Final Site-Wide Environmental Assessment
Department of Energy's
National Wind Technology Center
Golden, Colorado
at the National Renewable Energy Laboratory

DOE/EA-1914

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

May 2014

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Department of Energy
Golden Field Office
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FINDING OF NO SIGNIFICANT IMPACT

SITE-WIDE ENVIRONMENTAL ASSESSMENT OF THE DEPARTMENT OF ENERGY'S NATIONAL WIND TECHNOLOGY CENTER, GOLDEN, COLORADO AT THE NATIONAL RENEWABLE ENERGY LABORATORY

DOE/EA-1914

AGENCY: U.S. Department of Energy (DOE), Office of Energy Efficiency and Renewable Energy (EERE)

ACTION: Finding of No Significant Impact (FONSI)

SUMMARY: DOE is proposing an action to continue management and operation of the National Wind Technology Center (NWTC) site in Golden, Colorado at the National Renewable Energy Laboratory (NREL), and to potentially implement the following improvements:

- Increase and enhance research and support capabilities by constructing new facilities, modifying existing facilities, upgrading infrastructure, and performing site maintenance activities in the Research and Support Facilities areas (Zone 1 and Zone 2)
- Increase site use and density by adding wind turbines, meteorological towers and associated infrastructure, and grid storage test equipment at existing and proposed field test sites (Zone 2)
- Expand NWTC's power capacity to 50 megawatts (MW)

The action described above is hereinafter referred to as the Proposed Action. The purpose of the Proposed Action is to support DOE's mission in the research and development (R&D) of energy efficiency and renewable energy technologies by providing enhanced facilities and infrastructure to adequately support state-of-the-art wind energy research and testing. The need for the Proposed Action is to support DOE's need to research and test renewable energy and distributed energy systems. In addition, the Proposed Action would provide additional resources to support DOE R&D needs and requests from industry partners for testing, research, development, deployment, and demonstration in a rapidly growing industry.

The Proposed Action could include the following activities:

- Constructing new buildings and facilities
  - Wind Turbine Component Research and Testing Facility
  - Grid Storage Test Equipment on existing test pads
  - Staging and Maintenance Warehouse

- Modifying existing buildings
  - NWTC Administration Building addition
  - Structural Testing Laboratory addition
  - Distributed Energy Resources Test Facility upgrades
  - 2.5 Megawatt (MW) Dynamometer upgrades
  - Cool roof upgrades
  - Other modifications to existing buildings and facilities
- Upgrading infrastructure
  - Connecting the drinking water system to a municipal water supply
  - Installing a water tank to provide a reliable source for fire suppression
  - Upgrading on-site sewage treatment systems
  - Paving and widening onsite access roads
  - Routing new or upgrading existing data and telecommunications systems
- Routine activities for new or modified buildings and infrastructure
  - Routine technical tasks for research activities
  - Routine tasks for site maintenance
- Installing additional wind turbines, meteorological towers, and field test sites
  - Up to three utility-scale wind turbines (1 to 5 MW)
  - Up to four additional mid-scale wind turbines (from 100 watt to 1 MW)
  - Up to 11 additional small wind turbines (from 1 watt to 100 kilowatts)
- Upgrading on-site electrical infrastructure to provide for additional power capacity, up to 50 MW
  - Constructing an on-site electrical substation
  - Installing the on-site portions of a transmission line interconnect with the local utility

DOE completed Environmental Assessment (EA) DOE/EA-1914 to evaluate the potential environmental impacts of the Proposed Action. The analysis provided in the EA supports DOE's determination that the Proposed Action will not significantly affect the quality of the human and natural environment. The EA is hereby incorporated into this FONSI by reference.

DOE places a strong emphasis on avoiding, minimizing, and mitigating potentially adverse environmental impacts. As set forth in Section 4.6 of the EA, DOE and NREL have committed to incorporating additional measures and procedures to avoid, minimize, or mitigate environmental impacts during operation of the NWTC. Any contractors working on the NWTC would also be required to follow these committed measures, which are intended to ensure that the potential for adverse impacts to natural and cultural resources are minimized, if not eliminated. All applicable federal and state statutes and regulations would be followed in implementing the Proposed Action. Site-specific environmental protection and sustainable policies and the procedures associated with these policies are in place for protecting and enhancing the vegetation, wildlife, and natural resources of the laboratory sites; preventing pollution; complying with environmental requirements; and encouraging continual improvement in environmental protection and sustainability performance.

Context of Potential Impacts

DOE must evaluate the significance of an action in several different contexts, such as society as a whole (human, national), the affected region, the affected interests, and the locality. Significance varies with the setting of the Proposed Action. For instance, in the case of a site-specific action, significance would usually depend upon the impacts in the locale rather than in the world as a whole. Both short- and long-term impacts are relevant.

The Proposed Action is located in northwest Jefferson County, approximately 16 miles northwest of Denver. The 305-acre site is near the intersection of Colorado State Highways 93 and 128, between the cities of Boulder and Golden, and is approximately 15 miles north of the NREL South Table Mountain campus. The Jefferson/Boulder county line is the site's northern boundary line. The NWTC facility is surrounded primarily by open space and grazing land. The Rocky Flats National Wildlife Refuge borders the site on the south and east. The nearest residence is approximately 2,200 feet to the west of the site. There are no other residences within a four-mile radius of the NWTC. Two trailheads that access City of Boulder Open Space and Mountain Parks lands are located approximately 4,000 feet north and 5,000 feet northwest of the NWTC.

Based on the analysis in the EA, adverse impacts of the Proposed Action would range from negligible to minor due to the nature of the proposed activities. The impacts are limited to the local geographic area and are small-scale in nature. In addition, DOE and NREL have committed to implementing the measures listed in Section 4.6 of the EA to minimize or avoid potential environmental impacts. The Proposed Action itself would not cause any significant or cumulative adverse impacts nationally, regionally, locally, or at the statewide level.

Intensity of Potential Impacts

The following discussion is organized around the ten (10) intensity factors, described in the Council for Environmental Quality NEPA Implementing Regulations, 40 CFR 1508.27, which refer to severity of impact. The intensity of impacts considered is in terms of the following:

1) Impacts that may be both beneficial and adverse: As discussed in the EA, DOE analyzed and considered the beneficial and adverse impacts to relevant resource areas. An adverse impact is defined as a change that moves the resource away from a desired condition or detracts from its appearance or condition, while a beneficial impact would result in a positive change in the condition or appearance of the resource or a change that moves the resource toward a desired condition.

The analysis found that the Proposed Action would result in no adverse impacts to land use, traffic and transportation, visual quality and aesthetics, cultural resources, water resources, geology and soils, hazardous materials and waste management, utilities and infrastructure, and socioeconomics and environmental justice. Short-term, minor, adverse impacts on the noise environment would be expected due to heavy equipment noise generated during the construction of new facilities and wind turbines; however, operation of the new facilities and wind turbines would not have an adverse impact on the ambient noise environment and would comply with local noise ordinances for off-site

human receptors. Localized short-term, minor impacts on air quality would occur during construction activities due to fugitive dust and vehicle emissions, but would not impact regional air quality. Total annual CO_2 emissions from all activities in the Proposed Action would range from 9 to 22 percent of the threshold greenhouse gas emissions in the Council of Environmental Quality's (CEQ) guidance and would, therefore, not have an adverse effect on climate change.

Short- and long-term, minor, adverse impacts on vegetation would likely occur for construction of new facilities in previously undisturbed areas due to loss of vegetative cover and plant abundance. These impacts would be minimized by revegetating in accordance with NREL's stormwater pollution prevention procedures for construction activities at the NWTC. Long-term negligible impacts on wildlife would be expected from implementing the Proposed Action due to loss of foraging, nesting, and burrowing habitat within the project area. Based on surveys conducted at the NWTC, long- and short-term, direct, negligible adverse impacts on avian and bat population are anticipated from implementing the Proposed Action. Impacts on vegetation and wildlife at the NWTC would be minimized by Best Management Practices (BMPs) established in NREL's Natural Resource Conservation Program.

Beneficial impacts to the onsite transportation network would result from paving the gravel roads that provide access to the field test sites. Connection of the NWTC to a municipal water supply and construction of upgrades to the on-site sanitary sewer facilities would result in long-term, beneficial impacts on these systems at the NWTC by providing a reliable water source and adequate treatment capacity. Likewise, long-term, beneficial impacts would be expected as improvements in the electrical system would provide a modern electrical system to support expanded research and development activities at the NWTC. Additionally, long-term beneficial impacts to personnel and public safety are anticipated by providing improved water supply and water pressure for fire suppression. Short-term and long-term beneficial impacts to the socioeconomic climate would be realized from the proposed construction activities and the increase in payroll tax revenues, purchase of materials, and purchase of goods and services from a larger permanent workforce.

The Proposed Action would not result in significant irreversible resource commitments. Minor irretrievable impacts would occur as a result of construction, facility operation, and maintenance activities. Nonrenewable fossil fuels would be irretrievably lost through the use of gasoline and diesel fuel used to power worker vehicles and construction equipment during construction activities.

The EA evaluated adverse impacts of the Proposed Action separately from beneficial impacts, to determine whether such adverse impacts would have been significant in their own right, and no such impacts were found to be significant. In no cases did the analysis in the EA use beneficial impacts to offset the potential significance of any adverse impact. In addition, the EA did not use any long term beneficial impacts to offset the potential significance of any short term adverse impacts.

Accordingly, DOE concludes the Proposed Action will not have any significant adverse impacts and that the Proposed Action would have beneficial impacts to utilities and infrastructure, health and safety, and socioeconomics.

2) The degree to which the proposed action affects public health or safety:

The Proposed Action would not have an adverse affect on public health or safety. The NWTC is fenced around its entire perimeter and the only point of access is the security gate at the northeast corner of the site. Any visitors to the NWTC must check in at the security gate and provide government-issued photo identification to obtain a security badge before entering the site. All contractors performing construction activities at the site must conform to applicable federal, state, and DOE and NREL site-specific health and safety policies.

The Proposed Action would not offer any credible targets of opportunity for terrorists or saboteurs to inflict major adverse impacts to public health or safety, nor would the Proposed Action render the NWTC site as a whole any more susceptible to such intentional destructive acts that could further affect public safety.

3) Unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas:

Seven parcels of land accounting for approximately 22 percent of the NWTC have been designated as conservation management areas to protect the site's unique natural resources. These include two groundwater seep wetlands along hillsides, a seasonal pond, two headwater wetlands along ephemeral drainages, remnant tallgrass prairie within mesic mixed grassland, a prairie dog re-location area, areas designated as ancient soils, and an area designated as critical habitat for the Preble's meadow jumping mouse. Conservation management areas are managed in accordance with NREL's Natural Resource Conservation Program, which requires a higher level of review before any land disturbance. The NWTC is surrounded by parklands, including dedicated City of Boulder Open Space and Mountain Parks lands to the north, Jefferson County open space to the west, and the Rocky Flats National Wildlife Refuge to the east and south. A visual impacts analysis was conducted as part of the EA that compared photographs of the existing turbines and meteorological towers taken from several vantage points, including the closest trails and trailheads, with visual simulations of the proposed additional turbines and meteorological towers from the same vantage points. Eleven cultural sites are located within the viewshed of the NWTC and are discussed under intensity factor (8) below.

Based on the analysis provided in the EA, DOE has concluded that the Proposed Action would not cause any adverse impacts on unique characteristics of the geographic area.

4) The degree to which the effects on the quality of the human environment are likely to be highly controversial:

The analysis in the EA demonstrated that the impacts of the Proposed Action on the natural and human environment would be negligible to minor. Input received from federal, state, and local agencies and from the public during the scoping process and EA public comment period did reveal some concern about potential impacts to wildlife; however, biological surveys conducted at the NWTC over the past several years have indicated a relative abundance of wildlife species and only

minor impacts to typical population levels in the region due to onsite activities. Accordingly, the impacts of the Proposed Action are not highly controversial.

5) The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks:

A number of activities to be performed at the NWTC involve some level of risk to workers. DOE performed an analysis to identify those events relating to life safety and property protection that would represent the upper boundary of risk that would be presented by activities proposed for the facility. DOE assessed risks for several potential accident scenarios, including:

- Wind turbine blade failure with the partial or complete loss of one or more turbine blades
- Ice throw from turbine blades during cold weather / icing conditions
- Accidents from utility-scale energy storage systems, such as those systems using batteries or flywheels
- Loss of integrity of hydrogen generation and storage systems.

The analyses of these potential accident scenarios concluded that the risks are low and the chances of system failure are extremely remote. These risks would be further mitigated by the safety controls currently in place at the NWTC and the rigorous administrative structure in NREL's Integrated Safety Management System. Accordingly, the impacts of the Proposed Action are not highly uncertain, nor do they involve unique or unknown risks.

6) The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration:

The implementation of the Proposed Action is not likely to establish a precedent for future actions with significant impacts. The Proposed Action does not establish a precedent for future actions or represent a decision in principle about a future consideration. Neither scoping nor public comments raised any disputes pertaining to the appropriate scope of the Proposed Action, connectedness of other actions, or reasonably foreseeable future actions other than those considered. Accordingly, the Proposed Action would not establish a precedent.

7) Whether the action is related to other actions with individually insignificant but cumulatively significant impacts:

This Site-Wide EA considered past, present, and reasonably foreseeable short-term and long-term future actions at the NWTC as part of the Proposed Action. It also considered offsite factors and reasonably foreseeable offsite projects in a cumulative impacts scenario for analysis that included the adjacent Rocky Flats National Wildlife Refuge, transportation and infrastructure improvements, mining and reclamation activities, and transmission line upgrades. Five potentially affected resource areas were considered for cumulative impacts: land use, traffic and transportation, visual quality and

aesthetics, biological resources, and utilities and infrastructure. No significant cumulative impacts were anticipated for these resource areas.

As supported by the cumulative impacts analysis, DOE concludes the cumulative impacts of the Proposed Action would not be significant, and the Proposed Action is not related to other actions, that when combined, would have significant impacts.

8) The degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places (NRHP) or may cause loss or destruction of significant scientific, cultural, or historical resources:

Pursuant to Section 106 of the National Historic Preservation Act (16 U.S.C. 470 et seq.), DOE initiated consultation with six representatives of four tribes on July 17, 2013. The tribes were requested to provide information on properties of traditional religious and cultural significance within the vicinity of the Proposed Action and any comments or concerns they might have regarding the potential for the Proposed Action to affect those properties. No responses were received.

On August 21, 2013, DOE initiated consultation with the State Historic Preservation Office (SHPO). In the consultation letter, DOE summarized the results of earlier cultural resource surveys conducted at the NWTC and a more recent survey that identified a 6.5-acre area in the northwest portion of the site with a higher potential for prehistoric archaeological resources. DOE determined that the area would not be affected, because no actions are proposed for the identified area. In the event of any inadvertent archaeological discoveries, the SHPO would be contacted for resolution and further instruction regarding additional studies and potential avoidance, minimization, or mitigation measures in accordance with the National Historic Preservation Act.

DOE also provided the SHPO with the results of a viewshed analysis for historic properties within a two-mile radius of the highest visible feature at the NWTC. Eleven cultural resource sites were identified within the viewshed, one of which was listed on the National Register of Historic Places. This site, the former Rocky Flats Plant, has been demolished and the land restored to prairie grassland. The SHPO in a letter dated September 9, 2013, concurred with DOE's determination that the Proposed Action would result in no adverse effect on historic properties.

Accordingly, DOE concludes the Proposed Action will have no adverse effect on districts, sites, highways, structures, or objects listed or eligible for listing in the National Register of Historic Places.

9) The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act (ESA) of 1973:

On October 22, 2013, DOE initiated informal consultation with the U.S. Fish and Wildlife Service (USFWS), Region 6 Mountain-Prairie Region, for compliance with Section 7 of the Endangered Species Act, the Migratory Bird Treaty Act, and the Bald and Golden Eagle Protection Area. The USFWS in their January 15, 2014 response letter concurred with DOE's finding that the Proposed Action would not adversely affect the federally threatened Preble's meadow jumping mouse. The

USFWS also concurred with DOE's determination that the Proposed Action would have no effect on the federally threatened Ute ladies'-tresses orchid, Colorado butterfly plant, or Pawnee montane skipper. The January 15, 2014 response letter also provided guidance for wind energy projects, including USFWS recommendations for migratory birds, bald and golden eagles, and the Region 6 Outline for a Bird and Bat Conservation Strategy for Wind Energy Projects. Copies of the informal consultation letter and the USFWS response are found in **Appendix F** of the Final EA.

The USFWS requested that DOE initiate formal consultation for water-related activities under the Proposed Action which could affect federally listed species or critical habitat in downstream water-depleted regions along the Platte River in Nebraska. Water-related projects that need a federal authorization, funding, or are carried out by a federal agency require consultation with the USFWS under the ESA. On June 16, 2006, the USFWS issued a programmatic (Tier 1) biological opinion (PBO) for the Platte River Recovery Implementation Program (PRRIP) and water-related activities affecting flow volume and timing in the central and lower reaches of the Platte River in Nebraska. The action area for the PBO included the Platte River basin upstream of the confluence with the Loup River in Nebraska, and the main stem of the Platte River downstream of the Loup River confluence.

Individual water projects undergoing ESA consultation are required to offset the effects of these depletions on the ESA listed species. With the PRRIP in place, streamlined procedures are available for project proponents to seek ESA coverage under the Program umbrella. The South Platte Water Related Activities Program, Inc. (SPWRAP) is a Colorado nonprofit corporation established by Colorado water users for the purpose of representing water users' interests and partnering with the State of Colorado to implement the PRRIP in central Nebraska. All water-related activities requiring federal approval will be reviewed by the USFWS to determine if they meet two criteria: (1) that the activities comply with the definition of existing water-related activities and/or (2) that the proposed new water-related activities are covered by the applicable state's or the federal depletions plan.

DOE initiated formal consultation with the USFWS and submitted a streamlined biological assessment on January 15, 2014. Water use at the NWTC was determined to be greater than 0.1 acre-feet per year (*de minimus* for consultation) and is considered an adverse effect to Platte River species in Nebraska. The USFWS issued a site-specific (Tier 2) biological opinion to DOE on April 25, 2014. The USFWS determined that the Proposed Action meets the above criteria and, therefore, the Tier 2 biological opinion can tier from the June 16, 2006 PBO. Specifically, the USFWS determined that the flow-related adverse effects of the Proposed Action are consistent with those evaluated in the Tier 1 PBO for the whooping crane, interior least tern, piping plover, pallid sturgeon, western prairie fringed orchid, and whooping crane critical habitat and that these effects on flows are being addressed in conformance with the Colorado Plan for Future Depletions of the PRRIP. Copies of the formal consultation letters, including DOE's biological assessment and the USFWS's biological opinion, are found in **Appendix F** of the Final EA.

Based on analysis provided in the EA and consultation with the USFWS, DOE has concluded that the Proposed Action will not adversely affect an endangered or threatened species or any critical habitat on the NWTC site and that adverse effects to downstream species on the South Platte River due to water depletion are addressed by operation of the Colorado Plan for Future Depletions, as part of the PRRIP and the City of Boulder's membership in the SPWRAP program.

10) Whether the action threatens a violation of federal, state, or local law or requirements imposed for the protection of the human environment:

The Proposed Action does not violate any federal, state, or local law or requirement imposed for the protection of the environment. DOE and NREL have committed to implementing BMPs to avoid or mitigate any potential impacts concerning soils and erosion control, vegetation, and wildlife. The Proposed Action and BMPs are consistent with applicable federal, state, and local laws and requirements for the protection of the environment and with agency policy and direction.

Implementation of the Proposed Action may involve permits, notifications, and registrations required by federal, state, or local laws and ordinances. Additional project-specific permits may be associated with the Proposed Action. Both current and potential permits, notifications, and registrations are listed in **Appendix E** of the final EA.

Conclusion:

Based on the EA and the above considerations, DOE finds that the Proposed Action is not a major action that constitutes a significant effect on the human environment. This finding and decision is based on the consideration of DOE's NEPA implementing regulations (10 CFR Part 1021) and the Council on Environmental Quality's (CEQ) criteria for significance (40 CFR 1508.27), both with regard to the context and the intensity of impacts analyzed in the EA. Accordingly, the Proposed Action does not require the preparation of an environmental impact statement.

For questions about this FONSI or the Final EA, please contact:

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Issued in Golden, Colorado this 14 day of May 2014.

FOR Carol J. Battershell
Manager

DOE/EA-1914

FINAL

SITE-WIDE ENVIRONMENTAL ASSESSMENT
DEPARTMENT OF ENERGY'S
NATIONAL WIND TECHNOLOGY CENTER
GOLDEN, COLORADO
NATIONAL RENEWABLE ENERGY LABORATORY

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MAY 2014

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Acronyms and Abbreviations

$\mu g/m^3$	micrograms per cubic meter
APE	area of potential effect
APEN	Air Pollution Emissions Notice
AQCR	air quality control region
AST	aboveground storage tanks
bgs	below ground surface
BMP	best management practices
CAA	*Clean Air Act*
CCR	Code of Colorado Regulations
CDPHE	Colorado Department of Public Health and the Environment
CEQ	Council on Environmental Quality
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CESQG	conditionally exempt small quantity generator
CFR	Code of Federal Regulations
CGI	controllable grid interface
CO	carbon monoxide
CO_2	carbon dioxide
CRADA	competitive research and development agreements
C.R.S.	Colorado Revised Statutes
CSA	combined statistical area
CY	calendar year
dBA	A-weighted decibel
DERTF	Distributed Energy Resources Test Facility
DNL	day-night average sound level
DOE	Department of Energy
EA	environmental assessment
EDE	effective dose equivalents
EERE	Energy Efficiency and Renewable Energy
EHS	Environmental Health and Safety
EIS	environmental impact statement
EISA	*Energy Independence and Security Act*
EO	Executive Order
EPA	Environmental Protection Agency
ESA	*Endangered Species Act*
FAA	Federal Aviation Administration
FES	flywheel energy storage
FONSI	finding of no significant impact
FY	fiscal year
GHG	greenhouse gas
HAP	hazardous air pollutant
Hwy	Highway
IEC	International Electrotechnical Commission
kV	kilovolt
kW	kilowatt
LEED	Leadership in Energy and Environmental Design

LIDAR	light detection and ranging
LLP	Laboratory Level Procedure
LOS	level of service
MBTA	*Migratory Bird Treaty Act*
mg/m^3	milligrams per cubic meter
MOU	memorandum of understanding
MSA	metropolitan statistical area
MW	megawatt
NAAQS	National Ambient Air Quality Standards
NANSR	Nonattainment Major New Source Review
NASA	National Aeronautics and Space Administration
NEPA	*National Environmental Policy Act*
NHPA	*National Historic Preservation Act*
NO_2	nitrogen dioxide
NO_x	oxides of nitrogen
NOI	Notice of Intent
NPL	National Priorities List
NREL	National Renewable Energy Laboratory
NRHP	National Register of Historic Places
NSR	New Source Review
NWTC	National Wind Technology Center
OE	Office of Electricity Delivery and Energy Reliability
O&M	Operations and Maintenance
OHSAS	Occupational Health and Safety Assessment Series
OSHA	Occupational Safety and Health Administration
OSMP	Open Space and Mountain Parks
P.L.	Public Law
$PM_{2.5}$	particulate matter equal to or less than 2.5 micrometers in diameter
PM_{10}	particulate matter equal to or less than 10 micrometers in diameter
ppb	parts per billion
PPE	personal protection equipment
ppm	parts per million
PSD	Prevention of Significant Deterioration
psi	pounds per square inch
psig	pounds per square inch gauge
PV	photovoltaic
R&D	research and development
RCRA	*Resource Conservation and Recovery Act*
RFETS	Rocky Flats Environmental Technology Site
SC	state special concern (species designation in Colorado)
SIP	state implementation plan
SHPO	State Historic Preservation Office
SO_2	sulfur dioxide
SODAR	sonic detection and ranging
SOP	safe operating procedure
SPCC	Spill Prevention Control and Countermeasures
SSP	Site Sustainability Plan

SSPP	Strategic Sustainability Performance Plan
STL	Structural Testing Laboratory
SWP	Safe Work Permit
SWPPP	Stormwater Pollution Prevention Plan
TOSS	Turbine Operational Safety Strategy
tpy	tons per year
U.S.C.	*United States Code*
USFWS	United States Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	volatile organic compound
W	watt
WFO	Work for Others
Wind2H2	Wind-to-Hydrogen (project)
WNS	White-nose Syndrome

Site-Wide Environmental Assessment of the Department of Energy's National Wind Technology Center, Golden, Colorado at the National Renewable Energy Laboratory

1. INTRODUCTION

The U.S. Department of Energy (DOE) is proposing an action to continue management and operation of the National Wind Technology Center (NWTC) site in Golden, Colorado at the National Renewable Energy Laboratory (NREL), and to potentially implement the following improvements:

- Increase and enhance research and support capabilities by constructing new facilities, modifying existing facilities, upgrading infrastructure, and performing site maintenance activities in the Research and Support Facilities areas (Zone 1 and Zone 2)
- Increase site use and density by adding wind turbines, meteorological towers and associated infrastructure, and grid storage test equipment at existing and proposed field test sites (Zone 2)
- Expand NWTC's power capacity to 50 megawatts (MW)

The action described above is referred to throughout this document as the Proposed Action. The improvements would provide facilities and infrastructure that would adequately support the site's purpose and DOE's Office of Energy Efficiency and Renewable Energy (EERE) mission to research and develop renewable energy and energy efficiency technologies.

In accordance with the *National Environmental Policy Act* of 1969, as amended [42 United States Code (U.S.C.) 4321 et seq.) (NEPA), and DOE's NEPA implementing regulations [10 Code of Federal Regulations (CFR) Part 1021], DOE is required to evaluate the potential environmental impacts of DOE facilities, operations, and related funding decisions prior to taking action. DOE must apply the NEPA review process early in the planning stages for DOE proposals, and use the information to make an informed decision prior to undertaking a proposed action.

In 1996, DOE issued the *National Wind Technology Center Site-Wide Environmental Assessment* (DOE/EA-1127) and a Finding of No Significant Impact (FONSI) for site and infrastructure upgrades including constructing up to 20 new turbine field test sites, installing underground data and telecommunication cables, installing electrical infrastructure, improving site access roads, and operating and testing wind turbines. Operation and testing activities analyzed in the environmental assessment (EA) included ongoing installation, maintenance, operation, and testing of up to 20 wind turbines, and subsequent removal of wind turbines.

