Boresight Tower.

Searcher efficiency rates for the first half of the study period were approximately 50 percent, but improved to 68 percent during the full searcher efficiency study from March 1, 2009, through October 2, 2009.[3] Searcher efficiency for medium to large birds was 78 percent (21 of 27 birds found) and 76 percent (16 of 21 birds found) for small birds. As for total efficiency rates by tower, 62 percent (16 of 26 carcasses) were found by searchers at the North Boresight Tower and 71 percent (17 of 24 carcasses) were each found at the South Boresight Tower and the South Meteorological Tower.

A total of 28 birds (based on seven carcasses) were estimated as killed at the North Boresight Tower during the 1-year study period when a factor of four was used for the combined carcass removal and searcher efficiency rate. When 11 (the number of fatalities attributed to the tower) and 18 (total number of fatalities plus the number of individuals identified from single feathers/feather clumps) are used to calculate fatalities for the South Meteorological Tower, an estimate of a minimum of 44 and a maximum of 72 birds were killed at the tower during the 1-year period.

Summary of Findings

The following points summarize the findings of the avian study conducted for NASA’s proposed wind turbine project at Wallops Island:

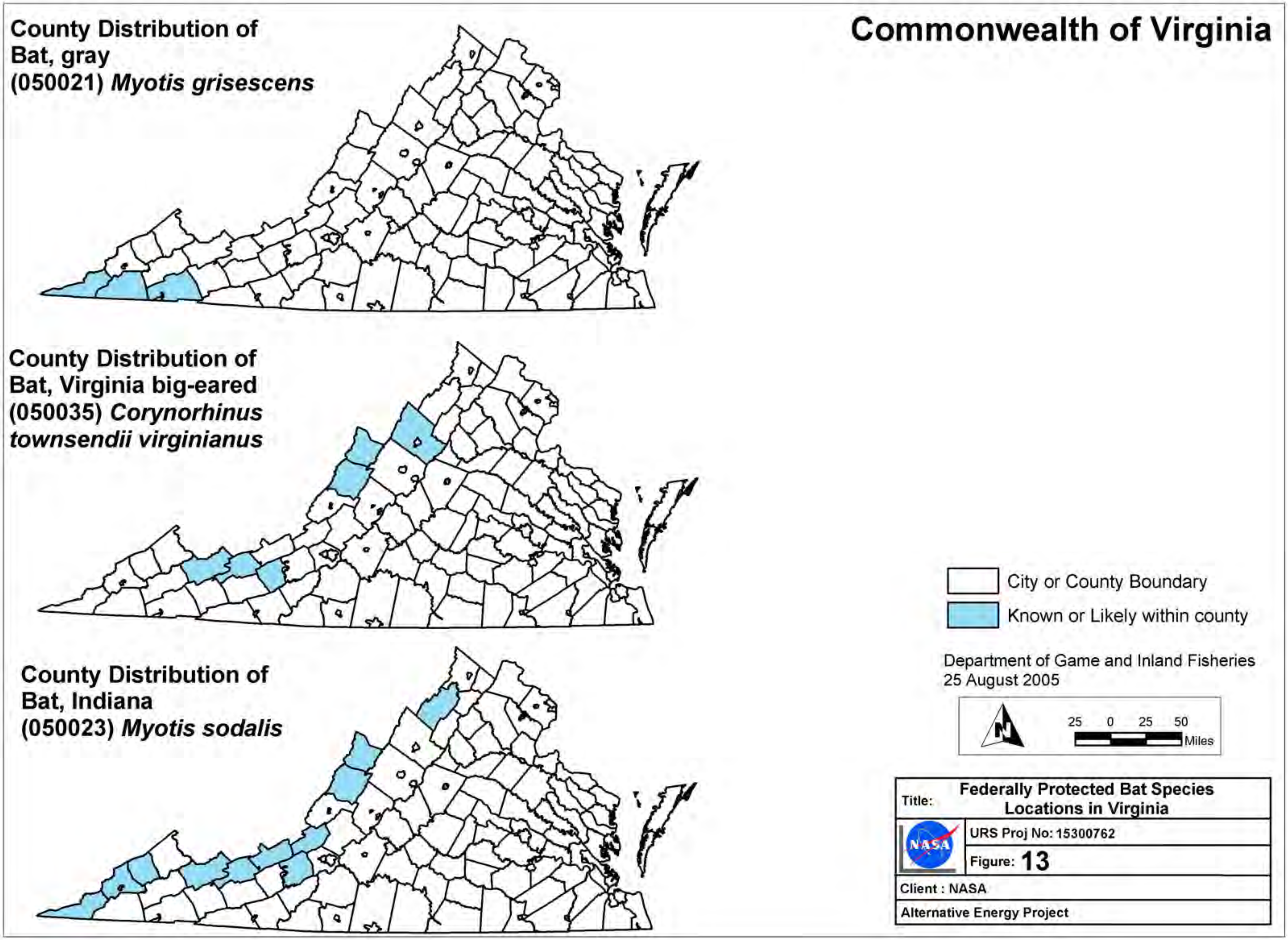
[3] These results include searches for the placed tailless mice (surrogates for bats).

- Avian observations included species that would be expected to occur in this area and included raptors, shorebirds, waterbirds, waterfowl, passerine and non-passerine species. The number of raptors was very low.
- Bird species that were observed in flocks of over 100 individuals within a survey period included Tree Swallow, Flicker, and Yellow-rumped Warbler. By far, the largest numbers of birds observed were flocks of migrating Snow Geese numbering in the hundreds and even thousands.
- Over 81 percent of the recorded flight heights were between 0 and 50 feet above ground, although larger flocks of birds were generally seen at heights over 100 feet above ground or resting in marshes. Less than 2 percent of the observed birds were within the proposed wind turbines' rotor sweep zone; they were generally hunting or feeding and observed in the August/September time period.
- Three State-listed species (Bald Eagle, Gull-billed Tern, and Peregrine Falcon) were observed during the surveys. Red Knot, a USFWS-candidate species, was observed during one survey. No federally listed species were documented during the survey. Piping Plover (federally and State threatened) and Upland Sandpiper (State threatened) are listed species found in the local area but were not observed during the surveys, likely due to lack of habitat in the areas surveyed.
- Documented bird and bat fatalities were greatest at the taller South Meteorological Tower (16) than the shorter, guyed, North Boresight Tower (7). There were no documented fatalities at the unguyed South Boresight Tower.
- Fatality rates of 28 and a range of 44 to 72 per tower per year were calculated for the North Boresight and South Meteorological towers, respectively.

3.2.3.2 Bats

Fifteen species of bat occur in Virginia, based on their normal geographical range. There are six *Myotis* species in Virginia, including the gray bat (*Myotis grisescens*), little brown bat (*M. lucifugus*), northern long-eared bat (*M. septentrionalis*), Indiana bat (*M. sodalis*), eastern smallfooted bat (*M. leibii*), and southeastern myotis (*M. austroriparius*). Other species include silverhaired bat (*Lasionycteris noctivagans*), eastern pipistrelle (*Perimyotis* [=*Pipistrellus*] *subflavus*), big brown bat (*Eptesicus fuscus*), evening bat (*Nycticeius humeralis*), eastern red bat (*Lasiurus borealis*), hoary bat (*L. cinereus*), seminole bat (*L. seminolus*), Rafinesque's big-eared bat (*Corynorhinus rafinesquii*), and the Virginia big-eared bat (*C. townsendii virginianus*) (VDGIF, 2009).

Of these, the Indiana bat, gray bat, and Virginia big-eared bat are listed as federally endangered under the Endangered Species Act (ESA). Rafinesque's big-eared bat is listed as State endangered. The three federally protected species live in the western parts of Virginia (see Figure 13) and do not likely inhabit or migrate in the vicinity of WFF. Wallops Island lies within the distribution range of Rafinesque's big-eared bat (VDGIF, 2009).



Commonwealth of Virginia
County Distribution of
Bat, gray
(050021) Myotis grisescens
County Distribution of
Bat, Virginia big-eared
(050035) Corynorhinus
townsendii virginianus
County Distribution of
Bat, Indiana
(050023) Myotis sodalis
City or County Boundary
Known or Likely within county
Department of Game and Inland Fisheries
25 August 2005
N
25 0 25 50
Miles
Title: Federally Protected Bat Species Locations in Virginia
NASA
URS Proj No: 15300762
Figure: 13
Client : NASA
Alternative Energy Project

This page intentionally left blank.

Summer–Fall 2008 Bat Study at Wallops Island

Between July 15 and October 21, 2008, passive acoustic bat surveys were conducted on Wallops Island in the area of the proposed wind turbines to document bat activity and identify species that occur in the area (Appendix B). Four Anabat® acoustic detectors deployed at the proposed wind turbine site (see Figure 12) collected data over 229 nights of recordings. Two detectors were placed in an existing 50-meter (164-foot) unguyed tower (the same tower as the "South Boresight Tower" in the previous sections), which is located approximately 427 meters (1,400 feet) south of the proposed wind turbine site, and two were situated on 10-meter (33-foot) poles in adjacent marshlands.

A total of 2,140 bat call sequences were recorded during the sampling period. The mean detection rate of all detectors was 9.3 detections per night. The highest detection rate was 15.9 detections per night, and the lowest rate was 2.4 detections per night. Bat calls were identified to the lowest possible taxonomic level, and were then grouped into six guilds based on similarity in call characteristics between some species and the uncertainty in the ability of frequency division detectors to adequately provide information for this differentiation. The six guilds are described below.

- Unknown – All call sequences with too few pulses (less than five) or of poor quality (such as indistinct pulse characteristics or background static).
- Myotid – All bats of the genus *Myotis*. While there are some general characteristics believed to be distinctive for several of the species in this genus, these characteristics do not occur consistently enough for any one species to be relied upon at all times when using Anabat® recordings.
- Eastern red bats, eastern pipistrelles, evening bats (RBEP) – These three species can produce calls distinctive only to each species. However, significant overlap in the call pulse shape, frequency range, and slope can also occur.
- Big brown/silver-haired bat (BBSH) – These species' call signatures commonly overlap and were therefore included as one guild.
- Hoary bat – Calls of hoary bats can usually be distinguished from those of big brown and silver-haired bats. Hoary bats are easily identified by calls varying in minimum frequency across a sequence.
- Big-eared bat– Known as "whispering bats," this species emits low-intensity calls and listens for insect-generated sounds while foraging close to the ground; detecting calls of these bats is therefore difficult. Calls of big-eared bats are not easily confused with calls of any other species that may coexist on Wallops Island.

Nightly call volumes varied over the survey period. Call volumes peaked between August 13 and August 16, with the greatest number of sequences (223) recorded on August 15. Sequences within the RBEP, BBSH, unknown, and to a lesser extent hoary bat guilds accounted for these peaks. On August 15, the majority of sequences (46.6 percent) identified to species belonged to eastern red bats. High frequency unknowns likely to be eastern red bats or eastern pipistrelles accounted for 44.4 percent of sequences recorded on August 15.

Over the entire study period, the majority of calls (55.2 percent) were identified as "unknown." Of these unknown sequences, sequences likely to be eastern red bats or eastern pipistrelles were most common (44.9 percent). The majority of call sequences could not be identified to guild or species, however, due to short call sequences (less than five pulses) or poor call signature formation, which were often a result of bats flying at the edge of the detection zone of the detector or flying away from the microphone.

Of the calls that were identified to species or guild, those of the RBEP guild were the most common (27.9 percent), followed by the species within the BBSH guild (15.7 percent), hoary bat guild (0.8 percent), and Myotid guild (0.3 percent).

Within the RBEP guild, eastern red bats accounted for 25.2 percent of the 2,140 total sequences recorded at Wallops Island, followed by sequences just as likely belonging to red bats *or* eastern pipistrelles (2.5 percent) and eastern pipistrelles (0.1 percent). Within the BBSH guild, sequences just as likely belonging to big brown *or* silver-haired bats accounted for 10.8 percent of the total sequences recorded, followed by those of big brown (4.4 percent) and silver-haired bats (0.5 percent).

Considering the level of bat activity documented at Wallops Island, numbers of recorded bat call sequences are not necessarily correlated with number of bats in an area. Acoustic detectors do not allow for differentiation between a single bat making multiple passes and multiple bats each recorded a single time. Similarly, acoustic interference can make detection of bats in certain areas difficult, lowering the estimate of acoustic activity.

Furthermore, calls of some bats, such as Rafinesque's big-eared bat, are not as detectable as calls of other bats, limiting the inferences that can be made about the presence or absence of listed species. Rafinesque's big-eared bat is the only special status species (State-endangered) likely to occur in the region of Wallops Island and surrounding counties (BCI, 2001). Although no call sequences likely belonging to Rafinesque's big-eared bats were detected, the bat's distribution range overlaps Wallops Island, which may provide suitable habitat (VDGIF, 2009). However, roosting and foraging data for this species are lacking (BCI, 2001). The 2008 summer-fall bat survey can neither confirm nor exclude the presence of Rafinesque's big-eared bat in the study area.

3.2.4 Threatened and Endangered Species

Under Section 7 of the ESA, as amended, (U.S.C. 1531–1544) Federal agencies, in consultation with the USFWS and the National Marine Fisheries Service (NMFS), are required to evaluate the effects of their actions on special status species of fish, wildlife, and plants, and their habitats, and to take steps to conserve and protect these species. Special status species are defined as plants or animals that are candidates for, proposed as, or listed as sensitive, threatened, or endangered by USFWS.

The Virginia Endangered Species Act (29 VAC 29.1-563–570) is administered by the Virginia Department of Game and Inland Fisheries (VDGIF) and prohibits the taking, transportation, processing, sale, or offer for sale of any State or federally listed threatened or endangered species. As a Federal agency, NASA voluntarily complies with Virginia's Endangered Species Act.

Table 15 shows the State and federally listed threatened or endangered species that may occur in the vicinity of WFF.

Table 15: Threatened and Endangered Species in the Vicinity of WFF

Scientific Name	Common Name	Federal Status	State Status
Birds			
Ammodramus henslowii	Henslow's Sparrow	—[1]	Threatened
Bartramia longicauda	Upland Sandpiper	—	Threatened
Charadrius melodus	Piping Plover	Threatened	Threatened
Charadrius wilsonia	Wilson's Plover	—	Endangered
Calidris canutus	Red Knot	Candidate Species	—
Falco peregrinus	Peregrine Falcon	—	Threatened
Sterna nilotica	Gull-billed Tern	—	Threatened
Haliaeetus leucocephalus	Bald Eagle	—	Threatened
Lanius ludovicianus	Loggerhead Shrike	—	Threatened
Lanius ludovicianus migrans	Migrant Loggerhead Shrike	—	Threatened
Mammals			
Sciurus niger cinereus	Delmarva fox squirrel	Endangered	Endangered
Corynorhinus rafinesquii macrotis	Rafinesque's eastern bigeared bat	—	Endangered
Reptiles			
Dermochelys coriacea	leatherback sea turtle	Endangered	Endangered
Eretmochelys imbricata	hawksbill sea turtle	Endangered	Endangered
Lepidechelys kempi	Kemp's ridley sea turtle	Endangered	Endangered
Caretta caretta	loggerhead sea turtle	Threatened	Threatened
Chelonia mydas	green sea turtle	Threatened	Threatened
Invertebrates			
Cicindela dorsalis dorsalis	northeast beach tiger beetle	Threatened	Threatened
Plants			
Amaranthus pumilus	seabeach amaranth	Threatened	Threatened

[1]Not listed designation

Figure 14 shows the known locations of protected species in the vicinity of WFF. The ESA also regulates the critical habitat of threatened and endangered species. Critical habitat is defined as the geographical area essential to the survival and recovery of a species. There is no designated critical habitat on Wallops Island.

3.2.4.1 Birds

Henslow's Sparrow

Henslow's sparrow is a small bird characterized by a large flat, striped olive-colored head, large gray bill, and short tail. In Virginia, they are rare transient, summer residents and winter visitors in the coastal plain with the only known summer occurrences in Accomack County. This species is believed to breed between May 15 and August 31 in neglected weedy fields commonly dominated by broom sedge, wet meadows, and the edges salt marshes. It occasionally inhabits dry and cultivated uplands, may favor moist lowland habitat and may use areas with widely scattered shrubs. It prefers undisturbed non-maintained areas and breeds in a variety of grassland habitats with tall, dense grass and herbaceous vegetation. The nonbreeding habitat during migration and winter includes moist grassy areas adjacent to open pine or second-growth forests.

Upland Sandpiper

Upland Sandpiper is medium-sized and the most terrestrial of North American shorebirds. Adults are overall scaly-brown in appearance above with a long slender neck, small rounded head, and large eye. Upland Sandpipers arrive in northern breeding areas in April/May and depart by September. Peak spring migration through the U.S. Mid-Atlantic States occurs in April. In Virginia, they are rarely seen in spring and late fall along the coast, and mostly seen in early fall. The preferred habitat of the Upland Sandpiper consists of large open grasslands, greater than 40.5 hectares (>100 acres), which are not extensively grazed or mowed and include large areas of short grass for feeding and courtship with interspersed or adjacent taller grasses for nesting and brood cover.

Piping Plover

Piping Plover is a small shorebird known to breed along the beaches of Wallops Island. Piping Plovers are small, beige and white shorebirds with a black band across their breast and forehead. The Plover breeds on coastal beaches from Newfoundland and southeastern Quebec to North Carolina, and winters primarily on the Atlantic Coast from North Carolina to Florida. Piping Plover habitat includes ocean beaches or sand or algal flats in protected bays, expansive sand flats, sandy mudflats, and sandy beaches. Nesting territories are establishing and courtship rituals are conducted beginning in late March or early April. Nests are situated above the high tide line on coastal beaches, sandflats at the ends of sand spits and barrier islands, gently sloping foredunes, blowout areas behind primary dunes, and washover areas cut into or between dunes.

The Piping Plover is known to nest on Wallops Island, and portions of the island are managed as protected areas by NASA (Figure 14). The northern and southern beaches have been closed to vehicle and human traffic during the Plover's nesting season (March 15–September 1) since 1986. Biologists from the CNWR monitor Piping Plover nesting activities and advise NASA on protection and management of the species. Biologists from the WFF USDA Wildlife Service Office aid with predator control.

Title: **Protected Species in the Vicinity of Wallops Island**

URS Proj No: 15300762

Figure: **14**

Client : NASA

Alternative Energy Project

This page intentionally left blank.

Monitoring was initiated at all CNWR units (including Assateague, Assawoman, and Metompkin) in 1996. Since then, there has been an increasing trend in the number of nesting pairs. However, since 2004, nesting has remained static and decreased at both the hook and overwash areas on Assateague Island, and has increased slightly at Assawoman and north Metompkin. The number of chicks fledged per nesting pair has decreased for all four areas.

Piping Plover nesting habitat has been delineated on Wallops Island dune and overwash areas at the northern and southern reaches of the property. South Wallops Island has experienced substantial erosion of 3.3 meters (11 feet) per year, resulting in a decrease in abundance of suitable habitat. Nesting Plovers have not been observed on South Wallops Island since at least 2000. North Wallops Island has simultaneously been accreting, resulting in additional potential habitat for Plover nesting.

Piping Plovers were observed feeding annually between 1996 and 2008, although exact numbers were not recorded. In 2009, four piping plover pairs attempted nests on north Wallops Island. Of these, three were successful and at least seven chicks were fledged. Five nesting attempts were made on North Wallops Island during 2007 and 2008, but none were successful in producing fledglings. During 2006, one pair of Plovers nested but the nest was abandoned due to attempted predation by a fox. Two nesting pairs were also observed in 2005, but one nest was lost to fox predation and the chicks of the second pair did not survive. In 2004, one nesting pair fledged 3 chicks; one pair is documented as nesting unsuccessfully in 2001 and 1998; in 1996, three pairs nested and two chicks were fledged in total. There were no nests observed in 2003, 2002, 2000, 1999, or 1997.

Wilson's Plover

Wilson's Plover is a migratory shorebird. An estimated 25 percent of U.S. populations winter in southern Florida. In Virginia, Wilson's Plover is an uncommon summer resident from April 24 through September 5 on the Eastern Shore. Its habitat includes coastal sandy and shell beaches, barrier and spoil islands, borders of salt ponds, tidal mudflats, inlets, bays, estuaries, and sometimes sandbars and muddy banks of rivers near the coast. In Virginia, nest habits have been documented on the upper portions of sandy beaches on barrier islands, usually within 30 meters (98.43 feet) of dune vegetation (but not in dense vegetation) and occasionally on overwash flats behind the dunes. Wilson's Plover has been documented in Accomack County and Assateague Island, VA.

Red Knot

The Red Knot is a medium-sized shorebird that undertakes an annual 30,000 kilometers (19,000 miles) hemispheric migration, from breeding grounds in the high Arctic to wintering grounds in South America.

Smith et al. (2008) indicates that Virginia's barrier islands play an important role in the life cycle of the Red Knot (*rufa* subspecies) because it provides important stop-over habitat during migration. Spring migration occurs between late April and mid-June (Cohen, et al. 2009; Smith, et al., 2008); peak counts in mid-May can be several hundred to about 1,000 at WFF (Vaughn, 1993). Cohen et al. (2009) indicates that Red Knot annual census numbers along the Virginia coastline are variable in spring and were 8,332 in 2007. Smith et al. (2008) reports that the total numbers of birds for the six Virginia barrier islands (south of Wallops Island between

Wachapreague and Fisherman's Island) surveyed during spring migration can be more than 12,000. Fall migrating Red Knots arrive again during the second week of July with the peak occurring sometime from late July through the end of August; peaks counts at WFF at this time of the year are 100 to 200 birds (Vaughn 1993).

During the 2009 migration season, flock sizes of 100 to 145 birds were observed on Assateague Island. In late May 2009, flocks of 5 to 30 individuals were observed on south Assawoman Island. On May 8, 2009 USFWS observed a flock size of almost 1,300 individuals on north Wallops Island. In late May 2009, flocks of approximately 20 to 200 Red Knots were observed on the beach at North Wallops Island.

The Red Knot principally uses marine habitats during migration. Coastal habitats providing sandy beaches to forage along the mouths of bays and estuaries are preferred. Red Knots are also known to use tidal flats in more sheltered bays or lagoons in search of benthic invertebrates or horseshoe crab eggs.

Peregrine Falcon

The average adult Peregrine Falcon has dark black plumage above, with much graying on the sides, with extensive spotting and barring. Populations nesting in northern latitudes are highly migratory. The Atlantic Coast from New Jersey to South Carolina and the barrier islands of the Texas Gulf Coast are important feeding areas for long-distance migrants. Peregrine Falcons are a diurnal raptor and are active year round. They feed primarily on medium-size birds up to small waterfowl and rarely prey on small mammals, lizards, and fish. Peregrine Falcons are known to occur in Accomack County, VA. A nesting pair with fledglings was documented at WFF in 2005 and 2009.

Gull-Billed Tern

The Gull-billed Tern is a stout, medium sized, white, blunt-billed bird that feeds in the marshes and adjacent coastal uplands of the southern and Gulf coasts of the United States. Gull-billed Terns migrate to the eastern U.S. breeding areas usually in mid-April and the adults typically depart in late July or early August. There are documented occurrences at CNWR and Fisherman Island National Wildlife Refuge and all known breeding colonies in Virginia are located on the barrier islands of the Eastern Shore.

Bald Eagle

The Bald Eagle is a raptor known for the characteristic white head, white tail, and a large bright yellow bill in adult birds. Bald Eagles migrate widely over most of North America, and most eagles that breed in the northern United States move south for the winter. Special habitat features for Bald Eagles include standing snags and hollow trees. Breeding habitat most commonly includes areas close (within 4 kilometers) to coastal areas, bays, rivers, lakes, or other bodies of water that reflect the general availability of primary food sources. Bald Eagles avoid areas with nearby human activity and development. Bald Eagles are documented at the CNWR and environmental scientists discovered a nesting pair of Bald Eagles within the northern section of Wallops Island in July 2009.

Loggerhead Shrike

There are two subspecies of *Lanius ludovicianus,* the Loggerhead Shrike and the Migrant Loggerhead Shrike, which are difficult to differentiate in the field. The major sources of data for Shrike distribution in Virginia do not distinguish the two subspecies, and occurrences listed in Virginia Fish and Wildlife reports may be either subspecies. The Loggerhead Shrike has a hooked, dark bill; bluish-gray head and back; white or grayish-white underparts, very faintly barred in adults; broad black mask extending above the eye and thinly across the top of the bill; gray to whitish rump; black tail with white tip; and large white patches on the black wings.

The Loggerhead Shrike's range includes California, eastern Oregon, eastern Washington, Canada, and south to southern Baja California, throughout Mexico, the Gulf Coast, and southern Florida. Shrikes move southward from the northern half of the breeding range for winter. During Virginia winters, Loggerhead Shrikes may move from pasture to shrub and open forest habitats during periods of cold, wet weather. Loggerhead Shrikes have been historically documented in Accomack County, but there are no recent records for the species on the Eastern Shore of Virginia.

Migrant Loggerhead Shrike

The Migrant Loggerhead Shrike differs from Loggerhead Shrike in that the gray of the upperparts are slightly paler and the underside is less purely white; the bill is also much smaller and the tail is decidedly shorter than the wing. Habitat conditions are the same for the migrant Loggerhead Shrike as for the Loggerhead Shrike. Although the Migrant Loggerhead Shrike has been documented in Accomack County, field identification to subspecies is rarely reported. Therefore, records for Migrant Loggerhead Shrike in Accomack County are likely to be Loggerhead Shrike, and the Migrant Loggerhead Shrike is not likely to occur within the vicinity of WFF.

3.2.4.2 Mammals

Delmarva Fox Squirrel

Delmarva fox squirrel is a large tree squirrel that is a well-marked and distinct subspecies restricted in range to the Delmarva Peninsula. The Delmarva fox squirrel was reintroduced at CNWR and the population there is currently about 180 squirrels. In Virginia, the Delmarva fox squirrel is known to occur in Accomack and Northampton Counties. Habitat for the Delmarva fox squirrel includes mature, open park-like stands of deciduous or mixed deciduous-pine forest, especially near farmland. It is not known to occur on Wallops Island due to the isolation of the island and the lack of suitable habitat for the species.

Rafinesque's Eastern Big-Eared Bat

Two subspecies of Rafinesque's eastern big-eared bat may occur in Virginia; *Corynorhinus rafinesquii macrotis* is found in the Atlantic and Gulf of Mexico lowlands and to a limited extent in the adjacent Piedmont, while *Corynorhinus rafinesquii rafinesquii* occurs mainly in the Ohio and Tennessee River valleys and in the southern Appalachians. Both subspecies are rare and at the edge of their ranges in Virginia, so their occurrence at Wallops Island is unlikely. They are uncommon to rare throughout their range. Many of the new roost sites found in Virginia were solitary roosts and colonies were very small; a 1993 survey found 24 new locations in four counties. The species occurs in Charles City, Greensville, Hanover, Isle of Wight, New Kent, Southampton, Surry, and Sussex Counties, as well as the cities of Chesapeake, Emporia, Franklin, Suffolk, and Virginia Beach. Rafinesque's eastern big-eared bats hibernate in the northern part of their range; they are not long-distance migrants for the winter.

Mating is in the fall and winter, and the gestation period is unknown. Single naked young are born in the nursery colony in May or June. This species roosts singly, in small clusters, or groups to 100 or more in hollow trees, under loose bark, houses, unoccupied buildings, and culverts. These bats occur in abandoned areas of man-made structures that are not normally visited by humans. They are commonly faithful to roost sites though they avoid temperature extremes and may need a variety of roosts to adjust for seasonal temperature and food fluctuations.

This bat is a slower flier but more maneuverable and can hover. Rafinesque's eastern big-eared bat is incidental in Virginia because it has adapted to temperate, arboreal zones found only in the extreme southeast United States.

Section 3.2.3.2 of this EA describes the findings of field surveys conducted during the summer and fall of 2008 to document activity patterns and species composition of bats in the project area. The 2008 bat survey could neither confirm nor exclude the presence of Rafinesque's big-eared bat within the Alternative Energy Project area. Although no call sequences likely belonging to Rafinesque's big-eared bats were detected during the survey, the bat's distribution range overlaps the project area, which may provide suitable habitat according to VDGIF.