In May 2002, DOE issued the *Final Site-Wide Environmental Assessment of the National Renewable Energy Laboratory's National Wind Technology Center* (DOE/EA-1378) and a FONSI for proposed short-term and long-term improvements at the NWTC. Short-term improvements included:

- Expanding the Structural Blade Testing Facility and Dynamometer test facility
- Installing 20 additional field test sites and three utility-scale turbines
- Installing additional smaller turbines
- Constructing the Distributed Energy Resources Test Facility (DERTF)
- Installing a 25-kilowatt (kW) electrolyzer system
- Research activities, building renovations, and modifications.

Long-term improvements included:

- 50,000 square feet of additional laboratory, office, or other support space
- Two additional utility-scale turbines
- New roadways and parking areas.

To address future agency plans, functions, programs and resource utilization, and changes to the regional environment, DOE has determined that a new comprehensive site-wide EA should be prepared to address potential impacts of continued operations, future site development, and changes in the local environment, as defined in the Proposed Action.

1.1 The National Environmental Policy Act and Related Procedures

NEPA, the Council on Environmental Quality (CEQ) NEPA regulations (40 CFR Parts 1500 to 1508), and DOE's NEPA implementing regulations (10 CFR Part 1021) require that DOE consider the potential environmental impacts of a proposed action before making a final decision about federal actions that could have environmental effects. The intent of NEPA is to help decision makers make well-informed decisions based on an understanding of the potential environmental consequences and take actions to protect, restore, or enhance the environment.

The CEQ regulations prescribe a structured approach for all federal agencies to use for environmental impact analysis. This approach also requires federal agencies to use an interdisciplinary and systematic process for decision making. This process evaluates a proposed action's potential environmental consequences and alternative courses of action. An EA provides evidence and analysis for determining whether to prepare a FONSI or if an environmental impact statement (EIS) is necessary. The EA can aid in an agency's compliance with NEPA when an EIS is unnecessary and facilitate preparation of an EIS when one would be required.

This document is a site-wide EA, similar to the documents DOE prepared for the NWTC in 1996 and 2002. DOE defines a site-wide environmental document as follows:

> A broad-scope EIS or EA that is *programmatic* in nature and identifies and assesses the individual and cumulative impacts of ongoing and reasonably foreseeable future actions at a DOE site. (10 CFR 1021.104)

A site-wide EA streamlines the environmental review process for current and future actions. It provides an overall NEPA baseline that is useful as a reference for project-specific NEPA reviews of new proposals. Site-wide EAs are conducted for a number of reasons, such as to improve and coordinate site and agency planning and to maximize cost savings. If a future project or activity requires a more detailed analysis, that project-specific evaluation can incorporate discussions from the site-wide EA by reference, in a process called tiering. At the NWTC, this Site-Wide EA will aid decisions about future use and development of the site.

In compliance with the CEQ and DOE NEPA regulations and DOE's procedures, this Site-Wide EA:

- Examines the potential environmental impacts of the Proposed Action and the No Action Alternative
- Addresses direct, indirect, and cumulative impacts
- Identifies unavoidable adverse environmental impacts of the Proposed Action and corresponding mitigation measures

- Describes the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity
- Characterizes any irreversible and irretrievable commitments of resources that would be involved should DOE decide to implement its Proposed Action

These requirements must be met before DOE can make a final decision to proceed with any proposed action that could cause adverse impacts to human health or the environment. This EA provides DOE decision makers with the information needed to make an informed decision about allocating funds for changes to the facilities and continued operation of the NWTC.

If proposals for new activities arise in the future, DOE would prepare subsequent environmental reviews or documents that would incorporate information from (that is, tier from) this EA, if applicable, and those reviews would focus only on those issues that have not been adequately addressed in this EA.

1.2 Background

The mission of DOE is to ensure the United States' security and prosperity by addressing its energy, environmental, and other challenges through transformative science and technology solutions. Various offices within DOE accomplish this mission.

1.2.1 DOE'S OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY, OFFICE OF ELECTRICITY DELIVERY AND ENERGY RELIABILITY, AND THE GOLDEN FIELD OFFICE

DOE's Office of Energy Efficiency and Renewable Energy works to strengthen the United States' energy security, environmental quality, and economic vitality through public-private partnerships. EERE leads the national effort to enhance energy efficiency and productivity, by supporting research, development, and deployment projects to bring clean, reliable, and affordable renewable energy technologies to the marketplace.

EERE has several renewable energy technology offices including the Wind Program. The goal of the EERE Wind Program is to improve the nation's overall economic strength and competitiveness, energy security, and environmental health through the development of wind technologies. This program is furthering the rapid expansion of clean, affordable, reliable domestic wind power to promote new job creation, increase rural economic development, and help meet the nation's energy needs. EERE's Wind Program works with industry, DOE national laboratories, state and local governments, and other federal agencies.

EERE's Wind Program focuses on research, testing, and field verification work needed by U.S. industry to fully develop advanced, affordable, reliable wind energy technologies; and on coordination with partners and stakeholders to overcome barriers to wind energy implementation. EERE's principal research to accomplish this goal is conducted at the NWTC.

The mission of DOE's Office of Electricity Delivery and Energy Reliability (OE) is to lead national efforts to ensure a resilient, reliable, and flexible electricity system. OE accomplishes this mission through research, partnerships, facilitation, modeling and analytics, and emergency preparedness.

Research performed in advanced distribution technologies and operating concepts at the NWTC's DERTF supports the OE by developing operational concepts and technologies to strengthen the power grid and

improve its reliability. This work includes technology development, testing and evaluation, and the development of standards and codes related to distributed generators and interconnection systems.

The DOE Golden Field Office is one of eight EERE offices. The Golden Field Office works to bring energy efficiency and renewable energy technologies, such as wind and solar power, to the world, using its greatest strengths – its understanding of business, customer-service culture, and focus on innovation – to the challenge. As the business center for EERE, the Golden Field Office builds partnerships to develop, commercialize, and encourage the use of those technologies, and in doing so, works closely with NREL, other national laboratories, the private sector, state and local governments, and many other stakeholders across the nation. The Golden Field Office also administers the contract for the management and operation of NREL.

1.2.2 NATIONAL RENEWABLE ENERGY LABORATORY

NREL is the nation's primary laboratory for research and development (R&D) of energy efficiency and renewable energy technologies. NREL's mission is to develop renewable energy and energy efficiency technologies and practices, advance related science and engineering, and transfer knowledge and innovations to the marketplace, addressing the nation's energy and environmental goals. Currently, NREL is operated for EERE by the Alliance for Sustainable Energy, LLC. NREL is a congressionally designated Federally Funded Research and Development Center specializing in energy efficiency and renewable energy.

Established in 1974, NREL began operating in 1977 as the Solar Energy Research Institute. It was designated a DOE national laboratory in September 1991 and its name was changed to NREL. NREL's activities range from fundamental research to deployment and commercialization of numerous renewable energy and energy efficiency technologies. Along with EERE, NREL supports energy efficiency and renewable energy projects for other DOE offices, other government agencies, and industry.

NREL facilities occupy five separate locations in Jefferson County, Colorado. The South Table Mountain campus and NWTC, both located in Golden, are the two main government-owned sites where R&D operations are conducted. The three other NREL-leased facilities are: (1) portions of the Denver West Office Park in Golden, (2) the Renewable Fuels and Lubricants Research Laboratory in Denver, and (3) the Joyce Street facilities in Arvada.

The 305-acre NWTC is in northwest Jefferson County, approximately 16 miles northwest of Denver. The site is near the intersection of Colorado State Highways (Hwy) 93 and 128, between the cities of Boulder and Golden, and is approximately 15 miles north of the South Table Mountain campus. The Jefferson/Boulder county line is the site's northern boundary line. A regional location map is presented in **Figure 1-1**.

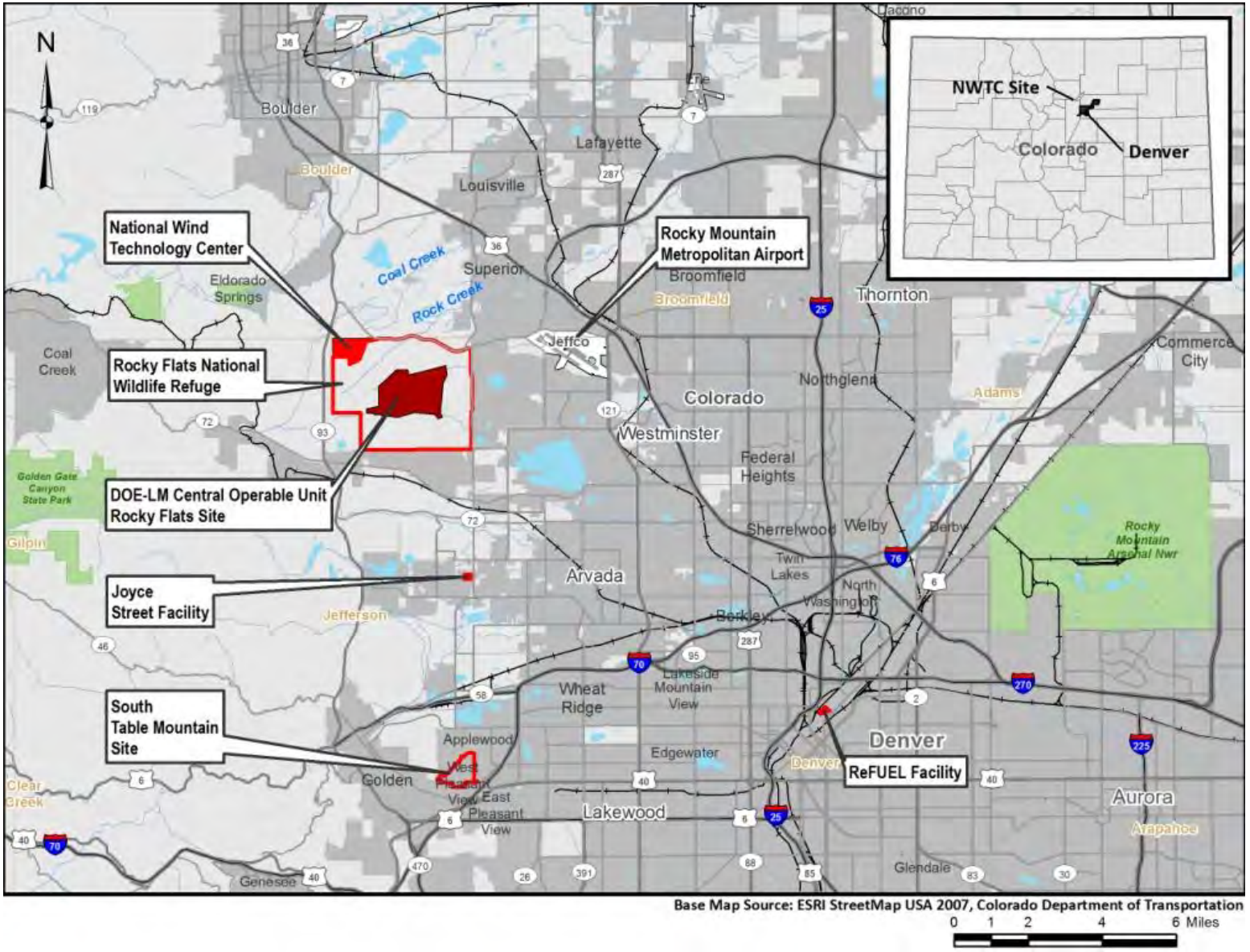


Figure 1-1. NWTC Regional Map

1.2.3 HISTORY OF THE NATIONAL WIND TECHNOLOGY CENTER

Since the mid-1970s, DOE has conducted wind R&D activities at the NWTC, formerly the Wind Energy Test Center, located in the northwest corner and outside the buffer zone of the DOE-owned former Rocky Flats Environmental Technology Site (RFETS), now designated as the Rocky Flats National Wildlife Refuge. DOE transferred ownership of the NWTC property located in the buffer zone from the Rocky Flats Office to the DOE Golden Field Office on March 24, 1993.

Rocky Flats National Wildlife Refuge was authorized by Congress in 2001. The National Wildlife Refuge is a portion of a 6,240-acre former nuclear weapons production facility (Rocky Flats Plant) operated by DOE from 1952 to 1992. After 1992, the property was designated as the RFETS. Although RFETS was designated as a National Priorities List (NPL) site under the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA), the buffer zone was managed as a "no activity zone" during the production years of the Rocky Flats Plant. Therefore, the U.S. Environmental Protection Agency (EPA) did not include the NWTC in the Rocky Flats NPL site (EPA 2003).

At the Rocky Flats Plant, plutonium triggers for nuclear warheads were manufactured in a 385-acre area in the middle of the site known as the Industrial Area or Central Operable Unit (see **Figure 1-1**). The NWTC is located approximately 4,500 feet northwest and upgradient of the Central Operable Unit. In 1989, weapons production at Rocky Flats ceased. Environmental remediation and closure began in 1992. Remediation at RFETS was conducted in accordance with CERCLA and *Resource Conservation and Recovery Act* (RCRA) regulations. DOE completed the cleanup in accordance with the Rocky Flats Cleanup Agreement, with oversight from the EPA and the Colorado Department of Public Health and Environment (CDPHE), on May 25, 2007. Under the *Rocky Flats National Wildlife Refuge Act* of 2001 (Rocky Flats Act), most of the 6,240-acre RFETS became the Rocky Flats National Wildlife Refuge in 2007 following certification from the EPA that cleanup and closure had been completed. Because of ongoing monitoring requirements, the Central Operable Unit in the center of the refuge will remain under the jurisdiction of DOE. The Rocky Flats site transferred to the DOE Office of Legacy Management in 2008. This office conducts the required operation and maintenance of remedial action systems, routine inspection and maintenance, and records-related activities.

The 305-acre NWTC property owned by DOE includes all of the surface rights. However, DOE does not own the mineral rights for the western 160 acres of the NWTC; these rights were historically owned by Rocky Mountain Fuel, which transferred them to NRC-CO, LLC on June 13, 2008. These mineral rights apply to the extraction of coal, shale, oil, and natural gas.

A company mining the property immediately adjacent to the NWTC's southern boundary held the mineral rights to the eastern 145 acres of the site until 2011. The mining company executed a lease surrender of their mining rights to the 145 acres to DOE on December 21, 2011, through an agreement with the Rocky Flats Natural Resource Damages Trustee Council (Rocky Flats Trustee Council 2009). The Trustee Council consists of representatives from CDPHE, the Colorado Attorney General's Office, the Colorado Department of Natural Resources, the DOE Office of Legacy Management, and the U.S. Department of the Interior. The memorandum of understanding (MOU) between DOE and the Trustee Council, the Natural Resource Conservation Program, and DOE's environmental management commitments are discussed in **Section 3.9.2.2** and **Section 4.6**.

Historically, the NWTC is EERE's and the nation's principal research site for wind power and distributed energy resources and it is a strategic asset important to EERE's Wind Program. Distributed energy resources are small-scale technologies, generally placed near the point of energy consumption, versus traditional "centralized" systems where electricity is generated at a remotely located large-scale power plant and then transmitted through power lines to the consumer (NREL 2013a). The NWTC has unique

capabilities that support the EERE Wind Program and the U.S. wind industry. NREL is an established leader accredited in wind field research, with the NWTC staff possessing more than 30 years of experience as unbiased technology evaluators with the ability to conduct wind turbine certification testing per International Electrotechnical Commission (IEC) standards accredited by the American Association of Laboratory Accreditation. Testing turbines in accordance with IEC standards includes evaluating noise levels at different wind speeds, duration performance over long periods of time, testing mechanical loads to validate simulation models, testing power performance at different wind speeds, testing power quality to assess power, flicker, and harmonics levels, and testing safety/function to verify manufacturer claims.

The NWTC's location near the mouth of Eldorado Canyon was selected because of intermittent, extreme high-wind characteristics that are favorable to research. The high wind events (with wind gusts up to 125 miles per hour) are generally seasonal with periods of calm winds between high wind events. These conditions are ideal for testing individual turbine performance under extreme wind conditions. They are not the type of conditions that are desired for full-time wind power generation (such as at a wind farm, where a group of a few to several hundred turbines produce electric power). There are no short-term or long-term plans to convert the site to a dedicated renewable energy generation facility.

Wind turbines and other energy generating facilities at the NWTC will continue to contribute power to the local electrical distribution system as a natural byproduct of the research and testing activities onsite. The current NWTC electrical generation capacity is 11.2 MW. However, turbine operations are curtailed to stay below an existing 10 MW generation limit, in accordance with an agreement with Xcel Energy, the local electric and natural gas company (see **Section 3.11.2**). As a result, some turbines must be shut down when others are operating.

Given the NWTC's mission as a Federally Funded Research and Development Center, wind turbines and other generation devices at the NWTC are most likely to be prototypes and advanced technology demonstration projects undergoing R&D and testing. To accomplish this objective, existing NWTC turbines are frequently shut down to enable installation of instrumentation and measurement devices, often removed from service to swap out and upgrade components, and selectively operated under specific wind conditions.

The NWTC's unique extreme-event wind conditions are ideal for full-scale turbine tests, including tuning simulation models, discovering potential problems, and verifying design requirements. It is during these extreme wind events, when all or most of the test turbines are operating, that the NWTC maximizes its power generation output. Even though the occurrence of extreme winds is much more common at the NWTC than conventional wind farm sites, the annual average wind speed is very low, mostly because winds are relatively calm during the spring and summer months (May through September). This period of calm is ideal for the NWTC's testing mission, as it enables installation and instrumentation of new prototype machines.

1.3 Purpose of and Need for Proposed Action

The purpose of the Proposed Action is to support DOE's mission in the R&D of energy efficiency and renewable energy technologies by providing enhanced facilities and infrastructure to adequately support state-of-the-art wind energy research and testing.

The need for the Proposed Action is to support EERE's and OE's needs to research and test renewable energy and distributed energy systems. In addition, the Proposed Action would provide additional resources to support DOE R&D needs and requests from industry partners for testing, research, development, deployment, and demonstration in a rapidly growing industry.

The NWTC would support strategic EERE wind energy goals through focused R&D, industry partnerships, and competitive funding awards to:

- Develop new cost-effective wind technologies
- Reduce the cost of wind energy to be competitive with other energy sources
- Increase the reliability of wind systems
- Provide new testing capabilities related to the study of wind farms
- Develop cost-effective distributed and small-scale wind technologies
- Increase the deployment of wind energy by facilitating the installation of wind systems

The NWTC would support the development of technologies that enable distributed generation [for example, photovoltaic (PV), wind, fuel cells, and microturbines], energy storage, and direct load control technologies to be integrated into the electric system, focusing on activities that would:

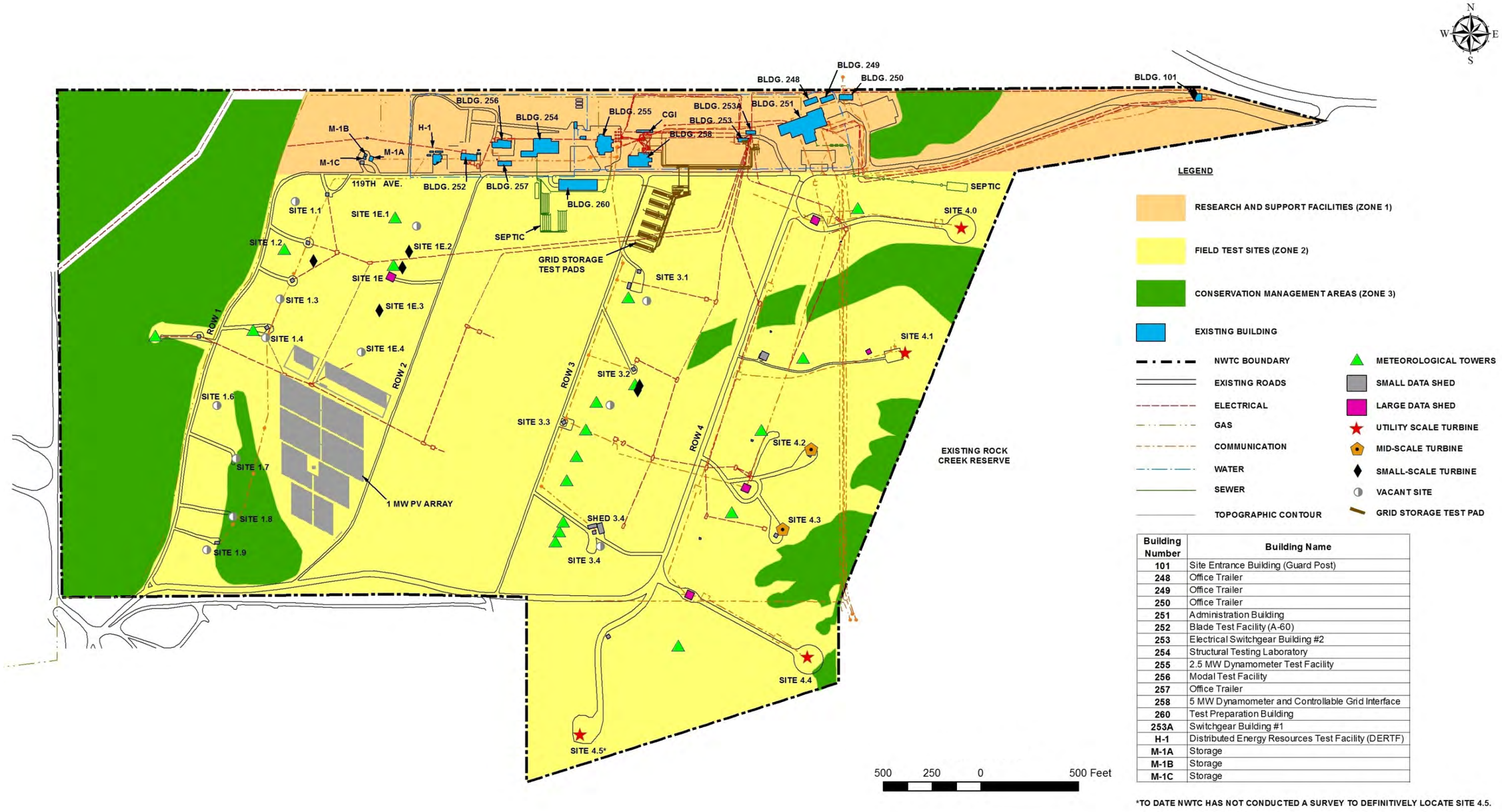
- Increase strategic research
- Research generation and storage of multiple renewables on one system
- Promote systems integration to industry and others outside of DOE
- Mitigate regulatory, economic, and institutional barriers

1.4 Description of Existing Facilities

The NWTC is divided into three zones. Zone 1, located between the north property boundary and the primary access road (West 119th Avenue), contains the Research and Support Facilities and includes offices, laboratories, and associated support infrastructure. Zone 2 is generally located south of the Research and Support Facilities and contains the field test sites that perform research and analysis of wind turbine components and prototypes ranging from small, home-scale devices (less than one kW) to large commercial utility-scale turbines capable of generating up to three MW of electricity. The field test sites also allow fundamental research to be conducted on aerodynamic and mechanical behavior of turbines, turbine interaction with atmospheric conditions, and distributed generation power components and systems. Zone 3, located along the western boundary with other smaller areas interspersed across the site, contains conservation management areas. Existing site facilities are shown in **Figure 1-2**. Surrounding land uses are depicted in **Figure 2-3**. The following sections describe existing facilities and research test sites at the NWTC.

1.4.1 RESEARCH AND SUPPORT FACILITIES (ZONE 1)

There are currently seven main buildings located within Zone 1 on the NWTC site that house research and administrative functions, ranging in size from 2,469 to 22,026 square feet, as illustrated in **Figure 1-2**.



Building Number	Building Name
101	Site Entrance Building (Guard Post)
248	Office Trailer
249	Office Trailer
250	Office Trailer
251	Administration Building
252	Blade Test Facility (A-60)
253	Electrical Switchgear Building #2
254	Structural Testing Laboratory
255	2.5 MW Dynamometer Test Facility
256	Modal Test Facility
257	Office Trailer
258	5 MW Dynamometer and Controllable Grid Interface
260	Test Preparation Building
253A	Switchgear Building #1
H-1	Distributed Energy Resources Test Facility (DERTF)
M-1A	Storage
M-1B	Storage
M-1C	Storage

*TO DATE NWTC HAS NOT CONDUCTED A SURVEY TO DEFINITIVELY LOCATE SITE 4.5.

Figure 1-2. National Wind Technology Center Existing Facilities

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The NWTC Administration Building (Building 251) is 22,026 square feet and has been in service since 1982. It is the hub and primary administrative building for the site (**Photo 1**). In addition to housing administrative and research support offices, the facility's conference rooms enable NREL to host national and international wind power specialists, conferences, and meetings. In the research support offices, engineers develop state-of-the-art computer modeling software to analyze next-generation turbine designs, as well as the data collected from tests and experiments. Researchers in the support offices also conduct design review and analysis, resource assessment, and utility integration studies. The high bay in Building 251 houses a small 225 kW dynamometer (an instrument for measuring the mechanical power of a wind turbine drivetrain) for indoor testing of small wind turbine blade components and subsystems by performing static (stationary) and dynamic (moving) load testing.

Photo 1 – Building 251

The Structural Testing Laboratory (STL), formerly the Industrial Users Facility (Building 254), is 11,394 square feet and was constructed in 1996. It supports research on wind turbine blades and staging of field projects. The STL provides office space for industry researchers, experimental laboratories, computer facilities for analytical work, and space for assembling components and turbines for atmospheric testing. The facility also houses two blade stands equipped with overhead cranes and hydraulic systems, control rooms, a high bay area, and several smaller test bays that protect proprietary information while companies disassemble turbines to analyze, test, and modify individual components.

In the high bay, NWTC researchers conduct a full range of structural evaluations on turbine blades, including ultimate static-strength, fatigue, vibration, and nondestructive tests to simulate varying wind conditions (**Photos 2 and 3**). NREL's expertise helps industry partners verify and improve new blade designs, analyze blade structural properties, and improve their manufacturing processes. Various “stress tests,” including fatigue and static tests, are conducted to simulate varying wind conditions.

Photos 2 and 3 - Researchers conducting fatigue blade tests

The Test Preparation Building (Building 260) is 11,000 square feet and is used to prepare large turbine blades delivered to the site for stress testing in the STL. The enclosed area allows researchers to install strain gauges and other instruments during all weather conditions. The prepared blade is transferred to the STL for testing by a large overhead mobile gantry crane. When not in use for preparing blades,

Building 260 is used to store equipment, construction materials, light-duty maintenance supplies (such as light bulbs and electrical wires), and all-terrain vehicles used onsite.

In addition to tests on the static and dynamic strength of turbine blades, dynamometers at the NWTC enable research staff and industry to verify the performance and reliability of wind turbine drivetrain prototypes and commercial machines (Musial and McNiff 2000; NREL 2013b). The drivetrain of a wind turbine consists of a combination of gears, couplings, bearings, shafts, gearboxes, generators, controllers, and power conversion systems that are typically housed in the nacelle of the turbine. Drivetrain component designs are tested by simulating operating field conditions in a laboratory environment, without waiting for nature-driven wind events to occur. **Photo 4** shows the 2.5 MW Dynamometer and **Figure 1-3** shows how a wind turbine drivetrain is coupled and tested using the 2.5 MW Dynamometer. The test turbine is rigidly fixed to a foundation and coupled through its low speed main shaft to the dynamometer. Rotational energy supplied by the dynamometer is converted to electrical energy by the turbine's generator. In a typical dynamometer test at the NWTC, a powerful motor replaces the rotor and blades of a wind turbine and, depending on test objectives, non-torque loading actuators may apply large thrust, bending, and shear loads normally generated by the turbine's rotor.

Photo 4 – 2.5 MW Dynamometer

The NWTC's 2.5 MW Dynamometer Building (Building 255) occupies 5,571 square feet and was commissioned in 1999. This dynamometer supports duration and characterization research and performance testing on geared and direct-drive wind turbine drivetrain systems up to 2.5 MW. A 7,767 square-foot building housing a 5 MW dynamometer (Building 258) and adjacent Controllable Grid Interface (CGI) enclosure was completed in mid-2012. The 5 MW Dynamometer provides a research facility capable of characterizing 5 MW drivetrain systems. This dynamometer is able to test the largest land-based wind turbine drivetrains currently in use, and provides the most complete simulation of wind turbine operating conditions in North America. The new facility has the ability to simulate the grid connection to test low-voltage ride-through capability and response to faults and other abnormal grid conditions (DOE 2013a). The CGI allows NREL to assess the natural variability of the wind resource and study its integration into routine grid operations, particularly with regard to the effects of wind on power regulation, load following, scheduling, line voltage, and energy reserves.

The CGI is used in combination with existing facilities, turbines, and buildings to integrate research capabilities for simulating grid interactions and grid anomalies including low-voltage and zero-voltage events. That is, the CGI allows for testing the effects of voltage drops due to the sudden lack of a renewable energy source (such as wind), without affecting the grid. In addition, the CGI and the 5 MW Dynamometer interconnect existing facilities, solar PV, turbines, and buildings to provide an integrated test capability with the unique opportunity to test drivetrains, electronics systems, and full wind power systems on an independent grid on a scale greater than five MW that provides flexibility to test single or multiple energy storage equipment components simultaneously on concrete pads (NREL 2011a).

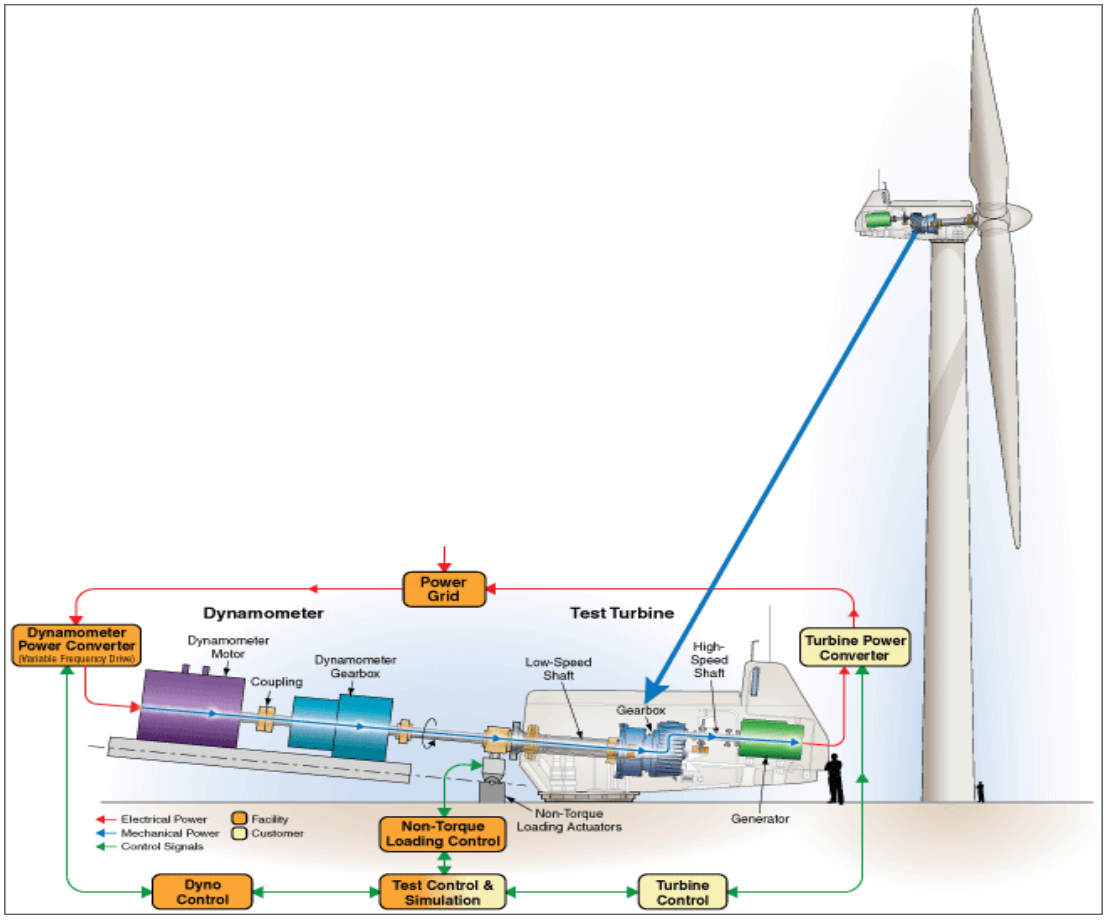

Figure 1-3. 2.5 MW Dynamometer

The DERTF (Building H-1) is a 1,790 square-foot facility located within the Research and Support Facilities area that was constructed in 1997 (see **Photo 5**). The DERTF is a working laboratory for interconnection and systems integration testing (NREL 2013a). This state-of-the-art facility includes generation, storage, and interconnection technologies, as well as electric power system equipment capable of simulating a real-world electric system. Researchers at the facility can vary equipment configurations and introduce common electrical disturbances on the replica grid. Routine tests include high voltage testing, electrical surge testing, electrical islanding testing, equipment qualification testing, and performance and reliability testing. These capabilities allow researchers to evaluate the real-time dynamics of distributed power systems, collect information about the long-term performance of such systems, and test new design concepts.

Data from tests at the facility are also used to characterize distributed energy resource equipment and support the development and validation of interconnection standards and certification tests. Distributed systems can include biomass-based generators, combustion turbines, concentrating solar power and PV systems, fuel cells, wind turbines, microturbines, engines/generator sets, storage and control technologies, and plug-in hybrid/electric vehicles. The use of test results can lead to better equipment, improvements to help equipment meet interconnection requirements, and a better understanding of the dynamics of equipment interconnected with the power grid. The facility is used by industry and academia for cooperative testing and characterization of developmental distributed energy systems.

DERTF researchers also examine issues related to renewable energy sources and hydrogen production via the electrolysis of water. The DERTF houses the Wind-to-Hydrogen (Wind2H2) demonstration project. The Wind2H2 project links wind turbines to electrolyzers, which pass the wind-generated electricity through water to split the water into hydrogen and oxygen. The hydrogen is then compressed in two stages and stored outside in five 3,500 pounds-per-square-inch gauge (psig) storage tanks and seven 6,000 psig storage tanks. The stored hydrogen can be used as fuel for internal combustion or fuel-cell electric vehicles. Alternatively, the stored hydrogen can also be used in an internal combustion or fuel cell generator. NREL is testing integrated electrolysis systems and investigating options for improved designs that will lower capital costs and enhance performance of the naturally varying power input from renewable sources to the electrolyzer.

A small scale PV solar array is connected directly to the DERTF to provide a distributed energy electrical source for supporting these research initiatives. This solar array does not generate power for the building, and the maximum output is 10 kW.

Photo 5 - The Distributed Energy Resources Test Facility (DERTF)

The Blade Test Facility (Building 252) occupies 2,469 square feet and is a small-scale facility used primarily for stress testing small blades and turbine components from 1 to 500 kW. The facility has been in operation supporting industry partners since 1990, and continually experiences a high demand for R&D of nine meter (30-foot) turbine blades.

Several smaller access control, support, and testing facilities are also located on the NWTC site. These include the Site Entrance Building or guard post, the electrical switchgear buildings, several trailers, and data sheds. Data sheds are small buildings that house instrumentation and computer equipment at a field test site that supports a turbine. Currently, the total area of all buildings at the NWTC is 56,033 square feet (NREL 2012a). There are approximately 7.6 acres of paved roads onsite, including parking areas. There are 10.4 acres of gravel roads. The total surface area covered by buildings, roads, and parking structures is approximately 20 acres, or 6.6 percent of the 305-acre property.

1.4.2 FIELD TEST SITES (ZONE 2)

Zone 2 is located south of Zone 1 and the site entrance road. Zone 2 contains the field test sites used for turbine research. As a research site, DOE and NWTC personnel work with many partners using competitive solicitations from industry, Work for Others (WFO) agreements, and DOE-funded competitive research and development agreements (CRADA) to conduct research on various turbine types and sizes. Depending on the terms of the agreement, turbines may remain onsite from one to several years. A variety of field tests are currently conducted, depending on research objectives.

Utility-scale turbine field testing includes certification testing, such as power quality and power performance tests, as well as measurements of acoustic noise, aerodynamic features, vibrations, and system fatigue. In addition, the NWTC has two advanced research turbines it uses to test new control schemes and equipment and conduct computer codes analysis. As today's utility-scale wind turbines become taller to reach wind resources found at greater heights, their structures are becoming more complex and their components more flexible and lighter weight. Control mechanisms are necessary to

prevent damage to turbines and possible system failures. However, wind turbines also must be designed to capture the maximum amount of energy from the wind, so NWTC researchers have been developing new controls to maximize energy capture and reduce wind loads on turbine components.

Mid-size turbine field tests provide data to boost the speed and scale of mid-size turbine deployment, in support of DOE's development and commercialization goals. These turbines provide engineers with platforms to field test advanced control algorithms (or computations). Control algorithms reduce turbine loading by responding to feedback measurements from blade acceleration data to reduce the turbine's load and increase energy capture. Beyond simple feedback instruments, measurements from special instrumentation, such as light detection and ranging (LIDAR) devices, provide information to use in advanced computations that further enhance turbine performance.

The small wind turbines are tested to IEC standards and in compliance with the American Wind Energy Association standards for small wind turbine systems (AWEA 2009). Small wind turbines that have been tested and certified give consumers greater confidence that the systems they install will perform within specified wind regimes as advertised by the manufacturer (NREL 2013c).

Onsite turbines are located within the research area's field test sites in Zone 2, and are aligned on north-south rows along access roads. In general, the current placement of turbines onsite is driven by research objectives and IEC certification testing (previously discussed in **Section 1.2.3**). For example, wind direction at the site is generally from northwest to southeast. The smaller turbines, located upwind on the western portion of the property, do not cause a wake (turbulence and other disturbances that form in the atmosphere downstream of a turbine) that would affect the larger turbines located on the eastern portion of the site. The existing utility-scale turbines are located on the eastern part of the site, specifically to avoid creating any wake or other disturbances of wind fetch (uninterrupted distance over which the wind blows without a significant change in direction) that might interfere with testing protocols of larger turbines. In this arrangement, neither the large nor small turbines are affected by one another, and several tests can be run simultaneously.

The NWTC's existing turbine field test sites currently support four utility-scale turbines ranging in output from 1.5 to 3 MW, three mid-scale turbines ranging from 100 to 600 kW, and nine small wind turbines ranging in size from one to eight kW (see **Table 1-1**). In addition to the wind turbines and meteorological towers, most utility-scale turbine field test sites contain a subsurface concrete pad foundation, utility infrastructure (electrical and telecommunications), an access road, a small data shed to house instrumentation and computer equipment, and one or more storage containers. Data sheds are typically 25 by 25 feet (7.6 by 7.6 meters) with insulation, heating, ventilation, and air conditioning, to house workers and monitoring equipment. A field test site for a utility-scale turbine will typically occupy 1.5 to 2 acres. For IEC testing, a typical utility-scale turbine requires 25 acres for upwind fetch. Chapter 2 contains a detailed drawing of a typical wind turbine and its components (**Figure 2-2**) and description of a typical field test site.

Table 1-1. Existing Turbines and Meteorological Towers at the NWTC

Size Range	Output	Number of Turbines	Hub Height in meters (feet)	Rotor Diameter in meters (feet)	Max. Rotor Height in meters (feet)[a]	Max. Height Meteorological Towers in meters (feet)
Utility-scale	1.5 to 3.0 MW	4	80 to 90 (262 to 295)	77 to 101 (253 to 331)	140 (459)	135 (443)
Mid-scale	100 to 600 kW	3	23 to 37 (75 to 120)	19 to 42 (62 to 138)	58 (189)	80 (262)
Small-scale	1 to 8 kW	9	9 to 24 (30 to 80)	2.1 to 8.5 (7 to 28)	29 (94)	80 (262)

[a] Maximum height from ground to tip of rotor blade at highest point of rotation.

A total of 18 field test sites are available to conduct field research on small to mid-size turbines. They are generally located on the western side of the NWTC property, along Rows 1 through 3, as shown in **Figure 1-2**. The four utility-scale field test sites are located on the eastern portion of the NWTC along Row 4, as shown on **Figure 1-2**.

1.4.3 MISCELLANEOUS SYSTEMS, TECHNICAL TASKS, AND MAINTENANCE

NREL's utility and infrastructure systems for electricity, water, natural gas, telecommunications, emergency response and fire protection, stormwater drainage, and sewage disposal are described in detail in **Section 3.11**.

1.4.3.1 Miscellaneous Renewable Energy Systems

SunEdison Origination, LLC (SunEdison) installed and currently owns and operates an eight-acre PV solar array on an easement provided by DOE on the western portion of the NWTC site. The 1.08 MW array provides power to the building and facility side of the NWTC's electrical system circuit. The PV array is metered and the power produced offsets a portion of NREL's energy consumption. A 20-year solar power and services agreement between SunEdison and DOE's Western Area Power Administration (Western) was established on December 31, 2008. Western purchases power generated from the PV array, and then sells it to the DOE Golden Field Office for use at the NWTC, through a 30-year intra-agency agreement that was executed on December 29, 2008. The location of the solar array is shown in **Figure 1-2**.

Infrastructure for energy storage systems exists in Zone 2 and connects to the CGI, five MW dynamometer, and utility-scale turbines. Infrastructure includes:

- Underground 13.2 kV cables leading from the CGI to the existing switchgear Building 253
- Underground distribution switches immediately southeast of the switchgear Building 253
- Interconnections from the underground distribution switches to the existing electrical infrastructure of the utility-scale turbines
- An array of transfer switches for interconnection to the grid storage pads
- Up to six concrete pads within a 0.6-acre footprint
- Auxiliary wiring for power and communication lines to field test sites

A small-scale solar PV panel system with a maximum output of 10 kW is located west of, and is interconnected to, the DERTF for research experiments to simulate the integration of different renewable energy sources for power production. Solar powered lights exist throughout the site. In addition, a small turbine and PV panel partially offset the electricity at the Site Entrance Building. All of the smaller supplemental renewable energy systems are connected to the building electrical circuit.

1.4.3.2 Routine Technical Tasks for Research Activities

Routine technical activities at the NWTC to facilitate research include:

- Loading and unloading large equipment (such as blades and turbine parts) from transportation vehicles with heavy equipment
- Preparing blades for testing
- Moving parts onsite with a mobile overhead gantry crane and heavy equipment
- Installing and removing wind turbines, meteorological towers, instrumentation, and associated infrastructure
- Monitoring atmospheric and wind turbine experiments
- Performing tests and certifications
- Inspecting, auditing, testing, maintaining, and repairing systems, processes, and equipment related to research
- Maintaining research equipment
- Conducting onsite environmental monitoring
- Other routine research tasks.

1.4.3.3 Routine Tasks for Site Maintenance

This category includes site activities and routine maintenance such as:

- Cleaning facilities and equipment
- Inspecting and auditing systems, processes, and equipment
- Maintaining equipment (such as drinking water tanks, mechanical rooms, and other supporting equipment)
- Maintaining landscape features (including mowing, trimming, weeding, replacing plants, upgrades, and similar activities)
- Snowplowing and minor maintenance work to roads, parking lots, and the site entrance at Hwy 128, as needed, to maintain safe and adequate traffic flow
- Controlling pests through an integrated pest management program
- Conducting preventive maintenance including items such as changing air filters and testing diesel generators
- Conducting corrective maintenance such as changing light bulbs, replacing leaking pump seals, resetting circuit breakers, and performing minor repairs
- Troubleshooting malfunctioning items and systems related to facilities

- Coordinating subcontractors who conduct water testing, integrated pest management, water deliveries, crane inspections, and minor building inspections
- Providing historical information and technical recommendations concerning building and facility operations
- Maintaining, testing, and performing minor repairs to the existing fire protection system, domestic water system (including water sample collection), and the two existing septic/leach systems used for wastewater handling (that is, pumping septic tank and changing filter)
- Other routine tasks

1.4.4 CONSERVATION MANAGEMENT AREAS (ZONE 3)

Seven parcels of land totaling approximately 69 acres, or 22 percent of the site, have been designated as conservation management areas (Zone 3) at the NWTC. These areas protect the site's natural resources and, in the westernmost area, prevent land development within critical wind corridors (upwind fetch areas) as shown in **Figure 1-2**. Designation of specific conservation management areas provides continued protection of the site's unique natural resources. NREL manages the site to minimize disturbance in these areas and implements protection measures if disturbance occurs. **Section 3.9.2.2** and **Section 4.6** provide a detailed discussion of NREL's MOUs with other agencies and commitments NREL has made to conserve these management areas.

1.4.5 ENERGY EFFICIENCY, RENEWABLE ENERGY, AND SUSTAINABILITY

NREL operates a long-standing laboratory program entitled Sustainable NREL that fosters environmental and social responsibility as part of establishing the laboratory as a global model for sustainability. Sustainable NREL advocates for all federal regulations, executive orders, DOE orders, and goals related to sustainable facility operations. This program also executes NREL-specific goals to reduce the laboratory's impacts on the community and the environment, and provides technical expertise to other organizations within the laboratory. Sustainable NREL provides leadership within the government and the community by actively mentoring and collaborating with other organizations to move sustainability into a new paradigm. NREL's campus is a living laboratory that showcases new technologies, design practices, and operating behaviors. In all campus development, NREL looks for opportunities to integrate energy efficiency and renewable energy, high-performance buildings, and sustainable transportation options. Onsite deployment of technologies developed by NREL researchers is also emphasized (NREL 2013d).

NREL's goal is to expand its leadership as a state of-the-art laboratory that supports innovative research, development, and commercialization of renewable energy and energy efficiency technologies that address the nation's energy and environmental needs. Fundamental to this goal is NREL's commitment to sustainability—operating in a manner that balances environmental, economic, and social values in the delivery of its mission. At NREL, sustainability is integral to both its research and operations. NREL is committed to demonstrating federal leadership in sustainability, working to continuously improve its performance, and to lead by example (NREL 2013d).

The Sustainable NREL policy outlines a vision for sustainability to maximize efficient use of resources, minimize waste and pollution, and serve as a positive force in economic, environmental, and community responsibility (NREL 2012b). This vision is further described through the Sustainable NREL program, which promotes campus sustainability through efforts to support fiscal responsibility through energy efficiency, deployment of renewable energy systems, recycling and composting programs, high performance sustainable buildings, greenhouse gas (GHG) management, climate change adaptation, transportation demand management, campus planning, and partnerships with the community and external

agencies. Sustainable NREL also works collaboratively with other directorates within NREL to optimize mutual benefit in project objectives and delivery (NREL 2013d).

In addition, Sustainable NREL facilitates the adoption of campus-wide behaviors and procedures to support sustainability goals (NREL 2013d). These initiatives include:

- Alternative commuting
- Alternative work schedules and telecommuting
- Green fleet creation
- GHG emissions reduction
- High performance sustainable campus and building design
- Educational outreach
- Electronic stewardship
- Energy efficiency
- Pollution prevention
- Recycling and composting
- Regional and local planning coordination
- Onsite renewable energy
- Water use efficiency and management
- Sustainable acquisitions
- Social responsibility
- Employee wellness and training

NREL has received numerous prestigious awards for outstanding commitment to sustainability. Most recently, NREL was awarded the DOE Sustainability Award for Comprehensive Energy Management Plan, the DOE Green Buy Program Gold Award, and EPA's Federal Electronics Challenge Platinum Level Award.

As a DOE national laboratory, NREL meets environmental and energy-related requirements that foster the sustainability of NREL's campus (NREL 2013d). In addition, NREL's energy efficiency, renewable energy, and sustainable design goals align with the DOE's Strategic Sustainability Performance Plan (SSPP) goals, in compliance with EO 13514. **Table 1-2** lists several DOE goals as part of the SSPP, and NREL's status in complying with that goal. In many cases, NREL exceeds the DOE goal.

Table 1-2. Goals Related to Energy Efficiency and Renewable Energy

SSPP Goal	DOE Goal	NREL Performance Status in FY 2012
(2.1)	30% energy intensity reduction by FY 2015 from a FY 2003 baseline	NREL's energy intensity decreased 29% since 2003
(2.2)	*Energy Independence and Security Act* (EISA) Section 432 energy and water evaluations	NREL conducted EISA evaluations for 50% of total site energy use.
(2.3)	Individual buildings or processes metering for 90% of electricity (by October 1, 2012); for 90% of steam, natural gas, and chilled water (by October 1, 2015)	NREL connected electricity, hot and chilled water, and natural gas meters in five new buildings to the Energy Dashboard.
(2.7)	7.5% of annual electricity consumption from renewable sources by FY 2013 and thereafter	Onsite renewable-energy sources supply 18.8% of NREL's total power

Source: NREL 2013d

The NWTC contributes considerably to NREL's onsite renewable energy generation goal (SSSP Goal 2.7). The NWTC has approximately 9.7 MW of installed wind turbine capacity and one MW from the solar array, as noted in **Table 1-3**.

Table 1-3. Onsite Renewable Energy at the NWTC

Source	Date Installed	System Capacity (MW)	FY12 Energy Produced (megawatt-hours per year)
Ground mounted PV array	2009	1.0	1,607.4
NREL research turbines	1994	1.37	25.9
Utility-scale wind turbine	2010	1.5	2,495
Utility-scale wind turbine	2011	2.3	741
Utility-scale wind turbine	2012	3.0	702
Utility-scale wind turbine	2009	1.5	363

Source: NREL 2013d

1.4.6 INTEGRATION OF OTHER ENVIRONMENTAL STATUTES AND REGULATIONS

To comply with NEPA, the planning and decision making process for actions proposed by federal agencies involves a study of other relevant environmental statutes and regulations. While not comprehensive, **Table 1-4** lists potentially applicable federal laws and regulations by resource area. **Table 1-5** lists potentially applicable state laws and regulations. However, the NEPA process does not replace procedural or substantive requirements of other statutes and regulations. It addresses them collectively in the form of an EA or EIS, which enables the decision maker to have a comprehensive view of major environmental issues and requirements associated with the Proposed Action.