3.2.4.3 Sea Turtles

Five federally endangered sea turtle species are transient in the waters off Wallops Island; the Leatherback, Hawksbill, Kemp's Ridley, Loggerhead, and Atlantic green sea turtles, which are known to migrate along east coast beaches. One loggerhead sea turtle nest was discovered on north Wallops Island in summer 2008 (Figure 14). Following flood inundation from several fall storms, CNWR personnel recovered approximately 170 eggs from the nest in October 2008. None were viable. No nests were observed in 2009. Sea turtle crawl tracks, a sign of potential nesting activity, have seldom been found on Wallops Island beaches. NASA coordinates with CNWR and USDA personnel in monitoring the Wallops Island beaches for sea turtle activity.

3.2.4.4 Invertebrates

Northeastern beach tiger beetles inhabit wide, sandy, ocean beaches from the intertidal zone to the upper beach. Eggs are deposited in the mid- to above-high tide drift zone. Larval beetles occur in a relatively narrow band of the upper intertidal to high drift zone, where they can be regularly inundated by high tides. Eight protected populations exist within the Eastern Shore of Chesapeake Bay, VA, geographic recovery area; however, there are no recorded populations on Wallops Island. The closest documented population is approximately 30 kilometers (20 miles) southwest of Wallops Island (USFWS, 2009c).

3.2.4.5 Plants

Seabeach amaranth habitat is restricted to sandy ocean beaches and consists of the sparsely vegetated zone between the high tide line and the toe of the primary dune. There have been no known or recorded occurrences of seabeach amaranth on Wallops Island to date. A single plant was identified by USFWS on the southern end of Assateague Island in 2004.

3.2.5 Fish

Common fish in the waters near Wallops Island include the Atlantic croaker (*Micropogonias undulatus*), sand shark (*Carcharias taurus*), smooth dogfish (*Mustelus canis*), smooth butterfly ray (*Gymnura micrura*), bluefish (*Pomatomus saltatrix*), spot (*Leiostomus xanthurus*), and summer flounder (*Paralichthys dentatus*). Salinity and water depths play a major role in determining if a coastal fish species is present in the bays and inlets near the island.

3.2.5.1 Essential Fish Habitat

The tidal marsh areas of Wallops Island act as nursery grounds for a variety of fish species due to the protection the marsh grasses provide and the abundance of food (NASA, 2008a). Eelgrass, for example, provides protection to the spot, the northern pipefish (*Syngnathus fuscus*), the dusky pipefish (*Syngnathus floridae*), and the bay anchovy (*Anchoa mitchilli*) (NASA, 2010b).

The Magnuson-Stevens Fishery Conservation and Management Act of 1976 (Magnuson-Stevens Act, 16 U.S.C. 1801 et seq.), as amended, gives the United States exclusive management authority over fisheries, except for highly migratory species of tuna, within a fishery conservation zone of 5 to 322 kilometers (3 to 200 miles) offshore. The Mid-Atlantic Fisheries Management Council is responsible for managing fisheries in Federal waters off the Atlantic Coast, including the project area fisheries, in accordance with the Magnuson-Stevens Act. To promote the long-term health and stability of managed fisheries, the Mid-Atlantic Fisheries Management Council utilizes Fishery Management Plans for the following species or species complexes: mackerel, squid and butterfish, bluefish, dogfish, surf clam and ocean quahog, summer flounder, scup, sea bass, and tilefish. The Magnuson-Stevens Act also mandates the identification of Essential Fish Habitat (EFH) for managed species. EFH is defined as the waters or substrate necessary for fish to spawn, breed, feed, or grow to maturity.

3.3 SOCIAL AND ECONOMIC ENVIRONMENT

3.3.1 Population

In 2006, the U.S. Census Bureau reported that the population of the Commonwealth of Virginia was about 7.6 million, and Accomack County's population was 39,345, with a population density of 218 people per square kilometer (84.2 people per square mile) (U.S. Census Bureau, 2000). The population growth rate in Accomack County between 2000 and 2006 was approximately 2.7 percent (U.S. Census Bureau, 2008a).

The village of Assawoman, approximately 8 kilometers (5 miles) to the southwest, is the closest residential community to Wallops Island. The towns of Wattsville and Atlantic are the closest incorporated communities to Wallops Island and are located approximately 13 kilometers (8 miles) and 8 kilometers (5 miles) northwest of Wallops Island, respectively. There is no specific census data available for Wattsville because it is an unincorporated residential area.

Chincoteague Island, VA, is approximately 13 kilometers (8 miles) northeast of Wallops Island. The Town of Chincoteague is the most densely populated area in Accomack County, with a resident population of 4,317 people. Area populations fluctuate seasonally. During the summer months the population increases due to tourism and vacationers who visit the nature reserve and beaches of Assateague Island. Daily populations often reach up to 15,000 in the summer months. Special events, such as the annual pony swim and roundup/auction, sponsored by the Chincoteague Volunteer Fire Department in July, draw crowds of up to 40,000. Table 16 lists the 2000 U.S. Census population of nearby towns in Accomack County (U.S. Census Bureau, 2008a).

Table 16: Town Population and Housing Units in Accomack County in 2008

Town	Population	No. of Housing Units
Accomack	547	234
Atlantic	539	272
Belle Haven	480	257
Bloxom	395	180
Chincoteague	4,317	3,970
Hallwood	290	120
Keller	173	87
Melfa	450	210
Onancock	1,525	725
Onley	496	273
Painter	246	114
Parksley	837	404
Saxis	337	194
Tangier	604	272
Wachapreague	236	229

Source: U.S. Census Bureau, 2008a

3.3.2 Employment and Income

This section provides general background information on employment and income data for the WFF region. This includes 2000 U.S. Census data on the employment, unemployment, income, and poverty characteristics of the region complied by the Virginia Employment Commission (VEC) and by Virginia Polytechnic Institute (Eastern Shore Chamber of Commerce, 2007). The section also includes employment statistics for WFF itself.

The unemployment rate in Virginia was 3.0 percent in 2007 (VEC, 2009). In 2007, Accomack County was approximately average in the Delmarva region in terms of unemployment rates. The total labor force of Accomack County is 19,091 people, 18,309 of whom are employed, resulting in an unemployment rate of 4.1 percent (VEC, 2009). Employment fluctuates seasonally in Accomack County and the Town of Chincoteague, with decreased unemployment occurring from June through October (VEC, 2009). Overall, the unemployment rates in Virginia and Accomack County have been declining since 2000.

Table 17 lists the distribution by broad occupational categories for Virginia, Accomack County, and Chincoteague, as reported by the U.S. Census Bureau.

Table 17: Occupational Distribution (percent)

Category	Virginia	Accomack County	Chincoteague
Management, professional, and related occupations	38	24	26
Sales and office occupations	26	22	26
Production, transportation, and material moving occupations	13	20	9
Service occupations	14	17	17
Construction, extraction, and maintenance occupations	10	11	15
Farming, fishing, and forestry occupations	1	6	7

Source: U.S. Census Bureau, 2000

Table 18 shows the income and poverty rates of the Commonwealth of Virginia, Accomack County, and Chincoteague. Accomack County and Chincoteague both have a higher percentage of families below the poverty level and a lower per capita income than Virginia as a whole; however, Accomack County and Chincoteague do not include major urban centers.

Table 18: Income and Poverty

Region	Median Household Income (2007)	Per Capita Income (2007)	Percent of Families Below Poverty Level (2007)
Virginia	$53,066	$28,255	9.9
Accomack County	$35,048	$18,468	18.0
Chincoteague	$36,566	$24,549	13.4

Source: U.S. Census Bureau, 2008b

In 2008, WFF employed a total of 1,485 people; 1,027 of those supported NASA (including 238 civil servants and 789 contractors), MARS employed 3 full-time people, and the remainder worked for either NOAA or the U.S. Navy (NASA, 2008a). The VEC reported that in 2007 NASA was the fourth largest employer in Accomack County; other large employers on the Eastern Shore are Perdue Farms (1,900 employees) and Tyson Foods (950 employees) (VEC, 2008).

Employment categories at WFF consist largely of managerial, professional, and technical disciplines with higher than regional average salaries. The mean salary of NASA employees for fiscal year 2008 was $88,047, while the median salary is in the $80,000–$90,000 range (NASA, 2008a). The median family income for Accomack County in 2008 was $41,845. Due to the wide gap between salaries of WFF employees and most area residents, the facility contributes considerably to the local economy (NASA, 2008a).

3.3.3 Environmental Justice

The goal of environmental justice from a Federal perspective is to ensure fair treatment of people of all races, cultures, and economic situations with regard to the implementation and enforcement of environmental laws and regulations, and Federal policies and programs. EO 12898, *Federal Action to Address Environmental Justice in Minority Populations and Low Income Populations*, (and the February 11, 1994, Presidential Memorandum providing additional guidance for this EO) requires Federal agencies to develop strategies for protecting minority and low-income populations from disproportionate and adverse effects of Federal programs and activities. The EO is "intended to promote non-discrimination in Federal programs substantially affecting human health and the environment."

Accomack County is on the lower end of income measures in the region, with a 2005 median family income of $32,837. As a result, the county is also on the higher end of poverty levels in the region based on U.S. Census Bureau data reports. The per capita income in Accomack County in 2007 was reported to be $18,468, with an estimated 18.0 percent of people below the poverty level (U.S. Census Bureau, 2008b). The per capita income in the Commonwealth of Virginia in 2007 was reported to be $28,255, with an estimated 9.9 percent of people below the poverty level statewide (U.S. Census Bureau, 2008b).

In order to ensure compliance with Executive Order 12898, NASA prepared an Environmental Justice Implementation Plan (EJIP) in 1996. NASA evaluated the demographic information in the vicinity of WFF and identified areas that have a higher concentration of minority persons and low-income persons based on federal guidelines. The EJIP also includes an evaluation of all programs at WFF, including tenant activities that could potentially affect human health and the environment. The EJIP demonstrates that NASA will continue to incorporate environmental justice in all its activities and monitor all programs to determine any potential environmental justice impacts on persons in the area. The EPA's Environmental Justice Coordinators Council has defined minority communities as those exceeding a 50 percent minority population. Table 19 provides a review of Accomack County Census data used to determine the baseline for the facility's EJIP.

Table 19: Environmental Justice Concerns – by Census Tract, Accomack County, VA

Tract	Location	Percent Minority 2000	Percent Low Income 2000	Percent Poverty 2000
9901	MD/VA line south including Fisher's Point	1.97	51.53	12.80
9902	MD/VA line south including Wallops Island to Assawoman Inlet	41.75	49.96	16.38
9903	West of 9902 and 9904, MD/VA line south to Ann's Cove Road	24.66	55.94	19.28
9904	East of Mears Station Road, South of 9902 south to Horseshoe Lead	59.14	51.61	27.14

Source: NASA, 2008a

Chincoteague Island, at approximately 13 kilometers (8 miles) northeast of Wallops Island, is the closest incorporated town to WFF. No minority or low-income communities exist on the portion of Chincoteague Island that lies within a 4-kilometer (2.5-mile) radius of Wallops Island.

EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks*, encourages Federal agencies to consider the potential effects of Federal policies, programs, and activities on children. The closest day care centers, schools, camps, nursing homes, and hospitals are addressed within the EJIP.

3.3.4 Aviation Safety Requirements

FAA regulates structures that may pose a threat to aviation safety. A sponsor proposing any type of construction or alteration of a structure that may affect the National Airspace System is required under the provisions of 14 CFR 77 to notify the FAA by completing the Notice of Proposed Construction or Alteration form (FAA Form 7460-1). The form should be sent to the Obstruction Evaluation service.

Any temporary or permanent structure, including all appurtenances, that exceeds an overall height of 61 meters (200 feet) above ground level or exceeds any obstruction standard contained in 14 CFR 77, should normally be marked and/or lighted. However, an FAA aeronautical study may reveal that the absence of marking and/or lighting will not impair aviation safety. Conversely, the object may present such an extraordinary hazard potential that higher standards may be recommended for increased conspicuity to ensure safety to air navigation. FAA Advisory Circular AC 70/7460-1K provides requirements for obstruction (wind turbines are included in the “obstruction” category) marking and lighting that (FAA, 2007).

3.3.5 Cultural Resources

The National Historic Preservation Act (NHPA) of 1966, (P.L. 89-665; 16 U.S.C. 470 et seq.) as amended, outlines Federal policy to protect historic properties and promote historic preservation in cooperation with other nations, Tribal governments, States, and local governments. The NHPA established the National Register of Historic Places (NRHP) and designated the State Historic Preservation Office (SHPO) as the individual responsible for administering State-level programs. The NHPA also created the Advisory Council on Historic Preservation (ACHP), the Federal agency responsible for overseeing the Section 106 process and providing commentary on Federal activities, programs, and policies that affect historic properties.

Section 106 of the NHPA and its implementing regulations (36 CFR 800) outlines the procedures for Federal agencies to follow to take into account their actions on historic properties. The Section 106 process applies to any Federal undertaking that has the potential to affect historic properties, defined in the NHPA as those properties that are listing in or eligible for listing in the NRHP. Under Section 106, Federal agencies are responsible for identifying historic properties within the Area of Potential Effects (APE) for an undertaking, assessing the effects of the undertaking on those historic properties, if present, and considering ways to avoid, minimize, and mitigate any adverse effects. Because Section 106 of the NHPA is a process by which the Federal government assesses the effects of its undertakings on historic properties, it is the primary regulatory framework that is utilized in the NEPA process to determine impacts on cultural resources.

Section 110 of the NHPA calls for Federal agencies to establish historic preservation programs to ensure the identification, protection, and use of historic properties. To that end, NASA WFF prepared in November 2003 a *Cultural Resources Assessment of Wallops Flight Facility, Accomack County, Virginia* (CRA) that examined each of the three land areas of the facility within WFF's property boundaries: Wallops Main Base, Wallops Mainland, and Wallops Island (NASA, 2003a). The study focused on aboveground resources at WFF that were constructed prior to 1955. Additionally, the CRA established a predictive model for understanding the archaeological potential over the entire WFF property.

Among the cultural resources identified at WFF in the CRA are six archaeological sites, two of which are historic sites on Wallops Island (Figure 15 and Figure 16) and a total of 166 buildings and structures that were at the time of the study at least 55 years old, 25 of which are located on Wallops Island. Comments from the SHPO (Virginia Department of Historic Resources [VDHR]) were received in a letter dated December 4, 2003 (NASA, 2003b). The letter concurred with the findings of the CRA. VDHR accepted the predictive model for archaeology at WFF, noting that many of the areas with moderate to high archaeological potential are unlikely to be disturbed by future construction or site use (NASA, 2003b).

Following the 2003 cultural resources assessment, an intensive-level survey and NRHP evaluation of 124 buildings and structures at WFF constructed prior to 1956 was conducted, and an historic context for these resources prepared. The findings were presented in the *Historic Resources Survey and Eligibility Report for Wallops Flight Facility* (NASA, 2004). Two resources—the Wallops Coast Guard Lifesaving Station (VDHR #001-0027-0100; WFF# V-065) and its associated Coast Guard Observation Tower (001-0027-0101; WFF# V-070)—were determined to be eligible for listing in the NRHP and Virginia Landmarks Register (NASA, 2004). The other surveyed resources were determined not to be eligible for listing in the NRHP because they lacked the historical significance or integrity necessary to convey their significance.

In a letter dated November 4, 2004, VDHR concurred with the findings and determinations in the *Historic Resources Survey and Eligibility Report*, agreeing that the Wallops Coast Guard Lifesaving Station was eligible for listing in the NRHP, with the Observation Tower as a contributing structure to the historic property (NASA, 2004). NASA has determined that the Wallops Coast Guard Lifesaving Station is located inside the explosive hazard arc of a nearby rocket motor storage facility and as a result, is planning the demolition or removal of the Lifesaving Station and Observation Tower. In compliance with Section 106 of the NHPA, NASA and VDHR are currently negotiating a Memorandum of Agreement to resolve the adverse effects of the proposed demolition.

Since the 2004 report, no additional large-scale identification and evaluation of historic properties has been conducted at WFF. Survey updates at WFF may reveal aboveground historic properties not identified in the 2004 report, including properties that have achieved 50 years of age since 2006 and properties that are less than 50 years of age that meet NRHP Criteria Consideration G, which states that properties may be eligible for listing in the NRHP if they possess exceptional importance.

Title: Wallops Mainland and Southern Wallops Island Prehistoric Archaeological Site Sensitivity

URS Proj No: 15300762

Figure: 15

Client : NASA

Alternative Energy Project

This page intentionally left blank.


679
803
Legend
WFF Boundary
Existing Facilities
Archaeological Sites - Historic
High
Moderate
0.5
0
0.5
1
Miles
Title: Wallops Mainland and Southern Wallops Island Historic Archaeological Site Sensitivity
URS Proj No: 15300762
Figure: 16
Client : NASA
Alternative Energy Project

This page intentionally left blank.

3.3.6 Transportation

The Eastern Shore of Virginia is connected to the rest of the State by the Chesapeake Bay Bridge-Tunnel. The primary north-south route that spans the Delmarva Peninsula is U.S. Route 13, a four-lane divided highway. Local traffic travels by arteries branching off U.S. Route 13. Activities at Wallops Island and Wallops Mainland generate traffic along Route 803. Primary access to WFF is provided by Route 175, a two-lane secondary road. Traffic in the region varies with the seasons—during the winter and early spring, traffic is minimal; during the summer and early fall, traffic increases due to the number of tourists in the area.

Wallops Main Base and Wallops Mainland are connected by approximately 10 kilometers (6 miles) of the paved, two-lane Route 679. A NASA-owned road, bridge, and causeway link Wallops Mainland to Wallops Island. Hard surface roads provide access to most buildings at WFF and are maintained by NASA and its tenants. Most organizations at WFF own and maintain a variety of vehicles ranging from sedans and vans to trucks. There is no public transportation on the facility. Many WFF employees carpool to and from the facility.

3.3.7 Aesthetics

Aesthetics is referred to as the study of sensory or sensory emotional values, and as a result is subjective by nature. There are no State or Federal regulations for aesthetics.

In order to assess aesthetics, a viewshed, which is the area that is visible from a fixed vantage point, must be defined. The viewshed from areas surrounding WFF is generally consistent due to the flat topography of the region. The general aesthetic character of the area is that of a rural and small-town landscape with little to moderate urban development. The horizon is typically defined by trees or water when a view of the ocean or estuaries is available. The foreground of a viewshed is typically the main focal point and after a few hundred feet, objects in the background tend to fade into the viewshed background, which around WFF is the open sky due to the absence of tall buildings or other elements that rise above the tree line. Photograph 1 below provides an example of the viewshed from Arbuckle Neck Road, located approximately 3.7 kilometers (2.3 miles) southwest of the proposed wind turbine site on Wallops Island.

Photograph 1: Viewshed from a vantage point west of WFF located approximately 3.7 kilometers (2.3 miles) southwest of the bridge that links Wallops Mainland to Wallops Island looking northeast toward the bridge.

Typical viewsheds from within WFF include a mix of buildings, roads, and other infrastructure such as towers, open grassy areas that are maintained in the summer by mowing, and forest. WFF's Wallops Island property contains a larger amount of natural areas compared to the Main Base, and the viewsheds from Wallops Island generally include one or more of the following in addition to buildings and infrastructure: wetland vegetation, maritime scrub-shrub forest vegetation, or the rock seawall and the ocean beyond. Photographs 2 and 3 show typical views at the Main Base, and Photograph 4 shows a typical view at Wallops Island. Figure 17 provides an aerial view of Wallops Island for context.

Photograph 2: Viewshed from a vantage point at the Main Base looking north toward the cafeteria building.

Photograph 3: Aerial overview of the Main Base looking east.

Photograph 4: Viewshed from launch pad 2 on South Wallops Island looking north.

Title: Oblique Aerial View of Wallops Island Viewed from the South End of the Island Looking North

URS Proj No: 15301785

Figure: 17

Client : NASA

Alternative Energy Project

This page intentionally left blank.

SECTION FOUR: ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

Section 4 presents the potential impacts on existing resources described in Section 3 that may result from the alternatives described in Section 2. This chapter contains discussions on potential impacts on resources under the three main categories of Physical Environment, Biological Environment, and Social and Economic Environment. Following an initial evaluation of potential impacts on all resources, NASA determined that there would be no impacts on groundwater, munitions and explosives of concern, or health and safety; therefore, these resources are not discussed in this EA.

Section 4 focuses on addressing the type, context, intensity, and duration of the project-related environmental impacts for each resource area included in this EA. The impacts can be described in different ways including:

- Type (beneficial or adverse)
- Context (site-specific, local, or regional)
- Intensity (negligible, minor, moderate, or substantial)
- Duration (short- or long-term)

The levels of impacts and their specific definitions vary based on the resource that is being evaluated. For example, the scale at which an impact may occur (local, regional, etc.) would be different for wetland impacts as compared to economic resources.

Under NEPA (42 U.S.C. 4321 et seq.), significant impacts are those that have the potential to significantly affect the quality of the human environment. Human environment is a comprehensive phrase that includes the natural and physical environments and the relationship of people to those environments (40 CFR Section 1508.14). Whether an alternative significantly affects the quality of the human environment is determined by considering the context in which it would occur, along with the intensity of the action (40 CFR Section 1508.27).

Additionally, mitigation measures that would reduce the potential for an impact are identified in Section 5.

4.2 PHYSICAL ENVIRONMENT

4.2.1 Land Resources

4.2.1.1 Topography

No Action Alternative

Under the No Action Alternative, implementation of the Alternative Energy Project would not occur; therefore, no impacts on topography would occur.

Proposed Action

Construction activities (e.g., land grading and excavation) and infrastructure installation (e.g., access roads, wind turbine footprints, crane pads, and underground cables) for the utility-scale wind turbines would have long-term, localized impacts on topography. Under the Proposed Action, total permanent ground disturbance for construction of the utility-scale wind turbines would be approximately 2,580 square meters (28,000 square feet) which equals 0.26 hectare (0.64 acre). This includes 2,100 square meters (22,650 square feet) for new roads, 33 square meters (350 square feet) for foundations, and 450 square meters (5,000 square feet) for the crane pads. In addition to permanent disturbance, approximately 260 square meters (2,800 square feet) would be temporarily disturbed during installation subsurface foundations for the turbines.

To minimize the impacts, previously disturbed areas such as the cleared area east of the U.S. Navy V-10/V-20 complex would be used for staging of equipment of materials and for construction vehicle parking (Figure 6). The foundation for the wind turbines and access roads would require filling of wetlands, resulting in permanently elevated areas of soil within the wetland, which would result in long-term adverse impacts on the topography in the areas immediately around the turbine footprints.

No changes in topography would occur with installation of the residential-scale wind turbines. The area of permanent ground disturbance would be limited to the 1-meter (3-foot) surface foundation and trenching for electrical lines; therefore, permanent ground disturbances would be localized and minor.

Alternative One

The types of impacts described under the Proposed Action are applicable for Alternative One; however, there would be less ground disturbance because only one utility-scale wind turbine would be constructed. Under Alternative One, total permanent ground disturbance at the proposed utility-scale wind turbine site would be approximately 870 square meters (9,400 square feet), which equals 0.09 hectare (0.22 acre). This includes 620 square meters (6,700 square feet) for new roads, 17.5 square meters (180 square feet) for foundations, and 225 square meters (2,500 square feet) for the crane pad. In addition to permanent disturbance, approximately 130 square meters (1,385 square feet) would be temporarily disturbed during installation subsurface foundations for the turbines. No changes in topography would occur with installation of the residential-scale wind turbines.

Installation of solar panels in the open, grassy areas of the Main Base would not alter topography. Since the exact location of three of the residential-scale wind turbines and the solar panels has not yet been determined, the total temporary ground disturbance resulting from construction and installation activities cannot be determined. The area of permanent ground disturbance would be limited to the 1-meter (3-foot) surface foundation for the residential-scale turbines, the support posts holding the solar panels, and trenching for electrical lines; therefore, permanent ground disturbances would be localized and minor.

Alternative Two

No changes in topography would occur with installation of the residential-scale wind turbines. Solar panels installed in the open, grassy areas of Wallops Main Base would not alter topography. Since the exact location of three of the residential-scale wind turbines and the solar panels has not yet been determined, the total ground disturbance resulting from construction and installation activities cannot be determined. The area of permanent ground disturbance would be limited to the 1-meter (3-foot) surface foundation for the residential-scale turbines, the support posts holding the panels, and trenching for electrical lines; therefore, permanent ground disturbances would be localized and minor.

4.2.1.2 Geology and Soils

No Action Alternative

Under the No Action Alternative, implementation of the Alternative Energy Project would not occur; therefore, no impacts on geology and soils would occur.

Proposed Action

Construction activities, including grading, clearing, filling, and excavation, would result in disturbance of the ground surface and would have the potential to cause soil erosion. NASA would minimize adverse impacts on soils by acquiring VSMP permits as necessary, and developing and implementing site-specific SWPPPs and Erosion and Sediment Control (E&SC) plans prior to ground disturbing activities. NASA would revegetate bare soils and incorporate landscaping measures in areas to be left unpaved when construction is complete.

Utility-scale wind turbines need deep foundations and firmly packed soils to maintain their horizontal stability. Construction of the pile foundation to support the wind turbine infrastructure would require driving precast concrete piles to depths of 30 meters (100 feet) below ground surface. The piles are expected to penetrate the surficial coastal deposits and terminate in the uppermost geologic layer, the Yorktown Formation, which occurs at a depth of 18 to 43 meters (60 to 140 feet) below the ground surface. Although the driven piles would create long-term changes to the subsurface geology immediately around the piles, the changes would be limited in extent and are considered negligible. Therefore, minor, long-term, and highly localized impacts would occur on geology.

The subsurface foundations of the residential-scale turbines would be installed to a maximum depth of 6 meters (20 feet), which would be entirely within the geologic layer of surficial coastal deposits at any of the potential Main Base or Mainland locations; therefore, no impacts on geology are anticipated from installation of the residential-scale wind turbines.

Accidental release of contaminants, such as hydraulic and lubricating oils or cooling fluids into the soil could also occur from routine maintenance of the turbines or an accidental release of pollutants from vehicles or equipment to a permeable surface. Any accidental release of contaminants or liquid fuels would be addressed in accordance with the WFF ICP. The impacts of an accidental release could be adverse, although the likelihood of an accidental release would be low due to spill prevention and containment measures. With implementation of mitigation measures, only short-term minor impacts on soils would occur under the Proposed Action.

Alternative One

Impacts on geology and soils for construction of the utility-scale and residential-scale wind turbines would be the same as described under the Proposed Action, but to a lesser extent since only one utility-scale wind turbine would be constructed.

The installation of solar panels on existing buildings at Wallops Main Base would have no impact on geology and minor, short-term impacts on soils. Because installation of solar panels would require only shallow excavation activities, no impacts on geology are anticipated. The construction of solar panels would result in disturbance of soils. NASA would minimize impacts on soils by acquiring VSMP permits as necessary, and developing and implementing site-specific SWPPPs and E&SC Plans prior to ground disturbing activities. NASA would revegetate bare soils and incorporate landscaping measures in areas to be left as pervious surfaces (not paved) when construction is complete.

Alternative Two

Impacts on geology and soils for construction of the residential-scale wind turbines would be the same as described under the Proposed Action, but to a lesser extent since no utility-scale wind turbine would be constructed. The types of impacts from solar panel installation described under Alternative One would be the same for Alternative Two, but the area of soil disturbance would likely be larger due to installation of more solar panels.

4.2.1.3 Land Use

No Action Alternative

Under the No Action Alternative, implementation of the Alternative Energy Project would not occur; therefore, no impacts on land use would occur.

Proposed Action

The area where the proposed utility-scale and residential-scale wind turbines would be located is zoned industrial by Accomack County and would be located in areas on WFF property that are currently unused and are not planned for future use. The construction and operation of the proposed wind turbines would not result in changes to land use, or impacts on NASA or the U.S. Navy’s use of the area; therefore, no impacts would occur.

Alternative One

Impacts on land use under Alternative One would be the same as described under the Proposed Action for wind turbine construction and operation. Installation of the solar panels in grassy areas at the Main Base would result in up to 16 hectares (40 acres) of land unavailable for future use. Approximately 120 hectares (300 acres) at the Main Base are currently occupied by buildings, roads, runways, and other infrastructure and 150 hectares (380 acres) are occupied by forest, leaving approximately 520 hectares (1,280 acres), or 66 percent of the Main Base unoccupied. The 16 hectares (40 acres) of land the solar panels would occupy is about 3 percent of the currently unoccupied land. This would result in long-term adverse impacts on land use in those specific areas.