Although Jefferson County does not have jurisdiction on land use and construction within the boundaries of federal lands in the county, consideration of the following local plans, policies, and planning criteria aids the assessment of potential environmental impacts from the proposed improvements and ongoing operations at the NWTC:

- Jefferson County Zoning Resolution

- Jefferson County Policies and Procedures, Part 3 - Regulations
- Jefferson County Comprehensive Master Plan
- North Plains Community Plan
- Arvada Comprehensive Land Use Plan
- Westminster Comprehensive Land Use Plan
- The Boulder Valley Comprehensive Plan
- The City of Boulder Open Space and Mountain Parks Grassland Ecosystem Management Plan
- The City of Boulder, Open Space and Mountain Parks Visitor Master Plan
- The City of Boulder, Open Space and Mountain Parks Marshall Mesa-Southern Grassland Trail Study Area Plan
- Rocky Mountain Metropolitan Airport Environs Land Use Plan

Table 1-4. Summary of Potentially Applicable Federal Statutes and Regulations

Federal Statutes and Regulations	Source
General	
National Environmental Policy Act of 1970	42 U.S.C. 4321 et seq.
Council of Environmental Quality NEPA Regulations	40 CFR Parts 1500 to 1508
Department of Energy NEPA Implementing Regulations	40 CFR Part 1021
Air Quality	
Clean Air Act of 1970 and Amendments of 1977 and 1990	42 U.S.C. 7401 et seq., as amended
National Primary and Secondary Ambient Air Quality Standards	40 CFR Part 50
Requirements for Preparation, Adoption, and Submittal of Implementation Plans, Review of New Sources and Modifications	40 CFR Part 51, Subpart I
Approval and Promulgation of Implementation Plans, Prevention of Significant Deterioration of Air Quality	40 CFR Part 52, Subpart A
National Emissions Standards for Hazardous Air Pollutants	40 CFR Part 61
State Operating Permit Programs	40 CFR Part 70
Federal Operating Permit Programs	40 CFR Part 71
Designation of Air Quality Control Regions	40 CFR Part 81, Subpart B
General Conformity Regulations	40 CFR Part 93, Subpart B
Title V Greenhouse Gas Tailoring Rule	75 *Federal Register* 31514
Federal Leadership in Environmental, Energy, and Economic Performance (5 October 2009)	Executive Order (EO) 13514
Noise	
Noise Control Act of 1972, as amended by the *Quiet Communities Act* of 2005	42 U.S.C. 4901 et seq., Public Law (P.L.) 92-574

Federal Statutes and Regulations	Source
Federal Highway Administration Procedures for Abatement of Highway Traffic Noise and Construction Noise	23 CFR Part 772
Occupational Health and Safety Administration Occupational Safety and Health Standards Subpart G, Occupational Health and Environmental Control, Standard Number 1910.95 Occupational noise exposure	29 CFR 1910.95
Airspace	
Safe, Efficient Use, and Preservation of the Navigable Airspace (prepare Obstruction Evaluation / Airport Airspace Analysis)	14 CFR Part 77; Forms 7460-1 and 7460-2 (FAA 2013)
Health and Safety	
Occupational Safety and Health Act of 1970	P.L. 91-596
Occupational Safety and Health Standards	29 CFR Part 1910
Hazard Communication Standard	29 CFR 1910.1200
Safety and Health Regulations for Construction	29 CFR Part 1926
DOE Worker Safety and Health Program	10 CFR Part 851
Protection of Children from Environmental Health Risks and Safety Risks (23 April 1997)	EO 13045
Geology and Soils	
Farmland Protection Policy Act of 1981	7 U.S.C. 4201
Soil and Water Conservation Act of 1977	16 U.S.C 2001 et seq.
Water Quality, Wetlands, Floodplains, and Coastal Zones	
Clean Water Act of 1972	33 U.S.C. 1251 et seq., as amended
Safe Drinking Water Act of 1974	42 U.S.C. 300(f) et seq.
Safe Drinking Water Act, Protection of Underground Sources of Drinking Water	42 U.S.C. 300h-7
Rivers and Harbors Act of 1899	33 U.S.C. 401 et seq.
Floodplain Management (24 May l977)	EO 11988
Protection of Wetlands (24 May l977)	EO 11990
Biological Resources	
Bald and Golden Eagle Protection Act of 1940	16 U.S.C. 668-668c
Endangered Species Act of 1973	16 U.S.C. 1531–1543
Migratory Bird Treaty Act of 1918	16 U.S.C. 703–712
Fish and Wildlife Coordination Act of 1934, as amended 1946, 1958, 1977	16 U.S.C. 661-667e
Plant Protection Act of 2000 (Title IV of the *Agricultural Risk Protection Act* of 2000)	7 U.S.C. 7701et seq.
Noxious Weed Act of 1974, as amended by Section 15, Management of Undesirable Plants on Federal Lands 1990	7 U.S.C. 2801-2813
Invasive Species (3 February 1999)	EO 13112

Federal Statutes and Regulations	Source
Protection and Enhancement of Environmental Quality (5 March 1970)	EO 11514, as amended by EO 11541 (7/1/70) and EO 11991 (5/24/77)
Responsibilities of Federal Agencies to Protect Conservation of Migratory Birds (10 January 2001)	EO 13186
Cultural Resources	
National Historic Preservation Act of 1966	16 U.S.C. 470 et seq., as amended
Archaeological Resources Protection Act of 1979	16 U.S.C. 470a-11, as amended
American Indian Religious Freedom Act of 1978	P.L. 95-341 and 42 U.S.C. 1996, as amended
The Native American Graves Protection and Repatriation Act of 1990	P.L. 101-601 and 25 U.S.C. 3001–3013
Archaeological and Historic Preservation Act of 1974	16 U.S.C. 469a et seq.
Antiquities Act of 1906	16 U.S.C. 431 et seq.
National Register of Historic Places	36 CFR Part 60
Protection of Historic Properties	36 CFR Part 800
Protection and Enhancement of the Cultural Environment (13 May 1971)	EO 11593
Indian Sacred Sites (24 May 1996)	EO 13007
Consultation and Coordination with Indian Tribal Governments (6 November 2000)	EO 13175
Preserve America (3 March 2003)	EO 13287
Hazardous Materials and Waste Management	
Resource Conservation and Recovery Act of 1976	42 U.S.C. 6901, as amended
Comprehensive Environmental Response, Compensation, and Liability Act of 1980	42 U.S.C. 103
Pollution Prevention Act of 1990	42 U.S.C. 133
Toxic Substance Control Act of 1976	15 U.S.C. 53
Superfund Amendments and Reauthorization Act of 1986	26 U.S.C. 9507
Oil Pollution Control Act of 1990	33 U.S.C. 2701 et seq.
Federal Insecticide, Fungicide, and Rodenticide Act of 1947	7 U.S.C. 136 et seq.
Identification and Listing of Hazardous Waste	40 CFR Part 261
Strengthening Federal Environmental, Energy, and Transportation Management	EO 13423
Federal Compliance with Pollution Control Standards	EO 12088
Federal Leadership in Environmental, Energy, and Economic Performance (5 October 2009)	EO 13514
Environmental Justice	
Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations (11 February 1994)	EO 12898

Federal Statutes and Regulations	Source
Transportation	
Hazardous Material Transportation Act of 1975	49 U.S.C. 1761

Table 1-5. Summary of Potentially Applicable State Statutes and Regulations

State Statutes and Regulations	Source
Colorado Air Quality Control Program Statutes and Permit Programs	Colorado Revised Statutes (C.R.S) 25-7-114, Sections 25-7-114 to 25-7-114.7
Colorado Department of Public Health And Environment, Air Quality Control Commission Regulation Number 3, Stationary Source Permitting And Air Pollutant Emission Notice Requirements	5 Code of Colorado Regulations (CCR) 1001-5
Colorado Department of Public Health and Environment , Air Quality Control Commission Regulation No. 1 Emission Control for Particulate Matter, Smoke, Carbon Monoxide, and Sulfur Oxides, Section III.D. Fugitive Particulate Emissions	5 CCR 1001-3 Section III.D
Vehicles and Traffic State Idling Standard	C.R.S. 42-14-105
Enacting ordnances for regulation of noise on public and private property	C.R.S. 30-15-401
Colorado Noise Abatement Statutes	C.R.S. 25-12-101 through C.R.S. 25-12-109
Colorado Statutes on Industrial and Commercial Safety, High Voltage Power Lines - Safety Requirements	C.R.S. 9-2.5-101
Notification of Surface Development	C.R.S. 24-65.5-101
Colorado Water Quality Control Act	C.R.S. 25-8-101 et seq. (2012)
Colorado Department Of Public Health and Environment, Division of Water Resources, Water Quality Control Commission Procedural Rules	5 CCR 1002-21
Colorado Nongame, Endangered, or Threatened Species Conservation Act	C.R.S. 33-2-101
Colorado Department of Natural Resources, Division of Wildlife Regulations on Nongame Wildlife	2 CCR 406-10
Colorado State Register for Historic Places	C.R.S. 24-80.1
Colorado Hazardous Waste Act	C.R.S. 25-15 Part 1, 2, 3, and 5
Colorado Hazardous Waste Regulations	6 CCR 1007-3

1.5 Public and Agency Involvement

Public participation and outreach efforts are a fundamental component of DOE's NEPA process, planning activities, and decision making. As part of the scoping process, the DOE Golden Field Office mailed over 5,000 scoping notices to local residents near the NWTC and to federal, state, and local agencies, stakeholders, and other interested parties informing them of DOE's plans to prepare the Site-Wide EA. Notices were also advertised in local papers including the *Boulder Daily Camera*, the *Colorado Hometown Weekly*, the *Denver Post*, and the *Golden Transcript*, and posted to the DOE and NREL websites. A hardcopy of the scoping letter was available for review at the Standley Lake Public Library.

DOE requested that interested parties provide comments on any potential issues or associated environmental impacts of implementing the Proposed Action, during a 30-day scoping period ending November 30, 2012. **Appendix A** contains a copy of the scoping notice (postcard), scoping letter, the newspaper notices, and the stakeholder mailing list. Comments received during the scoping period and responses to those comments are presented in **Appendix A**. The scope of the Proposed Action was revised with the input from the public and agencies.

As part of the public and agency involvement process, the DOE Golden Field Office mailed over 6,100 Notices of Availability to local residents near the NWTC and to federal, state, and local agencies, stakeholders, and other interested parties informing them of the availability of the Draft Site-Wide EA for public review and DOE's intention of receiving comments on it. Notices were advertised in local papers including the *Boulder Daily Camera*, the *Colorado Hometown Weekly*, the *Denver Post*, and the *Golden Transcript*, and posted to the DOE and NREL websites. The Draft Site-Wide EA was also posted on the DOE and NREL websites. A hardcopy of the Notice of Availability and the Draft Site-Wide EA were available for review at the Standley Lake Public Library. DOE requested that interested parties provide comments during a 30-day public review period that ended on February 15, 2014. A public meeting was held on January 22, 2014. **Appendix G** contains a copy of the Notice of Availability (postcard), a copy of the newspaper notices, and public comments received on the Draft EA by mail and email. DOE responses to comments received on the draft EA are presented in **Appendix G**.

DOE has contacted the following agencies and organizations. Copies of all consultation correspondence are included in **Appendix F**:

- Federal Aviation Administration (FAA)
- U.S. Department of Commerce – National Telecommunications and Information Administration (NTIA)
- U.S. Army Corps of Engineers
- U.S. Fish and Wildlife Service (USFWS)
- Oglala Sioux Tribe
- Southern Ute Tribe
- Ute Mountain Ute Tribe
- Ute Indian Tribe
- Colorado Historical Society – State Historic Preservation Office (SHPO)

Pursuant to Section 7 of the Endangered Species Act (16 U.S.C. 1531 et. seq.) and Section 106 of the National Historic Preservation Act (16 U.S.C. 470 et seq.), DOE provided letters to the USFWS, SHPO, and six representatives of four tribes describing the Proposed Action and requesting information regarding federally listed species and known historic or cultural resources in the area that might be affected by the proposed action. In addition, the FAA and NTIA were contacted concerning air space and radio frequency interference.

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2. PROPOSED ACTION AND ALTERNATIVES

This section describes the Proposed Action and alternatives. As discussed in **Section 1.1**, the NEPA process evaluates potential environmental consequences associated with a proposed action and considers alternative courses of action. Reasonable alternatives considered must satisfy the purpose of and need for a proposed action. In addition, CEQ regulations specify the inclusion of a No Action Alternative to which potential impacts can be compared. While the No Action Alternative would not satisfy the purpose of or need for the Proposed Action, it is still analyzed in accordance with CEQ regulations. Implementation of the Proposed Action, as described in the section below, is DOE's Preferred Alternative.

2.1 Proposed Action (Preferred Alternative)

Under the Proposed Action, DOE proposes the following improvements to the NWTC facility to support DOE's mission to research and develop energy efficiency and renewable energy technologies. The Proposed Action would consist of:

- Increasing and enhancing research and support capabilities through constructing new facilities, modifying existing facilities, infrastructure upgrades, and site maintenance activities in the Research and Support Facilities area (Zone 1 and Zone 2)
- Increasing site use and density by adding wind turbines, meteorological towers and associated infrastructure, and grid storage test equipment at existing and proposed field test sites (Zone 2)
- Expanding the NWTC's power capacity to 50 MW

The actual schedule for implementing the site improvements depends on federal budgeting decisions and changing R&D priorities; therefore, the Proposed Action cannot be specific with respect to site configurations and actual construction schedules. However, for analysis purposes, the details provided in this assessment are the best planning estimates that can be made at this time and are intended to generate maximized and incremental cumulative impact circumstances. Therefore, this Site-Wide EA employs a "bounding analysis" approach to evaluating potential environmental impacts resulting from a variety of potential development options within a conceptually defined site "build-out" scenario. This potential scenario may never occur or it could change to involve less development. All components of the Proposed Action would be discrete actions and remain independent of each other. This approach allows a comprehensive assessment of potential impacts from future site use and development.

The Proposed Action would improve research capabilities within the current 305-acre NWTC site. Improvements described in the following subsections of Chapter 2 would include up to:

- Constructing new buildings and facilities
  - Wind Turbine Component Research and Testing Facility
  - Grid storage test equipment areas
  - Staging and maintenance warehouse
- Modifying existing buildings
  - Building 251 addition
  - STL addition
  - DERTF upgrades
  - 2.5 MW Dynamometer upgrade
  - Cool roof upgrades
  - Other modifications to existing buildings and facilities

- Infrastructure upgrades
  - Drinking water system upgrades
  - Fire suppression system upgrades
  - Sanitary waste upgrades
  - Road improvements
  - Data and telecommunications improvements
- Routine activities for new or modified buildings and infrastructure
  - Routine technical tasks for research activities
  - Routine tasks for site maintenance
- Installation of additional turbines, meteorological towers, and field test sites
- Upgrading on-site electrical infrastructure to provide for additional power capacity, up to 50 MW

2.1.1 INCREASING AND ENHANCING RESEARCH AND SUPPORT CAPABILITIES (ZONE 1 AND ZONE 2)

DOE proposes new buildings, modifications to existing buildings, and associated infrastructure upgrades to increase and enhance research. As stated earlier, proposed construction activities may or may not be completed, based on funding.

2.1.1.1 New Construction

To maintain a leadership role in defining and conducting research in wind energy and electrical grid integration, DOE proposes constructing the following new facilities at the NWTC. All new buildings would comply with federal "Guiding Principles for New Construction and Major Renovations" (ISWG 2008).

Wind Turbine Component Research and Testing Facility

The Wind Turbine Component Research and Testing Facility would occupy up to 40,000 square feet and be located in Zone 1 between the Administration Building (Building 251) and the 5 MW Dynamometer (Building 258), as shown in **Figure 2-1**. The area of disturbance, including parking areas, sidewalks, and temporary construction laydown areas, would be approximately 120,000 square feet.

This facility would include the following critical research capabilities, which would fill existing testing gaps and provide integrated test capabilities to U.S. partners:

- Design-standard test capability – Would enable the development, characterization, and assessment of design standards and subcomponent and system test protocols, which enable enhanced reliability-based test methods
- Drivetrain component research laboratory – Would provide infrastructure to perform research on components for large-scale bearings, gears, couplings, and other drive components
- Large structural element and component research laboratory – Would provide capability to perform research and characterization on systems and components with proper simulation of boundary conditions and operating environments
- Integrated power electronics laboratory – Would provide grid interconnection validation of electrical systems, which includes full-scale hardware-in-the-loop testing for complete turbine systems

- Electromagnetic field research capability – Would offer simulated electromagnetic field discharge equipment and infrastructure to test and evaluate survivability of mechanical components, electrical systems, and other components
- Computation and analysis laboratory – Would provide a computational link to NREL's Energy Systems Integration Facility High Performance Computer infrastructure, which would enable simulation and data visualization of complex configurations and design of experiments
- Environmental conditioning chambers – Would offer modular environmental chambers capable of temperature, humidity, erosive, and icing conditioning, and could also simulate extreme marine environments
- Short-term energy storage – Would allow characterization and assessment of short-term storage solutions on the reliability of wind turbine safety-critical systems including super capacitors, flywheels, and advanced batteries
- Facility interconnect capabilities – Would serve as the central control station for field and certification research, allowing control and monitoring of site turbines
- Crosscutting technology capabilities – Would offer component and system-level research on water power devices, since the form and function of many water power systems are similar to wind-based technologies

Grid Storage Test Equipment

The combination of location, existing field test sites and facilities, and specialized technical expertise at the NWTC creates a framework for developing and testing utility-scale energy storage systems. Infrastructure for Grid Storage Test Pad areas exists within Zone 2 as shown in **Figure 2-1**. Each Grid Storage Test Pad area would be used to test grid storage equipment such as batteries and flywheels, along with associated electrical switchgear, motors, generators, and transformers. The equipment would be mounted outdoors on concrete pads or housed in temporary or permanent buildings to facilitate research and testing. Temporary buildings would be in place for the duration of the test.

The importance of energy storage systems becomes greater with increased reliance on renewable energy generation, due to the irregular availability of some renewable energy resources. For example, solar energy is only available during daytime hours on non-cloudy days, and wind can be irregular. The ability to store the energy that is generated would enable energy usage on cloudy days and during the night. A new capability for energy storage research would provide the framework for exploring emerging energy storage systems and concepts. The base infrastructure of the NWTC has features that would augment this capability. This combination of grid simulation, wind and PV field sites, component laboratories, and energy storage research facilities would provide a one-of-a-kind, full-system, grid-integrated simulation and research capability.

Staging and Maintenance Warehouse

A warehouse of up to 40,000 square feet would be constructed in Zone 1 west of the DERTF in the northwest corner of the site, within the shaded M-1 development area shown in **Figure 2-1**. This facility would be used to support indoor staging of test projects and maintenance of equipment. This would provide a sheltered indoor area for adding instrumentation to blades, for drivetrain assembly, and to store aerial lifts, forklifts, and other heavy equipment. It would also allow a sheltered area for conducting maintenance work on heavy equipment, and protect the equipment from inclement weather.

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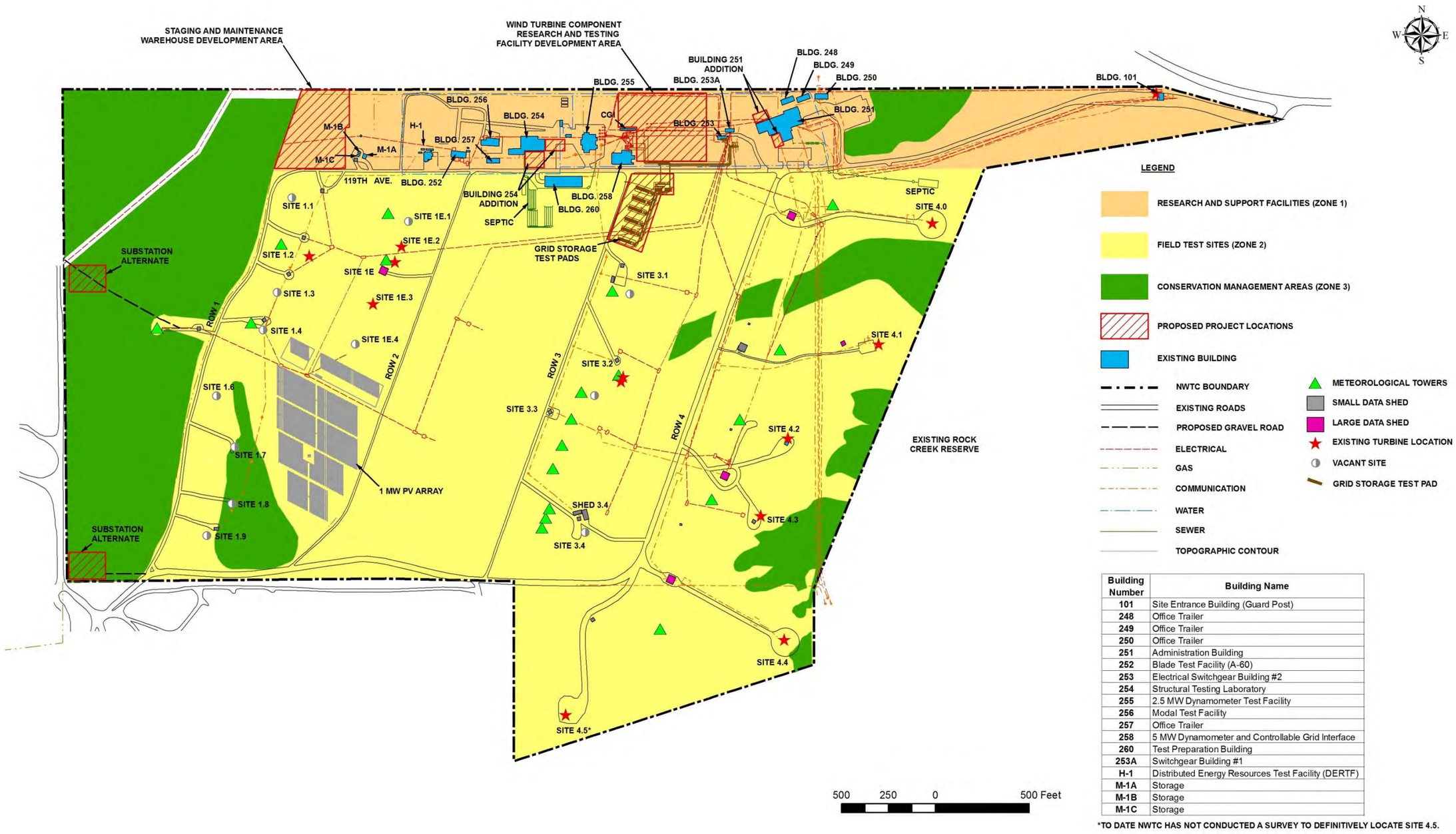

Building Number	Building Name
101	Site Entrance Building (Guard Post)
248	Office Trailer
249	Office Trailer
250	Office Trailer
251	Administration Building
252	Blade Test Facility (A-60)
253	Electrical Switchgear Building #2
254	Structural Testing Laboratory
255	2.5 MW Dynamometer Test Facility
256	Modal Test Facility
257	Office Trailer
258	5 MW Dynamometer and Controllable Grid Interface
260	Test Preparation Building
253A	Switchgear Building #1
H-1	Distributed Energy Resources Test Facility (DERTF)
M-1A	Storage
M-1B	Storage
M-1C	Storage

*TO DATE NWTC HAS NOT CONDUCTED A SURVEY TO DEFINITIVELY LOCATE SITE 4.5.

Figure 2-1. Proposed Project Locations at the National Wind Technology Center

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2.1.1.2 Modifications of Existing Buildings

Existing buildings must be maintained and improved to keep up with the rapid development of wind technology and to test and evaluate innovative and emerging products. The following sections discuss proposed upgrades to existing buildings.

Building 251 Addition

Building 251, located in Zone 1, is at occupant capacity even with ongoing space re-allocation activities that include relocating a machine shop, library, and high bay control room to create additional office space. Proposed upgrades to Building 251 would include:

- A new 5,000 square-foot office wing that would attach to the existing structure. Two locations are proposed as shown in **Figure 2-1**.
- Developing a non-torque loading system for distributed wind (small wind turbines at diverse locations) systems that would allow for unique R&D capability to research drivetrain systems under characteristic environments.
- Building a covered walkway and railing between Building 251 and three adjoining trailers, which currently house more than 40 staff. These improvements would help to minimize potential slip and fall hazards for staff commuting between trailers and facilities within Building 251.

Structural Testing Laboratory Addition

The STL (Building 254), located in Zone 1, provides office space for field, dynamometer, and structural test staff. The STL and office trailers are at capacity and unable to support any additional staff, part-time visiting professionals, or students. In addition to office space deficiencies, the laboratory space for evaluating mid-size components is limited. The size of the high bay limits research on fully enclosed test articles to specimens no greater than 30 meters (98 feet) in length, prohibiting controlled research on larger components. There remains a dedicated need for R&D on components and blades up to 50 meters (165 feet) in length. The following upgrades for the STL would include:

- Extending the STL high bay and overhead crane to enable the facility to provide a controlled environment for R&D on larger structural components.
- Constructing a new 2,500 square-foot addition to the STL to replace office space located in temporary trailers installed at the site. The potential new addition would be located to the south and adjacent to the existing structure as shown in **Figure 2-1**.

DERTF Upgrades

The Wind2H2 project at the DERTF, located in Zone 1, fuels internal combustion engines and fuel-cell electric vehicles with hydrogen (up to pressures of 6,000 psig). Additional compression, storage, and dispensing facilities to accommodate pressures of 10,000 psig would be installed (NREL 2011a). Initially, one outdoor 10,000 psig hydrogen tank would be sufficient to fuel hydrogen vehicles, but eventually capacity would be expanded to six 10,000 psig hydrogen tanks (NREL 2012a) to accommodate a larger capacity for fueling additional vehicles.

Upgrades to 2.5 MW Dynamometer

The 2.5 MW Dynamometer supports research on drivetrains of commercially available turbine sizes of less than 2.5 MW. The need to provide facilities and capabilities to support reliability and durability testing in the range of 1.5 to 2.5 MW is increasingly critical. Improvements would include developing a 2.5 MW scale non-torque loading system and replacing obsolete components with newer technologies.

Cool Roof Upgrades

Cool roofs reflect solar energy and radiate absorbed heat. Cool roofs achieve cooling energy savings in hot summers but can increase heating energy load during cold winters; therefore, the net energy savings of cool roofs varies depending on the local climate. Nationwide, DOE is working to install cool roofs where feasible in accordance with EO 13514. Any buildings could be considered for the installation of cool roofs.

Other Modifications to Existing Buildings and Facilities

Other modifications or expansions would be made to existing buildings and facilities, which are not currently defined and which would be required to accommodate new research or support operations and activities, including interior or exterior modifications or expansions.

2.1.1.3 Infrastructure Upgrades

NREL completed a site utility upgrade analysis for the conceptual design of possible infrastructure upgrades at the NWTC (NREL 2011b). The study was used to develop upgrades to the drinking water system, fire suppression system, sewer, and onsite roads.

Drinking Water System Upgrades

Drinking water for the NWTC is currently trucked in from off site to a water storage tank with a capacity of 15,000 gallons (see **Section 3.11.2**). For water safety and reliability reasons, it is desirable to upgrade the site infrastructure by connecting the NWTC to a municipal water system. The current workforce at the NWTC is approximately 159 people. To accommodate a potential population growth, up to 300 people, it is desirable to connect the site to a municipal water source through an interconnect service line, which would connect to the existing 15,000-gallon storage tank located within Zone 1.

The most likely connection would be to the City of Arvada's municipal water system's existing water main, located at the intersection of Hwy 72 and Hwy 93 (see **Figure 2-3**). The route of the interconnection line would be north from the water main point of connection approximately 2.33 miles along Hwy 93, then east about 0.27 miles along an existing roadway, and north to enter the NWTC property. The total distance from the connection point with the municipal main to the NWTC tanks is approximately 3.9 miles. The water service would be connected to the existing water tank using a three-inch inside diameter service line. The NWTC service line would need to include a pressure reducing valve (NREL 2011b).

Fire Suppression System Upgrades

A 200,000-gallon water storage tank would be installed to provide adequate water supply and water pressure for fire suppression. The proposed water storage tank would be installed on the ground, partially buried, or elevated to a maximum height of 150 feet (46 meters), and located in the Research and Support Facilities area (Zone 1) on the northern portion of the site. The water for this tank would either be trucked

to the site or provided by a municipal water system if the drinking water system upgrades of this Proposed Action are implemented.