Alternative Two

Impacts on land use under Alternative Two would be the same as described under the Proposed Action for wind turbine construction and operation. Installation of the solar panels in grassy areas at the Main Base would result in up to 32 hectares (80 acres) of land unavailable for future uses. Approximately 120 hectares (300 acres) at the Main Base are currently occupied by buildings, roads, runways, and other infrastructure and 150 hectares (380 acres) are occupied by forest, leaving approximately 520 hectares (1,280 acres), or 66 percent of the Main Base unoccupied. The 32 hectares (80 acres) of land the solar panels would occupy is about 6 percent of the currently unoccupied land. This would result in long-term adverse impacts on land use in those specific areas.

4.2.2 Water Resources

4.2.2.1 Surface Waters

No Action Alternative

Under the No Action Alternative, implementation of the Alternative Energy Project would not occur; therefore, no impacts on surface water within the project area would occur.

Proposed Action

Construction activities including grading, clearing, filling, and excavation would result in disturbance of the ground surface and would have the potential to cause soil erosion and the subsequent transport of sediment into waterways via stormwater. NASA would minimize impacts on surface waters by acquiring VSMP permits and by developing and implementing a site-specific SWPPP and E&SC plans prior to land disturbing activities.

Other possible impacts on surface waters during construction include spills or leaks of fuel or oil from vehicles or equipment. The site-specific SWPPP would include Best Management Practices (BMPs) for vehicle and equipment fueling and maintenance, and spill prevention and control measures would be implemented to reduce potential impacts on soils during construction and continued operation and maintenance of the two wind turbines. Any accidental release of contaminants or liquid fuels would be addressed in accordance with the existing WFF ICP.

The utility-scale wind turbines would be located in an area where stormwater primarily drains to the west toward Bogues Bay. Short-term minor impacts on surface water quality could occur during construction, but with implementation of mitigation measures for construction activities and stormwater flow, no long-term or adverse impacts on surface waters would occur.

Alternative One

The types of impacts on surface water would the same as those described under the Proposed Action for the construction wind turbines; however, because only one utility-scale wind turbine would be installed, there would be less land disturbance and less potential for a leak or spill due to less construction activity.

Installation of solar panels would not restrict stormwater flow at the Main Base. NASA would minimize impacts on surface waters during construction by acquiring VSMP permits and by developing and implementing a site-specific SWPPP and E&SC plans prior to land disturbing activities. Short-term minor impacts on surface water quality may occur during construction, but with implementation of mitigation measures for construction activities and stormwater flow, no long-term or adverse impacts on surface waters would occur.

Alternative Two

The types of impacts on surface water would the same as those described under the Proposed Action for the construction wind turbines; however, because no utility-scale wind turbine would be installed, there would be less land disturbance and less potential for a leak or spill due to less construction activity.

The types of impacts from solar panel installation described under Alternative One would be the same for Alternative Two, but the area of soil disturbance would be larger due to installation of more solar panels. Short-term minor impacts on surface water quality may occur during construction, but with implementation of mitigation measures for construction activities and stormwater flow, no long-term or adverse impacts on surface waters would occur.

4.2.2.2 Wetlands

No Action Alternative

Under the No Action Alternative, implementation of the Alternative Energy Project would not occur; therefore, no impacts on wetlands at WFF would occur.

Proposed Action

Due to siting constraints, including finding available land and areas that would not interfere with WFF's active airfields and tracking/telemetry systems, NASA determined that there are no practicable alternatives for the location of the two utility-scale wind turbines. The potential areas identified for the residential-scale wind turbines were selected to exclude wetlands.

NASA completed a wetland delineation in accordance with the USACE 1987 Wetland Delineation Manual (USACE, 1987) and regional guidelines to determine the precise location and size of the wetland area that would be affected by the construction of the utility-scale wind turbines and access roads. The delineation determined that both tidal and non-tidal wetlands are present within the project site (NASA, 2009a). Up to 0.36 hectare (0.88 acre) of tidal wetlands would be filled for construction of the utility-scale wind turbine pads, underground cables, and access roads; 0.29 hectare (0.71 acre) of estuarine intertidal emergent wetlands, 0.06 hectare (0.14 acre) of palustrine emergent wetlands, and 0.01 hectare (0.03 acre) of palustrine scrub-shrub wetlands. Table 20 below shows the estimated wetland impacts of the Proposed Action.

Table 20: Wetland Impacts under the Proposed Action

Wind Turbine Site	Permanent Impacts hectare (acre)
Southern turbine	0.17 (0.41)
Northern turbine	0.19 (0.47)
Total	0.36 (0.88)

Source: NASA, 2009a

The potentially affected wetlands are considered jurisdictional under Section 404 of the CWA and are regulated by the USACE. NASA completed a *Final Wetland Delineation for Alternative Energy Project* report which was sent to the USACE along with a request for preliminary jurisdictional determination (JD); the USACE responded in a letter dated April 30, 2009 with a preliminary JD. Prior to construction, NASA would notify the public and coordinate with applicable agencies including USACE, the VDEQ, VMRC, and the Accomack County Wetlands Board; these agencies would be notified of potential impacts on wetlands by VMRC through the JPA process. NASA would obtain necessary permits including CWA Section 404, Section 10, and Section 401 Water Quality Certification/Virginia Water Protection permits. NASA would implement wetland mitigation measures agreed upon through the JPA consultation process to offset the impacts from this project. Specifically, NASA would implement 0.362 hectare (0.895 acre) of wetland compensation at the Mainland (Figure 18). The mitigation area could be anywhere within the detail area shown on Figure 18.

Because the Proposed Action would involve federally funded and authorized impacts on jurisdictional wetlands, this EA serves as NASA's means for facilitating public review as required by EO 11990.

Alternative One

Under Alternative One, only the southern utility-scale wind turbine would be constructed. As shown in Table 20, up to 0.17 hectare (0.41 acre) of tidal wetlands would be permanently impacted for construction of the southern wind turbine. The agency consultation process and public notification required under EO 11990 and described under the Proposed Action would be the same for Alternative One.

The potential areas identified for the residential-scale wind turbines were selected to exclude wetlands. Installation of the solar panels would not affect wetlands.

Alternative Two

The potential areas identified for the residential-scale wind turbines and solar panels were selected to exclude wetlands; therefore no impacts on wetlands would occur under Alternative Two.

4.2.2.3 Floodplains

No Action Alternative

Under the No Action Alternative, implementation of the Alternative Energy Project would not occur; therefore, no impacts on floodplains would occur.

Proposed Action

The utility-scale wind turbines and the residential-scale wind turbine proposed at the Mainland guard station would be located within the 100-year and 500-year floodplains. The areas of the Main Base where residential-scale wind turbines would be installed are not within the floodplain.

Because of the siting constraints for placement of the wind turbines, no practicable alternatives to placement on Wallops Island, which is entirely within the floodplain, exist. NASA would ensure that construction activities comply with EO 11988 (Floodplain Management) and 14 CFR 1216.2 (NASA regulations on Floodplain and Wetland Management) to the maximum extent possible.

The functionality of the floodplain on Wallops Island and Mainland, provided both by the wetlands and the area of the island/Mainland itself, would not be substantially reduced due to the presence of the proposed facilities because the footprint of the facilities does not cover a substantial area of the island. Electrical cables would be buried underground, and any aboveground water-sensitive equipment (i.e., switchgear, electrical components) would be elevated above the base flood elevation, which is 3.4 meters (11 feet) amsl at both the Mainland and on Wallops Island.

Because the Proposed Action would involve federally funded and authorized construction in the 100-year floodplain, this EA also serves as NASA's means for facilitating public review as required by EO 11988.

Alternative One

The single utility-scale wind turbine and the residential-scale wind turbine proposed at the Mainland guard station would be located within the 100-year and 500-year floodplains. Because of the siting constraints for placement of the wind turbine, no practicable alternatives to placement of the utility-scale wind turbines on Wallops Island exist. NASA would ensure that construction activities comply with EO 11988 and 14 CFR 1216.2 to the maximum extent possible. Because the Proposed Action would involve federally funded and authorized construction in the 100-year floodplain, this EA also serves as NASA's means for facilitating public review as required by EO 11988.

The types of impacts on the floodplain would the same as those described under the Proposed Action for the construction wind turbines; however, because only one utility-scale wind turbine would be installed, there would be less construction in the floodplain. The areas of the Main Base where residential-scale wind turbines or solar panels would be installed are not within the floodplain.

Alternative Two

The residential-scale wind turbine proposed at the Mainland guard station would be located within the 100-year and 500-year floodplains. The types of impacts on the floodplain would the same as those described under the Proposed Action for the construction wind turbines; however, there would be less construction in the floodplain under Alternative Two. The areas of the Main Base where residential-scale wind turbines or solar panels would be installed are not within the floodplain; therefore no impacts on the floodplain would occur under Alternative Two.

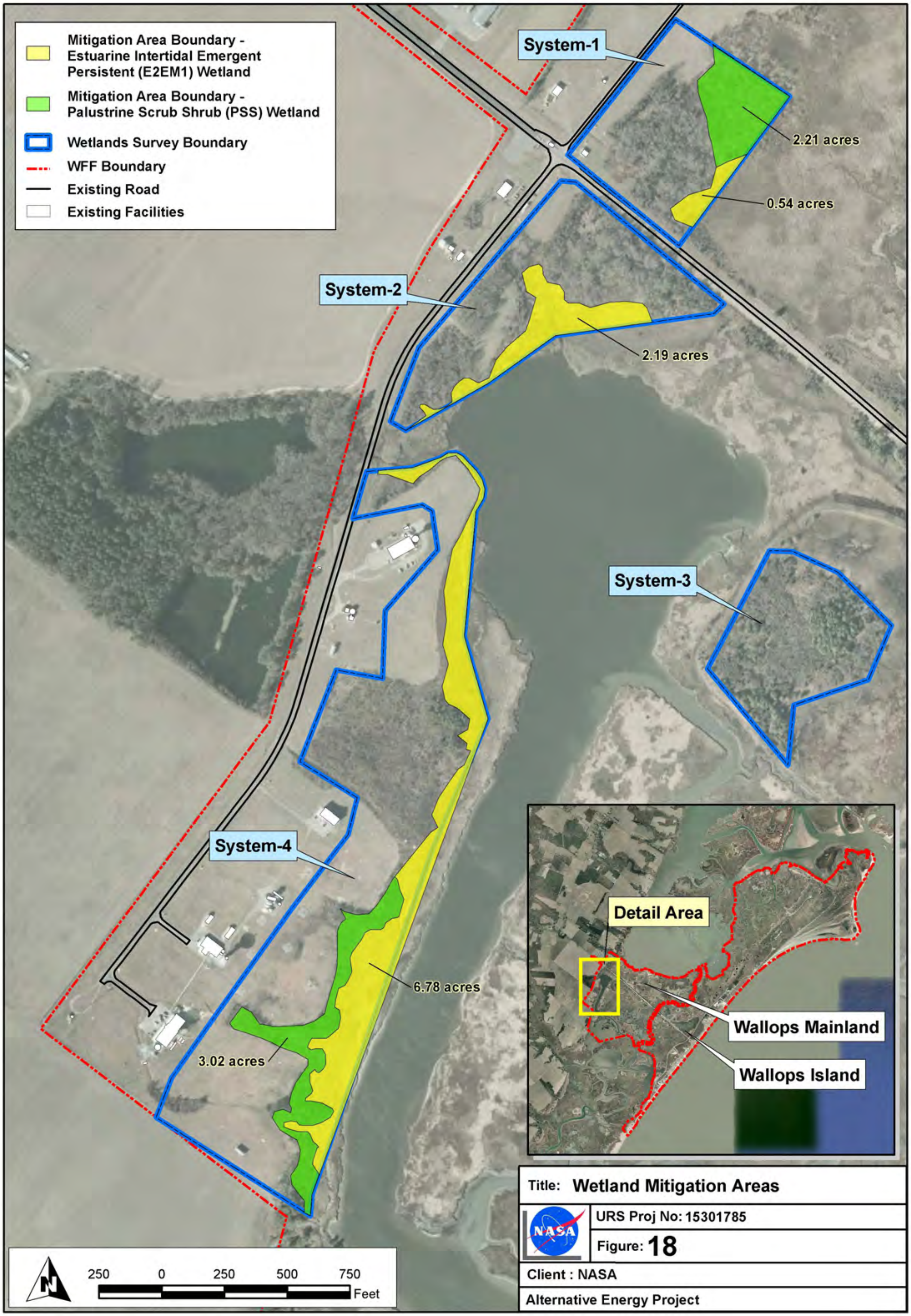
4.2.2.4 Coastal Zone Management

No Action Alternative

Under the No Action Alternative, implementation of the Alternative Energy Project would not occur; therefore, no impacts on the coastal zone would occur.

Proposed Action

All activities under the Proposed Action occur within Virginia's CMA as designated by Virginia's CZM Program. NASA has determined that the construction and operation of two wind turbines under the Proposed Action is consistent with enforceable policies of the CZM Program.



Title: **Wetland Mitigation Areas**

URS Proj No: 15301785

Figure: **18**

Client : NASA

Alternative Energy Project

This page intentionally left blank.

Based on the information and analysis in this EA and the Federal Consistency Determination (Appendix C), NASA determined that the Proposed Action is consistent to the maximum extent practicable with the enforceable policies of the CZM Program.

Alternatives One and Two

Activities under Alternatives One and Two would be conducted in a way that was consistent with the enforceable policies of the CZM Program.

4.2.3 Air Quality and Climate Change

No Action Alternative

Under the No Action Alternative, development of the Alternative Energy Project would not occur; therefore, emissions would remain at present levels as described in Section 3.1.3 (calendar year 2008 summary table for WFF GHG emissions). There would be no reduction in emissions resulting from the use of fossil fuels during the production of electricity at the source of the electric power generation that supplies WFF.

Proposed Action

The proposed wind turbines would be located in an attainment area for all criteria pollutants; therefore, NASA is not required to perform a general conformity review for the Proposed Action.

Construction equipment and construction worker's vehicles used during the construction activities (i.e., land clearing, access road, and turbine construction) would produce emissions resulting from the use of diesel engines. The use of diesel-or gasoline-powered emergency generators is not anticipated during the construction phase. Due to the operation of fossil-fuel burning equipment, there would be the potential to cause temporary, short-term air quality impacts. To help minimize such impacts and emissions, vehicles and equipment used for construction would be maintained in good working order. The non-road diesel engines are required by law to utilize low-sulfur diesel, which must meet a 500 parts per million (ppm) sulfur maximum. Idling of construction equipment would be prohibited when feasible.

The amount of disturbed area would be minimized by utilizing previously disturbed areas including use of a cleared area east of the U.S. Navy V-10/V-20 Complex facility and other designated staging areas (shown on Figure 6) for the staging of equipment and materials, and for construction vehicle parking. However, depending on weather conditions, there would be fugitive particulate (i.e., dust) emissions emitted during the construction activities, such as clearing and grading, access road construction, and pile driving. Although the following BMPs were not taken into consideration to estimate worst case emissions, NASA does require the inclusion of specific contract language to require contractors to implement dust suppression procedures (e.g., application of water) when necessary. Additionally, aggregate materials (permanent gravel road surface) would be used on surface access roads and on-site roads.

Based on the quantification of emissions, using EPA-approved emission factors and conservative assumptions where possible (i.e., not accounting for BMPs), the construction activity emissions for the Proposed Action would be minimal (see Table 21). For example, it was assumed that the construction crew would drive to the work site every day in personally owned vehicles (e.g., light-duty trucks), conservatively assuming that each person would drive their own vehicle. Construction timeframes were doubled.

Typical operational phase activities include wind turbine operation, power generation, and any associated maintenance activities that would require vehicular access and heavy equipment operation when large components would be replaced. Although there are no direct air emissions from operating a wind turbine, there may be VOC emissions created during the routine maintenance activities of applying lubricants, cooling fluids, and greases; however, VOC emissions would be negligible. Also during the operations phase, vehicular traffic would produce fugitive dust and tailpipe emissions, such as from the maintenance of access roads, but these types of emissions would be infrequent and negligible.

Table 21: Proposed Action Construction Emissions for WFF Mainland/Wallops Island

Emission Sources	Emissions[1] in tons per year					Emissions in metric tonnes per year			
	CO	NO_X	VOC	PM	SO_X[2]	CO_2	N_2O	CH_4	CO_2e
Site Preparation	-	-	-	<1	-	-	-	-	-
Personal Vehicles (Light-duty Diesel Trucks)	<1	<1	<1	<1	<1	11.6	<1	<1	11.8
Construction Equipment	1.8	3.3	<1	<1	<1	192.4	<1	<1	196.0
TOTAL	**2.5**	**3.8**	**<1**	**<1**	**<1**	**204.0**	**<1**	**<1**	**208.7**

[1] Construction emissions were quantified for the duration of the project.
[2] SO_X = sulfur oxides
Source: URS, 2009

There would be no long-term adverse impacts on air quality for the Proposed Action. Based on the quantification of criteria pollutants, NASA has concluded that project-related emissions would not likely have an impact on the area's compliance with the NAAQS. The short-term impact of constructing the wind turbines would be negligible compared to the long-term benefits of supplementing WFF's energy needs with fossil fuel-free power. Also, negligible emissions would be expected from the erection of the five residential-scale turbines.

Although there are no formally adopted NEPA thresholds of significance for GHG emissions, there are a multitude of State and regional regulatory programs requiring GHG emissions reductions. However, due to the absence of GHG thresholds, it is difficult to determine the level of proposed emissions that may significantly contribute to global climate change.

Given the absence of science-based or adopted NEPA significance thresholds for GHGs, the CO_2e emissions from the Proposed Action are compared to the EPA GHG baseline inventory of 2007 for the United States to determine the relative increase in proposed GHG emissions. Table 22 summarizes the annual GHG emissions from the Proposed Action and the most recent U.S. annual baseline GHG emissions. This data shows the CO_2e emissions from this alternative would amount to approximately 3.12×10^{-6} percent of the total GHG emissions generated across the United States; therefore, impacts on global climate change would not be substantial.

Table 22: Proposed Action GHG Construction Emissions for WFF Mainland/Wallops Island

Scenario/Activity	Emissions
Proposed Action (metric tonnes per year)	223.2
U.S. 2007 Baseline Emissions (10^6 metric tonnes per year)	7,150
Proposed Action Emissions as a Percent of U.S. Emissions	3.12×10^{-6}
Source: EPA, 2009	

Compared to the amount of GHGs emitted during the construction activity, the amount of GHGs offset by the operation of the two utility-scale wind turbines at WFF would be considerable.

One 2.0 MW wind turbine is estimated to annually reduce the following quantities of GHG emissions (USDOE, 2001):

- 2,720 tons of carbon dioxide (CO_2)
- 82.5 pounds (lbs) nitrous oxide (N_2O)

Each residential-scale turbine would reduce CO_2 by 3.3 tons and a negligible amount of N_2O. Potentially, an additional beneficial impact would be a regional reduction in criteria pollutant emissions resulting from the lowered use of fossil fuels during the production of electricity at the source of the electric power generation that supplies WFF.

Alternative One

Similar to the Proposed Action, reviews for general conformity would not be necessary. The same BMPs described under the Proposed Action to reduce construction emissions would reduce air quality impacts from the construction and installation activities of one wind turbine at Wallops Island and solar panels at the Main Base. Diesel- or gasoline-powered stationary emergency generators would not be used in association with the solar panels.

Construction activities associated with a single utility-scale wind turbine and five residential-scale wind turbines would be the same as described for Proposed Action, except the construction period would be shorter; therefore, construction-related emissions would be less. Similarly, the graded area required for all wind turbines would be less than under the Proposed Action. However, installation of the solar panels may require minimal grading at the Main Base. Although solar panels could potentially be placed on top of buildings as well as on the ground, emissions from grading for placement of solar panels on the ground were assumed to include the entire 3 hectares (7.5 acres) to account for worst-case emissions.

There would be no direct air emissions from operation of the solar panels. However, routine activities during the operational phase to produce power, and regular monitoring and maintenance activities to ensure safe and consistent operation could cause some emissions. Potentially, minor VOC emissions may occur during routine maintenance activities (e.g., mirror washing every few weeks or mirror replacement). Because maintenance vehicular traffic would be minimal, it would produce negligible amounts of fugitive dust and tailpipe emissions. Additionally, maintaining the vegetation around the solar panels would be negligible and no different from the current mowing operations at the Main Base.

Calculations were performed using EPA-approved emission factors and conservative assumptions. Similar to the Proposed Action, there would be beneficial impacts on regional air quality as a result of the operation of the wind turbine and solar panels, which are fossil fuel-free power sources. Based on the quantification of criteria pollutant emissions (see Table 23), these emissions would not likely have an impact on the area's compliance with the NAAQS. GHG emissions would be minimal compared to the reduction that would be achieved by using the alternative energy sources.

Table 23: Alternative One Construction Emissions for WFF Mainland/Wallops Island

Emission Sources	Emissions[1] in tons per year					Emissions in metric tonnes per year			
	CO	NO_X	VOC	PM	SO_X	CO_2	N_2O	CH_4	CO_2e
Site Preparation	-	-	-	<1	-	-	-	-	-
Personal Vehicles (Light-duty Diesel Trucks)	<1	<1	<1	<1	<1	9.7	<1	<1	9.8
Construction Equipment	1.4	2.5	<1	<1	<1	145.0	<1	<1	148.5
TOTAL	**1.9**	**2.9**	**<1**	**<1**	**<1**	**154.7**	**<1**	**<1**	**158.3**

[1]Construction emissions were quantified for the duration of the project.

Source: URS, 2009

Alternative Two

Although solar panels could potentially be placed on top of buildings as well as on the ground, emissions for land clearing operations for placement of all solar panels were assumed to include the entire 6 hectares (15 acres) to account for worst-case emissions. Additionally, emissions for land clearing operations for the five residential-scale wind turbines were calculated. Personally owned vehicle emissions and construction equipment were calculated for an installation period of 14 weeks.

Similar to the Proposed Action and Alternative One, reviews for general conformity would not be necessary under Alternative Two. The same BMPs described under the Proposed Action to reduce construction emissions for the construction of the wind turbines would apply to the installation of solar panels at the Main Base. Diesel- or gasoline-powered stationary emergency generators would not be used in association with the solar panels.

There would be no direct air emissions from operation of the solar panels or residential-scale wind turbines. However, routine activities during the operational phase to produce power, and regular monitoring and maintenance activities to ensure safe and consistent operation could cause some emissions. Potentially, minor VOC emissions may occur during routine maintenance activities (e.g., mirror washing every few weeks, mirror replacement, or lubricant/cooling fluid/grease application for wind turbines). Because maintenance vehicular traffic would be minimal, it would produce negligible amounts of fugitive dust and tailpipe emissions. Additionally, maintaining the vegetation around the solar panels would be negligible and no different from the current mowing operations at the Main Base.

Similar to the Proposed Action and Alternative One, beneficial impacts on regional air quality would result from the operation of the solar panels, which are a fossil fuel-free power source.

Based on the quantification of criteria pollutant emissions (see Table 24), these emissions would not likely have an impact on the area's compliance with the NAAQS. GHG emissions would be minimal (and reduced slightly by using the five residential-scale turbines) compared to the reduction that would be achieved by using the alternative energy source.

Table 24: Alternative Two Construction Emissions for WFF Main Base

Emission Sources	Emissions in tons per year					Emissions in metric tonnes per year			
	CO	NO_X	VOC	PM	SO_X	CO_2	N_2O	CH_4	CO_2e
Site Preparation	-	-	-	<1	-	-	-	-	-
Personal Vehicles (Light-duty Diesel Trucks)	<1	<1	<1	<1	<1	5.0	<1	<1	5.1
Construction Equipment	<1	<1	<1	<1	<1	89.9	<1	<1	92.2
TOTAL	**1.1**	**1.8**	**<1**	**<1**	**<1**	**94.9**	**<1**	**<1**	**97.3**

Source: URS, 2009

4.2.4 Radar

Under the No Action Alternative, implementation of the Alternative Energy Project would not occur; therefore, no impacts radar systems in the area would occur.

Proposed Action

Since the motion of wind turbine blades would have a similar velocity band as aircraft, the wind turbines were sited to prevent a negative impact upon radar systems at WFF. A study of the radar systems currently in use at WFF was conducted to assist NASA in identification of acceptable sites for the wind turbines (QinetiQ Inc., 2004). Figure 3 shows the acceptable locations for siting the utility-scale wind turbines, and illustrates the constraints placed on the siting to prevent interference with radar. Because the wind turbines would be located within areas that would not affect existing radar systems, no impacts on radar would occur under the Proposed Action.

To determine potentially suitable areas for installation of the residential-scale turbines, areas that could potentially affect radar systems were excluded. Therefore, no impacts on radar would occur with installation of any of the 2.4 kW wind turbines.

Alternative One

The wind turbine site selection process was the same as described under the Proposed Action. Solar panels would not affect radar systems. Therefore, no impacts on radar would occur under Alternative One.

Alternative Two

The wind turbine site selection process was the same as described under the Proposed Action. Neither the residential-scale wind turbines nor the solar panels would affect radar systems, so no impacts on radar would occur under Alternative Two.

4.2.5 Noise

No Action Alternative

Under the No Action Alternative, implementation of the Alternative Energy Project would not occur; therefore, there would be no additional increase in noise levels at WFF so no new impacts on humans or wildlife from noise would occur.

Proposed Action

Construction activities have the potential to generate temporary increases in noise levels from heavy equipment operations such as grading, filling, pile driving, and wind turbine construction. NASA would comply with local noise ordinances and State and Federal standards and guidelines for potential impacts on humans caused by construction activities.

OSHA limits noise exposure for workers to 115 dBA for a period of no longer than 15 minutes in an 8-hour work shift and to 90 dBA for an entire 8-hour shift. Workers near activities producing unsafe noise levels, both during construction and during maintenance or repair operations after the turbines are operational, would be required to wear hearing protection equipment. Therefore, impacts on the occupational health of construction workers as a result of construction noise are not expected.

Modern wind turbines are generally quiet in operation, and compared to the noise of road traffic, trains, aircraft and construction activities, to name but a few, the noise from wind turbines is very low (The Working Group on Wind Turbine Noise, 1996). Outside of homes that are at least 300 meters (980 feet) away from large wind turbines, the sound of a wind turbine generating electricity is likely to be about the same level as noise from a flowing stream about 50 to 100 meters (160 to 330 feet) away or the noise of leaves rustling in a gentle breeze. The noise level from a single wind turbine creates a sound pressure level of 50 to 60 dBA at a distance of 40 meters (131 feet) from the turbine, which is about the same level as conversational speech. At a house 500 meters (1,640 feet) away, the equivalent sound pressure level would be 25 to 35 dBA when the wind is blowing from the turbine towards the house (The Working Group on Wind Turbine Noise, 1996). Additionally, the proposed 2.0 MW wind turbine would use a generator and gearbox with elements that minimize noise.

The closest facility occupied by personnel to the utility-scale wind turbines would be the U.S. Navy V-10/V-20 Complex, which is approximately 120 meters (400 feet) east of the proposed northern wind turbine location. The two known locations of the residential-scale wind turbines are proposed at the WFF Visitor Center and the Mainland guard station. Employees and visitors to these facilities would hear the turbines while they were outside of the buildings, but they would not hear the turbines from inside the buildings. The noise from the residential-scale turbines, on windy days, may sound like a faint “whoosh.” However, most of the time the residential-scale turbines would not be heard by people standing outside of the Visitor Center or Mainland guard station, so the impacts on those employees and visitors would be minor. Neither the public nor employees and visitors to WFF outside of Wallops Island would be able to hear the utility-scale wind turbines; therefore, there would be no impacts on either of these two groups from operation of the wind turbines. Operation of two utility-scale and the residential-scale wind turbines would result in highly localized, long-term, minor impacts on the surrounding environment from noise.

Alternative One

The construction-related noise impacts and mitigation would be the same as described under the Proposed Action for construction of utility-scale and residential-scale wind turbines. The discussion of noise generated by wind turbines would be the same as described under the Proposed Action; however, there would be less noise generated compared to Proposed Action because only one utility-scale wind turbine would be operated.

Installation activities for the solar panels have the potential to generate temporary increases in noise levels around the Main Base from heavy equipment operations. NASA would comply with local noise ordinances and State and Federal standards and guidelines for potential impacts on humans caused by construction activities. OSHA limits noise exposure for workers to 115 dBA for a period of no longer than 15 minutes in an 8-hour work shift and to 90 dBA for an entire 8-hour shift. Workers near activities producing unsafe noise levels, both during installation and during maintenance or repair operations after the solar panels are operational, would be required to wear hearing protection equipment. Therefore, impacts on the occupational health of construction workers as a result of construction noise are not expected.

The operation of solar panels would not create any noise.

Alternative Two

Noise would be the same as described under the Proposed Action for construction and operation of wind turbines; however, there would be less noise generated compared to Proposed Action because only the residential-scale wind turbines would be installed.

The types of noise impacts and mitigation for installation of solar panels would be the same as described under Alternative One. However the duration of the noise related to installation of the solar panels would last approximately twice as long because double the amount solar panels would be installed compared to Alternative One. The operation of solar panels would not create any noise.

4.2.6 Hazardous Materials and Hazardous Waste

No Action Alternative

Under the No Action Alternative, implementation of the Alternative Energy Project would not occur; therefore, there would be no impact from hazardous materials and generation of hazardous waste.

Proposed Action

Construction activities would include the use of hazardous materials and hazardous waste generation (i.e., solvents, hydraulic fluid, oil, and antifreeze) from the construction equipment. With implementation of safety measures and proper procedures for the handling, storage, and disposal of hazardous materials and wastes during construction activities, no adverse impacts are anticipated during construction. In addition, NASA would require site-specific SWPPP to be developed prior to the start of construction activities that would contain BMPs related to spill prevention and clean-up procedures for hazardous materials and wastes.

The operation and maintenance of the utility-scale and residential-scale wind turbines would result in the use of hazardous materials (i.e., solvents, hydraulic fluid, oil, and paint) and generation of hazardous wastes for maintenance of the turbine engine and parts. Each turbine model has different specifications for lubricating oil and hydraulic fluid quantities. There are three main types of fluid in a wind turbine: cooling fluid for the generator (a mix of glycol and water, similar to that used in automobile radiators), lubricating oil for the gearbox (typically a synthetic lubricating oil), and hydraulic oil for operating the blade pitch system, yaw mechanism, and brakes.

The wind turbine generators would be equipped with sensors to automatically detect loss in fluid pressure and increases in temperature and would shut them down in case of a fluid leak. The turbines would also be equipped with fluid catch basin and containment systems to prevent any accidental releases from leaving the nacelle.

Based on the limited quantities of fluids contained in the wind turbine generators and the leak detection and containment systems engineered into their design, the potential for an accidental spill from a wind turbine generator malfunction is extremely limited. Furthermore, any accidental gear oil or other fluid leaks from the wind turbines would be contained inside the turbine towers, which are sealed around the base.

The wind turbine generator fluids would be checked periodically and must be replenished or replaced infrequently (generally less than once per year and sometimes only once every 5 years). When replacing these fluids, operations staff would climb up to the nacelle and remove the fluids in small (typically 19-liter [5-gallon]) containers and lower them to the ground using a small maintenance crane built into the nacelle itself. The containers would be transferred to a vehicle for transport to a facility for temporary storage (typically less than one month) before being picked up by a licensed transporter for recycling. Replacement fluids are added in the same method, only in reverse. Small quantities of replacement fluids, typically no more than a few 189-liter (50-gallon) drums of lubricating oil and hydraulic oil may be stored in existing facilities for replenishing and replacing spent fluids. These fluids would be stored indoors in appropriate containment. All operations staff would be trained in appropriate handling and spill prevention techniques to avoid any accidental spills. Because only small quantities of fluids would be transported, added, or removed at any one time and would be stored for short periods of time, the potential for an accidental spill during routine maintenance would be extremely limited.

Additionally, NASA would ensure implementation of WFF's ICP safety procedures, training, and mitigation measures, including spill prevention and response. Therefore, no impacts on human and environmental health due to hazardous materials and wastes are anticipated.

Alternative One

The types of construction and maintenance impacts for the wind turbines described under the Proposed Action would be the same for Alternative One. Maintenance of the solar panels, which primarily involves periodic cleaning, would involve the use of soap concentrates and water, which are not hazardous. Although small amounts of harmful toxins like arsenic and cadmium compounds are present inside the solar cells, they cannot cause adverse effects unless they enter the human body in high doses, which would not occur during normal installation, operation, and maintenance. At ambient temperature and pressure conditions, there would be no vapors or dust generated by the normal operation of PV systems (Markvart and Castaner, 2003). The only conceivable situation in which the substances contained within PV cells could become a threat to human health and safety would be if a fire were to engulf the panels and firefighters or others nearby were to inhale any contaminants released into the air (UCS, 1992).

After the expected 25-year life span of the solar panels, the PV cell systems would be decommissioned. NASA would recycle the solar panels by sending the spent cells to a smelting or refining facility that specializes in reclaiming materials such as glass, aluminum frames, and semiconductor materials. Currently, many manufacturers accept decommissioned solar panels. The following procedures for reprocessing waste materials and recycled silicon are representative of existing practices:

- Modules that can be recovered and repaired into working modules would be recovered.
- Modules that cannot be repaired into working modules would undergo a de-manufacturing process to recover aluminum frame material, and where possible recoverable materials. Specialized recyclers would then recycle materials appropriately.
- The remaining non-recoverable parts of the modules would be crushed and disposed of, according to all Federal, State, and local requirements, in controlled landfill sites.

With the implementation of WFF's ICP and proper procedures for the handling, storage, and disposal of hazardous materials and wastes, no impacts on human and environmental health due to hazardous materials and wastes are anticipated for this alternative.

Alternative Two

The types of impacts and mitigation measures would be the same as those described for wind turbines and solar panels under Alternative One. Less hazardous materials and wastes related to the wind turbines would be handled and generated compared to Alternative One. However, more hazardous materials and wastes would be handled and generated for the solar panels due to the use of more PV cells compared to Alternative One. With the implementation of WFF's ICP and proper procedures for the handling, storage, and disposal of hazardous materials and wastes, no adverse impacts on human and environmental health due to hazardous materials and wastes are anticipated for this alternative.

4.3 BIOLOGICAL ENVIRONMENT

4.3.1 Vegetation

No Action Alternative

Under the No Action Alternative, implementation of the Alternative Energy Project would not occur; therefore, no impacts on vegetation would occur.

Proposed Action

Short-term adverse impacts on vegetation are anticipated due to excavation and grading to construct the wind turbines, access roads, entrance and exit boreholes of directional drilling operations on Wallops Island, and the trenches for the residential-scale underground wire. NASA would minimize adverse impacts on vegetation during construction by minimizing the areas of disturbance to the extent practicable, using existing un-vegetated areas for staging (see Figure 6), acquiring VSMP permits as necessary, and developing and implementing site-specific SWPPPs and E&SC Plans prior to ground-disturbing activities. NASA would re-vegetate bare areas after soil disturbing activities, and incorporate landscaping measures in areas that would be left as pervious surfaces (not paved) when the project is complete.

There would be long-term, adverse impacts on vegetation at Wallops Island due to the permanent conversion of 0.36 hectare (0.88 acre) of wetlands to developed land, 0.29 hectare (0.71 acre) of estuarine intertidal emergent wetlands, 0.06 hectare (0.14 acre) of palustrine emergent wetlands, and 0.01 hectare (0.03 acre) of palustrine scrub-shrub wetlands. NASA would implement wetland mitigation measures agreed upon through the JPA consultation process to offset the impacts. Impacts would be localized to the area within the utility-scale wind turbine construction footprint shown on Figure 6.

Alternative One

Impacts on vegetation for Alternative One would be similar to those described under the Proposed Action. There would be long-term adverse impacts on vegetation at Wallops Island from construction of one utility-scale wind turbine due to the permanent conversion of 0.17 hectare (0.41 acre) of tidal wetlands to developed land. The wetland mitigation measures described under the Proposed Action would be the same for this alternative.

Installation of solar panels would result in the permanent loss of vegetation within the footprint of the support posts; however, the support posts would be placed in areas where high levels of human activity occur, including foot traffic and regular mowing. Impacts on vegetation from the solar panel installation would be long-term and adverse but localized.

Alternative Two

Installation of the residential-scale wind turbines would result in the permanent loss of vegetation within the surface foundation footprint; however, they would be placed in areas where relatively high levels of human activity occur, including foot traffic and regular mowing. The types of impacts would be the same as those described for solar panels under Alternative One; however, a larger area would be affected due to double the area of the solar panels compared to Alternative One.

4.3.2 Terrestrial Wildlife

No Action Alternative

Under the No Action Alternative, implementation of the Alternative Energy Project would not occur; therefore, no impacts on terrestrial wildlife would occur.

Proposed Action

There would be short-term adverse impacts on wildlife during all construction activities due to temporary noise disturbances. However, this would be similar to disruptions from existing daily operations at WFF. There would be long-term adverse impacts on terrestrial wildlife due to the permanent conversion of 0.36 hectare (0.88 acre) of the wetland habitat at Wallops Island to developed land for the utility-scale wind turbine foundations and access roads, which would permanently displace the terrestrial wildlife from the affected area. NASA would implement wetland mitigation measures agreed upon through the JPA consultation process to offset the impacts.

Alternative One

Construction-related noise impacts on terrestrial wildlife would be the same as those described under the Proposed Action. There would be long-term adverse impacts on terrestrial wildlife due to the permanent conversion of 0.17 hectare (0.41 acre) of wetland habitat at Wallops Island for the single utility-scale wind turbine foundation and access road, which would permanently displace the terrestrial wildlife from using the affected area. NASA would implement wetland mitigation measures agreed upon through the JPA consultation process to offset the impacts.

The solar panels would be installed in developed areas that are marginally suitable as wildlife habitat. Solar panels installed within grassy or open areas (not on buildings) would result in loss of foraging areas for some terrestrial wildlife (i.e., squirrels, raccoons, frogs, etc.). This would result in long-term adverse impacts on terrestrial wildlife from installation of the solar panels, although the impacts would be localized to the footprint of the support posts.

Alternative Two

There would be short-term adverse impacts on wildlife during wind turbine construction activities due to temporary noise disturbances. However, this would be similar to disruptions from existing daily operations at WFF. The types of impacts would be the same as those described for solar panels under Alternative One; however, the solar panels would affect an area twice as large as compared to Alternative One.

4.3.3 Avifauna – Birds

No Action Alternative

Under the No Action Alternative, implementation of the Alternative Energy Project would not occur; therefore, there would be no impacts on avifauna.

Proposed Action

Construction Impacts

Limited temporary short-term impacts on bird nesting from the construction of two 2.0 MW and five 2.4 kW turbines are anticipated as a result of wind turbine construction activities. These temporary impacts would be minimal because: 1) the total amount of habitat disturbance is minimal (approximately 1,651 square meters [17,771 square feet]), 2) large areas of similar habitat exist nearby, 3) the species nesting in the area are generally common and would be limited to individuals, 4) construction period is short-term (6 months), 5) birds are mobile and can avoid construction activities, and 6) birds are acclimated to other nearby towers, buildings, and site operations.

Long-term construction impacts for the two 2.0 MW turbines on birds are not anticipated from the conversion of approximately 0.36 hectare (0.88 acre) of estuarine and marine wetland habitat to developed land for the same reasons discussed above under temporary impacts. Implementation of mitigation measures as agreed upon through the JPA consultation process, such as restoration of wetlands on Wallops Island, would minimize the impacts from loss of habitat. Since the five 2.4 kW turbines are being sited in either developed or maintained (i.e., mowed) areas and there would be no disturbance to wetlands and forested lands, there would be no loss of habitat.

Operational Impacts

The impacts evaluated for the Proposed Action include direct impacts (i.e., fatalities resulting from collisions with the wind turbine rotors and monopoles) and indirect impacts (i.e., disruptions of foraging behavior, breeding activities, and migratory patterns resulting from alterations on landscapes used by nocturnally active birds [Kunz et al., 2007]). Given that the primary focus of the pre-construction avian study was to assess risk to birds from the two 2.0 MW turbines, operational impacts were assessed differently in this section for the two 2.0 MW turbines versus the five 2.4 kW turbines. A qualitative evaluation is provided for the residential-scale turbines based on data for similarly sized turbines. In either case, the evaluations provided in this section indicate that although avian fatalities would be expected from the operation of the wind turbines, substantial direct and indirect impacts are unlikely to occur.

Utility-Scale (2.0 MW) Wind Turbines

The total number of fatalities documented at WFF's existing towers (up to 68 per year at the South Meteorological Tower) is proportionally very small in comparison to the number of birds that resided in and/or migrated through this region over the same span of time. The WFF site is located in an area of Virginia where waterfowl, other waterbirds, shorebirds, songbirds, and raptors stopover or migrate through in numbers that are globally important. While the magnitude of this coastal region of Virginia as a bird migration corridor cannot be understated, data from the 2008–2009 WFF avian study (NASA, 2009d) indicates that the vast majority of birds flew around the existing towers. Nevertheless, given that coastal Virginia hosts a robust fall migration, the potential for risk for collision with the two proposed turbines at WFF may be higher at that time of year due to the large number of birds flying through.

Post-construction fatality rates are expected to be low due to the lack of habitat at the proposed turbine sites. The two proposed turbine sites are contiguous with (within 150 meters [500 feet]) WFF's existing developed lands and, therefore, from a regional perspective, operation of the turbines would only minimally reduce the area of preferred habitat and minimally increase the amount of developed area that would largely be avoided. There is abundant habitat for most birds in the adjacent uplands and salt marshes where there is minimal disturbance from site operations. While there would be some loss of habitat for nesting and or foraging for turbine construction, local, regional, and flyway migratory patterns would not shift in response to operation of the turbines.

Low post-construction fatality rates are also expected because most birds were observed flying below, or are known to migrate flying above, the rotor sweep zone. Flight heights of the vast majority of birds observed during the day time were between ground level and 15 meters (50 feet), well below the rotor sweep zone at 43 meters (140 feet). The less than 2 percent of birds observed within the height range of the wind turbine rotor sweep zone were not directly over the proposed wind turbine sites but rather spread out throughout the survey area. The potential for risk to nocturnal migrating birds is expected to be similarly low given that they generally fly above the height of most wind turbines. Fog or other inclement weather conditions, however, increases the level of risk to migrating birds since visibility can be greatly reduced. Communication towers, in comparison, exhibit much higher levels of fatality (one to two orders of magnitude) simply because their height (typically 150 meters [500 feet] and taller) is within the preferred zone of migration, their guy wires create additional collision hazards and steady-burning lights serve as an attractant (Kerlinger et al., 2009, in review).

The level of mortality documented for the WFF site is somewhat higher than the mortality rate reported at other wind projects. The number of fatalities for the WFF 2008–2009 avian study was conservatively estimated to be 28 fatalities per year at the guyed North Boresight Tower and 44 to 68 fatalities at the unguyed South Meteorological Tower. In a review of data from 30 wind farms in North America, Kerlinger et al. (2009) reported a rate of approximately seven carcasses per turbine per year for the eastern United States. These data aren't entirely comparable to WFF given differences in calculation of mortality rate (Kerlinger et al.'s rates are corrected for scavenging and searcher efficiency; a conservative factor of four was used to determine fatality rate in the WFF avian study). The lack of multi-bird fatality events (greater than three carcasses per tower on a single evening) in the WFF avian study is, however, comparable to the data reported by Kerlinger et al. (2009). Unlike communication towers for which a number of large-scale multi-bird mortality events have been documented, multi-bird mortality events at a single wind turbine are rarely observed (four times in approximately 25,000 turbine searches at 30 wind farms) (Kerlinger et al., 2009). These findings from Kerlinger et al.'s (2009) data review, in combination with the WFF avian study findings, suggest that the probability of large scale mortality events occurring at the WFF project would be low. So while there may be mortality at the individual level for a variety of birds, there is sufficient evidence to conclude that population level effects are very unlikely.

The mortality study component indicates that risk for collision with the proposed turbines is based on each species' population status. That is, risk may be highest for abundant and common species and lowest for State or federally listed avian species. Most of the species of carcasses recovered in the avian study are categorized by CNWR (USGS, 2006) as abundant or common during most seasons of the year (migratory species may be "uncommon," "occasional," or "rare" during some seasons. Abundant species are defined as "very numerous" and common species are "likely to be seen or heard in suitable habitat." Only one species (Marsh Wren – uncommon) was categorized as uncommon, occasional, rare, or accidental.

NASA has been monitoring the post-construction wildlife studies that have been conducted by the New Jersey Audubon Society at the Jersey Atlantic Wind, LLC/Atlantic County Utilities Authority (ACUA) five-turbine project in Atlantic City, NJ (Photograph 5). This facility was built in 2005 and post-construction monitoring of impacts on birds has been ongoing since August 2007. The Atlantic Ocean coastal setting is similar to the Wallops Island environment and supports similar avian species composition. These similarities provide an opportunity to determine the type of impacts that might occur at the proposed WFF project site.

Source: ACUA, 2005

Photograph 5: Jersey Atlantic Wind, LLC/Atlantic County Utilities Authority Wind Farm

Results of site-specific bird mortality studies taking place between August 2007 and August 2009 (ACUA, 2009) have been published, and during this period, carcasses of 40 birds (25 species; 2 were not related to collisions) were discovered near the operating wind turbines. Laughing Gull, which is an abundant breeder in southern coastal New Jersey, and passerines were the most frequently encountered during collision event searches. Carcasses of raptors, waterfowl, and shorebirds were infrequently observed. One carcass of a Peregrine Falcon, a New Jersey endangered species, was recovered in August 2007. Four State threatened osprey but no federally listed species were documented. A corrected mortality rate was estimated to be approximately 30 birds/turbine/year; this rate is within the range estimated from pre-construction monitoring at WFF (28 to 72 birds/turbine/year). The results regarding relatively low avian and bat mortality at the ACUA five-turbine project over the monitoring period lend strong support to the potential for the Wallops Island two 2.0 MW-turbine project to cause low risk to a similar coastal avian community given similarity in the actual mortality rate at ACUA and the estimated rate at WFF.

The potential risk to birds from the operation of two wind turbines at WFF is considerably lower in comparison to other human induced sources of fatality. As already discussed, because of their height, lighting, and guy wires, communication towers can create a significant collision hazard to nocturnally migrating avifauna. Another human induced hazard that poses a greater risk to birds is the approved harvest of large numbers of waterfowl each year. The Commonwealth of Virginia allows harvest of waterfowl in numbers that would not be matched by the fatality from the proposed wind turbines at WFF. According to the USFWS (Richkus et al., 2008), Virginia harvested more than 131,000 ducks in 2006 and 2007, a small proportion (approximately 8 percent) of the total number of ducks harvested along the Atlantic Flyway in those same years. The USFWS also allows for localized management of Double-crested Cormorant, one of the identified carcasses at WFF, because it can be a nuisance species in certain areas. These examples demonstrate that there are greater threats to avifauna at the individual and population level than the two proposed wind turbines at WFF.

A post-construction monitoring study has been proposed (NASA, 2009d) as a means of ground truthing the wind turbine's risk profile and to provide data for comparison of actual avian and bat mortality at the wind turbines with mortality estimated for the existing tower structures. The need for BMPs would be determined once the post-construction study is implemented. If it is determined that there is a need to mitigate for any potential impacts on avifauna at the proposed WFF wind turbines, potential avoidance and/or minimization BMPs could be implemented to reduce the potential long-term (direct and indirect) impacts. Since research is on-going regarding wind energy projects and how to avoid and minimize potential impacts, many BMPs have yet to be developed and/or proven. Details of the mitigation measures and proposed post-construction study can be found in Chapter 5 of this EA.

Residential-Scale (2.4 kW) Wind Turbines

A qualitative evaluation of the potential for risk to birds from residential-scale turbines is provided in the absence of site-specific information. The general assumption is that small, residential-scale wind projects have minimal impacts on birds and less impact than the larger utility-scale turbines. For example, the American Wind Energy Association (AWEA) says that "anecdotal evidence indicates that birds occasionally collide with small wind turbines as they do with any other type of structure. However, such events are rare and very unlikely to have any impact on bird populations. Large, utility-scale wind turbines account for less than 0.003% of all human-caused bird deaths, and small wind turbines have even less of an impact."

Further, Southwest Windpower, Inc., the manufacturer of 2.4 kW turbines, states in their Residential Wind and Birds fact sheet that "although no formal studies have been conducted with residential wind generators like those produced by Southwest Windpower, Inc., bird strikes are even rarer. This is due in part to their shorter towers [9-30 meters (30-110 feet)], and relatively small blades [1-3 meters (3-12 feet)] in diameter. Also, residential wind generators are typically installed over a more dispersed area, further reducing the chance of bird collision." Neither AWEA nor Southwest Windpower, Inc. track avian mortality at residential-scale windfarms and, therefore, project-specific information was sought during a literature review.

A review of relevant literature and discussions with industry experts were conducted to determine if there were post-construction monitoring results for projects similar to WFF that would be instructive in assessing the potential for avian risk from the 2.4 kW turbines. Post-construction monitoring to assess avian mortality rates generally has been conducted at the larger utility-scale projects and not on the smaller turbines projects like the 2.4 kW turbines proposed at WFF. In a review of avian mortality data for 33 wind turbine sites in the United States and Canada, Barclay, et al. (2007) determined that that the height of turbines had no effect on bird mortality rate (corrected mortality rates ranged between zero and nine per turbine per year). With the exception of two sites, data included in this analysis were from 31 sites with turbine heights between 30 and 94 meters (98 to 308 feet) tall. Two sites were included that have turbines less than 24.4 meters (80 feet) tall (San Gorgonio wind farm and Altamont Pass Wind Resource Area [APWRA], both in California). However, these projects are not appropriate for assessing risk to birds in Virginia, as discussed at the end of this section.

While there is a general lack of data for these smaller turbines in the peer reviewed literature, two relevant projects were identified for which there are avian monitoring data. Projects at Eastern Neck National Wildlife Refuge (NWR) and Presque Isle State Park were recently built and have a number of similarities to the WFF project. Both projects are described below. The USFWS is also considering installation of 7.52-meter (24.7-foot) vertical axis turbines at Izembek NWR in Alaska. The USFWS indicated in their Draft Environmental Assessment (USFWS, date not available; final EA is due April 2010) that there would be “little or no impact to existing bird use” based on a qualitative assessment; pre-construction avian monitoring has not been conducted. Post-construction surveys are planned.

In 2002, Eastern Neck NWR near Rock Hall, MD installed a single 18-meter (60-foot) tall, unguyed 10 kW wind turbine (7 meter [23-foot] radius blades) about 40 meters (130 feet) from the former refuge office. The turbine site has a number of similarities to the proposed 2.4 kW turbine sites at WFF including the following: the turbine at Eastern Neck NWR is in a coastal location (Chesapeake Bay), sited on elevated land that is regularly maintained, is an important stopover location in the Atlantic Flyway, and is adjacent to the building the generated electricity is meant to primarily serve. The woodland fringing the turbine at Eastern Neck NWR is more than 100 meters (330 feet) away, which may be slightly farther than woodland areas from the 2.4 kW turbines at WFF. The Eastern Neck NWR supports saltmarsh, forest, and agricultural fields, and the bird community is similar to that occurring at WFF and includes passerines, waterfowl, raptors, waterbirds, and shorebirds. A Bald Eagle nest is approximately 0.4 kilometer (0.25 mile) from the Eastern Neck NWR wind turbine.

Pre- and post-construction monitoring activities for birds were conducted for 3.5 years at Eastern Neck NWR to determine local bird community and use, determine scavenger species and rate, evaluate carcass searcher efficiency, and document mortality (Willis, no date). The turbine site was visited 478 times over 3.5 years (average of approximately one visit per 3 days); fewer visits occurred during the summer months when the turbine was less likely to be operational due to light winds. There were no more than 7 days between visits. The results of the survey indicated that 20 bird carcasses were recovered in the search area beneath the turbine. Seventeen of these carcasses were European Starling (*Sturnus vulgaris*) which nested in the cowling of the turbine. The Starlings returned to nest in the cowling even after routine maintenance activities were conducted to remove the nesting material and were observed flying into the nest even when the blades were turning. A Bank Swallow (*Riparia riparia*) and a Gray Catbird (*Dumtella carolinensis*) were two additional carcasses recovered. The third bird was scavenged prior to confirming species. Over the course of the study period, Willis (no date) reported the corrected mortality rate as 18.4 birds per year. Given that nesting European Starlings comprised a majority of the observed mortality, the mortality rate drops to 2.8 birds per year. This is lower than the rate of seven/turbine/year for the eastern United States (Kerlinger et al., 2009) and is lower than the rate reported for the WFF’s utility-scale turbines’ pre-construction study.

In 2007, Presque Isle State Park near Erie, PA installed a single 36-meter (118-foot) tall, unguyed 10 kW wind turbine 11 meters (35 feet) from the Tom Ridge Environmental Center

(TREC). The turbine site is located near the entrance to the State park on a bluff near Lake Erie. Like the Eastern Neck NWR turbine project, there are similarities between the TREC project and the 2.4 kW turbine proposed sites at WFF. The turbine at TREC was sited adjacent to the TREC building and is adjacent to developed and more naturalized areas. Natural and planted vegetation and a 2.8 hectare (7 acre) parking lot surround the turbine site. The turbine site is a former outdoor movie theater on maintained lawn. McWilliams and Brauning (1999) indicate that over 250 species of birds have been observed at the State park. Eighty-three species were observed during the year-long pre-construction study including raptors, gulls, waterfowl, waterbirds, and numerous types of passerines. Shorebirds were not documented.

Pre-construction monitoring activities for birds at the TREC site were conducted to determine local bird community and use through direct observation and recordings of nighttime calls between October 2006 and the date the turbine was erected in May 2007 (Anderson, 2009). A post-construction study was conducted between May 2007 and July 2008 to observe bird use and conduct carcass searches, nocturnal surveys, and scavenger surveys using site-specific methodology. During the 14 month post-construction monitoring, no bird (or bat) carcasses were recovered at the turbine site despite the documentation of use by a variety of birds. The study authors suggest that mortality may have occurred but were not observed due to undocumented scavenger activity. Nevertheless, the authors conclude that their results confirm low mortality rates for smaller turbines such as the one at TREC.

While the APWRA in California has more than 1,500 24-meter (79-foot) tall turbines (Barclay, et al., 2007), there is a lack of similarities between the large wind farm in inland California and the residential-scale turbines at WFF’s coastal Virginia location. Therefore, the avian mortality research conducted there is not particularly instructive in assessing impacts on birds from turbines sited in the northeastern United States (Kerlinger, 1996), and the APWRA data are not provided for comparison.

The Eastern Neck NWR and Presque Isle State Park turbine studies discussed in this section suggest that mortality at WFF would also be low given the similarities between sites and projects, and likely lower than the two utility-scale turbines. The proposed residential-scale turbine sites at WFF are adjacent to existing buildings and/or site operations, including the WFF Visitor Center and Mainland guard station, where birds have already acclimated to these features and related site activities. Further, given that the turbines would be on paved or otherwise maintained areas, if impacts occur, they are expected to be limited to common “backyard” species that use these disturbed areas. Most individuals would habituate to the presence of the turbines and would avoid the turbines. The two studies also suggest that there would be no impacts on foraging or breeding activities or migratory patterns.

Alternative One

The types of impacts on birds as a result of wind turbine construction would be the same as described for the Proposed Action; however, less impacts are anticipated because the surface area disturbance, and therefore amount of habitat disturbance, would be about half compared to the Proposed Action, and the construction period would be shorter. The impacts on birds from the five 2.4 kW turbines as discussed in the Proposed Action are expected to be the same as the Proposed Action.

Because the installation of solar panels at the Main Base would not alter or remove bird habitat, nor would their operation interfere with bird activities, no impacts on bird are anticipated from solar panels under Alternative One.

Alternative Two

Because the installation of solar panels at the Main Base would not alter or remove bird habitat, nor would their operation interfere with bird activities, no impacts on birds are anticipated from solar panels. As described under the Proposed Action, minimal adverse impacts are expected for the installation of up to five 2.4 kW turbines.

4.3.4 Avifauna – Bats

As discussed in Section 3, 15 species of bat occur in Virginia; of these, the Indiana bat, gray bat, and Virginia big-eared bats are listed as federally endangered under Section 7 of the ESA. Rafinesque's big-eared bat is listed as State endangered. The three federally protected species live in the western parts of Virginia (see Figure 13) and do not likely inhabit or migrate in the vicinity of WFF. However, Wallops Island lies within the distribution range of Rafinesque's big-eared bat (VDGIF, 2009).