Sanitary Waste Upgrades

Sewage treatment would continue to be provided via the two existing septic/leach systems. These systems treat sanitary waste only; no chemicals are discharged to the septic systems at the NWTC. Additional septic/leach systems may be added, as needed for each new building, or the site may add a package plant with a peak daily flow of 6,000 gallons, if additional capacity is needed. Installing a package plant would require adding 3,450 linear feet (1,052 meters) of eight inch polyvinyl chloride sanitary sewer pipe and developing an area to house the equipment and associated infrastructure (including electrical, data/telecom, parking, and pathways). The area to construct the package plant would be up to one acre and located within the Research and Support Facilities area (Zone 1) on the northern portion of the site (NREL 2011b).

Road Improvements

The main east-west road at the NWTC (119th Avenue) is paved from Hwy 128 all the way to the west to the DERTF. The north-south site roads that provide access to the turbine field test sites and other research facilities located in Zone 2 would be paved under the Proposed Action (see **Figure 2-1**). The roads are currently gravel or reclaimed asphalt and present a hazard during high wind events. The road improvements would include selectively reinforcing problem areas with a geogrid and 10 to 15 inches (25 to 38 centimeters) of recycled asphalt. To accommodate larger vehicles delivering large utility-scale turbine components, certain roadways would be re-aligned or widened to expand the turn radii. This would require an additional 200 square feet of paved area at critical corners for an estimated total additional paving of 1,200 square feet (NREL 2011b).

Data and Telecommunications Improvements

Routing new or upgrading existing data and telecommunications lines, both above ground and below ground, would provide data and telecommunication service to new and existing buildings, test facilities, and equipment. Upgrading or replacing existing data and telecommunication lines would use existing communication routes. Extending data and telecommunication service to new buildings, test facilities, and equipment would use existing data and telecommunication line routes when possible. New lines would parallel roadways or other already disturbed portions of the site whenever possible.

2.1.1.4 Routine Activities for New or Modified Buildings and Infrastructure

Routine activities for new or modified buildings and infrastructure include two categories: routine technical tasks for research activities and routine tasks for site maintenance.

Routine technical tasks for research activities include all of the current site activities and routine maintenance actions listed in **Section 1.4.3.2** that would support new or expanded activities enabled by other elements of the Proposed Action.

Routine tasks for site maintenance include all of the current site activities and routine maintenance actions listed in **Section 1.4.3.3** that would support new or expanded activities enabled by other elements of the Proposed Action.

2.1.2 INCREASING SITE USE AND DENSITY (ZONE 2)

An additional component of the Proposed Action would be to increase site use and density by adding wind turbines, meteorological towers and associated infrastructure at existing and new field test sites within Zone 2 (**Figure 2-1**). Currently, the NWTC conducts research and testing on full-scale wind turbines and components in support of the DOE's EERE Wind and Water Power Technologies Office. The NWTC's R&D mission changes annually in accordance with budgets, evolving DOE priorities, industry partnerships, and WFO agreements. There are also current multi-year research activities that are already funded under DOE competitive award programs (that is, Funding Opportunity Announcements), with testing being an integral part of the projects. Other research activities are funded through existing and anticipated competitive R&D agreements, WFO projects, and requests from industry to conduct testing according to IEC standards (previously described in **Section 1.2.3**).

To date, DOE and the NWTC have focused on the performance and cost optimization of energy for individual wind turbines by conducting testing for industry partners according to IEC standards. There are seven different strictly prescribed IEC tests that the NWTC routinely conducts, not only on turbine blades, but on all turbine components. For IEC Power Performance Testing, for example, the power generated by the turbine is tested based on the incoming wind speed. This type of testing requires widely spaced turbines so that the wind fetch is smooth, and there cannot be another turbine within 20 rotor diameters upwind of the turbine being tested. This is critical for acceptance of research reports by international accrediting agencies. The existing turbine configurations at the NWTC comply with these requirements. Such research and testing results provide feedback to manufacturers for modification of turbine component design and validation of simulation models.

As part of the Proposed Action, DOE would expand research activities into non-IEC testing such as wind plant aerodynamics studies that would require closer proximity and various configurations of turbines (NREL 2008). Detailed physical understanding and accurate, reliable prediction of wake ingestion (receiving disturbed wind flow caused by an upwind turbine) by wind turbines would provide several benefits to wind energy technology and wind farm operations. Initially, understanding and prediction would focus on the fundamental two-turbine interaction, but ultimately could advance to encompass interactions between multiple turbine rows like those in modern wind farms. Turbines could be installed in clusters, placed in a grid, or aligned parallel to each other with shorter distances between them. Specific benefits of such research would include the following:

- More reliable predictions of wind plant energy capture performance
- More credible forecasts of turbine lifetime and component failure
- Operating practices that reduce wake shedding (creation of air flow vortices and eddies) by upwind turbines and mitigate downwind wake effects
- Turbines designed and built to better tolerate wake ingestion
- Wind plant optimization that intelligently balances land area usage and turbine effectiveness

Current wind and turbulence profiles are adequately characterized to about 165 feet (50 meters) in the atmosphere. However, few measurements have been made on the new, larger turbines with hub heights greater than 50 meters, and it has already been shown that profiles used in wind farm models are inadequate (NREL 2008). Lack of understanding of the basic input parameters to wake/wind farm models at higher hub heights would be a primary research objective. Such research would address the systematic under-prediction of wake losses at large wind farms and the resulting discrepancy between predicted and actual power output, which generally results in over-estimating power production. Evaluating variables such as wind turbine type, wind speed, turbulence, and various wind turbine spacing and configurations

would be done. Developing more accurate wake models of wind farms would improve the ability to accurately predict power output from large wind farms. More accurate wake models would lead to:

- Significantly improved accuracy of the wake loss estimates that are used in wind array economic planning and may ultimately be used in short-term forecasting.
- More certain overall wind farm wake loss estimates. Quantifying uncertainties is important for both wind array operation and economics.
- Better load/suitability fatigue estimates. These are needed to ensure that individual wind turbines are not subject to excessive loading, which would reduce component lifetimes.
- Optimized wind power farm electricity production.
- Ensuring the maximum energy output from each site at the lowest possible cost is crucial to the success of individual projects and to the overall energy demand goals.

IEC testing, non-IEC testing, and simulation model development would be performed at the NWTC as part of the Proposed Action for the addition of turbines onsite. Even if turbines would be placed in close proximity to one another, selective shut-down of turbines would allow the IEC testing to be done under the strictly prescribed IEC requirements. Increasing the density of turbines onsite would allow for a number of data collection scenarios, and the resulting data would be used to modify or develop model simulations to keep pace with the rapidly developing wind industry.

Currently, NREL and industry partners are operating 16 turbines within Zone 2 at the NWTC site. **Table 1-1** in Chapter 1 describes these turbines, including their height, rotor diameter, capacity, and number and heights of associated meteorological towers. The Proposed Action would provide additional wind turbines and modify the number of existing field test sites and associated infrastructure to potentially include any combination of up to 7 (including the 4 currently onsite) large utility-scale wind turbines (1 to 5 MW), up to 7 (including the 3 currently onsite) mid-scale turbines (each rated from 100 to 1 MW), and up to 20 (including the 9 currently onsite) small wind turbines (each rated from 1 watt [W] to 100 kW) within Zone 2 (**Table 2-1)**. Currently, approximately 22 test sites are configured within Zone 2 of the NWTC. Under the Proposed Action, some test sites could be combined to create larger test sites that would support utility-scale turbines, or subdivided to create more numerous smaller test sites to accommodate small and mid-scale turbines. These would be considered the total numbers for turbines, meteorological towers, and associated facilities within Zone 2. It is not anticipated that the total number of turbines listed in **Table 2-1** would be present onsite at one time, since turbines are erected for testing purposes and then removed when testing is completed.

Table 2-1. Total Proposed Wind Turbines and Meteorological Towers at the NWTC

Size Range	Output [a]	Max. Number of Turbines [b]	Max. Hub Height in meters (feet)	Max. Rotor Diameter in meters (feet)	Max. Rotor Height in meters (feet) [c]	Max. Height Meteorological Towers in meters (feet) [d]
Utility-scale	1 MW to 5 MW	7	100 (328)	150 (492)	175 (574)	200 (656)
Mid-scale	100 kW to 1 MW	7	90 (295)	101 (331)	141 (46)	166 (545)
Small-scale	1 W to 100 kW	20	24 (80)	19 (62)	34 (112)	80 (262)

[a] Total power generation would not exceed 50 MW.
[b] Existing plus proposed turbines. See **Table 1-1** for a listing of existing turbines only.
[c] Maximum height from ground to tip of rotor blade at highest point of rotation.
[d] Assumes meteorological tower height is 25 meters (82 feet) above maximum rotor height.

Constructing a typical utility-scale wind turbine field test site would result in less than two acres of land disturbance. Any new sites for smaller turbines would disturb approximately 0.10 acre. Regardless of the size of a field test site, construction and installation activities would include the following elements (NREL 2011a):

- An access road and utility infrastructure, including a 13.2 kilovolt (kV) buried electrical cable and buried fiber optics telecommunications line.
- Temporary construction laydown areas and crane pads.
- The turbine structure, including the subsurface concrete foundation, tower, nacelle, and blades.
- One or more small data sheds, each typically 25 by 25 feet (7.6 by 7.6 meters) with insulation, heating, ventilation and air conditioning, used to house workers and monitoring equipment, remote sensing devices, such as LIDAR or sound detection and ranging (SODAR) equipment. These wind sensing units capture the spatio-temporal characteristics of the inflow, and are typically cube-shaped, four feet (1.2 meters) on a side. Alternatively, they could be trailer-mounted units with associated electronic instrumentation eight feet (2.4 meters) long by six feet (1.8 meters) wide. Up to 10 cube-shaped or trailer-mounted LIDAR or SODAR devices would be installed at various field test sites at any one time.
- One or more ancillary meteorological towers to hold monitoring devices, depending on research objectives.
- Built-in lightning protection for each turbine and meteorological tower. The lightning protection would consist of a lightning rod with a wire leading to a ring of underground cables (grounding rod) to safely dissipate the energy through static discharge in case of a lightning strike.

Currently, all utility-scale turbines exist on field test sites along Row 4. Each subsurface concrete foundation located at a field test site is designed for a turbine based on blade area, height, research needs, and the particular requirements of each individual turbine. The foundation for each turbine is different depending on the manufacturer (due to size, different bolt patterns, and other characteristics); therefore, the concrete foundation would need to be replaced if a new turbine would replace an existing turbine. Since there are only four utility-scale foundations currently onsite, additional foundations would be required, even if an existing field test site would be reused (**Figure 2-1**).

For a drawing of a typical turbine and its components, refer to **Figure 2-2**.

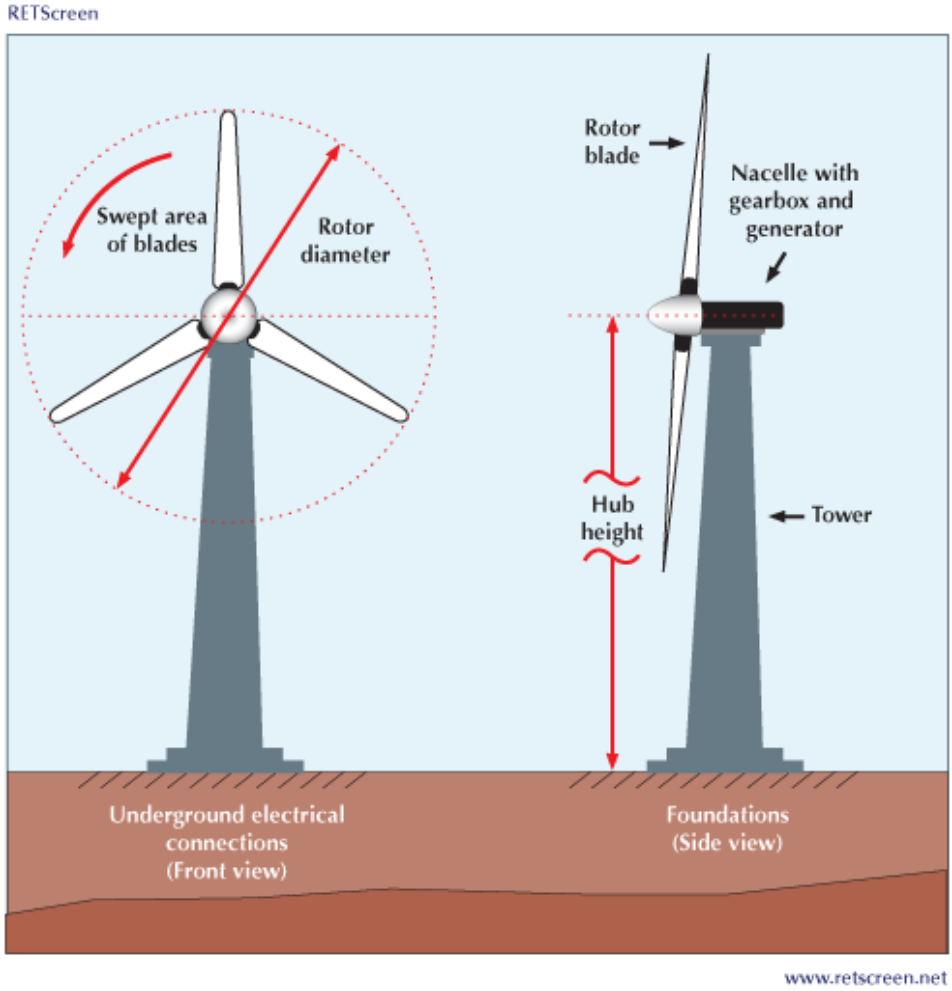

Figure 2-2. Schematic of a Typical Wind Turbine

In ideal circumstances, to support unobstructed IEC testing activities for one utility-scale turbine at a time, each field test site would require approximately 20 to 25 acres of land area, and approximately 50 to 100 acres of smooth undisturbed upwind flow (upwind locations could be offsite). However, under non-IEC testing of turbine interactions that simulate wind farm conditions and research scenarios, additional turbines could be installed closer to and upwind of existing onsite turbines.

This non-IEC testing (to study wake, wind fetch, or other impacts) would not require 20 to 25 acres per turbine, and would simulate wind farm conditions, such as the aerodynamic interactions of turbines both up- and down-wind of one another. Since turbines could be located closer together for non-IEC testing, additional turbines of any size could be located anywhere within Zone 2. These could be configured any number of ways to conduct research on different layouts. Turbines could be clumped together in an area, or placed in a grid pattern, a random pattern, a linear pattern in line with prevailing winds from the northeast, or other configurations. Turbine configurations would depend on the actual research needs at the time of installation. Furthermore, installations at the NWTC are not static. Rather, depending on the partnering agreements, grant specifications, or other research needs, turbines could be installed, operated for a period of time to collect research data, and then removed to allow for other research-driven configurations.

The Proposed Action would also include integrating field studies with simulation models to increase the understanding of wind resources and their interactions with turbine components. When siting and operating a wind farm, accurate forecasts of the wind resource facilitate the integration of wind energy into the electrical grid. The current limited state of knowledge of the wind inflow resource is directly related to the lack of field experiments relevant to wind turbines. Although many field studies have been carried out and long-term wind data from airports exist, these data do not correlate to the heights of advanced wind turbine operations. To develop relevant unsteady wind inflow modeling capability, an integrated approach, using both model simulation and field observation, is necessary. Initial model simulations provide guidance on how to perform effective field experiments. Field experiments provide data to validate and improve existing simulation capabilities, as well as to assist in developing new simulation strategies.

In addition, understanding the factors that affect wind turbine fatigue would enable more reliable turbine designs. Proper modeling of wind-inflow conditions in the design process would aid wind turbine designers to develop better configurations and components that can effectively withstand the induced loads and to develop control methodologies that can effectively mitigate their impact. Improved knowledge of the site variability of inflow conditions would also allow wind power developers to better evaluate turbine placement and aid in site suitability analysis. This would result in improved operational performance and reliability, lessened uncertainty in planning operations and maintenance, reduced ultimate loads, and diminished fatigue damage of wind turbines. All of these data would serve to decrease design overhead and its associated costs, make turbine design refinement easier, and reduce the overall cost of wind energy (NREL 2008). Under the Proposed Action, up to a total of 30 meteorological towers (and associated infrastructure) would be installed onsite, including the 19 that currently exist.

The height of each meteorological tower would extend approximately 25 meters (82 feet) above the rotor height, or up to 200 meters (656 feet); the current maximum height is 135 meters (443 feet). In some cases, more than one meteorological tower would be associated with one utility-scale turbine. In addition, 10 of the 30 meteorological towers, plus associated infrastructure, would be erected to support upwind and downwind turbulence inflow R&D studies. Meteorological towers would be supported by guy wires that would be attached every 60 feet (18 meters) up the tower. Up to three guy wires would be anchored to the ground for each tower attachment point. The guy wire anchoring radius would be between 60 and 100 percent of the tower height.

Configuration of meteorological towers would vary based on research needs. For example, there could be one or multiple meteorological towers for each turbine. The meteorological towers could be located upwind or downwind of a turbine, or surround the turbine in all directions, depending on the research needs and the type of meteorological data to be collected (for example, uninterrupted wind fetch, or wind inflow and wake measurements from turbine interactions). Meteorological tower data collection could be used in combination with remote sensing devices (such as LIDAR and SODAR) to provide a three-dimensional illustration of the inflow to and wake from turbines with various heights and rotor diameters.

2.1.3 EXPANDING POWER CAPACITY

Build-out of the NWTC site would require improving the site's electrical infrastructure. The NWTC has approached its limit for power capacity and utilities, and upgrades would be necessary for long-term site sustainability. Upgrades would include onsite infrastructure upgrades, higher-capacity electrical interconnection, and data/telecommunication cabling.

The capacity factor (ratio of actual power generation to theoretical maximum generation if the machine ran at full rated capacity all the time) of an NWTC turbine is less than 10 percent, where a typical wind farm turbine would be 30 to 40 percent. As stated before, turbines are not placed at the NWTC for the

purpose of power generation or sale of power to the electric company; power generation is a byproduct of R&D activities.

The current NWTC electrical generation capacity is 11.2 MW. Turbine operations are being curtailed to stay below an existing 10 MW generation limit in accordance with an agreement with Xcel Energy (see **Section 3.11.2**) to accommodate existing utility infrastructure limitations. Assuming wind technology development continues its current trend toward larger turbines, the maximum combined rated electrical generation capacity for the NWTC site for the next five years is estimated to be up to 30 MW. In the next 5 to 10 years, electrical generation capacity is estimated to be up to 50 MW, as additional turbines are added and smaller scale turbines are replaced with larger units.

The Proposed Action would provide for additional power capacity at the NWTC, as described below.

The NWTC would upgrade existing electrical infrastructure onsite and add an interconnection to the local utility, including a new higher voltage electrical service (transmission) to accommodate a total of 50 MW of onsite electrical generation capacity. The interconnection is reasonably foreseeable, as it would accommodate the estimated increase in generation capacity and allow for future growth; however, the options for routing the offsite interconnection line have not been identified in detail. Therefore, only the onsite impacts of a 50 MW transmission interconnection are being analyzed in this EA. DOE and NREL would work with the utility transmission provider to design and install a potential onsite substation and create a point of interconnection on the Eldorado to Plainview transmission line. An onsite substation would handle the transfer of the power from the site to the transmission provider, using a transmission line. An onsite substation would convert site-generated power from a lower voltage of 13.2 kV/34.5 kV to a higher voltage of 115 kV. The higher voltage power could then be transferred via transmission lines to the electric company's power system.

There are five potential transmission line options, as shown in **Figure 2-3** and described below. Note that the five options for increasing transmission capacity have not yet been characterized in detail and initial feasibility studies are not complete. This EA analyzes only the effects to resources located on the NWTC property. Should DOE propose to implement one of the five offsite transmission capacity options, that proposal would be subject to the appropriate level of surveys, studies, and NEPA review at that time.

Eldorado Option 1 starts at a potential onsite substation that would be located on the western edge of the NWTC site near the existing Xcel Energy distribution feed or in the southwest corner of the NWTC site. The onsite substation would occupy up to 1.25 acres, including fencing, and the total land disturbance during construction would be up to 5.75 acres. The transmission line from the onsite substation would follow the property line north to the Boulder County line, then turn and follow the county line west, on the Boulder County side to avoid the active quarry located in Jefferson County, before converging with the existing Eldorado-to-Plainview 115 kV transmission line and paralleling it in a northwest direction to the Eldorado substation. The interconnection would require upgrades and potential addition of approximately 0.7 acres to the Eldorado substation. Approximately 2.7 miles of transmission line would be required.

Eldorado Option 2 starts at a new substation that would be located on the western edge of the NWTC site near the existing Xcel Energy distribution feed or in the southwest corner of the NWTC site. The substation would occupy up to 1.25 acres, including fencing, and the total land disturbance during construction would be up to 5.75 acres. The transmission line from the substation would follow the property line north to the Boulder County line. The route corridor then would turn and follow the county line west, on the Boulder County side to avoid the active quarry located in Jefferson County, to Hwy 93. It would then turn northeast and parallel Hwy 93 and cross the existing Eldorado-to-Superior 115 kV transmission line, before paralleling it on the north side in a westerly direction to the point of intersection

with the Eldorado-to-Plainview 115 kV transmission line. The line would then turn northwest and parallel the Eldorado-to-Plainview 115 kV transmission line to the Eldorado substation. The interconnection would require upgrades and potential addition of approximately 0.7 acres to the Eldorado substation. Approximately 3.0 miles of transmission line would be required.

Eldorado Option 3 starts at a new substation that would be located on the western edge of the NWTC site near the existing Xcel Energy distribution feed or in the southwest corner of the NWTC site. The substation would occupy up to 1.25 acres, including fencing, and the total land disturbance during construction would be up to 5.75 acres. The route corridor would begin at the southwest corner of the NWTC site and proceed west, crossing Hwy 93 and paralleling the border of Hogan Ranch and the active quarry to the point of intersection with the Eldorado-to-Plainview 115 kV transmission line. At the point of intersection, a switchyard would be required. The line would then turn northwest and parallel the Eldorado-to-Plainview 115 kV transmission line to the Eldorado substation. The interconnection would require upgrades and potential addition of approximately 0.7 acres to the Eldorado substation. Approximately 3.0 miles of transmission line would be required.

Plainview Option 1 starts at a new substation that would be located at either the western edge of the NWTC site near the existing Xcel Energy distribution feed or in the southwest corner of the NWTC site. The substation would occupy up to 1.25 acres, including fencing, and the total land disturbance during construction would be up to 5.75 acres. The transmission line would travel due west to Hwy 93, where it would turn south and parallel the highway on the east side to the point where it would converge with the existing Eldorado-to-Plainview 115 kV transmission line. Connection through a new switchgear facility would result in approximately five acres of total construction disturbance. Approximately 1.6 miles of transmission line would be required.

Plainview Option 2 would involve either of two options, an aboveground or underground electrical interconnection. The electrical line interconnection would require a new onsite substation that would be located either on the western edge of the NWTC site near the existing Xcel Energy distribution feed or in the southwest corner of the NWTC site. The onsite substation would occupy up to 1.25 acres, including fencing, and the total land disturbance during construction would be up to 5.75 acres. The electrical line would continue south from either potential onsite substation, paralleling the existing Denver & Rio Grande Western Railroad rail spur. The route then would cross the rail spur going west to a new switchgear facility located near the existing Plainview substation. Connection through a new switchgear facility would result in approximately five acres of total construction disturbance. Approximately 1.6 miles of transmission line would be required.

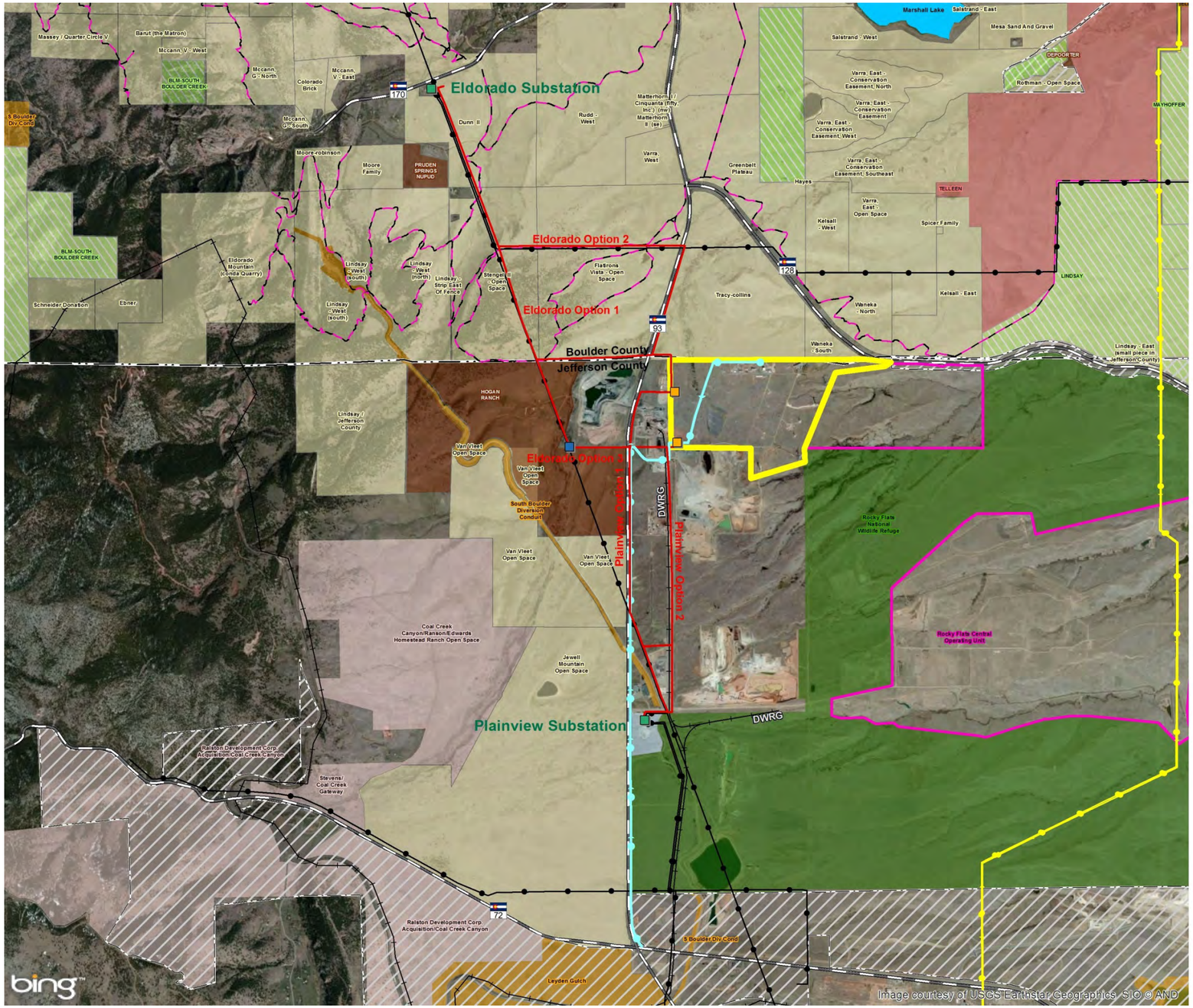

Figure 2-3. Proposed NWTC Transmission Line and Water Interconnects

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2.2 No Action Alternative

CEQ regulations specify the inclusion of the No Action Alternative in the alternatives analysis (40 CFR 1502.14). The No Action Alternative serves as a baseline against which the impacts of the Proposed Action and other potential action alternatives can be evaluated. Under the No Action Alternative, current operations and activities would continue at the NWTC as described in **Section 1.4**.