The central portion of Wallops Island is primarily marsh (dominated by common reed) and maintained lawn with a limited amount of forest habitat. The small amount of forest habitat may limit the amount of local resident bats that use Wallops Island for seasonal roosting activities. Local resident bats may roost farther inland and mainly utilize the estuarine and marine wetland habitat (marsh vegetation) of Wallops Island for foraging purposes. Additionally, non-resident bats may forage in the marsh while passing through on their annual seasonal migration. This situation is illustrated by the peak in activity observed in mid-August during the acoustical monitoring bat survey for this project—call volumes peaked between August 13 and August 16, with the greatest number of call sequences recorded on August 15 (Tetra Tech, 2008).

No Action Alternative

Under the No Action Alternative, development of the WFF would not occur and there would be no impacts on bats.

Proposed Action

In 2005, the U.S. Government Accountability Office (GAO) completed a report titled *Impacts on Wildlife and Government Responsibilities for Regulating Development and Protecting Wildlife* (GAO, 2005). The GAO report states that there is a "lack of complete and definitive information on the interaction of bats with wind turbines. As previously noted, bats have collided with wind turbines in significant numbers in some parts of the United States, but scientists do not have a complete understanding regarding why these collisions occur."

The GAO report states that bats are known to have the ability to echolocate to avoid collision with objects; however, their collision with wind turbines remains a mystery. The few studies that have been conducted show that most of the bat mortality has occurred during the migratory season (July through September), which suggests that migrating bats are involved in most of the fatalities. In addition, one study showed that lower wind speeds were associated with higher fatality rates. The report also states: "However, experts admit that much remains unknown about why bats are attracted to and killed by turbines and about what conditions increase the chances that bats will be killed."

Although the 2005 GAO report is relatively old in the context of the emerging wind energy field, there are still few studies on bats to date that provide useful information relevant to the proposed wind turbine project at WFF. Several investigations of avian activity at Wallops Island and the surrounding vicinity (e.g., Chincoteague Island, Assateague Island) have been conducted, including a 2004 Phase I Avian Risk Assessment at WFF for installation of a wind turbine on Wallops Island (Curry & Kerlinger, 2004), but very little information on bats at WFF or in the surrounding areas has been collected.

Background research on bats conducted in 2008 for an acoustic bat survey at WFF (Appendix B) stated that despite the recent increase in general bat studies resulting from the growing wind-energy industry, most of the questions regarding risk to bats from wind turbines remain unanswered (Tetra Tech, 2008).

Mortality of eight bat species has been documented at wind energy facilities in the eastern United States (Kunz et al., 2007a), with most fatalities occurring during what is generally considered the fall migration period. Species documented in the vicinity of wind turbines in the eastern United States include little brown myotis, northern myotis, eastern pipistrelle, seminole, hoary, silver-haired, red, and big brown bats. With the exception of eastern pipistrelles, the species affected most frequently—hoary, red, and silver-haired bat—are long-distance migrants, traveling dramatically greater migration distances than other North American species (Cryan, 2003; Cryan et al., 2004; Cryan and Brown, 2007).

Very little is understood about the behavior of migrating bats and the reasons behind their apparent susceptibility to collision with wind turbines. Among the scientific community, a variety of hypotheses have been proposed to explain this ecological concern. Several of these hypotheses suggest attraction of bats to wind turbines due to: (1) creation of linear habitat and/or potential roosts; (2) placement of wind turbines in habitats or areas with conditions favorable for foraging and high insect abundance; and, (3) attraction through auditory cues. Other hypotheses suggest that turbines create an electromagnetic disorientation, or postulate that bats are unable to accurately determine wind turbine blade speed through echolocation. Further, it is unknown whether bats echolocate while migrating, and whether failure to echolocate could cause collision mortality, as bats are clearly able to avoid objects and maneuver rapidly while foraging (Kunz et al., 2007a).

Although there have been some studies in the past several years conducted on bat mortalities and wind turbines, most of these studies have been conducted in landscapes that are different from the WFF coastal environment—such as California, West Virginia, and Kentucky. The most relevant study to the WFF environment to date was conducted in New Jersey in 2007 and 2008 at the Jersey Atlantic Wind, LLC/ACUA wind power facility (ACUA, 2009).

The results are preliminary and the numbers of carcasses reported were uncorrected for observer efficiency or scavenger removal. Correcting for these and other biases will likely increase the estimates of collision mortality. Preliminary results of post-construction wildlife monitoring reported that 53 bat carcasses were found in the study area around the wind turbines between the start of the project (in August 2007) and December 2008. To date, only two species have been documented: Eastern red bat (*Lasiurus borealis*) and hoary bat (*Lasiurus cinereus*). During the searches, more than three times as many red bats as hoary bats were found and the data suggest that 85 percent of all bat collision events occurred during August and September (ACUA, 2009).

Construction Impacts

Temporary impacts on bats as a result of foraging disruptions caused by the wind turbine construction activities are anticipated. However, these temporary impacts would be minimal because: 1) no known or suspected roosting habitat is being impacted, 2) the total amount of foraging habitat disrupted is minimal (approximately 1,651 square meters [17,771 square feet]), 3) plenty of other foraging areas exist nearby, 4) the construction activities are not being performed at night during bat foraging activities, and 5) the construction period is short term (6 months). Additionally, the scheduling of construction activities can be done so as to minimize these temporary impacts by disrupting only one migration of the bat's annual migration cycle during the approximate 6-month construction period for the utility-scale wind turbines.

Because the Proposed Action would result in the removal of 0.36 hectare (0.88 acre) of wetlands, there would be long-term adverse impacts on bats due to the conversion of estuarine and marine wetland habitat to developed land. The long-term impacts on bats would be minimal for the same reasons discussed above under temporary impacts. Implementation of mitigation measures as agreed upon through the JPA consultation process, such as restoration of wetlands on Wallops Mainland, would minimize the impacts from loss of habitat.

Operational Impacts

The relatively low bat mortality at the ACUA five-turbine project over the monitoring period lends strong support to the potential for the two 2.0 MW-turbine project at Wallops Island to cause low risk to a similar coastal avian community. However, under the Proposed Action, there would be long-term adverse impacts on bats from the operation of two utility-scale 2.0 MW wind turbines and up to 5 residential-scale wind turbines.

These impacts fall into two categories: direct and indirect impacts. Direct impacts refer to fatalities resulting from collisions with the wind turbine rotors and monopoles. Indirect impacts refer to disruptions of foraging behavior, breeding activities, and migratory patterns resulting from alterations of landscapes used by bats (Kunz et al., 2007a). Bat fatalities due to the operation of the wind turbines are anticipated; however, because the factors that cause bat fatalities are unknown, the number of fatalities and whether they pose a substantial impact is difficult to determine. A few potential reasons bats may be attracted to wind turbines (resulting in fatalities) are listed below; however, the significance of each is unknown (Kunz et al., 2007a):

- Attraction to the wind turbines for roosting purposes during migration
- Attraction to the sounds wind turbines make
- Attraction by the complex electromagnetic fields they produce
- Attraction of the insects, and thus the bats to feed, due to thermal inversions associated with the weather

A post-construction monitoring study has been proposed (NASA, 2009d) to ground truth the wind turbines' risk profile and to provide data for comparison of actual bat mortality at the wind turbines with mortality estimated for the existing tower structures. The need for BMPs would be determined once the post-construction study is implemented. Details of the mitigation measures and proposed post-construction study can be found in Chapter 5 of this EA.

If it is determined that there is a need to mitigate any potential impacts on avifauna at the proposed WFF wind turbines, potential avoidance and/or minimization BMPs would be implemented to reduce the potential long-term (direct and indirect) impacts. Since research is ongoing regarding wind energy projects and how to avoid and minimize potential impacts, many BMPs have yet to be developed or proven. The following BMPs may be implemented, if appropriate:

- Post-construction fatality monitoring studies utilizing the most proven up-to-date protocol, which may include visual, acoustic, radio tracking, mist-net, thermal imaging, and other monitoring techniques.
- Modified operation of wind-energy facilities (either changing turbine cut-in speed or temporarily stopping wind turbines) to reduce bat fatalities. Seasonal low wind shutdowns during predictable nights or periods of high bat kills could reduce fatalities considerably. Current studies suggest that bat fatalities occur primarily on low wind nights (BWEC, 2008).
- Ultrasonic deterrents that use high amplitude sonar “jamming” sounds as a potential method of deterring bats from wind turbine facilities (BWEC, 2008).

Alternative One

The types of impacts on bats as a result of wind turbine construction would be the same as described for the Proposed Action; however, there would be fewer impacts because: 1) the surface area disturbance to construct a single utility-scale wind turbine would be about half of the area required for the Proposed Action, and 2) there would be only one utility-scale turbine that could result in direct impacts on bats. Therefore, the amount of habitat disturbance would be less. The construction period would be shorter compared to the Proposed Action, resulting in fewer short-term adverse impacts on bats.

Because the installation of solar panels at the Main Base would not alter or remove bat habitat, nor would their operation interfere with bat activities, no impacts on bats are anticipated from solar panels under Alternative One.

Alternative Two

The types of impacts on bats as a result of residential-scale wind turbine construction would be the same as described for the Proposed Action; however, there would be fewer impacts because the surface area disturbance to construct the residential-scale wind turbines would be substantially less compared to the Proposed Action and would not occur within or adjacent to wetlands. Therefore, the amount of habitat disturbance would be less.

Because the installation of solar panels at the Main Base would not alter or remove bat habitat, nor would their operation interfere with bat activities, no impacts on bats are anticipated from solar panels under Alternative Two.

4.3.5 Threatened and Endangered Species

No Action Alternative

Under the No Action Alternative, implementation of the Alternative Energy Project would not occur; therefore, no impacts on State or federally listed threatened or endangered species or federally designated critical habitat would occur.

Proposed Action and Alternatives

Based on the proposed location of the wind turbines and the likelihood that Wallops Island may provide suitable habitat for listed avian species, the flight path of birds may be affected by the wind turbines. Because the proposed solar panel installation lies within a highly developed area of the Main Base, installation and operation of the solar panels would not disturb or affect State or federally listed species or their habitat.

Table 25 lists the federally endangered, threatened, and candidate species of concern within the vicinity of WFF that may be affected by the Proposed Action, and lists NASA’s determination of effects under Section 7 of the ESA. The area of effect for the construction of the wind turbines includes the footprint, access road infrastructure, work space for construction and staging areas (Figure 6). The operational area of effect of the wind turbines would include the overall height of the tower and top of the blades, the diameter of the blades, and the rotational area of the blades. Effects to State-listed species are discussed in the text below.

Table 25: Determination of Effects on Federally Listed Threatened and Endangered Species

Scientific Name	Common Name	Determination of Effect
Birds		
Charadrius melodus	Piping Plover	May affect, likely to adversely affect
Calidris canutus	Red Knot	May affect, likely to adversely affect
Mammals		
Sciurus niger cinereus	Delmarva fox squirrel	No effect
Reptiles		
Dermochelys coriaces	leatherback sea turtle	No effect
Eretmochelys imbricate	hawksbill sea turtle	No effect
Lepidechelys kempi	Kemp’s ridley sea turtle	No effect
Caretta caretta	loggerhead sea turtle	No effect
Chelonia mydas	green sea turtle	No effect
Invertebrates		
Cicindela dorsalis dorsalis	northeast beach tiger beetle	No effect
Plants		
Amaranthus pumilus	seabeach amaranth	No effect

While a collision with a turbine by a State or federally listed species could occur since these birds exist in the area, the potential impact should be much lower and not substantial in comparison to more common and abundant species. Listed species were infrequently observed during the surveys but no carcasses were recovered during the fatality study. The lack of observations of Piping Plover, Wilson's Plover, and Upland Sandpiper during the 12-month survey combined with the lack of viable habitat in the proposed wind turbine area for these species indicates the risk should be very low. Only Peregrine Falcon might nest on the marshes near the proposed turbine sites; however, whether the individuals observed nest in the area or are part of a migratory population is unknown. Bald Eagle, Gull-billed Tern, and Red Knot would not likely nest in the vicinity of the turbines because there is little or no suitable habitat. These birds will forage in the general vicinity, but not likely in large numbers.

Henslow's Sparrow

The utility-scale wind turbines and access roads would be constructed within potentially suitable habitat for this species. Avian mortality has been documented as an adverse effect of birds colliding with the rotating blades of wind turbines. To reduce the effects to Henslow's Sparrow resulting from habitat disturbance, NASA has proposed the minimum necessary width for the access roads to the utility-scale wind turbines. The Proposed Action may result in minor adverse impacts on the Henslow's Sparrow.

Upland Sandpiper

The utility-scale wind turbines and access roads would be constructed in wetlands that are not the preferred habitat of the Upland Sandpiper (open grassy areas), presenting a reduced risk of avian mortality associated with wind turbine collision. Noise from the construction activities would be of short duration and would likely present minor, if any, startle reactions for birds that were close to the proposed wind turbine sites. The Proposed Action may result in minor adverse impacts on the Upland Sandpiper.

Piping Plover

The utility-scale wind turbines and access roads would be constructed on the opposite side of Wallops Island from preferred habitat and historical nesting sites of the Piping Plover, presenting a reduced risk of avian mortality associated with wind turbine collision. Residential-scale wind turbines would not be constructed on Wallops Island. No construction is planned for areas within known Piping Plover nesting habitat. Noise from construction activities would be of short duration and would likely present minor, if any, startle reactions.

WFF has developed a protected species monitoring plan, which includes the Piping Plover, in cooperation with USFWS (NASA, 2010c). NASA would continue to coordinate with CNWR and USDA personnel in monitoring the Wallops Island beach for Piping Plover activity. These personnel routinely monitor Assateague, Wallops Island, Assawoman, and Metompkin Island beaches for Piping Plovers during nesting season. Any nests discovered would be appropriately marked using a Global Positioning System (GPS) unit, identified with signage, and closed to personnel or visitor access. Additionally, educational signs would be posted at all beach access points to raise awareness of the species and to provide contact information. Basic species identification would be included in the natural resources training module of the WFF EMS, a requirement for all new employees at the facility. WFF would continue to distribute its annual

Piping Plover nesting announcement; this annual message is sent to all WFF employees, informing them of the potential for encountering the protected species.

Although suitable habitat would not be affected by the project, avian mortality has been documented as an adverse effect of birds colliding with the rotating blades of wind turbines and cannot be discounted. As such, the Proposed Action may affect, and is likely to adversely affect, the Piping Plover.

Wilson's Plover

The utility-scale wind turbines and access roads would be constructed on the opposite side of the island from the preferred habitat of Wilson's Plover, presenting a reduced risk of avian mortality associated with wind turbine collision. No construction is planned for areas within potential nesting habitats or areas of the beach and lagoon environments within which the species typically would stopover, nest, and/or feed. Noise from the construction activities would be of short duration and would likely present minor, if any, startle reactions. The Proposed Action may result in minor adverse impacts on the Wilson's Plover.

Red Knot

All construction activities would be located outside of the beach and lagoon environments within which the species typically would stopover and/or feed. Red Knots would be expected to be present in areas suitable for Piping Plover nesting during similar times of year. As such, NASA would continue to coordinate with CNWR and USDA staff during their monitoring efforts along the Wallops Island beach. Additionally, educational signs would be posted at all beach access points to raise awareness of the species. Basic species identification will be included in the natural resources training module of the WFF EMS, a requirement for all new employees at the facility. WFF would add the Red Knot to its annual Piping Plover nesting announcement; this annual message is sent to all WFF employees informing them of the potential for encountering the protected species.

Although the Red Knot has been observed in Accomack County, the Proposed Action would occur on the opposite side of Wallops Island from the Red Knot's preferred habitat of tidal flats and sandy or pebbly beaches (i.e., on the sound side). This is where Red Knots have been historically been observed to occur on Wallops Island. However, because Red Knots may also utilize marsh habitat and that potential effects cannot be discounted, the Proposed Action may affect, and is likely to adversely affect, the Red Knot.

Peregrine Falcon

The utility-scale wind turbines and access roads would be constructed within potentially suitable habitat for the Peregrine Falcon. Avian mortality has been documented as an adverse effect of birds colliding with the rotating blades of wind turbines. Nesting habitat would not be affected by the project. To reduce the effects to the Peregrine Falcon resulting from habitat disturbance, NASA has proposed the minimum necessary width for the access roads to the utility-scale wind turbines. Because Peregrine Falcons may utilize marsh habitat, the Proposed Action may result in minor adverse impacts on the Peregrine Falcon.

Gull-Billed Tern

The utility-scale wind turbines and access roads would be constructed within potentially suitable habitat for the Gull-billed Tern. Avian mortality has been documented as an adverse effect of birds colliding with the rotating blades of wind turbines. Nesting habitat would not be affected by the project. To reduce the effects to the Gull-billed Tern resulting from habitat disturbance, NASA has proposed the minimum necessary width for the access roads to the utility-scale wind turbines. Because Gull-billed Terns may utilize marsh habitat, the Proposed Action may result in minor adverse impacts on the Gull-billed Tern.

Bald Eagle

The active Bald Eagle nest identified within the northern section of Wallops Island is located atop a large loblolly pine tree approximately 3.97 kilometers (2.5 miles) away from the northern utility-scale wind turbine. The nest is approximately 3.88 kilometers (2.4 miles) away from the nearest point of the access road for the northern utility-scale wind turbine. The utility-scale wind turbines and access roads would be constructed within potentially suitable habitat for this species. However, the proposed access roads would be constructed through habitat that is dominated by common reed and is unlikely to produce substantial amounts of carrion that may attract Bald Eagles. Furthermore, vehicle strikes associated with access roads are unlikely due to the low speed of traffic; the posted speed limit is 25 miles per hour on North Bypass Road, the main paved road adjacent to the utility-scale wind turbine access roads.

The greatest potential impacts from construction and operation of the Proposed Action would be associated with fatal avian collisions with utility-scale wind turbine towers or spinning blades, a documented adverse effect. No activity resulting from this project would occur within 201.17 meters (660 feet) of the known nest site. To reduce the effects to the Bald Eagle resulting from habitat disturbance, NASA has proposed the minimum necessary width for the access roads to the wind turbines.

Any use of the proposed wind turbine sites is most likely by transitory Eagles. There are no known roosts in the area affected by the Proposed Action. Because Bald Eagles may utilize marsh habitat, the Proposed Action may result in minor adverse impacts on the Bald Eagle.

Loggerhead Shrike

The utility-scale wind turbines and access roads would be constructed within potentially suitable habitat for this species; however, Shrikes are not particularly alarmed by proximity to human activity. Avian mortality has been documented as an adverse effect of birds colliding with the rotating blades of wind turbines. To reduce the effects to the Loggerhead Shrike resulting from habitat disturbance, NASA has proposed the minimum necessary width for the access roads to the utility-scale wind turbines. Since Shrikes may utilize marsh and marsh-edge habitat, the Proposed Action may result in minor adverse impacts on the species.

Migrant Loggerhead Shrike

The utility-scale wind turbines and access roads would be constructed within potentially suitable habitat for this species. Avian mortality has been documented as an adverse effect of birds colliding with the rotating blades of wind turbines. To reduce the effects to the Migrant Loggerhead Shrike resulting from habitat disturbance, NASA has proposed the minimum necessary width for the access roads to the utility-scale wind turbines. Although records exist for the Migrant Loggerhead Shrike in Accomack County, Virginia, field identification to subspecies is rarely reported. Therefore, records for Migrant Loggerhead Shrike in Accomack County are likely to be Loggerhead Shrike, and Migrant Loggerhead Shrike is not likely to occur within the action area. The Proposed Action may result in minor adverse impacts on the species since Shrikes may utilize marsh and marsh-edge habitat.

Delmarva Fox Squirrel

No effects are anticipated to the Delmarva fox squirrel because the site of the Proposed Action lacks essential habitat elements for the species. Their preferred habitat is old growth loblolly pine forests; deep, deciduous swamps; or backwoods adjacent to pine woods. The Proposed Action is anticipated to have no effect on the Delmarva fox squirrel.

Rafinesque's Eastern Big-Eared Bat

The utility-scale wind turbines and access roads would be constructed within potentially suitable habitat for this species. In addition, bat mortality has been documented as an adverse effect of bats colliding with the rotating blades of wind turbines. However, Rafinesque's eastern big-eared bat is not known to occur in Accomack County; the northern limit of its range is southeast Virginia. Therefore, nesting habitat would not be affected by the Proposed Action. To reduce the potential effects to Rafinesque's eastern big-eared bat resulting from habitat disturbance, NASA has proposed the minimum necessary width for the access roads to the utility-scale wind turbines. The Proposed Action may result in minor adverse impacts on affect the species.

Sea Turtles

The sites of the Proposed Action lacks essential habitat elements for the loggerhead sea turtle, green sea turtle, leatherback sea turtle, hawksbill sea turtle, and Kemp's ridley sea turtle. The Proposed Action is anticipated to have no effects on federally listed sea turtles.

Northeastern Beach Tiger Beetle

The site of the Proposed Action lack essential habitat elements for the Northeast beach tiger beetle. There are no beaches within the project study limits or in close proximity to the proposed construction activity. No effect to this species is anticipated due to the lack of habitat in the area of the Proposed Action.

Seabeach Amaranth

The sites of the Proposed Action lack essential habitat elements for the seabeach amaranth. There are no beaches within the project study limits or in close proximity to the proposed construction activity. No effect to the seabeach amaranth is anticipated due to the lack of habitat in the area of the Proposed Action.

Agency Consultation

NASA prepared a Biological Assessment (BA) (Appendix D) with determinations of effects to the species listed in Table 25. The BA was submitted to USFWS and NMFS along with submittal of this Draft EA. No response has been received to date.

In addition, NASA has prepared monitoring plan to assess the presence of protected species within its property boundaries. This plan will help NASA and USFWS better determine a baseline and effects to species and will serve as a basis for adaptive management of protected species.

4.3.6 Essential Fish Habitat

No Action Alternative

Under the No Action Alternative, implementation of the Alternative Energy Project would not occur; therefore, no impacts on EFH would occur.

Proposed Action

Because EFH is located within the wetlands that would be affected by the by construction of two proposed utility-scale wind turbines, NASA completed an EFH Checklist (Appendix E) to determine what, if any impacts may occur on EFH. Based on the EFH Checklist, NASA has determined that the Proposed Action would result in adverse effects on EFH, but they would not be substantial. Effects on EFH would be offset by 0.362 hectare (0.895 acre) of compensatory mitigation at WFF's Mainland.

Alternative One

Because EFH is located within the wetlands that would be affected by construction of one utility-scale wind turbine, NASA completed an EFH Checklist (Appendix E) to determine what, if any impacts may occur on EFH. Based on the EFH Checklist, NASA has determined that Alternative One would result in adverse effects on EFH, but they would not be substantial. Effects on EFH would be offset by compensatory mitigation at WFF's Mainland.

Because the potential solar panel installation areas are all located on upland at the Main Base, no EFH is located near the proposed solar panel sites. Therefore, NASA has determined that the installation and operation of solar panels at the Main Base would have no effect on EFH.

Alternative Two

Because the areas identified as potentially suitable for residential-scale wind turbines and solar panels are all located on upland (exclusively at the Main Base for solar panels), no EFH is located near the proposed sites. Therefore, NASA has determined that the construction of up to 5 residential-scale wind turbines and the installation and operation of solar panels at the Main Base would have no effect on EFH.

4.4 SOCIAL AND ECONOMIC ENVIRONMENT

4.4.1 Population, Employment, and Income

No Action Alternative

Under the No Action Alternative, implementation of the Alternative Energy Project would not occur, and there would be no impacts on population, employment, and income.

Proposed Action

Construction activities would result in a temporary increase in the number of workers at WFF; however, because local contractors would primarily be used, no long-term increase in population is anticipated due to construction activities. Some non-local construction workers are anticipated to require lodging in local motels and hotels. Assuming up to 16 workers would be on-site at any given time for installation of the utility-scale wind turbines, and estimating that half of those workers (8) would be non-local and therefore require lodging and meals, approximately $28,200 would enter the local economy based on per diem rates alone over the 6-month construction period (peak season per diem rates were used for the 2-month period of July and August, off-season rates used for remaining 4 months). Local construction workers, with the exception of one or two manufacturer's representatives, and WFF staff would be used for installation of the residential-scale wind turbines.

Construction activities would benefit the local economy due to employment opportunities for local construction workers and increased numbers of people in Accomack County during business hours, resulting in a potential increase in the use of local stores and businesses for purchases.

Because the turbine manufacturer would provide operations and maintenance support, existing WFF maintenance staff would operate and monitor the two utility-scale wind turbines with the assistance of the manufacturer as necessary. No new permanent WFF jobs would be created for operation and maintenance; therefore, no impacts on population, employment, or income are anticipated under the Proposed Action.

Alternative One

Impacts for construction and operation of one wind turbine would be similar to those described under the Proposed Action, but fewer construction workers would be needed and the construction period would be shorter. Assuming up to 16 workers would be on-site at any given time for installation of the utility-scale wind turbine, and estimating that half of those workers (8) would be non-local and therefore require lodging and meals, approximately $19,600 would enter the local economy based on per diem rates alone over the 4-month construction period (peak season per diem rates were used for the 2-month period of July and August, off-season rates used for remaining 2 months). Local construction workers, with the exception of one or two manufacturer's representatives, and WFF staff would be used for installation of the residential-scale wind turbines.

Installation of solar panels would result in a temporary increase in the number of workers at WFF; however, because local contractors would primarily be used, no long-term increase in population is anticipated due to installation activities. Some non-local construction workers are anticipated to require lodging in local motels and hotels. Assuming up to 10 workers would be on-site at any given time for installation of the solar panels, and estimating that half of those workers (5) would be non-local and therefore require lodging and meals, approximately $11,000 would enter the local economy based on per diem rates alone over the 2-month construction period (peak season per diem rates were used).

Construction activities would benefit the local economy due to employment opportunities for local construction workers and increased numbers of people in Accomack County during business hours, resulting in a potential increase in the use of local stores and businesses for purchases. The operation and maintenance of the solar panels would be conducted by existing WFF maintenance staff. Therefore, no new permanent WFF jobs would be created and no impacts on population, employment, or income are anticipated under Alternative One.

Alternative Two

Impacts for installation of solar panels would be similar to those described under Alternative One; however, more construction workers would be needed and the construction period would be longer. Assuming up to 10 workers would be on-site at any given time for installation of the solar panels, and estimating that half of those workers (5) would be non-local and therefore require lodging and meals, approximately $19,600 would enter the local economy based on per diem rates alone over the 2-month construction period (peak season per diem rates were used for the 2-month period of July and August). Local construction workers, with the exception of one or two manufacturer's representatives, and WFF staff would be used for installation of the residential-scale wind turbines.

Construction activities would benefit the local economy due to employment opportunities for local construction workers and increased numbers of people in Accomack County during business hours, resulting in a potential increase in the use of local stores and businesses for purchases. The operation and maintenance of the solar panels would be conducted by existing WFF maintenance staff. Therefore, no new permanent WFF jobs would be created and no impacts on population, employment, or income are anticipated under Alternative Two.

4.4.2 Environmental Justice

No Action Alternative

Under the No Action Alternative, implementation of the Alternative Energy Project would not occur; therefore, there would be no disproportionately high or adverse impacts on low-income or minority populations.

Proposed Action

NASA complies with EO 12898 by incorporating Environmental Justice into their mission. As a result, NASA has prepared an EJIP that examines whether its programs and actions may disproportionately and adversely affect minority and low-income populations around WFF.

Minority and low-income communities are located within Accomack County adjacent to WFF property. Because no displacement of residences or businesses would occur as a result of the Proposed Action, and the wind turbines would be similar to the types of infrastructure (i.e., towers and antennas) already established at WFF, visual impacts would be minimal and no disproportionately high or adverse impacts on low-income or minority populations would occur. Visual impacts on the communities surrounding WFF are discussed more in Section 4.4.5, Aesthetics. In addition, the Proposed Action would involve activities similar to those currently conducted at WFF, and the EJIP found that current WFF activities do not disproportionately affect low-income or minority populations (NASA, 1996). Therefore, no impacts are predicted for environmental justice.

Alternatives One and Two

The environmental justice impacts for Alternatives One and Two would be the same as described under the Proposed Action.

4.4.3 Cultural Resources

Section 106 of the NHPA requires Federal agencies take into consideration the effects of their undertakings on historic properties and to allow the ACHP the opportunity to comment on such undertakings. As defined in the Act, "historic properties" are one of five resource types—buildings, structures, objects, sites, or districts—that are listed in or eligible for listing in the NRHP. Although buildings and archaeological sites are most readily recognizable as historic properties, a diverse range of resources are listed in the NRHP including roads, landscapes, and vehicles. As noted above, resources less than 50 years of age are not generally eligible for listing in the NRHP, but may be if they are of exceptional importance. Accordingly, to comply with Section 106 of the NHPA, NASA must consider the effects of the proposed undertaking on all properties that are listed in or eligible for listing in the NRHP—both those owned by NASA within the boundaries of WFF, as well as those located outside of WFF that may be affected by an undertaking.

The geographical area within which an undertaking may affect historic properties is the APE. As stipulated in Section 106, Federal agencies must identify historic properties within the APE and consider the effects of the undertaking on these properties. The *Historic Resources Survey and Eligibility Report for Wallops Flight Facility* (NASA, 2004) referenced earlier in this report serves as the baseline for the identification of the aboveground historic properties at WFF, while the archaeological sensitivity model presented in the *Cultural Resources Assessment, NASA Wallops Flight Facility* (NASA, 2003a) serves as the baseline for identifying potential archaeological resources. Together these studies, discussed in the Cultural Resources Management Plan (CRMP) for WFF, likely account for many of the historic properties present at WFF, and as such, allow an assessment of the potential for an undertaking to affect historic properties.

In December 2009, NASA WFF initiated Section 106 consultation with VDHR for the Alternative Energy Project. To facilitate this, NASA WFF submitted to VDHR the *National Historic Preservation Act Section 106 Assessment of Alternative Energy Project*, a Section 106 effects analysis of the utility-scale wind turbine component of the Alternative Energy Project, prepared by URS, on the grounds that this is the component of the project most likely to have adverse effects on historic properties (NASA, 2009b). Since initiation of the Section 106 process, NASA has revised its alternatives to include a residential-scale wind turbine component. The Section 106 process remains ongoing pending further development of the solar panel and residential-scale wind turbine components.

No Action Alternative

Under the No Action Alternative, implementation of the Alternative Energy Project would not occur; therefore, there would be no impacts on cultural resources.

Proposed Action

Aboveground Resources

Utility-scale turbines: Because specific guidelines for Section 106 review of wind turbine projects have not yet been developed in Virginia, the VDHR Section 106 guidance on cell towers was used to determine the APE. This guidance recommends an APE for cell towers of 61 meters (200 feet) or more in height that extends 3.2 kilometers (2 miles) from the cell tower to account primarily for indirect visual effects. Because wind turbines are similar to cell towers in terms of their potential for visual impact, this 3.2-kilometer (2-mile) APE was used to determine effects on historic properties for the two utility-scale turbines.

No identified historic properties within the APE would be directly affected by construction of the two utility-scale turbines under the Proposed Action. The utility-scale turbines would have indirect visual effects on the two NRHP-eligible resources identified within the APE—the Wallops Coast Guard Lifesaving Station and its associated Coast Guard Observation Tower.

A digital rendering of the projected viewshed from the historic properties toward the utility-scale turbines indicates that, although the wind turbines would be approximately 2.7 kilometers (1.7 miles) away, they would still be partially visible from the Wallops Coast Guard Lifesaving Station. However, the visual impact would be minimal. Since the 1940s, the setting and feeling of the Wallops Coast Guard Lifesaving Station and Observation Tower have been compromised by the construction of numerous utilitarian buildings and structures associated with the Navy, the National Advisory Committee for Aeronautics, and NASA development. Among these is the ASR 8 Radar, a 24-meter (79-foot) structure located immediately adjacent to the Wallops Coast Guard Lifesaving Station. Given this context, the construction of the utility-scale turbines 2.7 kilometers (1.7 miles) from the Wallops Coast Guard Lifesaving Station and Observation Tower would not have an adverse effect on these historic properties.

Eighty unevaluated resources exist within the APE, 13 of which are over 50 years of age. Some of these 13 may be found to be eligible for listing in the NRHP once they are evaluated; if so, construction of the proposed wind turbines would have an indirect visual effect on them. However, these unevaluated resources are also associated with the Navy, the National Advisory Committee for Aeronautics, or the NASA development of the area after 1942 and are utilitarian in nature. The portions of the APE in which the built resources are located are currently characterized by numerous towers, test stands, and antennae from various periods of construction. Given this context, the construction of the utility-scale turbines is not likely to have an adverse effect on the setting or feeling of any yet-to-be identified NRHP-eligible resources, if present, in the APE.

The utility-scale turbine component of Alternative One is anticipated to have no adverse effect on historic properties outside of WFF, should they be present, given the nature of the existing viewshed to WFF. The majority of the facilities at WFF exhibit rooftop radar antennas, beacons, heating, ventilation and air conditioning (HVAC) systems, cooling towers, and other industrial equipment, and the presence at WFF of numerous towers, including elevated water storage tanks, boresight, meteorological, and radio equipment platforms.

Residential-scale turbines: Because the exact locations of the residential-scale wind turbines have not yet been determined, a precise APE for this component has also not been determined. Per the Federal Communications Commission's *Nationwide Programmatic Agreement for*

Review of Effects on Historic Properties for Certain Undertakings Approved by the Federal Communications Commission (2004), a cell tower 200 feet tall or less would require an 0.8-kilometer (0.5-mile) APE to account for indirect visual effects on historic properties (Section C.4.a). Therefore, this could be applied to the residential-scale wind turbines.

Because the locations of the residential-scale wind turbines have not been determined, it is not possible to determine whether historic properties are in the APE or whether these properties would be directly or indirectly affected by the project component. Not all the properties within WFF have been evaluated for their eligibility for listing in the NRHP, specifically those that have achieved 50 years of age since 1955, and therefore were not included in the 2004 survey. However, there would be no demolition or alteration of buildings or structures for construction of the residential-scale wind turbines; therefore, the residential-scale wind turbines are not expected to have direct adverse effect to historic properties.

Given the nature of the WFF facility, it is not likely that the residential-scale wind turbines would have an indirect adverse effect on unidentified historic properties located within the boundaries of WFF, should they be present. As discussed above, the resources within WFF—with the exception of the Wallops Lifesaving Station and Observation Tower, which is more than a half a mile from all proposed locations—are all associated with the U.S. Navy, National Advisory Committee for Aeronautics, or NASA development of the area after 1942 and are utilitarian in nature. WFF is characterized by numerous towers, test stands, and antennae from various periods of construction. Given this context, the construction of the residential-scale turbines is not likely to have an adverse effect on the setting or feeling of any yet-to-be identified NRHP-eligible resources, if present, within the boundaries of the WFF.

Indirect visual effects on historic properties outside of the WFF property cannot be determined at this time. Once the locations of the residential-scale wind turbines are determined, NASA would consult with VDHR.

Archaeological Resources

The 2003 CRA included a sensitivity model developed to characterize the potential for archaeological resources at WFF (NASA, 2003a). According to the mapping produced for the assessment, the proposed locations for the two utility-scale turbines on Wallops Island are in an area mapped as low archaeological sensitivity. The proposed installation of five residential-scale turbines will also occur in areas determined to have a low potential for archaeological resources. Eight archaeological sites exist within WWF; however, none of these sites are located in the areas proposed for ground disturbance for construction of the wind turbines. Previously disturbed areas, including the cleared area east of the U.S. Navy V-10/V-20 complex, would be used for staging equipment and material and for construction vehicle parking. Therefore, the proposed construction of the wind turbines is not expected to have an adverse effect on archaeological resources. If unanticipated archaeological resources are identified during construction, the procedures outlined in the *Integrated Cultural Resource Management Plan* (NASA, 2006) would be followed to ensure compliance with Section 106 of the NHPA.

Alternative One

Aboveground Resources

Utility-scale turbines: Based on the analysis of impacts from the construction of two utility-scale turbines (described under the Proposed Action), NASA determined that the construction of one utility-scale turbine on Wallops Island is not likely to have an adverse effect on aboveground historic properties within the 3.2-kilometer (2-mile) APE.

Residential-scale turbines: Based on the analysis of impacts from the construction of the five residential-scale turbines (described the Proposed Action), it is not possible to determine whether historic properties are in the APE, or whether these properties may be directly or indirectly affected by the project component. However, there would be no demolition or alteration of buildings or structures for construction of the residential-scale wind turbines; therefore, the residential-scale wind turbines are not expected to have direct adverse effect to historic properties. Given the nature of the WFF facility, it is not likely that the residential-scale wind turbines would have an indirect adverse effect on as-yet unidentified historic properties within the boundaries of WFF, if present. Indirect visual effects on historic properties outside of the WFF property cannot be determined at this time. Once the locations of the residential-scale wind turbines are determined, NASA would consult with VDHR.

Solar panels: Although the precise locations of the solar panels are not yet known, NASA has indicated that they would refer to the determinations of eligibility in the *Historic Resources Survey and Eligibility Report for Wallops Flight Facility, Accomack County, Virginia* (NASA, 2004) and other formal determinations of eligibility to ensure that solar panels are located only on or adjacent to resources found to be ineligible for listing in the NRHP. Therefore, it is not likely that the installation of solar panels would have an adverse effect on aboveground historic properties, either identified or yet-to-be identified, within the boundaries of the WFF property. However, indirect visual effects to historic properties outside of the WFF Main Base cannot be determined at this time. Once the locations of the solar panels are determined, NASA would consult with VDHR.

Archaeological Resources

According to the CRA assessment in 2003, the proposed location for the utility-scale turbine on Wallops Island is in an area mapped as low archaeological sensitivity. Although the locations of the residential-scale turbines and solar panels are only generally known, NASA used the archaeological sensitivity model of the 2003 CRA (NASA, 2003a) to identify potential installation areas also having low archaeological probability (Figure 4 and Figure 5), thus avoiding installation of wind turbines and solar panels in areas of moderate and high archaeological sensitivity. If unanticipated archaeological resources are identified during construction, the procedures outlined in the *Integrated Cultural Resource Management Plan* (NASA, 2006) would be followed to ensure compliance with Section 106 of the NHPA.

Alternative Two

Aboveground Resources

Residential-scale turbines: Based on the analysis of impacts from the construction of the five residential-scale turbines (described under the Proposed Action), it is not possible to determine whether historic properties are in the APE, or whether these properties may be directly or indirectly affected by the project component. However, there would be no demolition or alteration of buildings or structures for construction of the residential-scale wind turbines; therefore, the residential-scale wind turbines are not expected to have a direct adverse effect on historic properties. Given the nature of the WFF facility, it is not likely that the residential-scale wind turbines would have an indirect adverse effect on as-yet unidentified historic properties within the boundaries of WFF, if present. Indirect visual effects on historic properties outside of the WFF property cannot be determined at this time. Once the locations of the residential-scale wind turbines are determined, NASA would consult with VDHR.

Solar panels: Based on the analysis of impacts from the installation of solar panels (described under Alternative One), NASA determined that the installation of solar panels at the Main Base is not likely to have an adverse effect on aboveground historic properties, either identified or yet-to-be identified, within the boundaries of the WFF property. However, indirect visual effects on historic properties outside of WFF Main Base cannot be determined at this time. Once the locations of the solar panels are determined, NASA would consult with VDHR..

Archaeological Resources

Although the locations of the residential-scale turbines and solar panels are only generally known, NASA used the archaeological sensitivity model of the 2003 CRA (NASA, 2003a) to identify potential installation areas having low archaeological probability (Figure 4 and Figure 5), thus avoiding installation of wind turbines and solar panels in areas of moderate and high archaeological sensitivity. If unanticipated archaeological resources are identified during construction, the procedures outlined in the *Integrated Cultural Resource Management Plan* (NASA, 2006) would be followed to ensure compliance with Section 106 of the NHPA.

Section 106 Consultation

NASA determined that the proposed construction of two utility-scale turbines on Wallops Island or the installation of solar panels at the Main Base is not likely to have an adverse effect on aboveground historic properties within the 3.2-kilometer (2-mile) APE for the proposed utility-scale turbines or to archaeological resources within the area of ground disturbance associated with the Proposed Action. In December 2009, NASA submitted the *Section 106 Assessment of Alternative Energy Project, Wallops Flight Facility, Wallops Island, Virginia* (NASA, 2009b) report along with a letter requesting project review and concurrence to VDHR. In a letter dated January 25, 2010, VDHR stated that they were unable to make an informed decision concerning the effects of the proposed undertaking (Appendix G). VDHR stated that they did not have enough information to adequately evaluate the effects of the undertaking, specifically the lack of exact location and configuration of the solar panel component. VDHR requested NASA to seek comments of the National Park Service (NPS), specifically the Assateague Island National Seashore. As such, NASA is currently consulting with NPS and is providing additional information to VDHR regarding the proposed project.

4.4.4 Transportation

No Action Alternative

Under the No Action Alternative, implementation of the Alternative Energy Project would not occur; therefore, no impacts on transportation would occur.

Proposed Action

Temporary impacts on traffic flow would occur during construction activities due to an increase in the volume of construction-related traffic at roads in the immediate vicinity of Wallops Island and the transportation of wind turbine parts and equipment. Traffic lanes may be temporarily closed or rerouted during construction, and construction equipment and staging could interfere with typical vehicle flow. NASA would coordinate all transportation activities, including closures, traffic control, safety issues, etc. with Accomack County and the Virginia Department of Transportation Accomack Residency Office. To mitigate potential delays, NASA would:

- Provide adequate advance notification of upcoming activities for all areas that would be affected by construction-related traffic, temporary closures, or re-routing
- Coordinate any traffic lane or pedestrian corridor closures with all appropriate officials
- Place construction equipment and vehicle staging so as to not hinder traffic and pedestrian flow
- Minimize the use of construction vehicles in residential areas

The utility-scale wind turbine's tower and blades would be delivered to WFF via truck over public roads and would be characterized as an oversize load by the Department of Transportation (DOT). The transport of an oversize load would require a permit from the Virginia Department of Motor Vehicles. Oversize items that are trucked to Wallops Island (i.e., via Route 679 and 803) may require temporary closure of roadways. The closure would likely last a maximum of 2 hours and would occur in the middle of the night if possible for minimal impact on traffic. NASA would coordinate the closure with Accomack County, the Virginia State Police, and the Virginia DOT Accomack Residency Office.

Alternative One

The transportation impacts for Alternative One are the same as those described under the Proposed Action. The same mitigation measures for construction-related traffic and transportation of the wind turbine parts and equipment would apply and would also be implemented for transportation of the solar panel parts and equipment, except the solar panels and equipment would not be transported as an oversize load.

Alternative Two

The same mitigation measures described under the Proposed Action would be implemented at the Main Base for construction-related traffic and transportation of the solar panel parts and equipment, except the solar panels and equipment would not be transported as an oversize load.

4.4.5 Aesthetics

No Action Alternative

Under the No Action Alternative, activities would remain at present levels and there would be no impacts on aesthetics.

Proposed Action

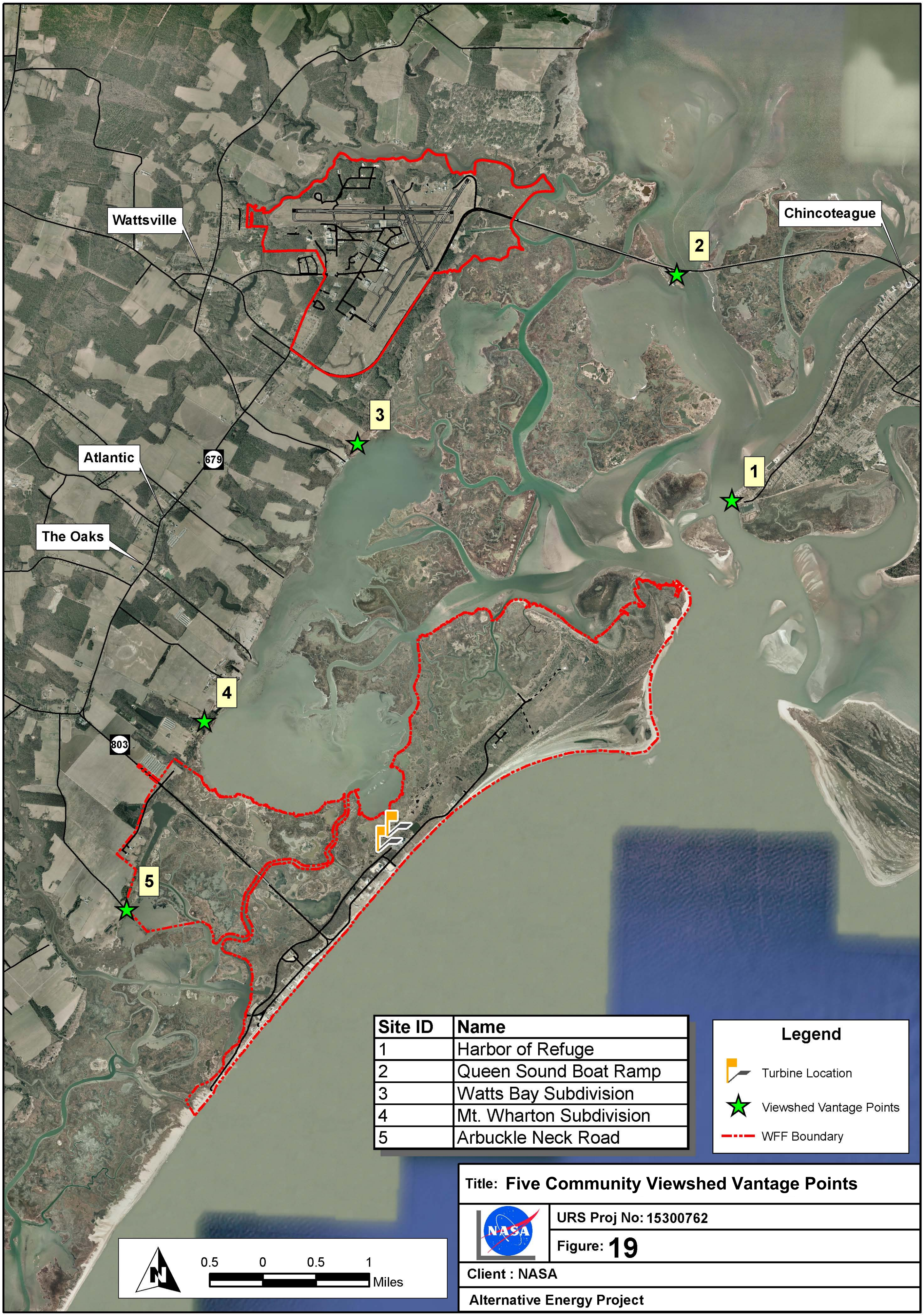
In 2008, NASA conducted an aesthetics study to determine what impacts, if any, the construction of two wind turbines on Wallops Island would have on the local viewshed. Figure 19 shows the locations of five vantage points that were used in the study. The vantage points were chosen because they represented viewsheds of the turbines from rural residences west of Wallops Island, from the town of Chincoteague to the north, and from Assateague Island National Seashore which is located northeast of Wallops Island.

Because CNWR and Assateague Island National Seashore are visited by thousands of people each year to enjoy their undeveloped nature and seaside views, these two areas would be considered key vantage points from a public perspective when looking back towards the viewshed that includes WFF. The character of WFF and surrounding region is generally considered highly aesthetic by those that come to participate in recreational, cultural, and other leisure activities. The five viewshed vantage points are summarized in Table 26 below.

Table 26: Aesthetics Analysis Vantage Points

Vantage Point No.	Description of Vantage Point	Vantage Point Location	Distance and Direction from Proposed Wind Turbine Site
1	Harbor of Refuge	Southern tip of Chincoteague Island	7.7 kilometers (4.8 miles) northeast
2	Queen Sound Boat Ramp	Between Mainland and Chincoteague Island	10 kilometers (6.2 miles) northeast
3	Watts Bay Residential Subdivision	Mainland	6.3 kilometers (3.9 miles) north
4	Mount Wharton Residential Subdivision	Mainland	3.1 kilometers (1.9 miles) northwest
5	Arbuckle Neck Road	Mainland	3.7 kilometers (2.3 miles) southwest

Digital photographs taken from each vantage point were modified to include a simulation of the two wind turbines in their proposed location on Wallops Island (Appendix F). Photograph 6 below shows an example of the viewshed from Arbuckle Neck Road including the simulation of the wind turbines, which is the same view as shown without wind turbines in Photograph 1, for comparison.



Site ID	Name
1	Harbor of Refuge
2	Queen Sound Boat Ramp
3	Watts Bay Subdivision
4	Mt. Wharton Subdivision
5	Arbuckle Neck Road

Legend

- Turbine Location
- Viewshed Vantage Points
- WFF Boundary

Title: Five Community Viewshed Vantage Points

URS Proj No: 15300762

Figure: 19

Client : NASA

Alternative Energy Project

This page intentionally left blank.

Photograph 6: Viewshed from a vantage point located approximately 3.7 kilometers (2.3 miles) southwest of the bridge that links Wallops Mainland to Wallops Island looking northeast toward the bridge.

The simulated wind turbines in photographs 1, 2, and 3 of Appendix F are barely visible; therefore, the wind turbines would not result in a substantial change to the viewshed from recreational areas along Chincoteague Island, Assateague Island, and Watts Bay Subdivision, respectively. As shown by the simulation of photographs 4 and 5 in Appendix F, the wind turbines would be visible from the closest residential community, Mount Wharton subdivision, and from Arbuckle Neck Road (see Photograph 6 above).

As shown in all the simulated photographs, the landscape surrounding the proposed turbine site already contains radio towers, the U.S. Navy V-10/V-20 Complex, and the bridge that links Wallops Mainland with Wallops Island. The turbines would be painted white so that they would blend well with the sky to reduce visual impacts. Because of the height of the turbines (approximately 120 meters [395 feet] at the top of the blade), it is not possible to site them in a location or manner completely invisible to the public and WFF workers and visitors.

Aesthetics is highly subjective and dependent on people's perceptions of whether the wind turbines are a negative or positive impact on the landscape. NASA would provide educational information via newsletters and public announcements (including the availability of this Draft EA) to the surrounding communities regarding the benefits of the wind turbines. In addition, the wind turbines could potentially become a popular public attraction, which is what happened at the ACUA wind farm. Although the ACUA wind farm is at an industrial facility and therefore not open to the public, ACUA established a public viewing area and a frequently visited Web site that shows the wind turbines via webcam 24 hours a day. NASA would likely establish a public viewing area at the WFF Visitor Center, and would give pre-arranged educational tours for outreach and education about wind energy.

Operation of the wind turbines would create shadow flickering caused by the intermittent shadow cast by the moving blades. However, due to overcast days where no shadow flickering would occur and the sun angle changing the location of the shadow flicker throughout the day, the timing, position, and size of the shadow flickering will change constantly. For the utility-scale wind turbines, shadow flickering would occur within the immediate area surrounding the turbines to a distance of about 300 meters (1,000 feet) away from each wind turbine. For the residential-scale wind turbines, shadow flickering would occur within about 110 meters (350 feet) of the wind turbines. The amount of shadow flicker depends on the angle in which the sun hits the turbine blades. Shadow flickering would be seen by people at nearby facilities including the U.S. Navy V-10/V-20 Complex for the utility-scale turbines, and the WFF Visitor Center and guard station for the residential-scale wind turbines. Because some people could be bothered by the flickering effect, the wind turbines may result in long-term adverse impacts within the shadow of the wind turbines; however, these effects would be most likely to bother people that occupy these facilities long-term such as permanent employees.

Another operational impact would be the potential distraction from the lights located on the utility scale wind turbines—FAA regulations stipulate that all wind turbines over 61 meters (200 feet) include lights to warn pilots of their presence. Red or white intermittent lights, such as the ones found on communication towers, would be used. Due to the distance of the surrounding communities, the lights on the wind turbines would be nearly impossible to see from residences and businesses, and therefore would not result in visual impacts on the public.

Alternative One

The aesthetic impacts from the wind turbines for Alternative One would be the same as those described under the Proposed Action; however, with one utility-scale turbine instead of two, there would be fewer impacts. NASA would likely establish a public viewing area at the WFF Visitor Center for the single utility-scale turbine on Wallops Island, and would give pre-arranged educational tours for outreach and education about wind energy.

Implementation of solar panels would result in long-term changes to the viewshed at the Main Base. Visual impacts would affect WFF employees and visitors at the Main Base but the solar panels would not be visible to the public in the area. The solar panels would not substantially alter the characteristics of the viewshed at the Main Base because they would be installed in areas that are already highly developed (roads, buildings, towers, etc.). Although aesthetics is highly subjective, because the Main Base is a highly industrialized setting with numerous antenna arrays and other infrastructure, solar panels should not present a negative impact on the viewshed.

Alternative Two

The aesthetic impacts from the residential-scale wind turbines under Alternative Two would be similar to those described under the Proposed Action, but on a smaller scale. A residential-scale turbine would be visible to the public at the WFF Visitor Center, and NASA would give pre-arranged educational tours for outreach and education about wind energy.

Implementation of solar panels would result in long-term changes to the viewshed at the Main Base. Visual impacts would affect WFF employees and visitors at the Main Base, but the solar panels would not be visible to the public in the area. The solar panels would not substantially alter the characteristics of the viewshed at the Main Base because they would be installed in areas that are already highly developed (roads, buildings, towers, etc.). Although aesthetics is highly subjective, because the Main Base is a highly industrialized setting with numerous antenna arrays and other infrastructure, solar panels should not present a negative impact on the viewshed.

4.5 CUMULATIVE EFFECTS

The CEQ defines cumulative effects as the "impact on the environment which results from the incremental impact of the action(s) when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR 1500). NASA has determined that the Proposed Action alternatives, in conjunction with the impacts of other WFF projects and operations, could result in cumulative impacts on some resources.

4.5.1 Wallops Research Park

The Wallops Research Park (WRP) project intends to create an integrated business park for aerospace research and development programs, scientific research, commercial space industries, and educational centers. Development of the WRP will take place adjacent to the Main Base at WFF over a 20-year period; some development has occurred, but the majority of the Proposed Action has not been constructed. WRP would consist of a multi-use development created for non-retail commercial, government space, science research, educational facilities, and public recreation areas.

4.5.2 North Unmanned Aerial System Airstrip

NASA is currently considering the construction of an unmanned aerial system (UAS) airstrip on north Wallops Island. The purpose of the North UAS Airstrip is to provide a venue and infrastructure to support launch and recovery operations for UASs. UASs are small aircraft that serve as platforms for small science instruments. They are controlled remotely by a pilot on the ground and are powered by batteries or small model aircraft gasoline engines. The east-west orientation of this airstrip would provide an alternative to the north-south positioning of the current UAS airstrip on south Wallops Island. An EA is currently being prepared. The implementation date of the UAS airstrip would occur no earlier than mid-2011.

4.5.3 Shoreline Restoration and Infrastructure Protection Program

A Shoreline Restoration and Infrastructure Protection Program (SRIPP) is currently being planned at WFF to help reduce the risk of damage to existing NASA, U.S. Navy, and MARS assets on Wallops Island that are at risk due to extensive shoreline retreat. The SRIPP would involve:

1) Extending Wallops Island's existing rock seawall a maximum of 1,400 meters (4,600 feet) south of its southernmost point;

2) Placing sand dredged from a shoal located offshore in Federal waters on the Wallops Island shoreline; and

3) Renourishing the Wallops Island's beach with sediment taken from one of three sources: the beach on the north end of Wallops Island, or from one of two sand shoals located offshore in Federal waters. The renourishment cycle is anticipated to occur every 5 years, with a total of 9 renourishment cycles over the 50-year life of the SRIPP.

Implementation of this program is planned for 2011. A Programmatic EIS is currently being prepared for the SRIPP. Additionally, there have been other beach restoration projects along the Maryland and Virginia coastline due to beach and shoreline erosion.