2.3 Alternatives Considered but Eliminated from Detailed Study

Under NEPA, consideration and analysis of reasonable alternatives to the Proposed Action are required in an EA. Considering alternatives helps to avoid unnecessary impacts and allows for an analysis of reasonable ways to achieve the stated purpose. To warrant detailed evaluation, an alternative must be reasonable. To be considered reasonable, an alternative must be suitable for decision making (that is, any necessary preceding events have taken place), capable of implementation, and satisfactory with respect to meeting the purpose of and need to which the agency is responding with the Proposed Action.

DOE has considered acquiring, leasing, or obtaining easements for additional acreage near the NWTC to preserve wind fetch and allow for the potential installation of additional wind turbines, related test facilities, and infrastructure. Any final decision on such expansion would depend on the availability of such lands, which would be determined at a later date. As such, a final decision on land parcels is not expected to be the subject of decision making in this Site-Wide EA. As set forth in DOE's NEPA regulations, this Site-Wide EA may be supplemented, as necessary, by performing additional environmental studies at a future date to support any land acquisition, lease, or easement decisions. This alternative was considered but was eliminated from detailed study.

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3. AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

Chapter 3 describes the affected environment and environmental consequences associated with the Proposed Action and No Action alternatives. In compliance with NEPA and CEQ implementing regulations, this Site-Wide EA analyzes all potentially relevant resource areas including land use, traffic and transportation, noise, air quality and climate change, visual quality and aesthetics, cultural resources, water resources, geology and soils, biological resources, hazardous materials and waste management, utilities and infrastructure, human health and safety, accident risk, socioeconomics and environmental justice, and intentional destructive acts. As appropriate, each section defines the resource assessed, describes the existing environment, and discusses the environmental consequences of the Proposed Action and No Action Alternative. Discussions of the environmental consequences of the Proposed Action are divided into subsections pertaining to increasing and enhancing research and support capabilities, increasing site use and density, and expanding the site power capacity. These subsections correspond to the description of the Proposed Action in Chapter 2.

Potential impacts are described in terms of type, context, duration, and intensity. General definitions of these terms are below.

- Type describes the impact as beneficial or adverse, direct, or indirect.
  - Beneficial: A positive change in the condition or appearance of the resource or a change that moves the resource toward a desired condition.
  - Adverse: A change that moves the resource away from a desired condition or detracts from its appearance or condition.
  - Direct: An effect on a resource by an action at the same place and time. For example, soil compaction from construction traffic is a direct impact on soils.
  - Indirect: An effect from an action that occurs later or perhaps at a different place and often to a different resource, but is still reasonably foreseeable. For example, removing vegetation may increase soil erosion and cause increased sediment in a stream.
  - Cumulative: Impacts to resources that are added to existing impacts from other actions. For example, surface water sediment runoff from the project, added to the sediment load from other unrelated projects in the area, may additionally decrease surface water quality.
- Context describes the area (site-specific) or location (local or regional) in which the impact would occur.
- Duration is the length of time an effect would occur.
  - Short-term impacts generally occur during construction or for a limited time thereafter, generally less than two years, by the end of which the resources recover their pre-construction conditions. For example, increased traffic during construction activities would be short-term since traffic return to normal levels once construction has been completed.
  - Long-term impacts last beyond the construction period, and the resources may not regain their pre-construction conditions for a longer period of time.

The intensity of an impact is based on how the Proposed Action would affect each resource. The levels used in this EA are:

- Negligible: Impact at the lowest levels of detection with barely measurable consequences.

- Minor: Impact is measurable or perceptible, with little loss of resource integrity, and changes are small, localized, and of little consequence.
- Moderate: Impact is measurable and perceptible and would alter the resource but not modify overall resource integrity, or the impact could be mitigated successfully in the short term.
- Major: Impacts would be substantial, highly noticeable, and long-term.

The offsite aspects of the five options for increasing transmission capacity, which are described in **Section 2.1.3** as part of expanding power capacity, have not yet been characterized in detail and initial feasibility studies are not complete. Therefore, the impact analysis in this EA is limited to their effects to resources located on the NWTC property. Should DOE propose to implement one of the five offsite transmission capacity options, that proposal would be subject to the appropriate level of surveys, studies, and NEPA review at that time.

3.1 Land Use

3.1.1 DEFINITION OF THE RESOURCE

The term "land use" refers to real property classifications that describe either natural conditions or the types of human activity occurring on a parcel. In many cases, land use descriptions are codified in local zoning laws. However, there is no nationally recognized convention or uniform terminology for land use categories. As a result, the meanings of various land use descriptions, "labels," and definitions vary among jurisdictions.

3.1.2 EXISTING ENVIRONMENT

3.1.2.1 Project Site

The NWTC is composed of 305 acres administered by the DOE Golden Field Office and managed by NREL. The site is near the intersection of Hwy 93 and Hwy 128, between the cities of Boulder and Golden. The Jefferson/Boulder county line is the site's northern boundary line. The NWTC site is located just outside of the buffer zone of the former RFETS, which is now the Rocky Flats National Wildlife Refuge, located south and east of the site.

The NWTC is divided into three zones. Zone 1, located between the north property boundary and the primary access road (West 119th Avenue), contains the Research and Support Facilities and includes offices, laboratories, and associated support infrastructure. Zone 2 is generally located south of the Research and Support Facilities and contains the field test sites that perform research and analysis of wind turbine components and prototypes ranging from small, home-scale devices (less than 1 kW) to large commercial utility-scale turbines capable of generating up to three MW of electricity. The field test sites also allow fundamental research to be conducted on aerodynamic and mechanical behavior of turbines, turbine interaction with atmospheric conditions, and distributed generation power components and systems. Zone 3, located along the western boundary with other smaller areas interspersed across the site, contains conservation management areas. Existing site facilities are shown in **Figure 1-2**.

The 305-acre NWTC property administered by DOE includes all of the surface rights. However, the U.S. government does not have the mineral rights for the western 160 acres of the NWTC; these rights were historically owned by Rocky Mountain Fuel, which transferred them to NRC-CO, LLC on June 13, 2008. These mineral rights apply to the extraction of coal, shale, oil, and natural gas.

The mining company held the mineral rights to the eastern 145 acres of the site until 2011. The mining company executed a lease surrender of their mining rights to the 145 acres to DOE on December 21, 2011, through an agreement with the Rocky Flats Natural Resource Damages Trustee Council (Rocky Flats Trustee Council 2009). The Trustee Council consists of representatives from the CDPHE, the Colorado Attorney General's Office, the Colorado Department of Natural Resources, the DOE Office of Legacy Management, and the U.S. Department of the Interior.

3.1.2.2 Surrounding Areas

Land uses on properties surrounding the site include dedicated City of Boulder Open Space and Mountain Parks (OSMP) lands to the north, the Rocky Flats National Wildlife Refuge to the east and south, and private industrial uses to the west. The industrial areas to the west consist of aggregate mining facilities along Hwy 93. To the west of the mining facilities are Jefferson County open space and the former site of Hogan Ranch, which is now part of a City of Boulder conservation easement (Boulder Daily Camera 2007).

Rocky Flats National Wildlife Refuge was authorized by Congress in 2001. The wildlife refuge is a portion of a 6,240-acre former nuclear weapons production facility operated by DOE from 1952 to 1992. In 1992, the site was designated as an NPL site under CERCLA. A buffer zone was established as a "no activity zone" during the production years of the Rocky Flats Plant. The "no activity zone" was a buffer area around the Rocky Flats site where manufacturing and activities involving nuclear materials were prohibited. The EPA does not consider the NWTC site to have been a part of the Rocky Flats NPL site (EPA 2003). Under the *Rocky Flats National Wildlife Refuge Act* of 2001 (Rocky Flats Act), most of the 6,240-acre site became the Rocky Flats National Wildlife Refuge in 2007 following certification from the EPA that cleanup and closure had been completed. Because of ongoing monitoring requirements, the Central Operable Unit in the center of the refuge will remain under the jurisdiction of DOE. The Rocky Flats site transferred to the DOE Office of Legacy Management in 2008. This office conducts the required operation and maintenance of remedial action systems, routine inspection and maintenance, records-related activities, and stakeholder support, as well as administration of the Rocky Flats National Wildlife Refuge with the U.S. Fish and Wildlife Service (USFWS). As a national wildlife refuge, Rocky Flats is managed to preserve and restore native ecosystems, provide habitat for native plants and wildlife, conserve threatened and endangered species, and provide opportunities for scientific research. The site has been restored to native prairie grasslands and no structures are present onsite. The site will also be open for public use in the future.

The Jefferson County Comprehensive Plan includes the North Plain Area Plan, which encompasses the NWTC and surrounding area within Jefferson County. The majority of the area surrounding the NWTC is designated as open space, with areas immediately west and southwest of the NWTC designated for industrial and mineral extraction (Jefferson County 2011). Boulder County and the City of Boulder jointly own and manage open space north of the NWTC under the Boulder Valley Comprehensive Plan (City of Boulder 2010).

Municipalities in the surrounding area include the cities of Arvada, Westminster, Superior, and Boulder. The City of Arvada is located south and southeast of the NWTC. Although most of Arvada's residential and commercial development is over one mile from the NWTC, the industrial area immediately west of the NWTC is incorporated into the City of Arvada boundaries (Denver Post 2013). The City of Westminster is directly east of the NWTC. The incorporated area within the City of Westminster immediately adjacent to the Rocky Flats National Wildlife Refuge is mostly open space; residential land uses are about 1.5 miles east of the wildlife refuge (City of Westminster 2008). The town of Superior is northeast of the corner of the NWTC. There is existing residential development near the border of Superior and Rocky Flats National Wildlife Refuge; however, the town center is over four miles northeast

of the NWTC boundary. The southern extent of the City of Boulder is approximately 3.5 miles north of the NWTC.

3.1.2.3 Applicable Plans and Policies

The NWTC is a federal property that is subject to the policies and practices of DOE and NREL; however, consideration was given to the plans, policies, and planning criteria of local municipalities, counties, and other federal agencies surrounding the NWTC when preparing the assessment of potential environmental impacts from the proposed improvements and ongoing operations at the NWTC.

3.1.3 ENVIRONMENTAL CONSEQUENCES

3.1.3.1 Evaluation Criteria

The potential for land use effects is based on the level of land use sensitivity in areas affected by the Proposed Action and the compatibility of the Proposed Action with existing conditions. The Proposed Action could have an adverse effect with respect to land use if any the following were to occur:

- Be inconsistent or not compliant with existing land use plans or policies
- Preclude an existing land use from being used for its intended purpose
- Preclude continued use or occupation of an area
- Be incompatible with adjacent land use to the extent that public health or safety is threatened
- Conflict with planning criteria established to ensure the safety and protection of human life and property

3.1.3.2 Proposed Action

Increasing and Enhancing Research and Support Capabilities (Zone 1 and Zone 2)

Proposed development, including new facilities and modifications to existing facilities within Zone 1 (Research and Support Facilities), would be consistent with the existing facilities found in the area. Development would not preclude existing land use or continued use or occupation of any portion of the NWTC.

The Proposed Action would not have an impact on land use in surrounding areas and would be consistent with surrounding open space and industrial land uses. Low density development of research facilities would be consistent with these land uses. Site development is not anticipated to cause growth in the surrounding area. Therefore, increasing and enhancing research and support capabilities in Zone 1 and 2 would not have impacts on land use within NWTC boundaries or in adjacent areas.

Increasing Site Use and Density (Zone 2)

Proposed construction of additional wind turbines (field test sites) would be consistent with existing turbines and equipment found in the area. Development would not preclude existing land use or continued use or occupation of any portion of the NWTC. The Proposed Action would not have an impact on land use in surrounding areas and would be consistent with surrounding open space and industrial land uses. Low density development of wind turbines would be consistent with these land uses. Site development is not anticipated to cause growth in the surrounding area.

Constructing new turbines and meteorological towers requires coordination to address Federal Aviation Administration (FAA) requirements associated with Jefferson County Airport height restrictions and obstruction lighting regulations for navigation and communication equipment. The NWTC would follow the FAA Form 7460 process, which relates to an air space analysis that would occur when new towers are proposed. Light fixture requirements are likely to be similar to existing fixtures, but it is possible they may be needed in multiple locations for the taller towers. Increasing site use and density in Zone 2 would not have impacts on land use within NWTC boundaries or in adjacent areas.

Expanding Power Capacity

Developing transmission corridors onsite would be consistent with existing land uses. Development would not preclude existing land use or continued use or occupation of any portion of the NWTC. The Proposed Action would not have an impact on land use in surrounding areas and would be consistent with surrounding open space and industrial land uses. Site infrastructure development is not anticipated to cause growth in the surrounding area. Therefore, expanding power capacity would not have impacts on land use within NWTC boundaries.

3.1.3.3 No Action Alternative

Under the No Action Alternative, site development of the NWTC would not occur and no changes in land use would be anticipated; therefore, no impacts would be expected.

3.2 Traffic and Transportation

3.2.1 DEFINITION OF THE RESOURCE

Transportation is defined as the system of roadways, highways, and all other transportation networks that are in the vicinity of a Proposed Action and could reasonably be expected to be affected by the Proposed Action. Traffic relates to changes in the number of vehicles on roadways and highways as a result of the Proposed Action. Traffic safety relates to changes in the number of vehicle accidents along roadways or highways affected by the Proposed Action.

3.2.2 EXISTING ENVIRONMENT

3.2.2.1 Road Network

The NWTC has one primary access point from Hwy 128 to West 119th Avenue. West 119th Avenue is paved and provides access to the Research and Support Facilities located in the northern portion of the site and to gravel roads that provide access to the field test sites in the southern portion of the site. Hwy 93 is located to the west of the site and intersects Hwy 128 to the northwest of the NWTC. Employees and visitors to the NWTC enter the site from the primary access point on Hwy 128. Employees use their badges at the entrance to open the gate. Visitors must check in at the NWTC Site Entrance Building to receive a security badge before entering the site.

3.2.2.2 Traffic

Traffic volumes on the roads within the NWTC are very low and well within current design capacities. Vehicle use associated with operations at the NWTC consists of passenger vehicles and delivery trucks. Most of the vehicles present at the NWTC and the surrounding roadways are passenger vehicles. Based on the number of times per day that a badge is used to open the main gate, approximately 175 vehicles enter the site daily.

As shown in **Table 3-1**, the annual average daily traffic along Hwy 128 is between 4,700 and 9,500 vehicles, with a volume/capacity ratio between 0.38 and 0.69 (CDOT 2013). The volume/capacity ratio measures the amount of traffic on a road relative to the designed capacity of that road and provides a general indication of the daily traffic levels. The annual average daily traffic along Hwy 93 is 16,000, with a volume/capacity ratio of between 0.69 and 0.81. A ratio under 0.85 is considered under capacity; above 1.0 is considered over capacity. The level of service (LOS) is a broader rating between A and F—where A is uncongested and F is congested—that accounts for average stopped delay for vehicles travelling along a roadway (City of Arvada 2005). In 2001, the City of Arvada rated the LOS along Hwy 128 as A to C (uncongested) and along Hwy 93 as E to F (congested).

Table 3-1. Traffic Counts and Volume/Capacity Ratios for Offsite Roadways

Road	Traffic Count (annual average daily traffic)	Volume/Capacity Ratio
Hwy 128 (east of the NWTC)	4,700	0.38
Hwy 128 (northwest of the NWTC at intersection with Hwy 93)	9,500	0.69
Hwy 93 (south of the NWTC)	16,000	0.69
Hwy 93 (northwest of the NWTC at intersection with Hwy 128)	16,000	0.81

Source: CDOT 2013.

3.2.2.3 Accidents

In 2012, 11 accidents were reported along Hwy 128 between Indiana Street and Hwy 93. One accident resulted in injuries and no fatalities were reported. None of the accidents occurred within 0.5 miles of the turnoff for the NWTC. Forty-four accidents were reported along Hwy 93 between its intersections with Hwy 128 and Hwy 72. Six accidents resulted in injuries and one fatality was reported (Bourget 2013). No vehicle accidents are known to have occurred on the NWTC site.

3.2.2.4 Future Road Improvements

Transportation planning around the NWTC falls under a number of jurisdictions including the Colorado Department of Transportation, Jefferson County, and Boulder County. As part of the Jefferson County Comprehensive Master Plan, Jefferson County developed a major thoroughfare plan identifying major transportation projects to meet county transportation needs. This plan includes widening Hwy 128 and Hwy 93 from two to four lanes (Jefferson County 2012). However, given the high levels of demand for state and federal road construction funds and limited local funding, these projects are not currently slated for construction and are unlikely in the near future. North of the project area, Boulder County, the City of Boulder, and the State of Colorado are widening the shoulders along Hwy 93 between Hwy 128 and Hwy 170 (Denver Post 2013). Construction is anticipated to be completed by the fall of 2014.

3.2.2.5 Public Transportation

The Regional Transportation District Route GS that runs between Golden and Boulder has a bus stop at Hwy 93 and 120th Avenue. This bus stop is approximately one mile from the NWTC.

3.2.3 ENVIRONMENTAL CONSEQUENCES

3.2.3.1 Evaluation Criteria

A substantial increase in traffic on local roadways, altered traffic patterns that could increase congestion, interference with any mode of transportation, or degradation of existing transportation systems related to the Proposed Action would be considered an adverse effect.

3.2.3.2 Proposed Action

Increasing and Enhancing Research and Support Capabilities (Zone 1 and Zone 2)

Increasing and enhancing research and support capabilities in Zones 1 and 2 would result in increased traffic and parking lot use associated with construction equipment and contractor vehicles. Construction activities would require delivery of materials to, and removal of debris from, construction sites; however, construction traffic would compose a small percentage of site traffic. Additionally, many of the construction vehicles would be driven to work sites and kept onsite for the duration of construction, resulting in relatively few additional trips.

Although the total number of employees working onsite during construction and operations could increase, a major increase in onsite traffic or reduced access to the site would not be anticipated. No impacts on parking are anticipated. As buildings are constructed or renovated, additional infrastructure needed to support motorized vehicle and alternative modes of commuting for each facility would be addressed during project design.

The increase in employees under the Proposed Action would be expected to incrementally increase offsite traffic along Hwy 93 and Hwy 128. However, this increase would not adversely impact the existing capacity or LOS along these roadways. The increase in offsite traffic due to construction would be short-term and negligible. It is anticipated that the D to F rating for LOS on Hwy 93 would continue under the Proposed Action, and traffic levels would not worsen due to the Proposed Action. Accident rates would also be anticipated to increase incrementally; however, the increase would be considered minor compared to the overall traffic levels and accident levels on both roadways.

Increasing Site Use and Density (Zone 2)

Increasing site use and density in Zone 2 would result in increased traffic and parking lot use associated with construction equipment and contractor vehicles. Construction activities would require delivery of materials to, and removal of debris from, construction sites, including oversize loads of wind turbine components; however, construction traffic would compose a small percentage of overall site traffic. Additionally, many of the construction vehicles would be driven to work sites and kept onsite for the duration of construction, resulting in relatively few additional trips. Although the total number of employees working onsite during operations could increase, it would not be anticipated to result in a major increase in onsite traffic or reduced access to the site. No impacts on parking are anticipated. There would be beneficial impacts to the onsite transportation network from paving the gravel roads that provide access to the field test sites.

The increase in employees under the Proposed Action would be expected to incrementally increase offsite traffic along Hwy 93 and Hwy 128. However, this increase would not adversely impact the existing capacity or LOS along these roadways. Barring unforeseen widening, it is anticipated that the D to F rating for LOS on Hwy 93 would continue under the Proposed Action, but traffic levels would not worsen due to the Proposed Action. Accident rates would also be anticipated to increase incrementally; however,

the increase would be considered minor compared to the overall traffic levels and accident levels on both roadways. The increase in offsite traffic due to construction would be short-term and negligible.

Expanding Power Capacity

Expanding power capacity would result in increased traffic and parking lot use associated with construction equipment and contractor vehicles. Construction activities would require delivery of materials to, and removal of debris, from construction sites; however, construction traffic would compose a small percentage of site traffic. Additionally, many of the construction vehicles would be driven to work sites and kept onsite for the duration of construction, resulting in relatively few additional trips. No traffic or transportation impacts are anticipated during construction and operations, as expanding power capacity would not directly result in additional traffic at the NWTC or offsite.

3.2.3.3 No Action Alternative

Under the No Action Alternative, existing conditions, activities, and employment levels would continue unchanged at the NWTC. No impacts would be anticipated. No changes to onsite or offsite traffic patterns would be anticipated. The LOS would remain congested along Hwy 93.

3.3 Noise (Acoustics)

3.3.1 DEFINITION OF THE RESOURCE

Sound is defined as a particular auditory effect produced by a given source, for example the sound of rain on a rooftop. Noise and sound share the same physical aspects, but noise is considered a disturbance while sound is defined as an auditory effect. Noise is defined as any sound that is undesirable because it interferes with communication, is intense enough to damage hearing, cause ear pain, or is otherwise annoying. Noise can be intermittent or continuous, steady or impulsive, and can involve any number of sources and frequencies. It can be readily identifiable or generally nondescript. Human response to increased sound levels varies according to the source type, characteristics of the sound source, distance between source and receptor, receptor sensitivity, and time of day. How an individual responds to the sound source will determine if the sound is viewed as music to one's ears or as annoying noise. Affected sensitive receptors are specific (for example, schools, churches, or hospitals) or broad (for example, nature preserves or designated districts) areas in which occasional or persistent sensitivity to noise above ambient levels exists.

Noise Metrics and Regulations. Although human response to noise varies, measurements can be calculated with instruments that record instantaneous sound levels in decibels. A-weighted decibels (dBA) are used to characterize sound levels that can be sensed by the human ear. "A-weighted" denotes the adjustment of the frequency range to what the average human ear can sense when experiencing an audible event. The threshold of audibility is generally within the range of 10 to 25 dBA for normal hearing. The threshold of pain occurs at the upper boundary of audibility, which is normally in the region of 135 dBA (EPA 1981a). **Table 3-2** compares common sounds and shows how they rank in terms of the effects on hearing. As shown, a whisper is normally 30 dBA and considered to be very quiet, while an air conditioning unit 20 feet away is considered an intrusive noise at 60 dBA. Noise levels can become annoying at 80 dBA and very annoying at 90 dBA. To the human ear, each 10 dBA increase seems twice as loud (EPA 1981b).

Table 3-2. Sound Levels and Human Response

Noise Level (dBA)	Common Sounds	Effect
10	Just audible	Negligible*
30	Soft whisper (15 feet)	Very quiet
50	Light auto traffic (100 feet)	Quiet
60	Air conditioning unit (20 feet)	Intrusive
70	Noisy restaurant or freeway traffic	Telephone use difficult
80	Alarm clock (2 feet)	Annoying
90	Heavy truck (50 feet) or city traffic	Very annoying Hearing damage (8 hours)
100	Garbage truck	Very annoying*
110	Pile drivers	Strained vocal effort*
120	Jet takeoff (200 feet) or auto horn (3 feet)	Maximum vocal effort
140	Carrier deck jet operation	Painfully loud

Sources: EPA 1981b; *Extrapolation from EPA table of sound levels and human response.

Federal Regulations. Under the *Noise Control Act* of 1972, the Occupational Safety and Health Administration (OSHA) established workplace standards for noise. The minimum requirement states that constant noise exposure must not exceed 90 dBA over an eight-hour period. The highest allowable sound level to which workers can be constantly exposed is 115 dBA, and exposure to this level must not exceed 15 minutes within an eight-hour period. Instantaneous exposure, such as impact noise, is limited to 140 dBA. If noise levels exceed these standards, employers are required to provide hearing protection equipment that will reduce sound levels to acceptable limits.

Sound levels, resulting from multiple single events, are used to characterize noise effects from aircraft or vehicle activity and are measured in day-night average sound level (DNL). The DNL noise metric incorporates a "penalty" for nighttime noise events to account for increased annoyance. DNL is the energy-averaged sound level measured over a 24-hour period, with a 10-dBA penalty assigned to noise events occurring between 10:00 p.m. and 7:00 a.m. DNL values are obtained by averaging sound exposure levels over a given 24-hour period. DNL is the designated noise metric of the FAA, U.S. Department of Housing and Urban Development, and EPA for modeling airport environments.

According to the criteria of the U.S. Air Force, the FAA, and the U.S. Department of Housing and Urban Development, residential units and other noise-sensitive land uses are "clearly unacceptable" in areas where the noise exposure exceeds 75 dBA DNL, "normally unacceptable" in regions exposed to noise between 65 and 75 dBA DNL, and "normally acceptable" in areas exposed to noise of 65 dBA DNL or under. The Federal Interagency Committee on Noise developed land use compatibility guidelines for noise in terms of a DNL sound level (FICON 1992). For outdoor activities, the EPA recommends 55 dBA DNL as the sound level below which there is no reason to suspect that the general population would be at risk from any of the effects of noise (EPA 1974).