4.5.4 Expansion of the Wallops Flight Facility Launch Range

NASA and MARS facilities will be upgraded to support up to and including medium large class suborbital and orbital expendable launch vehicle (ELV) launch activities from WFF. Components of the project include site improvements required to support launch operations (such as facility construction and infrastructure improvements); testing, fueling, and processing operations; up to two static fire tests per year; and launching of up to six ELVs and associated spacecraft per year from Pad 0-A. Implementation of the project would result in a maximum of 18 orbital-class launches from MARS Launch Complex 0 per year (12 existing launches from Pad 0-B, and 6 additional launches from Pad 0-A). The first orbital launch from Pad 0-A is currently planned for 2011.

4.5.5 WFF Launch Range Activities

NASA can currently launch up to approximately 102 rockets a year from the launch areas on Wallops Island. These include a maximum of 60 from the Sounding Rocket Program, 12 from orbital rocket missions at Pad 0-B, and 30 from Navy missiles and drones (NASA, 2005). Debris from various WFF launch operations (i.e., spent rockets, payloads, drones, and rocket-boosted projectiles) lands in the Atlantic Ocean. This debris may consist of a variety of components including metals, batteries, electrical components, and propellants.

4.5.6 Potential Cumulative Effects by Resource

Resources that may experience cumulative impacts are discussed below.

4.5.6.1 Surface Waters

The Proposed Action would have a minor and temporary impact on the water resources of the affected region; the incremental contribution to cumulative water resource impacts from the Proposed Action would not be significant.

4.5.6.2 Wetlands

The Proposed Action would have a minor and temporary as well as permanent impact on wetlands of the affected region. Table 27 shows the area of wetland impacts for recent projects at WFF. The type of impact for all current projects would be permanent fill.

Table 27: Area of Wetlands Affected for Current Proposed Projects on Wallops Island

Project[1]	Area of Wetlands Affected hectares (acres)
Wallops Research Park	0.4 (1)
UAS Airstrip	1.4 (3.5)
Alternative Energy Project	0.4 (0.9)
SRIPP	0
Expansion of WFF Launch Range – Alternative One[2]	1.7 (4.1)
Total	**3.9 (9.6)**

[1]Existing WFF launch activities do not directly affect wetlands.
[2]Because Alternative One would result in a larger area of wetlands impacts than Alternative Two, it was used for the cumulative effects analysis.

In addition, past projects have resulted in wetlands impacts. Table 28 provides detailed information on Wallops Island wetland impacts including the area impacted, compensation that was completed as mitigation, and the net change in wetland area. NASA would obtain necessary permits including Section 404 and Section 10 permits for all proposed projects that would affect wetlands. NASA is currently preparing a wetlands inventory and assessment for WFF. The goal of this effort is to provide strategic regulatory, environmental, and land use analysis of all wetlands on the Main Base, Wallops Mainland, and Wallops Island in order to develop a comprehensive long-term wetland management plan for the facility.

Table 28: Area of Wetlands Affected from Past Projects on Wallops Island

Date	Project	Area Impacted hectares (acres)	Impact Type	Compensation hectares (acres)	Net Change hectares (acres)
Oct. 1997	Pad 0-A	0.13 (0.32)[1]	Permanent Fill	0.71 (1.76)	0.55 (1.44)
Feb. 2002	Navy MFR	0.0085 (0.021)	Temporary Fill	0.0085 (0.02)[1]	0 (0)
Nov. 2004	Navy DDG	0.85 (2.1)	Permanent Fill	0.76 (4.35)	0.91 (2.25)
Apr. 2008	Boat Dock	0.014 (0.033)	Permanent Fill, Shading	0.026 (0.064)	0.0125 (0.031)
	Total	**1 (2.47)**		**2.5 (6.2)**	**1.5 (3.7)**

[1]Because Alternative One would result in a larger are of wetlands impacts than Alternative Two, it was used for the cumulative effects analysis.

NASA would implement compensatory wetland mitigation measures (agreed upon through the JPA consultation process) to offset any impacts.

4.5.6.3 Air Quality

Construction-related and operational activities that would occur under the Proposed Action for the Alternative Energy Project and the other projects that are reasonable and foreseeable at WFF would occur at different locations and at different times over a period of several years. Tables 20 and 21 show the estimated emissions from the preferred alternatives of current and planned WFF projects (listed above in Section 4.5) using conservative assumptions to create worst case scenarios.

Site preparation (i.e., earth moving and soil disturbance) and wind erosion for the projects would result in various amounts of fugitive particulate (i.e., dust) emissions (PM_{10} and $PM_{2.5}$). The amount of fugitive dust emissions would depend on numerous factors, such as: the degree of vehicular traffic; amount of exposed soil; soil moisture content; and wind speed. Construction activities would create combustion product (tailpipe) emissions (mostly PM, NO_X, and CO) from vehicles (e.g., contractor personally owned vehicles, delivery trucks, heavy construction equipment), and temporary non-road equipment powered by internal combustion engines.

BMPs (e.g., dust suppression, establishment of lower speed limits in construction areas) and legal requirements (i.e., use of low sulfur fuel, anti-idling regulations) would be implemented during each project to minimize and mitigate those emissions to the maximum extent practicable. Criteria pollutant emissions from mobile sources associated with the WFF projects listed in Table 29 would be short-term, negligible, and localized.

The operational phases of these projects would produce similar criteria pollutant emissions on an annual basis, although only the first year of operational emissions was estimated. BMPs (e.g., use of alternative fueled vehicles at WFF) and installation of the two wind turbines proposed for the Alternative Energy Project would help minimize criteria pollutant emissions locally. In addition, a positive impact in a regional reduction in criteria pollutant emissions could result from the decreased use of fossil fuels during the production of electricity at the electric power generation plant that currently supplies WFF.

Table 29: WFF Cumulative Project Criteria Pollutant Emissions in Tons

Project	CO	NO_X	VOC	PM_{10}	SO_X
Wallops Research Park	Data Unavailable[1]				
UAS Airstrip	31	62	12	66.1	6
Alternative Energy Project	2.5	3.8	<1.0	<1.0	<1.0
SRIPP	106.6	751.4	28.2	24.5	18.4
Expansion of WFF Launch Range – Alternative One	7.7	20.5	2.1	1.8	25.7
WFF Launch Range Activities[2]	1.9	19.2	1.6	2.5	28.7
Total	**149.7**	**856.9**	**44.9**	**95.9**	**79.8**

[1]Quantitative air analysis not performed for this project.
[2]Based on 2008 WFF baseline emissions.

Cumulative emissions from the Alternative Energy Project, Expansion of the WFF Launch Range, and the SRIPP are unlikely to lead to a violation of the NAAQS as regional concentrations are already in attainment, with no indication that a re-designation for any criteria pollutant is imminent. Therefore, minimal and short-term cumulative impacts from construction-related and operational activities are anticipated without significant effects on local or regional air quality.

Although cumulative impacts from all construction related and operational activities are anticipated to be minimal, WFF is in the process of decentralizing the Central Boiler Plant/steam system with individual propane-fired boilers. Table 30 provides the estimated emissions reduction resulting from this action.

Table 30: Emissions Reduction Resulting from Central Boiler Plant Decentralization in Tons

Pollutant	2007 Emissions	Proposed Emissions After Decentralization	Percent Change
CO	1.86	2.6	39% increase
NO_X	17.8	4.55	74% reduction
PM	1.2	0.25	79% reduction
SO_X	27	<1	99% reduction

4.5.6.4 Climate Change

The potential effects of proposed GHG emissions are by nature global and cumulative since individual sources are not large enough alone to have an appreciable effect on the climate. Such an impact on global climate change would only occur when GHG emissions from anthropogenic sources and sinks combine with proposed GHG emissions on a global scale.

Overall, construction vehicles, equipment, and non-road vehicle sources would emit minimal GHG emissions during the site preparation and construction phases of the projects shown in Table 31. However, dredging operations for the SRIPP would produce considerably more GHG emissions compared to the other WFF projects. The operational phases of the WFF projects would also create GHG emissions on an annual basis, although only the first year of operational emissions was estimated.

Given the absence of science-based or adopted NEPA significance thresholds for GHGs, all of the CO_2e emissions presented in Table 31 from the year with the highest (worst) emissions are compared to the EPA 2007 GHG baseline inventory to determine the relative increase in proposed GHG emissions from WFF.

Table 31: WFF Cumulative Project Greenhouse Gas Emissions in Metric Tonnes

Project	CO_2e Emissions[1]
Wallops Research Park	Data Unavailable[2]
UAS Airstrip	17,390
Alternative Energy Project	218
SRIPP	37,250
Expansion of WFF Launch Range – Alternative One	445
WFF Launch Range Activities[3]	1,400
Total	**56,703**

[1]Only CO_2e emissions are included as this is a representation of all GHG emissions.
[2]Quantitative air analysis not performed for this project.
[3]Based on 2008 WFF baseline emissions.

Although the Alternative Energy Project Proposed Action and other proposed projects would not cause substantial cumulative impacts associated with global climate change, there are several measures currently in place at WFF, as well as initiatives to be implemented in the near future, which would reduce energy consumption and thereby reduce GHG emissions. For example, the installation of two 2.0 MW wind turbines and/or solar panels (with an equivalent amount of energy generated by two 2.0 MW wind turbines) proposed on Wallops Island under the Alternative Energy Project would reduce the use of fossil fuels to generate electricity. This would result in a beneficial impact on the cumulative effects of planned and on-going projects in the area, since it has been documented that the three largest GHG emission sources in Virginia are transportation, non-utility uses of fuel in commercial industrial and residential facilities, and electricity generation (Bryant, 2008).

In addition to the Alternative Energy Project, WFF has replaced almost 50 percent of its entire light-duty government-owned fleet (30 out of 70 vehicles) with newer, more fuel-efficient vehicles, as well as switched all of its diesel vehicles to using 20-percent biodiesel. In addition, the aforementioned decentralization of the Central Boiler Plant/steam system with individual propane-fired boilers would result in an estimated emissions reduction of approximately 4,400 metric tonnes per year of CO_2.

4.5.6.5 Terrestrial Wildlife and Migratory Birds

Construction and launch noise could temporarily affect wildlife at Wallops Island (e.g., short-term disruption of daily/seasonal behavior). Some vegetative damage may occur from heat from the launch and acid deposition in the near-field areas. Potential adverse cumulative impacts on terrestrial wildlife and migratory birds could result from habitat alteration and disturbance from existing and planned projects at WFF including avian injury and fatality from operation of the wind turbines for the Alternative Energy Project Proposed Action. However, since large areas of habitat would remain on Wallops Island and the surrounding area, and the findings of the 2008–2009 WFF avian study (Appendix A) suggest that no substantial direct or indirect impacts are would occur from operation of two wind turbines on Wallops Island.

4.5.6.6 Threatened and Endangered Species

As part of both the SRIPP Programmatic EIS and the Expansion of the WFF Launch Range EA, NASA prepared a BA for potential effects to the federally listed threatened and endangered species for each project. The conclusion of the Section 7 process on both projects is pending.

NASA’s determinations of effects from the Proposed Actions for the Expansion of the WFF Launch Range, SRIPP EIS, and the Alternative Energy Project are shown in Table 32. Because no federally listed threatened or endangered species or federally designated critical habitat occur within the vicinity of the WRP, NASA determined that no effects to federally threatened endangered species would occur from that project. No evaluations of effects to federally listed species have been made for the North UAS Airstrip project yet.

Table 32: Determination of Effects to Federally Protected Species for WFF Projects

Species	Project[1]		
	Expansion of WFF Launch Range	Alternative Energy Project	SRIPP
Plants			
Seabeach amaranth	May affect, not likely to adversely affect	No effect	May affect, not likely to adversely affect
Whales			
Humpback, Fin, Right Whales	May affect, not likely to adversely affect	ND	May affect, not likely to adversely affect
Sperm, Sei, Blue Whales	May affect, not likely to adversely affect	ND[2]	No effect
Mammals			
Delmarva Peninsula fox squirrel	No effect	No effect	No effect
Insects			
Northeastern Beach Tiger Beetle	No effect	No effect	No effect
Sea Turtles			
Leatherback Sea Turtle	May affect, not likely to adversely affect	No effect	May affect, not likely to adversely affect
Kemp's Ridley Sea Turtle	May affect, not likely to adversely affect	No effect	May affect, not likely to adversely affect
Loggerhead Sea Turtle	May affect, likely to adversely affect	No effect	May affect, not likely to adversely affect
Hawksbill Sea Turtle	May affect, not likely to adversely affect	No effect	No effect
Atlantic Green Sea Turtle	May affect, likely to adversely affect	No effect	May affect, not likely to adversely affect
Birds			
Red Knot	May affect, not likely to adversely affect	May affect, likely to adversely affect	May affect, not likely to adversely affect
Piping Plover	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect

[1]Because the WRP project area did not contain potential for listed species or their habitat, no determinations or formal Section 7 consultation was done for that project; the UAS project has not started therefore the potential effects on listed species have not been evaluated.
[2]ND = no determination made because no suitable habitat present within project area, documented absence of the species within the project area, or project would result in no effect to the species.

NASA would adhere to all avoidance and mitigation measures issued by USFWS. Therefore, the current range of operations on Wallops Island, when combined with the Alternative Energy Project Proposed Action and other WFF projects including the SRIPP, is not anticipated to result in adverse cumulative effects to State or federally listed threatened or endangered species. During the execution of all future projects, NASA would continue working with the USFWS and NMFS to minimize the effects of its actions on protected species.

4.6 PERMITS, LICENSES, AND APPROVALS

The following list of potential permits, licenses, and approvals are likely to be required for the Proposed Action. The agency responsible for each is included after the identified permit, license, or required consultation. Any required permits, licenses, or approvals would be obtained prior to construction.

- CWA Section 404 Dredge and Fill Permit, USACE
- Rivers and Harbors Act Section 10 Permit, USACE
- CWA Section 401 Water Quality Certification/Virginia Water Protection Permit, VDEQ
- Wetlands Permit, Accomack County Wetlands Board
- Biological Opinion, USFWS
- EFH Consultation, NMFS
- Section 106 Consultation, VDHR
- VSMP Permits, Virginia DCR
- Federal Consistency Determination, VDEQ

SECTION FIVE: MITIGATION AND MONITORING

5.1 MITIGATION

CEQ regulations (40 CFR 1508.20) define mitigation to include: (1) avoiding the impact altogether by not taking a certain action or parts of an action; (2) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (3) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating the impact over time by preservation and maintenance operations during the lifetime of the action; and (5) compensating for the impact by replacing or providing substitute resources or environments. Described below are NASA's proposed mitigation measures for wind turbines under the WFF Alternative Energy Project. Mitigation measures are described by resource area.

5.1.1 Wetlands

Up to 0.36 hectare (0.88 acre) of wetlands would be filled under the Proposed Action; 0.29 hectare (0.71 acre) of estuarine intertidal emergent wetlands, 0.06 hectare (0.14 acre) of palustrine emergent wetlands, and 0.01 hectare (0.03 acre) of palustrine scrub-shrub wetlands. The potentially affected wetlands are considered jurisdictional under Section 404 of the CWA and are regulated by the USACE, VDEQ, and Accomack County Wetlands Board. Prior to construction, NASA would notify the public and coordinate with applicable agencies including USACE, the VDEQ, VMRC, and the Accomack County Wetlands Board; these agencies would be notified of potential impacts on wetlands by VMRC through the JPA process. NASA would obtain necessary permits including CWA Section 404, Section 10, and Section 401 Water Quality Certification/Virginia Water Protection permits and accordingly would implement a minimum of 0.362 hectare (0.895 acre) of wetland compensation at the Mainland (Figure 18).

5.1.2 Birds and Bats

The Federal Aviation Administration (FAA) requires that any structure taller than 61 meters (200 feet) above ground level must have aircraft warning lights. Gehring, et. al. (2009) found that the use of red or white flashing obstruction lights strongly correlated with a decrease in avian fatalities compared to non-flashing, steady burning lights at tower systems. Gehring, et. al. further stated that "Removing non-flashing lights from towers is one of the most effective and economically feasible means of achieving a significant reduction in avian fatalities at existing communication towers." Because the proposed wind turbines would be taller than 61 meters (200 feet), NASA would utilize either red or white flashing light systems.

Numerous technologies and methodologies (e.g., blade color patterns, flight diverters, acoustic deterrents, etc.) are currently under development to lessen the potential risk that wind turbines pose to avifauna. NASA may consider implementing such technologies to both test their efficacy and to reduce potential impacts.

5.2 MONITORING

Under NEPA, a Federal agency has a continuing duty to gather and evaluate new information relevant to the environmental impact of its actions. Below is a summary of NASA's proposed monitoring plan for the implementation of the two utility-scale wind turbines on Wallops Island. The focus of the monitoring plans would be to track the effects of the project on birds and bats.

5.2.1 Post-Construction Utility-Scale Wind Turbine Avian Fatality Monitoring

A proposed monitoring study approach focused solely on documenting avian fatalities from the utility-scale wind turbines is described below. NASA may also consider conducting post-construction field studies at some time to allow for a comparison of avian and bat fatality at the utility-scale wind turbine sites with fatalities at the existing tower structures surveyed in 2008 and 2009. This would allow NASA to determine differences in fatality at these different structure types, while also observing avian and bat behavior with the addition of the two wind turbines Wallops Island.

NASA proposes to conduct a minimum of two years of post-construction fatality surveys at the utility-scale wind turbines. Surveys would include carcass searches, searcher efficiency trials, scavenger removal trials, and estimation of searchable area. These trials would be used to estimate overall avian and bat collision fatalities. Surveys would be conducted from March 1 through November 1. The first year of surveys would take place after the wind energy facility is fully operational. More detail regarding the proposed monitoring plan is provided below.

5.2.1.1 Fatality Searches

Bird and bat carcass searches would be conducted at each wind turbine within a 120 meter by 120 meter (395-foot by 395-foot) rectangular area. Search plots would be centered at the base of the turbine tower and the area would be searched along transects no more than 5 to 6 meters (16 to 20 feet) apart. Searches would be made every three days throughout the study period.

Field surveyors would likely be NASA biologists trained in the search protocol. Transects at each of the turbines would be walked slowly to visually locate bird and bat carcasses, including portions of carcasses. Search intervals would vary (i.e., approximately one to two hours per turbine location) depending upon specific ground conditions.

A standardized data sheet would be used for each search. The data sheet would include detailed weather observations, time, date, and observer name and carcass species identification. The data collected would also include:

- Digital photographs of each carcass, including:
  1. The posture and habitat in which it was found;
  2. The dorsal and ventral sides;
  3. Photographs that indicate the gender and reproductive condition of bats (if possible); and
  4. Any identifying characteristics such as bill, foot, wing or tail shape, and plumage coloration for birds.
- Additionally, data collection would include:
  1. Turbine number;
  2. Location of carcass;
  3. Estimated distance and direction from turbine;
  4. Distance and bearing from transect from which it was first spotted;

5. Condition of carcass (whole or partial, extent of injury and some measure of decomposition to estimate time of death);
6. Preliminary estimate of days since death;
7. Position of carcass (face-up/down, sprawled, balled up, etc);
8. Species, age and sex, if determinable; and
9. Substrate conditions when found (marsh/water, short/long grass, dense fragmite cover).

Searches would begin as close to sunrise as possible. To ensure personnel safety, searches not occur in high wind, extreme heat, rain, or foggy conditions. Carcasses found during the survey effort would be cataloged and stored in a freezer. If observers cannot determine species type because partial bird or bat carcasses were found, USFWS, VDGIF, or other expert biologists would be contacted to assist in species identification efforts. Where individual feathers, as opposed to carcasses or clumps of feathers (including feather tracts) are found, observers would note these but they would not be considered wind turbine fatalities. Any larger than expected fatality events or evidence of rare, threatened, or endangered species would be reported to USFWS and VDGIF staff within 48 hours of the discovery.

Weather conditions from the night (for night migrants) and day (for other birds) prior to the surveys will be collected from local and national weather databases, or from personal observation at or near the site. If carcasses are found, descriptions of visibility conditions the night prior to the fatality surveys would be investigated and reported, particularly information concerning percent cloud cover and the presence of fog or low cloud ceilings.

5.2.1.2 Carcass Removal Trials

Carcass removal by scavengers would be monitored using no less than 30 specimens per year and would be performed periodically throughout the survey season. Planted carcasses would include an equal assortment of small birds, large birds and bats (or tailless mice, as bat surrogates). Carcasses would be fresh, inconspicuously marked, and would be placed in various ground cover types and at different turbine locations. Carcasses would be monitored daily (during the first week) for removal and thereafter weekly until the carcass disappears. During carcass checks, the location and condition of the carcass would be recorded on standardized data sheets to document the degree of scavenging (e.g., wing missing, tail missing, head missing, breast eaten, etc.) over time. Incidental signs such as tracks or scat adjacent to the carcasses would also be identified and documented.

5.2.1.3 Searcher Efficiency Trials

Individual searcher efficiency trials would be conducted periodically during the survey period. Marked carcasses of various sizes, taxa, and species will be placed without prior knowledge of the searcher at various locations and in various ground cover types. A record of how many days it took for a carcass to be found would be noted.

5.2.1.4 Searchable Area

Bird and bat fatalities are expected to be found within a circle centered on the turbine, with a radius of 80 percent of the turbine height. To facilitate searches along transects, the fatality area would be defined as a square that circumscribes this circle. As a result of brushy vegetation, water, or other conditions, the fatality area around the turbines may not be entirely searchable. To adjust for carcasses that may not be found because of this potential bias, those areas that cannot be searched would be measured via GPS. The estimate of birds or bats that may have actually been present within the unsearchable areas would be extrapolated from the numbers of fatalities found in the searchable area.

5.2.1.5 Calculation of Adjusted Fatality Estimates

Using searcher efficiency, carcass removal, and searchable area estimates determined empirically, an overall estimate of bird and bat fatalities would be calculated. The resulting estimates would be larger than the numbers of carcasses found for both birds and bats.

5.2.1.6 Survey Report

After the completion of each annual fatality survey a report of findings would be prepared. A summary of the results of the fatality searches would include recorded data for each carcass found, including the variables described above. Results of the carcass removal and searcher efficiency studies would also be presented. An estimated fatality rate would be calculated as presented above. A discussion of the species of carcasses discovered during the fatality search would also be presented. Recommendations for any modifications to subsequent post-construction avian and bat fatality studies at the project site would also be presented. This report would be distributed to interested stakeholders including USFWS and VDGIF.

5.2.2 Facility Threatened and Endangered Species Monitoring

To monitor the potential cumulative effects of its actions on threatened or endangered species, NASA, in cooperation with USFWS, has developed a protected species monitoring plan for Wallops Island (NASA, 2010c). NASA would implement this plan in spring 2010. NASA will continue to coordinate with CNWR and USDA personnel in monitoring the Wallops Island beach for Piping Plover and Red Knot activity. These personnel routinely monitor Assateague, Wallops Island, Assawoman, and Metompkin Island beaches for Piping Plovers during nesting season. Red Knots would be expected to be present in areas suitable for Piping Plover nesting during similar times of year. Any Piping Plover nests discovered would be appropriately marked using a Global Positioning System (GPS) unit, identified with signage, and closed to personnel or visitor access. FAA lighting requirements on the turbines would be satisfied with flashing lights rather than steady-burning lights, as studies indicate that flashing lights result in significantly fewer avian fatalities. An annual summary report of the monitoring results and events will be distributed to interested stakeholders including USFWS and VDGIF.

5.3 ADAPTIVE MANAGEMENT

Adaptive management is a tool to help agencies and organizations make better decisions in a context of uncertainty as more information becomes available. Adaptive management utilizes ongoing, data collection and analysis to assess and if necessary, to modify existing processes.

For the Alternative Energy Project, NASA based its assessment of risks to birds and bats on preconstruction data. This methodology carries inherent uncertainties, and as such adjustments to this monitoring protocol may be made as deemed necessary. For example, NASA may consider adding additional study years, changing duration of the study, or modifying the frequency of searches. Before modifying the study plan, NASA would consult with interested stakeholders including USFWS and VDGIF.

Similarly, considerable uncertainty exists regarding the effectiveness of various wind turbine mitigation strategies in reducing impacts on birds and bats. Based upon results of monitoring and the technological maturity of future mitigation strategies, NASA may consider implementing, augmenting, or replacing these technologies as circumstances warrant. NASA would consult with interested stakeholders including USFWS and VDGIF prior to implementing or modifying mitigation measures.

This page intentionally left blank.

SECTION SIX: LIST OF PREPARERS

Name	Title	Areas of Responsibility in EA
URS		
Shari Silbert	Environmental Scientist, Wallops Environmental Office	WFF Onsite Project Manager, Document Development and Review
Jeffrey Reidenauer	Principal Environmental Scientist	Project Management, Document Review
Suzanne Richert	Principal Environmental Scientist	Project Management, NEPA Compliance, Social and Economic Environment Sections, Viewshed, Noise
Ashley Kurzweil	Environmental Scientist	Physical Environment, Alternative Energy Information
Charles Benton	Senior Wetland Scientist	Wetlands
Tom Page	Senior Biologist	Bats
Katie Eberhart	Senior Ecologist	Birds
Richard Podolsky	Principal Ecologist	Birds
Douglas Kibbe	Certified Wildlife Biologist	Birds
Angela Chaisson	Principal Biologist	Independent Technical Reviewer
Larry Poole	Senior Project Manager	Community Viewshed
Mike Kendall	Principal Air Quality Scientist	Air Quality
Sally Atkins	Senior Air Quality Scientist	Air Quality
Bethany Lambright	Staff Air Quality Scientist	Air Quality
Varna Boyd	Principal Archaeologist	Cultural Resources - Archaeology
Chris Polglase	Principal Archaeologist	Cultural Resources - Archaeology
Jeremy Lazelle	Senior Archaeologist	Cultural Resources - Archaeology
Carrie Albee	Senior Principal Historian	Cultural Resources - Aboveground
Linda Mackey	Architectural Historian	Cultural Resources - Aboveground
Sarah Cleary	Architectural Historian	Cultural Resources - Aboveground
Lee-Ann Lyons	Graphics Specialist	Cultural Resources - Aboveground
Christopher Ditton	Geographical Information Systems Specialist	Figures
Amy Siegel	Internal Technical Editor	Editing
Ivy Porpotage	Internal Technical Editor	Editing
NASA		
Philip Smith	Electrical Engineer	Alternatives, Document Review
Joshua Bundick	Environmental Protection Specialist	NEPA Compliance, Alternatives, Project Management, Document Review
Joel Mitchell	Environmental Engineer	Biology and Wetlands, Document Review
USACE		
Robert Cole	Environmental Scientist	Document Review

This page intentionally left blank.

SECTION SEVEN: AGENCIES, ORGANIZATIONS, AND PERSONS CONSULTED

7.1 INTRODUCTION

NEPA states that "There shall be an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to the proposed action." NASA has engaged stakeholders and the general public in planning the Alternative Energy Project and preparing this EA. Stakeholders include Federal and State agencies, local governments, business interests, landowners, residents, and environmental organizations.

7.2 SCOPING PROCESS

During the Alternative Energy Project planning process, NASA provided several opportunities for public and stakeholder involvement. Scoping letters were sent to targeted stakeholders and agencies in April 2008. An example letter and stakeholder responses are included in Appendix G. NASA also held several meetings with various stakeholders during the planning of this project. The meetings are summarized below:

- In February 2008, NASA met with members of the Accomack County Board of Supervisors to introduce and discuss the proposed project.
- In March 2008, NASA met with A&N Electric Cooperative to introduce the project and to discuss interconnection requirements for installing alternative energy sources at WFF.
- In April 2008, NASA hosted six stakeholder groups including Federal and State regulatory agencies and local environmental organizations at the Chincoteague National Wildlife Refuge's Herb Bateman Center. This meeting was held to discuss NASA's proposed Avian and Bat Study Plan. In spring and summer 2008, Draft and Final copies of the Plan were sent to each participant for review and comment.
- In August 2009, NASA held a Trust Resources Meeting with six Federal and State regulatory agencies. During this meeting, NASA consulted with the other agencies on potential impacts to wetlands and protected species.

NASA formally invited the USACE to participate as a cooperating agency in the EA process. The USACE accepted this request and has assisted NASA in the preparation of this Draft EA (Appendix G).