State and Local Regulations. The State of Colorado allows counties to enact ordinances that regulate noise on public and private property (C.R.S. 30-15-401). Jefferson County has adopted C.R.S. 25-12-103, maximum permissible noise levels, into the county ordinances (see **Table 3-3**).

Table 3-3. Maximum Noise Levels by Sound Source Permitted in Jefferson County

Zone	Maximum Sound Level (dBA)	
	7 a.m. to 7 p.m.	7 p.m. to 7 a.m.
Residential	55	50
Commercial	60	55
Light industrial	70	65
Industrial	80	75

Source: C.R.S. 25-12-103

Construction Sound Levels. Building demolition and construction work can cause an increase in sound that is well above the ambient level. A variety of sounds are emitted from loaders, trucks, pavers, and other work equipment. **Table 3-4** lists noise levels associated with common types of construction equipment. Construction equipment usually exceeds the ambient sound levels by 20 to 25 dBA in an urban environment and up to 30 to 35 dBA in a quiet suburban area.

Table 3-4. Predicted Noise Levels for Construction Equipment

Construction Equipment	Predicted Noise Level at 50 feet (dBA)
Backhoe	72 to 93
Concrete mixer	74 to 88
Crane	75 to 87
Front loader	72 to 83
Grader	80 to 93
Jackhammer	81 to 98
Paver	86 to 88
Pile driver	95 to 110
Roller	73 to 75
Truck	83 to 94

Source: EPA 1971.

3.3.2 EXISTING ENVIRONMENT

The ambient noise environment around the NWTC facility is affected primarily by existing operations onsite, including wind turbines, construction activities, installing/removing aerial structures, and other wind technologies. In addition, Hwy 128 is located to the north of the facility, Hwy 93 is to the west, a sand and gravel mining processing operation is located to the south and west, and a blasting company has a small installation to the west. However, the NWTC facility is surrounded primarily by open space and grazing land. The Rocky Flats National Wildlife Refuge borders the site on the south and east (NREL 2012c). There are no sensitive human noise receptors in the immediate vicinity of the NWTC. The nearest residence is approximately 2,200 feet (667 meters) to the west of the site. There are no other residences within a four-mile radius (6.4 kilometer) of the NWTC. The Green Belt Plateau trailhead is approximately 4,000 feet (1,212 meters) north of the NWTC and the Flatirons Vista trailhead is approximately 5,000 feet (1,515 meters) northwest of the NWTC. In addition, an access point for the Coalton Trail is located off Hwy 128 east of the NWTC entrance (City of Boulder 2014).

Turbines create intermittent noise during operation. Noise is also generated from high-lift and support equipment when turbines are installed or removed. This noise is considered temporary. The 2002 Site-Wide EA took a qualitative approach to estimating the noise from turbine operations at the NWTC. **Table 3-5** lists noise levels that were estimated for the proposed wind turbines at the time, assuming that the turbines would generate 90 dB measured at 100 feet from the test pad site.

Table 3-5. Predicted Noise Levels for Existing Wind Turbines at the NWTC

Distance in feet (meters)	dBA
100 (30.6)	90
200 (60.6)	84
400 (121.2)	78
800 (242.4)	72
1,600 (484.8)	66
3,200 (969.6)	60
6,400 (1,939.2)	54

Source: DOE 2002.

3.3.3 ENVIRONMENTAL CONSEQUENCES

3.3.3.1 Evaluation Criteria

Noise impact analyses typically evaluate potential changes to the existing noise environment that would result from implementing the Proposed Action. Potential changes in the acoustical environment can be beneficial (if they reduce the number of sensitive receptors exposed to unacceptable noise levels or reduce the ambient sound level), negligible (if the total number of sensitive receptors exposed to unacceptable noise levels is essentially unchanged or there is little to no change in the ambient sound level), or adverse (if they result in increased sound exposure to unacceptable noise levels or ultimately increase the ambient sound level). Projected noise effects for construction-generated noise were evaluated qualitatively for the alternatives considered. Estimated noise levels from operation of the utility-scale turbines were predicted using noise modeling techniques.

3.3.3.2 Proposed Action

Increasing and Enhancing Research and Support Capabilities (Zone 1 and Zone 2)

Short-term, minor, adverse effects on the noise environment would be expected due to heavy equipment noise generated during the construction of the Wind Turbine Component Research and Testing Facility, grid storage test equipment on existing test pads, and a staging and maintenance warehouse. Populations potentially affected by increased noise levels from construction activities would include NREL personnel accessing buildings and facilities adjacent to the Proposed Action areas, depending on their proximity to construction activities.

Wind Turbine Component Research and Testing Facility. This facility is proposed to be constructed adjacent to other research and testing facilities. This site is not near off-installation populations. Approximately seven existing facilities are within 160 feet of the proposed construction site, and three are within 50 feet. Estimated short-term noise levels outside this facility are projected to be approximately 90 to 94 dBA at 50 feet and 80 to 84 dBA at 160 feet during construction activities. However, noise generation would be short-term and intermittent, lasting only for the duration of the construction

activities. Once construction activities have been completed, noise levels surrounding the project area would return to the normal level.

Grid Storage Test Equipment. The concrete pads for the proposed grid storage test area are already in place. Construction activities would include installing equipment to support tests of energy storage systems. This site is not near off-installation populations or near on-installation noise-sensitive receptors. Several buildings are located to the north of the project area, with the nearest at approximately 50 feet. Installation activities could result in noise levels ranging from 90 to 94 dBA. Noise generation would be short-term and intermittent, lasting only for the duration of the activities. Once construction activities have been completed, noise levels surrounding the project area would return to the normal level.

Staging and Maintenance Warehouse. The proposed facility would be constructed adjacent to other research and testing facilities to the east and south and the conservation management areas to the west. The nearest facility would be approximately 50 feet from the project area, and construction activities could result in noise levels ranging from 90 to 94 dBA outside of this building. However, these facilities would be used for storage and would not be regularly occupied. Noise generation would be short-term and intermittent, lasting only for the duration of the activities. Once construction activities have been completed, noise levels surrounding the project area would return to the normal level.

Modifications of Existing Buildings and Facilities. The proposed noise from construction for modifications would be similar to those described above. Proposed construction would be within 50 feet of existing facilities, and noise levels could reach 90 to 94 dBA. Noise generation would be short-term and intermittent, lasting only for the duration of the activities. Once construction activities have been completed, noise levels surrounding the project area would return to the normal level.

Impacts from Operational Noise. Operation of the proposed Wind Turbine Component Research and Testing Facility, grid storage tests, and staging and maintenance warehouse would not generate noise that is different from existing conditions. It is not anticipated that operational activities would increase ambient noise levels nor result in long-term effects on the noise environment.

Summary. Construction activities associated with increasing and enhancing research and support capabilities (Zone 1 and Zone 2) would result in short-term, minor adverse effects on the ambient noise environment, lasting only for the duration of the construction projects. Once construction activities are completed, operation of the new facilities would not increase the ambient noise level.

Increasing Site Use and Density (Zone 2)

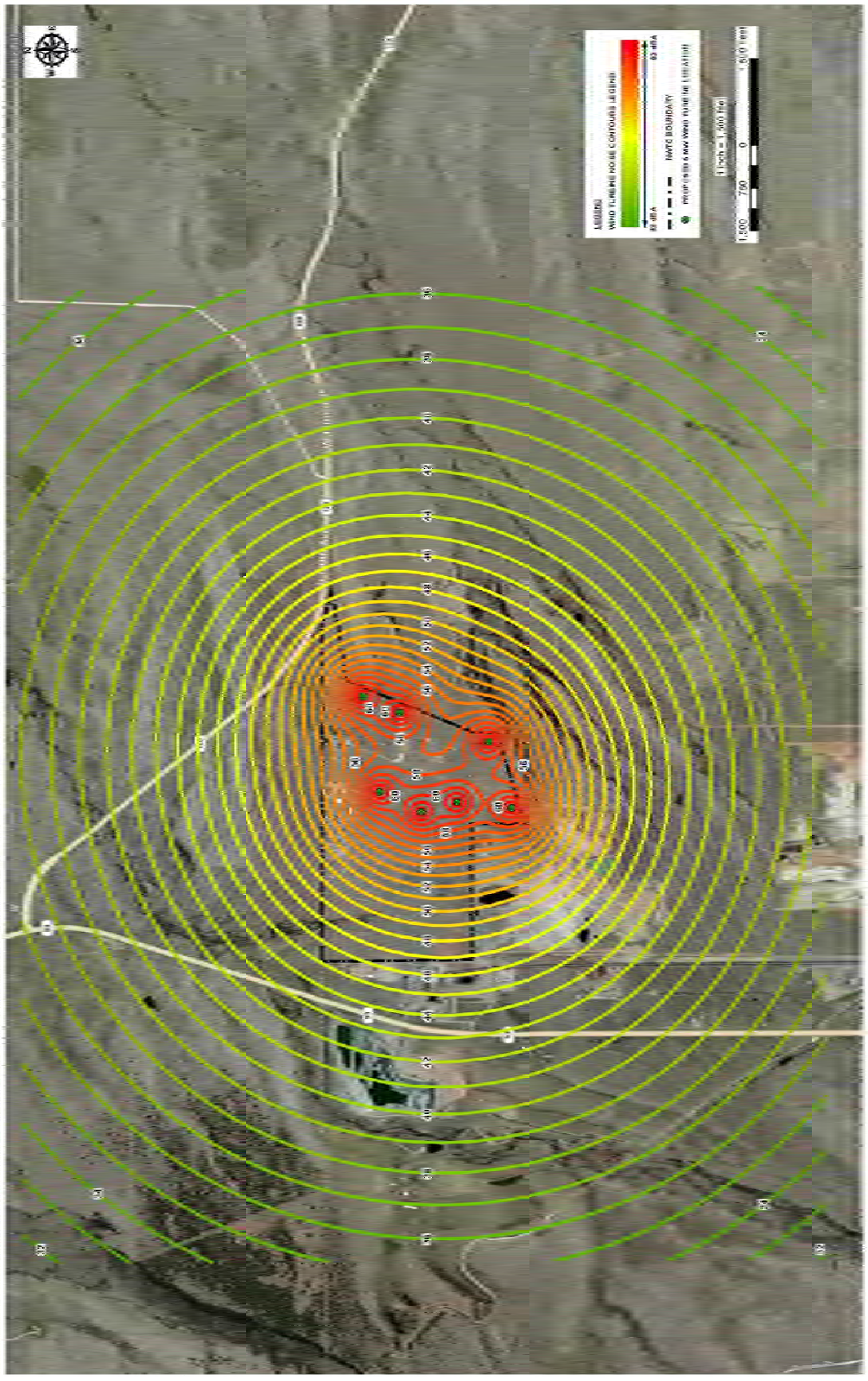
Impacts from Construction Noise. Short-term, minor, adverse effects on the noise environment would be expected to occur from construction of additional wind turbines, meteorological towers, and associated infrastructure at existing and new field sites within Zone 2. The nearest occupied facilities would be approximately 400 feet or more away. Personnel in these facilities would be exposed to noise levels of approximately 72 to 76 dBA. Noise generation would be short-term and intermittent, lasting only for the duration of the activities. Once these activities have been completed, noise levels surrounding the project area would return to the normal level.

Impacts from Operational Noise. Operation of the proposed wind turbines would generate mechanical noise from the generator and gearbox located in the nacelle and aerodynamic noise from the turbine blades as they sweep through the air. Using a "worst-case scenario" bounding analysis that conservatively assumes that all seven proposed 5 MW wind turbines would be installed and operating concurrently, the potential noise emissions associated with these turbines were modeled using the Cadna-A acoustical analysis software. Cadna-A is a predictive model that is based on the international acoustical standard

ISO 9613, "Acoustics - Attenuation of sound during propagation outdoors". Noise emissions data for the newer, larger five MW wind turbines are not readily available; therefore, the noise assessment began by developing a representative sound power level, called the noise emissions term, using noise emissions data for other wind turbines. An estimate of the sound power level for a single five MW wind turbine was developed by performing a simple regression analysis using the MW rating, rotor diameter, and sound power levels for smaller wind turbines. From this analysis, the predicted sound power levels at five MW were 110.8 dBA with a 95 percent confidence interval of 107.6 to 113.9 dBA. Conservatively assuming the upper bound of the confidence interval, the sound power level input used in the Cadna-A noise model was established as 113.9 dBA for a five MW wind turbine.

In the Cadna-A model, the seven proposed wind turbines were placed at the following locations: Site 3.1, Site 3.3, and Site 3.4 in Row 3; and Site 4.0, Site 4.1, Site 4.4, and Site 4.5 in Row 4 (see **Figure 2-1**). The analysis assumed the topography is flat and contains no obstacles in the propagation path. Cadna-A was configured to assume that the ground is only 70 percent acoustically absorptive. The model also assumed no directional preference due to winds. These are all very conservative modeling assumptions.

Calculated noise levels along the property line ranged from 45 dBA (on the west side, farthest from the proposed turbines) to 61 dBA (on the east and south side, closest to the proposed turbines) (see **Figure 3-1**). Calculated noise levels on the east and south property lines are higher than elsewhere because of the closer proximity of the turbines in Rows 3 and 4. However, at distances of 1,600 feet (500 meters) from the property line, noise levels were calculated to attenuate to a range of 42 to 48 dBA, well below the most restrictive daytime noise limit of 55 dBA for residential receptors (see **Table 3-3**). At 3,200 feet (1,000 meters), the calculated noise levels were shown to attenuate to a range of approximately 38 to 41 dBA. If actual wind turbine noise emissions (sound power levels) are lower than the levels estimated for this analysis, then the noise levels would be lower. Since the land use to the east and south of the NWTC is open space in the Rocky Flats National Wildlife Refuge, there are no residential receptors within this distance, and no noise impacts to humans from turbine operations would be anticipated.



NWTC personnel could experience increased noise levels from operation of the proposed wind turbines. These individuals would be expected to experience noise levels of approximately 50 dBA, if they are outside existing facilities. Fifty dBA is equivalent to light automobile traffic at 100 feet (30 meters) and is less than the acceptable noise levels for residents. Noise levels would be even lower inside office buildings.

The Colorado noise statute (C.R.S. 25-12-103), which has been adopted by Jefferson County, sets a maximum noise level of 55 dB for residential receptors during the hours between 7:00 a.m. and 7:00 p.m.; however, the permitted noise levels may be increased by 10 dBA for a period not to exceed 15 minutes in any one-hour period. Periodic, impulsive, or shrill noises are considered a public nuisance when such noises are at a sound level of five dBA less than those listed in **Table 3-3**.

Summary. Construction activities associated with increasing site use and density in Zone 2 would result in short-term, minor adverse effects on the ambient noise environment, lasting only for the duration of the construction projects. Operation of the new facilities would not have an adverse impact on the ambient noise environment for human receptors and would comply with local noise ordnances for off-site human receptors.

Expanding Power Capacity

Impacts from Construction Noise. The five options proposed would have similar noise impacts. Therefore, their noise discussion is consolidated into one section. Short-term, minor, adverse effects on the noise environment would be expected to occur from the required electrical infrastructure improvements, including onsite infrastructure upgrades, higher capacity electrical interconnection, and data/telecommunication cabling. The proposed construction activities would be short-term and intermittent, and noise generation would only last for the duration of the activities. Potential substation and interconnection substation locations would be near the western edge of the NWTC. The nearest occupied buildings would be over 8,500 feet (2,591 meters) away. Personnel could be exposed to noise levels of 66 to 70 dBA at these facilities. In addition, installation of the proposed transmission line could impact individuals using the Boulder County Trail or traveling along Hwy 93; however, most construction activities would occur in existing utility right-of-way areas. Once construction activities have been completed, noise levels surrounding the project area would return to the normal level.

Impacts from Operational Noise. Operation of the new substation and transmission line serving the NWTC would not generate noise that is different from existing conditions. It is not anticipated that operational activities would increase ambient noise levels nor result in long-term effects on the noise environment.

Summary. Construction of the new on-site substation and transmission line would result in short-term, minor adverse effects on the noise environment. Operational activities associated with the proposed expansion of the NWTC's power capacity would not result in long-term effects on the ambient noise environment.

3.3.3.3 No Action Alternative

Under the No Action Alternative, the NWTC would not increase and enhance research and support capabilities in Zone 1 and 2, increase site use and density in Zone 2, or expand power capacity for the installation; therefore, the local and regional noise environment would not change from existing conditions. There would be no direct or indirect adverse impacts on the noise environment from implementing the No Action Alternative.

3.4 Air Quality and Climate Change

3.4.1 DEFINITION OF THE RESOURCE

In accordance with the federal *Clean Air Act* (CAA) requirements, the air quality in a given region or area is measured by the concentration of various pollutants in the atmosphere. The measurements of these "criteria pollutants" in ambient air are expressed in units of parts per million (ppm), parts per billion (ppb), milligrams per cubic meter (mg/m^3), or micrograms per cubic meter ($\mu g/m^3$). The air quality in a region is a result not only of the types and quantities of atmospheric pollutants and pollutant sources in an area, but also surface topography, the size of the topological "air basin," and the prevailing meteorological conditions.

Ambient Air Quality Standards. The CAA directed the EPA to develop, implement, and enforce strong environmental regulations that would ensure clean and healthy ambient air quality. To protect public health and welfare, EPA developed numerical concentration-based standards, or National Ambient Air Quality Standards (NAAQS), for pollutants that have been determined to impact human health and the environment. EPA established both primary and secondary NAAQS under the provisions of the CAA. NAAQS are currently established for six criteria air pollutants: ozone, carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), respirable particulate matter (including particulate matter equal to or less than 10 micrometers in diameter [PM_{10}] and particulate matter equal to or less than 2.5 micrometers in diameter [$PM_{2.5}$]), and lead. The primary NAAQS represent maximum levels of background air pollution that are considered safe, with an adequate margin of safety to protect public health. Secondary NAAQS represent the maximum pollutant concentration necessary to protect vegetation, crops, and other public resources, along with maintaining visibility standards. The State of Colorado has adopted the NAAQS for criteria pollutants with the exception of one SO_2 standard. **Table 3-6** presents the primary and secondary EPA NAAQS and the Colorado SO_2 secondary standard.

Attainment versus Nonattainment and General Conformity. The EPA classifies the air quality in an air quality control region (AQCR), or in subareas of an AQCR, according to whether the concentrations of criteria pollutants in ambient air exceed the NAAQS. Areas within each AQCR are therefore designated as either "attainment," "nonattainment," "maintenance," or "unclassified" for each of the six criteria pollutants. Attainment means that the air quality within an AQCR is less than or equal to the NAAQS. Nonattainment indicates that criteria pollutant levels exceed NAAQS. Maintenance indicates that an area was previously designated nonattainment but is now attainment. An unclassified air quality designation by EPA means that there is not enough information to appropriately classify an AQCR, so the area is considered attainment. EPA has delegated the authority for ensuring compliance with the NAAQS in the State of Colorado to the CDPHE, Air Pollution Control Division. In accordance with the CAA, each state must develop a state implementation plan (SIP), which is a compilation of regulations, strategies, schedules, and enforcement actions designed to maintain compliance or move the state into compliance with all NAAQS.

The General Conformity Rule contains procedures and criteria for determining whether a proposed federal action would conform to applicable CAA implementation plans. The rule and its regulations apply to any proposed federal action that would cause emissions of criteria air pollutants above threshold levels (see **Table 3-9**) to occur in locations designated as nonattainment or maintenance areas. More specifically, CAA conformity is ensured when a federal action does not cause a new violation of the NAAQS; contribute to an increase in the frequency or severity of violations of NAAQS; or delay the timely attainment of any NAAQS, interim progress milestones, or other milestones toward achieving compliance with the NAAQS.

Table 3-6. National and State Ambient Air Quality Standards

Pollutant	Averaging Time	Primary Standard		Secondary Standard
		Federal	Colorado	
CO	8-hour (1)	9 ppm (10 mg/m^3)	Same	None
	1-hour (1)	35 ppm (40 mg/m^3)	Same	None
Lead	Quarterly average	1.5 $\mu g/m^3$	Same	Same as primary
	Rolling 3-month average	0.15 $\mu g/m^3$ (2)	Same	Same as primary
NO_2	Annual arithmetic mean	53 ppb (3)	Same	Same as primary
	1-hour	100 ppb (4)	Same	None
PM_{10}	24-hour (5)	150 $\mu g/m^3$	Same	Same as primary
$PM_{2.5}$	Annual arithmetic mean (6)	15 $\mu g/m^3$	Same	Same as primary
	24-hour (7)	35 $\mu g/m^3$	Same	Same as primary
Ozone	8-hour (8)	0.075 ppm (2008 standard)	Same	Same as primary
	8-hour (8)	0.08 ppm (1997 standard)	Same	Same as primary
	1-hour (9)	0.12 ppm	Same	Same as primary
SO_2	Annual arithmetic mean	0.03 ppm	Same	0.5 ppm (3-hour federal standard) (1) 700 $\mu g/m^3$ (0.267 ppm) (3-hour Colorado standard)
	24-hour (1)	0.14 ppm	Same	0.5 ppm (3-hour) (1)
	1-hour	75 ppb (10)	Same	None

Sources: EPA 2011, CDPHE 2012.

Notes: Parenthetical values are approximate equivalent concentrations.

1. Not to be exceeded more than once per year. Final rule signed October 15, 2008. The 1978 lead standard (1.5 $\mu g/m^3$ as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978 standard, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.
2. The official level of the annual NO_2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of cleaner comparison to the one-hour standard.
3. To attain this standard, the three-year average of the 98th percentile of the daily maximum one-hour average at each monitor within an area must not exceed 100 ppb (effective January 22, 2010).
4. Not to be exceeded more than once per year on average over three years.
5. To attain this standard, the three-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15.0 $\mu g/m^3$.
6. To attain this standard, the three-year average of the weighted annual of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 $\mu g/m^3$ (effective December 17, 2006).
7. To attain this standard, the three-year average of the fourth-highest daily maximum eight-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm (effective May 27, 2008).
8. a. To attain this standard, the three-year average of the fourth-highest daily maximum eight-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.
   b. The 1997 standard – and the implementation rules for that standard – will remain in place for implementation purposes as EPA undertakes rulemaking to address the transition from the 1997 ozone standard to the 2008 ozone standard.
   c. EPA is in the process of reconsidering these standards (set in March 2008).
9. a. EPA revoked the one-hour ozone standard in all areas, although some areas have continuing obligations under that standard (anti-backsliding).
   b. The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is $\leq$ one.
10. Final rule signed on June 2, 2010. To attain this standard, the three-year average of the 99th percentile of daily maximum one-hour averages at each monitor within an area must not exceed 75 ppb.

Key: ppb = parts per billion; ppm = parts per million; mg/m^3 = milligrams per cubic meter; $\mu g/m^3$ = micrograms per cubic meter

Federal Prevention of Significant Deterioration. Federal prevention of significant deterioration (PSD) regulations apply in attainment areas to a major stationary source (that is, a source with the potential to emit 250 tons per year [tpy] of any criteria pollutant), and a significant modification to a major stationary source (that is, a change that adds 10 to 40 tpy to the facility's potential to emit, depending on the pollutant). Additional PSD major source and significant modification thresholds apply for GHGs, and are discussed two paragraphs below. PSD permitting can also apply to a project if all three of the following conditions exist: (1) the project is a modification with a significant net emissions increase to an existing PSD major source, (2) the project is within 10 kilometers of national parks or wilderness areas (that is, Class I areas), and (3) regulated stationary source pollutant emissions would increase the 24-hour average concentration of any regulated pollutant in the Class I area of one $\mu g/m^3$ or more (40 CFR 52.21[b][23][iii]). A Class I area includes national parks larger than 6,000 acres, national wilderness areas and national memorial parks larger than 5,000 acres, and international parks. PSD regulations also define ambient air increments, limiting the allowable increases to any area's baseline air contaminant concentrations, based on the area's Class designation (40 CFR 52.21[c]).

Title V Requirements. Title V of the CAA Amendments of 1990 requires states and local agencies to permit major stationary sources. A Title V major stationary source has the potential to emit criteria air pollutants and hazardous air pollutants (HAPs) at levels equal to or greater than major source thresholds. Major source thresholds vary depending on the attainment status of an ACQR. The purpose of the permitting rule is to establish regulatory control over large, industrial-type activities and monitor their impact on air quality. Section 112 of the CAA lists HAPs and identifies source categories that are subject to HAP emissions control requirements. The State of Colorado requires any source that emits 100 tpy or more of a criteria pollutant to obtain a Title V permit.

Greenhouse Gas Emissions. GHGs are gaseous emissions that trap heat in the atmosphere. These emissions occur from natural processes and human activities. The most common GHGs emitted from natural processes and human activities include carbon dioxide (CO_2), methane, and nitrous oxide. On September 22, 2009, the EPA issued a final rule for mandatory GHG reporting from large GHG emissions sources in the United States. The purpose of the rule is to collect comprehensive and accurate data on CO_2 and other GHG emissions that can be used to inform future policy decisions. In general, the threshold for reporting is 25,000 metric tons or more of CO_2 equivalent emissions per year, but excludes mobile source emissions. GHG emissions are also factors in PSD and Title V permitting and reporting, according to an EPA rulemaking issued on June 3, 2010 (75 *Federal Register* 31514). GHG emissions thresholds of significance for inclusion in PSD permitting of stationary sources are 75,000 tons of CO_2 equivalent per year and 100,000 tons of CO_2 equivalent per year under these permit programs.