7.3 DRAFT EA

NASA considered information obtained during scoping in preparing the Draft EA. The public was notified of the opportunity to review and comment on this Draft EA by e-mail and announcements in local newspapers. The Draft EA is also available for public review at the following locations:

NASA WFF Technical Library Building E-105 Wallops Island, VA 23337 (757) 824-1065 Hours: Mon–Fri: 8 a.m. to 4:30 p.m.	**Island Library** 4077 Main Street Chincoteague, VA 23336 (757) 336-3460 Hours: Mon: 10 a.m. to 2 p.m. Tues: 10 a.m. to 5 p.m. Wed, Fri, Sat: 1 p.m. to 5 p.m.
Eastern Shore Public Library 23610 Front Street P.O. Box 360 Accomac, VA 23301 Phone: (757) 787-3400 Monday, Tuesday, Wednesday, Friday: 9 a.m. to 6 p.m. Thursday: 9 a.m. to 9 p.m. Saturday: 9 a.m. to 1 p.m.	**Northampton Free Library** 7401 Railroad Avenue Nassawadox, Virginia, 23413 (757) 442-2839 Monday, Tuesday, Wednesday, Friday: 9 am - 6 pm Thursday: 9 am - 9 pm Friday: 9 am - 6 pm Saturday: 9 am - 1 pm

The Draft EA can be viewed on the WFF Environmental Office Web site at: http://sites.wff.nasa.gov/code250/AltEnergy_DEA.html.

A limited number of copies of the Draft EA are available by contacting:

Joshua A. Bundick
NEPA Program Manager
Wallops Flight Facility, Code 250.W
Wallops Island, VA 23337
Phone: (757) 824-2319
Fax: (757)824-1819

Written comments on the Draft EA are requested within 30 days of the publication of the Notice of Availability in local newspapers.

Comments submitted by mail should be addressed to:

250/NEPA Manager
WFF Alternative Energy Project
NASA Goddard Space Flight Center's Wallops Flight Facility
Wallops Island, Virginia 23337

Comments may also be submitted via e-mail to: Joshua.A.Bundick@nasa.gov.

Below in Table 33 is a list of agencies, organizations, and persons consulted during the planning of the Project and the preparation of the Draft EA. NASA will consider public comments on the Draft EA in preparing the Final EA. The Final EA is planned for completion in the summer of 2010. A Notice of Availability will be published in local newspapers to ensure that interested persons and organizations are aware of the document's progress.

Table 33: Agencies, Organizations, and Individuals Consulted

Name	Organization	Participated in Scoping	Sent a Copy of Draft EA
Federal Agencies			
Ms. Barbara Rudnick	EPA	X	X
Mr. Michael Blaich	FAA	X	X
Ms. Julie Crocker	NMFS, Protected Resources Division		X
Mr. David O'Brien	NMFS, Habitat Conservation Division	X	X
Ms Trish Kicklighter	NPS, Assateague Island National Seashore		X
Mr. Doug Crawford	NOAA, Command and Data Acquisition Station		X
Mr. Robert Cole	USACE, Norfolk District	X	X
Mr. Bryan Connor	U.S. Department of Energy		X
Dr. Marilyn Ailes	U.S. Navy, Surface Combat Systems Center	X	X
CAPT J.M. Hinson	U.S. Navy, Fleet Forces Command		X
CDR John Keegan	U.S. Navy, Surface Combat Systems Center		X
Mr. Louis Hinds, III	USFWS, Chincoteague National Wildlife Refuge	X	X
LT Mark Merriman	U.S. Coast Guard		X
Ms. Cindy Schulz	USFWS, Virginia Field Office	X	X
State Agencies			
Mr. Richard Baldwin	Mid-Atlantic Regional Spaceport		X
Mr. Frank Daniel	VDEQ, Tidewater Regional Office		X
Ms. Ellie Irons	VDEQ, Office of Environmental Impact Review		X
Ms. Ruth Boettcher	VDGIF, Wildlife Diversity Division	X	X
Mr. Ron Grayson	VDHR	X	X
Mr. George Badger, III	VMRC, Habitat Division	X	X
Mr. Tommy Oliver	Virginia State Corporation Commission	X	X
Local Government			
Mr. Steven Miner	Accomack County Administration		X
Mr. Grayson Chesser	Accomack County Board of Supervisors		X
Ms. Laura Belle Gordy	Accomack County Board of Supervisors		X
Ms. Wanda Thornton	Accomack County Board of Supervisors	X	X
Mr. Ronald Wolff	Accomack County Board of Supervisors	X	X
Mr. David Fluhart	Accomack County Building and Zoning	X	X
Mr. Robert Ritter	Town of Chincoteague, Virginia		X
Mayor John Tarr	Town of Chincoteague, Virginia		X

Name	Organization	Participated in Scoping	Sent a Copy of Draft EA
Other Organizations and Individuals			
Mr. Vernon Brinkley	A & N Electric Cooperative	X	X
Mr. George Stricker	Accomack Wind Energy Project	X	X
Ms. Kathy Phillips	Assateague Coastal Trust		X
Mr. Charlie Smith	Audubon Society	X	X
Mr. Nick Olmstead	BaySys Technologies, Inc.		X
Dr. Adam Duerr	College of William and Mary Center for Conservation Biology	X	X
Dr. Bryan Watts	College of William and Mary Center for Conservation Biology	X	X
Ms. Suzanne Taylor	Chincoteague, Virginia Chamber of Commerce		X
Mr. Denard Spady	Citizens for a Better Eastern Shore		X
Mr. Jim Rapp	Delmarva Low Impact Tourism Experiences		X
Mr. Jeff Davis	Eastern Shore Chamber of Commerce		X
Mr. Steven Habeger	Eastern Shore Defense Alliance		X
Ms. Donna Bozza	Eastern Shore of Virginia Tourism Commission		X
Dr. Jonathan Miles	James Madison University	X	X
Ms. Amber Parker	Marine Science Consortium		X
Ms. Judy Dunscomb	The Nature Conservancy, Charlottesville	X	X
Mr. Stephen Parker	The Nature Conservancy, Virginia Coast Reserve		X
Mr. Barry Truitt	The Nature Conservancy, Virginia Coast Reserve	X	X
Mr. Randy Fox	Trails End Campground		X
Dr. Karen J. McGlathery	Virginia Coast Reserve Long-Term Ecological Research Project		X
Mr. Patrick Wilson	Virginia Wind Energy Collaborative		X
Mr. David Burden	Virginia Eastern ShoreKeeper		X
Federal and State Elected Officials			
Honorable Mr. Lynwood Lewis, Jr.	Virginia House of Delegates		X
Honorable Mr. Ralph Northam	Virginia Senate		X

SECTION EIGHT: REFERENCES

Accomack County. 2001. Code of Regulations, County of Accomack, VA, Article II: Noise, Sec. 38-32 through 35. http://www.municode.com/resources/gateway.asp?pid=13191&sid=46. Site accessed March 9, 2009.

American Wind Energy Association (AWEA). 2009. How Much Water Do Wind Turbines Use Compared to Conventional Power Plants? American Wind Energy Association Resources Web site: http://www.awea.org/faq/water.html. Site accessed February 14, 2010.

Anderson, K.W. 2009. A study of the potential effects of a small wind turbine on bird and bat mortality at Tom Ridge Environmental Center, Erie, Pennsylvania. Gannon University. Revised March 20, 2009. 16 pp.

Atlantic County Utilities Authority (ACUA). 2005. Jersey-Atlantic Wind Farm Fact Sheet and Web site. http://www.acua.com/acua/content.aspx?id=492&ekmensel=c580fa7b_20_88_btnlink#. Site accessed May 6, 2009.

ACUA. 2009. Post-Construction Wildlife Monitoring at the Atlantic City Utilities Authority-Jersey Atlantic Wind Power Facility. Submitted to: New Jersey Board of Public Utilities, New Jersey Clean Energy Program, Two Gateway Center (8th Floor), Newark, NJ 07102. Quarterly Report for September 1–December 30, 2008. Submitted by New Jersey Audubon Society.

Barclay, R.M.R., E.F. Baerwald, and J.C. Gruver. 2007. Variation in bird and bat fatalities at wind energy facilities: assessing the effects of rotor size and tower height. Canadian Journal of Zoology 85: 381-387.

Bats and Wind Energy Cooperative (BWEC). 2008. Bats and Wind Energy Cooperative Research Web Site – Operational Mitigation & Deterrents. http://www.batsandwind.org/main.asp?page=research&sub=operational. Site accessed August 14, 2009.

Bat Conservation International (BCI). 2001. Bats in Eastern Woodlands. Bat Conservation International, Austin, Texas.

BP Solar. 2009. BP Solar: Product Data Sheets Archive Web Site. http://www.bp.com/sectiongenericarticle.do?categoryId=9019649&contentId=7036978. Site accessed December 31, 2009.

British Wind Energy Association (BWEA). 2009. British Wind Energy Association Web Site. http://www.bwea.com/ref. Site accessed December 23, 2009.

Bryant, Preston L., Jr. The Honorable. 2008. Governor’s Commission on Climate Change, Final Report: A Climate Change Action Plan. December.

Cohen, J.B., S. Karpanty, J. Fraser, B. Watts, and B. Truitt. 2009. Residence Probability and Population Size of Red Knots During Spring Stopover in the Mid-Atlantic Region of the United States. Journal of Wildlife Management. 73(6): 939-945.

Commonwealth of Virginia, 1975. Groundwater Conditions in the Eastern Shore of Virginia, Planning Bulletin 45, State Water Control Board, December 1.

Cryan, P.M. 2003. Seasonal distribution of migratory tree bats (*Lasiurus* and *Lasionycteris*) in North America. Journal of Mammalogy 84:579-593.

Cryan, P.M., M.A. Bogan, R.O. Rye, G.P. Landis, and C.L. Kester. 2004. Stable hydrogen isotope analysis of bat hair as evidence for seasonal molt and long-distance migration. Journal of Mammalogy 85, 995–1001.

Cryan P.M. and A.C. Brown. 2007. Migration of bats past a remote island offers clues toward the problem of bat fatalities at wind turbines. Biological Conservation, Vol. 139, I-II.DOE. 2001.

Curry, R.C. and P. Kerlinger. 1998. Avian Mitigation Plan, Kenetech Model Wind Turbines, Altamont Pass WRA. National Avian Wind Power Meeting III. http://www.altamontsrc.org/alt_rl.php. Site accessed February 12, 2010.

Curry & Kerlinger, L.L.C. 2004. Phase I Avian Risk Assessment for the James Madison University-NASA Wind Power Project, Wallops Island, Accomack County Virginia. September. Draft. Paul Kerlinger, Ph.D., Curry & Kerlinger, L.L.C., P.O. Box 453, Cape May Point, NJ 08212. currykerlinger.com.

Earthscan. 2008. Planning and Installing Photovoltaic Systems, A guide for installers, architects and engineers. Second edition. Earthscan, 8-12 Camden High Street, London, NW1 0JH, UK. www.earthscan.co.uk.

Eastern Shore Chamber of Commerce. 2007. Community Economic Development for the Eastern Shore: Summit Report - June 2007. Prepared by: Virginia Tech Office of Economic Development. 702 University City Boulevard, Blacksburg, Virginia 24061-0162. Prepared by Mike Potter, John Provo, Ph.D., Sibel Atasoy, Eric Howard, and Charlotte Anders. August. http://www.esvachamber.org/ecoprofile.html. Site accessed February 3, 2009.

Environment Canada. 2006. National Inventory Report 1990-2004 Greenhouse Gas Sources and Sinks in Canada. November 11. http://www.ec.gc.ca/pdb/GHG/inventory_report/2004_report/ann13_e.cfm. Site accessed December 1, 2009.

Federal Aviation Administration (FAA). 2007. Advisory Circular AC 70/7460-1K. February 1. http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgAdvisoryCircular.nsf/0/b993dcdfc37fcdc486257251005c4e21. Site accessed December 3, 2009.

Federal Communications Commission. 2004. Nationwide Programmatic Agreement for Review of Effects on Historic Properties for Certain Undertakings Approved by the Federal Communications Commission. FCC 04-222. September.

Federal Emergency Management Agency (FEMA). 1984. Flood Insurance Rate Map Community Panel Number 510001 0070 B, Accomack County, Virginia. June 1.

FEMA. 1992. Flood Insurance Rate Map Community Panel Number 510001 0100 C, Accomack County, Virginia. April 2.

Federal Energy Regulatory Commission (FERC). 2009. Hydrokinetic Projects Web Site. http://www.ferc.gov/industries/hydropower/indus-act/hydrokinetics.asp. Site accessed December 23, 2009.

Gamesa. 2009. Gamesa G87 – 2.0 MW Brochure. March. http://www.gamesacorp.com/files/Documentos%20PDF/Ingles/Fichas%20aerogeneradores/G87-INGLES_nuevo.pdf. Site accessed December 3, 2009.

Gehring, J., P. Kerlinger, and A.M. Manville II. 2009. Communication towers, lights, and bird: successful methods of reducing the frequency of avian collisions. Ecological Applications 19:505-514.

Iberdrola Engineering & Construction (Iberdrola). 2009. Detailed Engineering Study. Energy Savings Project at the NASA Wallops Island Facility, Wallops Island, VA Wind Farm 2xGE 1.5 MW T80. Madrid. June.

Interuniversity Microelectronics Centre (IMEC). 2009. Large Area Solar Cells With 18.4% Conversion Efficiency, Featuring Cu-plated Contacts. *ScienceDaily*. Site accessed February 8, 2010. http://www.sciencedaily.com- /releases/2009/09/090921092045.htm

James Madison University (JMU). 2005. Energy Analysis of NASA Wallops Island Facility, Mainland and Island, Wallops Island, Virginia. Prepared by EMO Energy Solutions, LLC, 2832 Edgelea Road, Vienna, VA 22181. January 5.

Jones & Stokes. 2007. Addressing Climate Change in NEPA and CEQA Documents. Updated in August. www.climatechangefocusgroup.com.

Kerlinger, P. 1996. A literature survey of tower and wind turbine impacts on birds in the northeastern United States and the influence of ceilometers on bird flight. July 11, 1996. 25 pp.

Kerlinger, P., J. Gehring, W. Erickson, R. Curry, A. Jain, and J. Guarnaccia. 2009 in review. Night Migrant Fatalities and Obstruction Lighting at Wind Turbines in North America; A Review.

Koltz, L., 1986. The Vascular Flora of Wallops Island and Wallops Mainland, Virginia, Castanea, Vol. 51, December.

Kunz, T.H., E.B. Arnett, W.P. Erickson, A.R. Hoar, G.D. Johnson, R.P. Larkin, M.D. Strickland, R.W. Thresher, and M.D. Tuttle. 2007. Ecological impacts of wind energy development on bats: questions, research needs, and hypotheses. Frontiers in Ecology and the Environment 5:315-324.

Markvart, T., Castaner, L. 2003. Practical Handbook of Photovoltaics: Fundamentals and Applications. Chapter VII-2. ISBN 1-856-17390-9. http://www.bnl.gov/pv/files/pdf/art_170.pdf. Site accessed February 10, 2010.

Maryland Energy Administration. 2007. Geothermal Energy Website. http://www.energy.state.md.us/facts/renewable/geothermal.asp. Site accessed December 3, 2009.

McWilliams, G. M., and D. W. Brauning, 1999. The birds of Pennsylvania. Comstock Publ. Assoc. Ithaca, NY.

Meng, A.A., III and J.F Harsh. 1988. Hydrologic Framework of the Virginia Coastal Plain. U.S. Geological Survey (USGS) Professional Paper 1404-C, 82 pp.

Miles, Jonathan J., Ph.D. 2006. Wind Power Feasibility Study at NASA-Wallops Space Flight Center. Final Report. Jonathan J. Miles, Ph.D., Professor, Department of Integrated Science and Technology, Director, JMU Office of the Virginia Wind Energy Collaborative, James Madison University. Mark Lotts, Projects Administrator. Jeff Briggs, Outreach Administrator. June 29.

Mitsubishi. 2009. Mitsubishi Electric Corporation Press Release, Photovoltaic Cell Efficiency Record Broken. http://www.renewableenergyworld.com/assets/documents/story/2009/2-18-09%202458%20PV%20Conversion%20Record.pdf. February.

National Aeronautics and Space Administration (NASA). 1996. Environmental Justice Implementation Plan.

NASA. 1997. *Environmental Assessment for Range Operations Expansion at the National Aeronautics and Space Administration Goddard Space Flight Center Wallops Flight Facility*. Prepared by Computer Science Corporation. October.

NASA. 2003a. Cultural Resources Assessment of Wallops Flight Facility, Accomack County, Virginia. Report prepared for the National Aeronautics and Space Administration Goddard Space Flight Center Wallops Flight Facility, Wallops Island, Virginia by URS Group, Inc. and EG&G Technical Services, Inc., Gaithersburg, Maryland.

NASA. 2003b. Comments from the Virginia Department of Historic Resources (VDHR) to NASA in a letter dated December 4, 2003.

NASA. 2004. Historic Resources Survey and Eligibility Report for Wallops Flight Facility.

NASA. 2005. Final Site-Wide Environmental Assessment, Wallops Flight Facility, Virginia. Prepared for NASA Goddard Space Flight Center. Prepared by URS-EG&G. January.

NASA. 2006. Integrated Cultural Resource Management Plan.

NASA. 2007. *Wallops Range User's Guide 2007*, Weather Underground: Historical Data for Wallops Island. Wallops Flight Facility Range Safety Office.

NASA. 2008a. NASA. *Environmental Resources Document, Wallops Flight Facility*. July.

NASA. 2008b. Environmental Assessment for Wallops Research Park. Final Report. Prepared by URS Group, Inc. August.

NASA. 2009a. Wetland Delineation for Alternative Energy Project. Final Report. Prepared by URS Group, Inc. April.

NASA. 2009b. National Historic Preservation Act Section 106 Assessment of Alternative Energy Project, Wallops Flight Facility, Wallops Island, Virginia. Prepared by URS Group, Inc.

NASA. 2009c. Letter from Joel Mitchell, NASA Wallops Flight Facility Code 250.W to Tidewater Regional Office, Attn: Mr. Will Williams, Air Compliance Section, Virginia Department of Environmental Quality. Subject: NASA Goddard Space Flight Center Wallops Flight Facility, Air Emissions Annual Update for Calendar Year 2008. Ref: S/C Plant ID: 51-001-00005, Registration No. 40217, Main Base Facility. March 27.

NASA. 2009d. Wallops Flight Facility Alternative Energy Demonstration Project Wind Energy Avian Study Report. Prepared by Tetra Tech NUS, Inc., 20251 Century Boulevard, Suite 200, Germantown, Maryland 20878 and Curry & Kerlinger, LLC. December 23.

NASA. 2010a. Global Climate Change: NASA's Eyes on the Earth Web Site. http://climate.nasa.gov/causes/. Site accessed January 3, 2010.

NASA. 2010b. Essential Fish Habitat Assessment for NASA Wallops Flight Facility Shoreline Restoration and Infrastructure Program. Prepared by URS Group, Inc. February.

NASA. 2010c. WFF Protected Species Monitoring Plan. Draft. February.

National Audubon Society. 2010. Christmas Bird Counts Web site. Historical Results: Data for a CBC Count Circle. Make a Table: VACI (Chincoteague N.W.R.). http://www.audubon.org/bird/cbc/hr/index.html. Site accessed January 6, 2010.

Nexion DG. 2009. Nexion DG Website. Refurbished wind turbines. http://nexiondg.com/.

Old Dominion Electric Cooperative (ODEC). 2008. Form 10-K for the Fiscal Year Ended December 2008. Filed with the U.S. Securities and Exchange Commission.

QinetiQ Inc. 2004. Phase I Report: The requirements for determining the Radar Impact of the Wallops Island Wind Farm site. Under JMU Support Agreement V04-109-01. For consideration by: Dr. Jonathan Miles, Integrated Science and Technology, James Madison University. May 21. QinetiQ Ref: QINETIQ/S&E/SPS/CR041421.

Richardson, D.L. 1992. Hydrogeology and Analysis of the Ground-Water Flow System of the Eastern Shore, Virginia. USGS Open-File Report 91-490, 118 pp.

Richkus, K.D., K.A. Wilkins, R.V. Raftovich, S.S. Williams, and H.L. Springs. 2008. Migratory bird hunting activity and harvest during the 2006 and 2007 hunting seasons: Preliminary estimates. U.S. Fish and Wildlife Service. Laurel, Maryland, USA.

Runyon, J. 2008. Turbines. Renewable Energy World. Finding a Second Life for Retired Wind Turbines. http://www.renewableenergyworld.com/rea/news/article/2008/07/finding-a-second-life-for-retired-wind-turbines-52888. July. Site accessed February 12, 2010.

Smith, F.M., A. E. Duerr, B.J. Paxton, and B.D. Watts. 2008. An Investigation of Stopover Ecology of the Red Knot on the Virginia Barrier Islands. Center for Conservation Biology Technical Report Series, CCBTR-07-14. College of William and Mary, Williamsburg, VA. 35 pp.

Southwest Windpower. 2010. Skystream 3.7® Technical Specifications Fact Sheet and 60 ft (18.3 m) Monopole Tower Technical Specifications Fact Sheet. http://www.skystreamenergy.com/. Site accessed February 17, 2010.

Tetra Tech. 2008. Summer-Fall 2008 Passive Acoustic Monitoring Bat Survey Report for the Goddard Space Flight Center Wallops Flight Facility in Wallops Island, Virginia. Prepared for Tetra Tech NUS, Inc. 20251 Century Boulevard, Suite 200, Germantown, Maryland 20878. Prepared by Stantec Consulting, 30 Park Drive, Topsham, ME 04086. December. Final.

Union of Concerned Scientists (UCS). 1992. Cool Energy: Renewable Solutions to Environmental Problems. Prepared by Michael Brower, MIT Press, 220 pp.

URS. 2009. Calendar Year 2008 Greenhouse Gas Emissions for Wallops Flight Facility, spreadsheet of calculations. Prepared for NASA Wallops Flight Facility in support of the Alternative Energy Project. Prepared by URS, Herndon, VA. December.

U.S. Army Corps of Engineers (USACE). 1987. Environmental Laboratory. Corps of Engineers Wetlands Delineation Manual, Technical Report Y-87-1, US Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

USACE. 2007. Focused Archive Search Report, Ordnance and Explosives Impact Areas and Chemical Warfare Materials Ocean Dump Sites off Wallops Island, Accomack County, Virginia. USACE St Louis District. January.

U.S. Census Bureau. 2000. Chincoteague Zip Code. http://factfinder.census.gov/servlet/. Site accessed January 14, 2008.

U.S. Census Bureau. 2008a. State & County QuickFacts. Accomack County. http://quickfacts.census.gov/qfd/states/51000.html. Site accessed August 3, 2009.

U.S. Census Bureau. 2008b. Populations Estimate Program. Virginia Population Estimate. http://factfinder.census.gov/servlet/. Site accessed August 3, 2009.

U.S. Department of Agriculture (USDA). 1994. *Accomack County Soils Description and Preliminary Soils Map, Accomack County, Virginia*. Accomack County Soil Conservation Service (SCS). November.

U.S. Department of Energy (USDOE). 2001. Updated State-level GHG Emission Factors for Electricity Generation. Office of Integrated Analysis and Forecasting, Energy Information Administration. March.

USDOE. 2005. Energy Efficiency and Renewable Energy. Timeline-The History of Solar. http://www1.eere.energy.gov/solar/pdfs/solar_timeline.pdf. Site accessed February 8, 2010.

USDOE. 2006. Geothermal Technologies Program Frequently Asked Questions. http://www1.eere.energy.gov/geothermal/faqs.html. Site accessed December 23, 2009.

USDOE. 2008. Energy Efficiency and Renewable Energy. EERE News, Study: Solar Power Could Provide 10% of U.S. Electricity by 2025. http://apps1.eere.energy.gov/news/news_detail.cfm/news_id=11835. Site accessed February 8, 2010.

U.S. Environmental Protection Agency (EPA). 1974. *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*. Prepared by the EPA Office of Noise Abatement and Control. March.

EPA. 2007. *Designated Sole Source Aquifers in EPA Region III: Columbia and Yorktown-Eastover Multi-Aquifer System, Accomack and Northampton Counties*. http://www.epa.gov/reg3wapd/drinking/ssa/columbiayorktown.htm. Site accessed February 3, 2009.

EPA. 2008a. Air and Radiation Web site. National Ambient Air Quality Standards (NAAQS) http://www.epa.gov/air/criteria.html. Site accessed December 16, 2009.

EPA. 2008b. WaterSense website. http://www.epa.gov/watersense/basic/why.htm. Site accessed February 5, 2008.

EPA. 2009. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007.*

EPA. 2009. Technology Transfer Network Clearinghouse for Inventories & Emissions Factors Web Site. Emissions Factors & AP-42. http://www.epa.gov/ttnchie1/ap42/. Last updated December 30, 2009. Site accessed December 31, 2009.

U.S. Fish and Wildlife Service (USFWS). 2009a. Atlantic Flyway Map. Available at: library.fws.gov/Pubs/atlantic_flywaymap%20_bw.pdf. Site accessed May 5, 2009.

USFWS. 2009b. Wallops Island National Wildlife Refuge. http://www.fws.gov/refuges/profiles/index.cfm?id=51571. Site accessed December 23, 2009.

USFWS. 2009c. Northeastern Beach Tiger Beetle (Cicendela dorsalis dorsalis) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Virginia Field Office, Gloucester, Virginia. February.

USFWS. No date. Environmental Assessment. U.S. Fish and Wildlife Service, Helical Construction of Vertical Axis Wind Turbines – Alaska Peninsula & Izembek National Wildlife Refuges. 32 pp.

U.S. Government Accountability Office (GAO). 2005. Wind Power Impacts on Wildlife and Government Responsibilities for Regulating Development and Protecting Wildlife. Report to Congressional Requesters. GAO-05-906. September. http://www.gao.gov/new.items/d05906.pdf.

U.S. Geological Survey (USGS). 2006. Bird Checklists of the United States, Chincoteague National Wildlife Refuge. http://www.npwrc.usgs.gov/resource/birds/chekbird/r5/chinco.htm. Site accessed January 6, 2010.

Vaughn, C. R. 1993. Birds of Wallops Island, Virginia 1970-1992. NASA Technical Memorandum 104589.

Virginia Department of Environmental Quality (VDEQ). 2008a. Final 2008 305(b)/303(d) Water Quality Assessment Integrated Report for Virginia. Approved by EPA on December 18, 2008. http://www.deq.state.va.us/wqa/ir2008.html. Site accessed December 2, 2009.

VDEQ. 2008b. Federal Consistency Reviews. http://www.deq.virginia.gov/eir/federal.html. Site accessed January 16, 2008.

VDEQ. 2008c. Air Regulations Web site. Ambient Air Quality Standards, Chapter 30. http://www.deq.state.va.us/air/regulations/air30.html. Site accessed March 12, 2009.

VDEQ. 2009. State Water Control Board. 9 VAC 25-260 Virginia Water Quality Standards. Statutory Authority: § 62.1-44.15 3a of the Code of Virginia. With Amendments Effective August 20, 2009. http://www.deq.state.va.us/wqs/download.html. Site accessed December 13, 2009.

Virginia Department of Game and Inland Fisheries (VDGIF). 2009. Wildlife Species Information: Mammals. http://www.dgif.virginia.gov/wildlife/information/?t=2. Site accessed December 23, 2009.

Virginia Employment Commission (VEC). 2008. Accomack Community Profile. Economic Information Services Division. Updated February 1, 2008. http://www.alex.vec.virginia.gov/lmi/pdfs/communityprofiles/5104000001.pdf. Site accessed December 31, 2009.

VEC. 2009. Virginia Employment Commission Web site. Economic Information Services Division. Accomack Community Profile. Released March 2008.

http://www.alex.vec.virginia.gov/lmi/pdfs/communityprofiles/5104000001.pdf. Site accessed January 29, 2009.

Willis, T. No date. Avian Interactions With A Small Scale, Grid-Connected Wind Energy Project At Eastern Neck National Wildlife Refuge, Rock Hall, Maryland. Final Report. 19 pp.

The Working Group on Wind Turbine Noise. 1996. The Assessment and Rating of Noise from Wind Farms. September. ETSU-R-97. Available from: New & Renewable Energy Enquiries Bureau (ETSU). Harwell, Didcot, Oxon, OX11 0RA. Data published on the British Wind Energy Web Site at http://www.bwea.com/ref/noise.html, site accessed December 23, 2009.

Personal Communications

Caudle, William. 2010. Personal communication with Mr. Joshua Bundick regarding spacing requirements of solar panels. January.

Smith, Philip. 2009. Personal communication via email with Ms. Suzanne Richert at URS. September 19.