EO 13514, "Federal Leadership in Environmental, Energy, and Economic Performance," was signed in October 2009 and requires agencies to set strategic sustainability goals for reducing GHG emissions. One requirement within EO 13514 is the development and implementation of an agency SSPP that prioritizes agency actions based on lifecycle return on investment. Each SSPP is required to identify, among other things, "agency activities, policies, plans, procedures, and practices" and "specific agency goals, a schedule, milestones, and approaches for achieving results, and quantifiable metrics" relevant to the implementation of EO 13514. On September 10, 2010, DOE released its SSPP to the public. This implementation plan describes specific actions the DOE will take to achieve its individual GHG reduction targets, reduce long-term costs, and meet the full range of goals of the EO. All SSPPs segregate GHG emissions into three categories: Scope 1, Scope 2, and Scope 3 emissions. Scope 1 GHG emissions are those directly occurring from sources that are owned or controlled by the agency. Scope 2 emissions are indirect emissions generated in the production of electricity, heat, or steam purchased by the agency. Scope 3 emissions are other indirect GHG emissions that result from agency activities but from sources that are not owned or directly controlled by the agency. The GHG goals in the DOE SSPP include

reducing Scope 1 and Scope 2 GHG emissions by 28 percent by 2020, relative to FY 2008 emissions, and reducing Scope 3 GHG emissions by 13 percent by 2020, relative to FY 2008 emissions (DOE 2010).

In addition to the DOE-wide SSPP, a site specific review is completed annually and reported in the NREL Site Sustainability Plan (SSP). The NREL SSP lists each SSPP goal and provides a description of how each goal is being implemented and/or attained at the site (see **Section 1.4.5**).

3.4.2 EXISTING ENVIRONMENT

The NWTC is located within the Metropolitan Denver Intrastate AQCR. The Metropolitan Denver Intrastate AQCR includes Adams, Arapahoe, Boulder, Clear Creek, Denver, Douglas, Gilpin, and Jefferson counties in Colorado. The area has been designated by the EPA as marginal nonattainment for ozone (eight-hour averaging time). The area has been designated as unclassified/attainment for all other criteria pollutants (EPA 2012a, 2012b). No Class I areas are located within 10 kilometers of the NWTC (40 CFR Part 81).

The most recent emissions inventories for the Metropolitan Denver Intrastate AQCR are shown in **Table 3-7**. The Metropolitan Denver Intrastate AQCR is considered the regional area of influence for the air quality analysis. Ozone is not a direct emission; it is generated from reactions of volatile organic compounds (VOCs) and nitrogen oxides (NO_x), which are precursors to ozone. Therefore, for the purposes of this air quality analysis, VOC and NO_x emissions are used to represent ozone generation potential.

Table 3-7. Local and Regional Air Emissions Inventories for Areas Impacted by the Proposed Action

	NO_x (tpy)	VOC (tpy)	CO (tpy)	SO_2 (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)
Jefferson County, Colorado	14,521.39	26,467.27	83,780.29	2,897.01	10,407.51	2,523.01
Metropolitan Denver Intrastate AQCR	94,978.34	128,146.68	427,105.80	15,238.66	68,575.73	15,665.11

Source: EPA 2008.

A 2012 internal evaluation of NREL facilities confirmed continued compliance with all Colorado and EPA air permit requirements. Colorado's CDPHE, Air Pollution Control Division regulates air emissions through air permits and Air Pollutant Emission Notices (APENs). An APEN is required if any non-attainment criteria pollutant emissions exceeds one ton per year. An operating permit is required if any non-attainment criteria pollutant emission exceeds one ton per year. The DOE Golden Field Office currently maintains four APENs and one operating permit for emergency generators located at the NWTC. **Table 3-8** lists emissions for these generators. All individually air permitted equipment would continue to be classified as minor sources. Overall, the facility is classified as a minor source, is currently not subject to the Title V operating permitting program, and is not a PSD or nonattainment area major source (NREL 2012c).

Table 3-8. Emergency Generator Emissions

	NO_x (tpy)	VOC (tpy)	CO (tpy)	SO_2 (tpy)	PM_{10} (tpy)
Emergency generators	9.58	0.81	3.72	0.02	0.67

Emissions are based on 500 hours of operations on APCD and EPA written guidance for emergency generators.

3.4.3 ENVIRONMENTAL CONSEQUENCES

3.4.3.1 Evaluation Criteria

The significance criteria depend on whether the Proposed Action is located in an attainment, nonattainment, or maintenance area for criteria pollutants. Other significance criteria include whether New Source Review (NSR) air quality construction permitting is triggered or Title V operating permitting is triggered. Major NSR air quality construction permitting is divided into Nonattainment Major NSR (NANSR) for nonattainment pollutants and PSD permitting for attainment pollutants. All of these significance criteria are discussed in the following paragraphs.

Attainment Area Pollutants. The attainment area pollutants for the location of this Proposed Action are NO_2, SO_2, lead, and $PM_{2.5}$. The impact in NAAQS "attainment" areas would be considered significant if the net increases in these pollutant emissions from the federal action would result in any one of the following scenarios:

- Cause or contribute to a violation of any national or state ambient air quality standard
- Expose sensitive receptors to substantially increased pollutant concentrations
- Exceed any evaluation criteria established by a SIP or permit limitations/requirements

Impacts on ambient air quality were assessed by comparing the increase in emissions under the Proposed Action to the county or AQCR emissions inventory.

Nonattainment or Maintenance Area Pollutants. The nonattainment area pollutant for the location of this Proposed Action is ozone (measured as NO_x and VOC). Maintenance pollutants for the location of the Proposed Action are CO and PM_{10}. Effects on air quality in NAAQS "nonattainment" areas are considered significant if the net changes in these project-related pollutant emissions result in any of the following scenarios:

- Cause or contribute to a violation of any national or state ambient air quality standard
- Increase the frequency or severity of a violation of any ambient air quality standard
- Delay the attainment of any standard or other milestone contained in the SIP

With respect to the General Conformity Rule, effects on air quality would be considered significant if the proposed federal action's direct or indirect emissions exceed de minimis threshold levels established in 40 CFR 93.153(b) for individual nonattainment pollutants or for pollutants for which the area has been redesignated as a maintenance area. In addition, if a facility has a specific general conformity budget listed in the SIP, a proposed action that results in an exceedance of that budget would be considered to have a significant effect on air quality. NREL is not specifically listed in the Colorado SIP as having a specific General Conformity budget.

Table 3-9 presents the General Conformity de minimis thresholds, by regulated pollutant. As shown in this table, de minimis thresholds vary depending on the severity of the nonattainment area classification. Note that emissions sources subject to NANSR, PSD, or even minor NSR air permitting are not required to be counted towards the General Conformity de minimis thresholds. The reasoning for this is they would already be required to go through an approval process with the appropriate federal, state, or local air quality regulatory authority.

Table 3-9. General Conformity de minimis Emissions Thresholds

Pollutant	Status	Classification	de minimis Limit (tpy)
Ozone (measured as NO_x or VOCs)	Nonattainment	Extreme Severe Serious Moderate/marginal (inside ozone transport region) All others	10 25 50 50 (VOCs) / 100 (NO_x) 100
	Maintenance	Inside ozone transport region Outside ozone transport region	50 (VOCs)/100 (NO_x) 100
Carbon monoxide	Nonattainment / maintenance	All	100
PM_{10}	Nonattainment	Serious Moderate No special classification	70 100 100
	Maintenance	All	100
$PM_{2.5}$ (measured directly, or as SO_2, or NO_x, or VOC as significant precursors)	Nonattainment / maintenance	All	100
SO_2	Nonattainment / maintenance	All	100
NO_x	Nonattainment / maintenance	All	100
VOCs	Nonattainment / maintenance	All	100
Lead	Nonattainment / maintenance	All	25

Source: 40 CFR 93.153, as of January 9, 2012.

Nonattainment Major NSR Permits. The following factor was considered in evaluating the significance of air quality impacts with respect to NANSR permitting requirements:

- If the net increase in stationary source emissions qualifies the facility as a NANSR major source. This major source threshold varies from 10 tpy to 100 tpy for nonattainment pollutants, depending on the severity of the nonattainment classification and the pollutant (40 CFR 51.165).

PSD and Title V Permits. The following factors were considered in evaluating the significance of air quality impacts with respect to PSD permitting requirements prior to construction:

- If the net increase in stationary source emissions qualifies the facility as a PSD major source. This includes 250 tpy emissions per attainment pollutant (40 CFR 52.21(b)(1) and 40 CFR 52.21(a)(2), or 75,000 tpy emissions of GHGs.
- If the Proposed Action occurs within 10 kilometers of a Class I area and if it would cause an increase in the 24-hour average concentration of any regulated pollutant in the Class I area of one $\mu g/m^3$ or more (40 CFR 52.21[b][23][iii] and 40 CFR 52.21[a][2]).

The following factor was considered in evaluating the significance of air quality impacts with respect to Title V operating permit requirements (40 CFR 71.2 and 40 CFR 71.3):

- If the increase in stationary source emissions under the Proposed Action qualifies the facility as a Title V major source. This includes the potential to emit 100 tpy for criteria pollutants, or 10 tpy of any individual HAP, or 25 tpy of all HAPs combined, or 100,000 tpy of GHGs.

3.4.3.2 Proposed Action

Increasing and Enhancing Research and Support Capabilities (Zone 1 and Zone 2)

The Proposed Action includes new construction, modification of existing buildings and facilities, and infrastructure upgrades for Zone 1 and 2. New construction proposed includes a Wind Turbine Component Research and Test Facility, components of the grid storage test pad area, and a staging and maintenance warehouse. Modification activities would include addition to Building 251, STL addition, DERTF upgrades, 2.5 MW Dynamometer upgrades, and cool roof upgrades. Infrastructure upgrades would include drinking water system upgrades, fire suppression system upgrades, sanitary waste upgrades, road improvements, and data and telecommunication improvements.

The activities would generate air pollutant emissions from site-disturbing activities such as grading, filling, compacting, and trenching; operating construction and demolition equipment; and haul trucks transporting construction supplies, excavation material, and demolition debris. Construction, modification, and upgrading activities would also generate particulate emissions as fugitive dust from ground-disturbing activities and from fuel combustion in construction and demolition equipment. Fugitive dust emissions would be greatest during the initial site preparation activities and would vary from day to day depending on the work phase, level of activity, and prevailing weather conditions. The quantity of uncontrolled fugitive dust emissions from a construction site is proportional to the area of land being worked and the level of activity. Construction and demolition activities would incorporate best management practices (BMPs) and control measures (for example, frequent use of water for dust-generating activities) to minimize fugitive particulate matter emissions. Additionally, the work vehicles are assumed to be well-maintained.

Construction and demolition workers commuting daily to and from the job site in their personal vehicles would also result in criteria pollutant air emissions. Based on the size of the proposed activities and the assumed duration of the activities, it is not expected that emissions from the proposed activities would contribute to or affect local or regional attainment status with the NAAQS.

Emissions for the proposed new construction activities in Zone 1 and 2 would be produced only for the duration of the construction activities, which, for the purposes of the air quality analysis, is conservatively assumed to be 240 work days (that is, five days per week, four weeks per month, and 12 calendar months). While a timeline has not been proposed and the proposed construction activities could take place over multiple years, emissions have been conservatively calculated for one calendar year (CY), 2015. Air emissions from the following new construction are summarized in **Table 3-10:**

- 40,000 square-foot wind turbine component research and testing facility, including approximately 120,000 square feet of total disturbed area.
- Infrastructure for grid storage test pads has been constructed; no new construction would be required.
- 40,000 square-foot staging and maintenance warehouse (including approximately 80,000 square feet of total disturbed area).

Appendix B contains detailed calculations and the assumptions used to estimate the air emissions. Note that all construction emissions are not stationary sources but are classified as mobile source emissions.

Table 3-10. Estimated Air Emissions Resulting from New Construction in Zones 1 and 2, Proposed Action (CY 2015)

Activity	NO_x tpy	VOC tpy	CO tpy	SO_2 tpy	PM_{10} tpy	$PM_{2.5}$ tpy	CO_2 tpy
Project combustion	4.85	0.61	2.13	0.38	0.35	0.34	549.22
Project fugitive dust	-	-	-	-	6.28	0.63	-
Haul truck, on-road	0.26	0.06	0.18	0.00	0.01	0.01	127.92
Project commuter	0.07	0.07	0.66	0.00	0.01	0.01	119.01
Total Emissions	**5.18**	**0.74**	**2.97**	**0.38**	**6.65**	**0.99**	**796.15**
Percent of Jefferson County inventory	0.036%	0.003%	0.004%	0.013%	0.064%	0.039%	*
Percent of Metropolitan Denver Intrastate AQCR inventory	0.0055%	0.0006%	0.0007%	0.0025%	0.097%	0.0063%	0.00075%
General conformity applicability thresholds	100	100	100	NA	100	NA	NA

Notes: * Data not available. NA = Not applicable.

Emissions for the proposed modification activities in Zone 1 and 2 would be produced only for the duration of the modification activities, which, for the purposes of the air quality analysis, is conservatively assumed to be 240 work days (that is, five days per week, four weeks per month, and 12 calendar months). While a timeline has not been proposed and the proposed modification activities could take place over multiple years, emissions have been conservatively calculated for one CY, 2015.

Proposed modification activities include the following assumptions:

- Building 251 – 5,000 square-foot addition, covered walkway (estimated to include 500 square feet of total disturbed area), and interior updates
- Building 254, STL – 2,500 square-foot addition, extension of the STL high bay, and interior upgrades
- DERTF – Installation of six 10,000 psig hydrogen tanks encompassing approximately 20 square feet of disturbed area for each tank (120 square feet total)
- 2.5 MW Dynamometer – Interior improvements, no ground disturbed
- Cool roofs – Exterior improvements, no ground disturbed

Air emissions from the listed modifications are summarized in **Table 3-11**. **Appendix B** contains detailed calculations and the assumptions used to estimate the air emissions. Note that all modification emissions are not stationary sources but are classified as mobile source emissions.

Table 3-11. Estimated Air Emissions Resulting from Modifications in Zones 1 and 2, Proposed Action (CY 2015)

Activity	NOx tpy	VOC tpy	CO tpy	SO_2 tpy	PM_{10} tpy	$PM_{2.5}$ tpy	CO_2 tpy
Project combustion	4.78	0.46	2.11	0.38	0.34	0.33	541.81
Project fugitive dust	-	-	-	-	0.40	0.04	-
Haul truck, on-road	0.03	0.01	0.02	0.00	0.00	0.00	14.31
Project commuter	0.07	0.07	0.66	0.00	0.01	0.01	119.01
Total Emissions	**4.88**	**0.54**	**2.79**	**0.38**	**0.75**	**0.38**	**675.13**
Percent of Jefferson County inventory	0.034%	0.002%	0.003%	0.013%	0.007%	0.015%	*
Percent of Metropolitan Denver Intrastate AQCR inventory	0.0051%	0.0004%	0.0007%	0.0025%	0.0011%	0.0024%	0.00063%
General conformity applicability thresholds	100	100	100	NA	100	NA	NA

Notes: * Data not available. NA = Not applicable.

Emissions for the proposed infrastructure upgrades in Zone 1 and 2 would be produced only for the duration of the upgrade activities, which, for the purposes of the air quality analysis, is conservatively assumed to be 240 work days (that is, five days per week, four weeks per month, and 12 calendar months). While a timeline has not been proposed and the proposed upgrade activities could take place over multiple years, emissions have been conservatively calculated for one CY, 2015. Proposed infrastructure upgrades include the following assumptions:

- Drinking water system – 3.9 miles (2.4 kilometers) of new water line, estimated 206,000 square feet of total disturbed area
- Fire suppression system – Installing a 200,000-gallon water storage tank (estimated to be 20 feet in diameter and 100 feet high)
- Sanitary waste system – Installing approximately 3,450 (1,052 meters) linear feet of pipe and disturbing approximately one acre of land for housing equipment and infrastructure
- Road improvements – 1,200 square feet of additional paving
- Data and telecommunications improvements – Installing an estimated 2.0 miles (3.2 kilometers) of lines, or an estimated 52,800 square feet of total disturbed area

Table 3-12 summarizes air emissions from the listed infrastructure upgrades. **Appendix B** contains detailed calculations and the assumptions used to estimate the air emissions. Note that all modification emissions are not stationary sources but are classified as mobile source emissions.

Table 3-12. Estimated Air Emissions Resulting from Infrastructure Upgrades in Zones 1 and 2, Proposed Action (CY 2015)

Activity	NO_x tpy	VOC tpy	CO tpy	SO_2 tpy	PM_{10} tpy	$PM_{2.5}$ tpy	CO_2 tpy
Project combustion	4.85	0.42	2.13	0.38	0.35	0.34	549.56
Project fugitive dust	-	-	-	-	5.88	0.59	-
Haul truck, on-road	0.14	0.04	0.10	0.00	0.01	0.00	71.92
Project commuter	0.07	0.07	0.66	0.00	0.01	0.01	119.01
Total Emissions	**5.06**	**0.53**	**2.89**	**0.38**	**6.25**	**0.94**	**740.49**
Percent of Jefferson County inventory	0.035%	0.002%	0.003%	0.013%	0.060%	0.037%	*
Percent of Metropolitan Denver Intrastate AQCR inventory	0.0053%	0.0004%	0.0007%	0.0025%	0.0091%	0.006%	0.00070%
General conformity applicability thresholds	100	100	100	NA	100	NA	NA

Notes: * Data not available. NA = Not applicable.

Based on the emissions calculations, emissions from the proposed construction, modification, and infrastructure upgrade activities within Zones 1 and 2 under the Proposed Action are not expected to (1) cause or contribute to a violation of any national or state ambient air quality standard, (2) increase the frequency or severity of a violation of any ambient air quality standard, (3) expose sensitive receptors to substantially increased pollutant concentrations, (4) exceed any evaluation criteria established by a SIP, or (5) delay the attainment of any standard or other milestone contained in the SIP. Particulate emissions from construction sites larger than 25 acres are subject to CDPHE Air Pollution Control Division fugitive particulate emissions permits. None of the proposed improvements are anticipated to result in land disturbance over 25 acres. Construction vehicles, equipment, and construction personnel vehicles would be required to minimize emissions through BMPs. Unnecessary idling of vehicles and equipment is prohibited, including the idling of vehicles for occupant comfort, heating, or cooling (C.R.S. No. 42-14-105).

In addition, it is anticipated that two emergency generators would be installed as part of increasing and enhancing research and support capabilities for the new Wind Turbine Component Research and Testing Facility and staging and maintenance warehouse. Any new emergency generator emissions would be minor and would be evaluated to determine if an APEN would be required. Table 3-13 lists the anticipated emissions from each proposed generator, based on 500 hours of operation per year. **Appendix B** contains detailed calculations and the assumptions used to estimate the air emissions.

In summary, localized, short-term minor effects on air quality would be expected from the proposed construction, modification, and infrastructure upgrade activities associated with increasing and enhancing research and support capabilities in Zone 1 and Zone 2. Operation and maintenance of the new facilities, modified facilities, and infrastructure upgrades are expected to generate long-term, minor, adverse effects on air quality, due to the possible increase in personnel vehicles, operating additional heating-ventilation-air conditioning systems, temporary equipment for testing, and the use of maintenance vehicles. Appropriate BMPs would be employed, such as minimizing vehicle trips and keeping vehicles and equipment maintained, to minimize emissions.

Table 3-13. Estimated Air Emissions Resulting from Emergency Generator Emissions

	NO_x tpy	VOC tpy	CO tpy	SO_2 tpy	PM_{10} tpy	$PM_{2.5}$ tpy	CO_2 tpy
Wind Turbine Component Research and Testing Facility	0.091	0.0025	0.024	0.029	0.0028	-	4.667
Staging and maintenance warehouse	0.091	0.0025	0.024	0.029	0.0028	-	4.667
Total Emissions	**0.181**	**0.005**	**0.048**	**0.058**	**0.0056**	**-**	**9.334**

Increasing Site Use and Density (Zone 2)

The Proposed Action includes new construction of up to 3 large utility-scale wind turbines, 4 mid-scale wind turbines, and 11 small wind turbines in Zone 2. New construction proposed would also include an access road, utility infrastructure, temporary construction laydown areas and crane pads, one or more data sheds, up to 11 ancillary meteorological towers, and new or upgraded data and telecommunications lines.

The construction activities would generate air pollutant emissions from site-disturbing activities such as grading, filling, compacting, and trenching; operating construction and demolition equipment; and haul trucks transporting construction supplies, excavation material, and demolition debris. Construction activities would also generate particulate emissions as fugitive dust from ground-disturbing activities and from the combustion of fuels in construction and demolition equipment. Fugitive dust emissions would be greatest during the initial site preparation activities and would vary from day to day depending on the work phase, level of activity, and prevailing weather conditions. The quantity of uncontrolled fugitive dust emissions from a construction site is proportional to the area of land being worked and the level of activity. Construction activities would incorporate BMPs and control measures (for example, frequent use of water for dust-generating activities) to minimize fugitive particular matter emissions. In addition, the work vehicles are assumed to be well-maintained and could use diesel particle filters to reduce emissions. Construction and demolition workers commuting daily to and from the job site in their personal vehicles would also result in criteria pollutant air emissions. Based on the size of the proposed activities and the assumed duration of the activities, it is not expected that emissions from the proposed activities would contribute to or affect local or regional attainment status with the NAAQS.

Emissions for the proposed wind turbine construction activities in Zone 2 would be produced only for the duration of the construction activities, which, for the purposes of the air quality analysis, is conservatively assumed to be 240 work days (that is, five days per week, four weeks per month, and 12 calendar months). Wind turbine components are anticipated to be transported to the sites by truck, assembled in laydown areas, and lifted into place by cranes. While an exact timeline has not been proposed and the proposed construction activities could take place over multiple years, emissions have been conservatively calculated for one CY, 2015, for the associated infrastructure and one utility-scale turbine and five mid-scale or small wind turbines. It is anticipated that an additional utility-scale wind turbine and five mid-scale or small wind turbines would each be installed in CY 2016 and CY 2017. Air emissions from wind turbine installation and associated infrastructure construction in Zone 2 are summarized in **Table 3-14** for CY 2015 and in **Table 3-15** for CY 2016 or CY 2017. **Appendix B** contains detailed calculations and the assumptions used to estimate the air emissions. Note that all construction emissions are not stationary sources but are classified as mobile source emissions.

Table 3-14. Estimated Air Emissions Resulting from Wind Turbine and Associated Infrastructure Construction in Zone 2, Proposed Action (CY 2015)

Activity	NO_x tpy	VOC tpy	CO tpy	SO_2 tpy	PM_{10} tpy	$PM_{2.5}$ tpy	CO_2 tpy
Project combustion	26.80	5.43	13.93	5.76	1.03	1.00	2,932.07
Project fugitive dust	-	-	-	-	3.45	0.35	-
Haul truck, on-road	0.02	0.00	0.01	0.00	0.00	0.00	7.14
Project commuter	0.08	0.09	0.84	0.00	0.01	0.01	159.20
Total Emissions	**26.90**	**5.52**	**14.78**	**5.76**	**4.49**	**1.36**	**3,098.41**
Percent of Jefferson County inventory	0.185%	0.021%	0.018%	0.199%	0.043%	0.054%	*
Percent of Metropolitan Denver Intrastate AQCR inventory	0.0283%	0.0043%	0.0035%	0.0378%	0.0065%	0.0087%	0.0029%
General conformity applicability thresholds	100	100	100	NA	100	NA	NA

Notes: * Data not available. NA = Not applicable.

Table 3-15. Estimated Air Emissions Resulting from Wind Turbine Construction in Zone 2, Proposed Action (CY 2016 or CY 2017)

Activity	NO_x tpy	VOC tpy	CO tpy	SO_2 tpy	PM_{10} tpy	$PM_{2.5}$ tpy	CO_2 tpy
Project combustion	22.05	5.05	11.84	5.38	0.69	0.67	2,393.86
Project fugitive dust	-	-	-	-	2.99	0.30	-
Haul truck, on-road	0.00	0.00	0.00	0.00	0.00	0.00	1.97
Project commuter	0.02	0.24	0.22	0.00	0.00	0.00	39.67
Total Emissions	**22.07**	**5.29**	**12.06**	**5.38**	**3.68**	**0.97**	**2,435.50**
Percent of Jefferson County inventory	0.152%	0.020%	0.014%	0.186%	0.035%	0.038%	*
Percent of Metropolitan Denver Intrastate AQCR inventory	0.0232%	0.0041%	0.0028%	0.0353%	0.0054%	0.0062%	0.0023%
General conformity applicability thresholds	100	100	100	NA	100	NA	NA

Notes: * Data not available. NA = Not applicable.

Based on the emissions calculations, emissions from the proposed construction activities for increasing site use and density in Zone 2 are not expected to (1) cause or contribute to a violation of any national or state ambient air quality standard, (2) increase the frequency or severity of a violation of any ambient air quality standard, (3) expose sensitive receptors to substantially increased pollutant concentrations, (4) exceed any evaluation criteria established by a SIP, or (5) delay the attainment of any standard or other milestone contained in the SIP. In summary, short-term, minor effects on air quality would be expected from the proposed construction activities associated with increasing site use and density in Zone 2.

It is anticipated that no direct air emissions from wind turbine operations would occur. However, wind energy facilities generate low levels of air emissions from vehicles associated with regular site inspections, infrequent maintenance activities, and wind erosion from bare ground and access roads. There could be some minor VOC emissions during routine changes of lubricating and cooling fluids and greases. However, all these activities would be limited in extent and duration and should have no adverse air quality impact. In addition, it is anticipated that three emergency generators would be installed for the operation of the proposed wind turbines, with each one requiring an APEN once construction is complete. **Table 3-16** lists the anticipated emissions for each proposed generator, based on 500 hours of operation per year. **Appendix B** contains detailed calculations and the assumptions used to estimate the air emissions. Additional emergency generators may be needed to ensure operations of facilities in the future. New generators would comply with the CAA and air emissions would be evaluated to determine permitting and reporting requirements.

Table 3-16. Estimated Air Emissions Resulting from Three Emergency Generator Emissions

	NO_x tpy	**VOC tpy**	**CO tpy**	**SO_2 tpy**	**PM_{10} tpy**	**$PM_{2.5}$ tpy**	**CO_2 tpy**
One emergency generator per wind turbine	0.091	0.0025	0.024	0.029	0.0028	-	4.667
Total Emissions from Three Emergency Generators	**0.273**	**0.0075**	**0.072**	**0.087**	**0.0084**	**-**	**14.001**

Decommissioning wind energy facilities could occur and would include dismantling wind turbines and their support facilities, disposal of debris, restoration grading, and revegetation as needed. Activities for decommissioning would be similar to those for construction but on a more limited scale and for a shorter duration; therefore, they would be expected to have short-term negligible impacts on air quality.

Expanding Power Capacity

The proposed build-out of the NWTC site would include improving the site's electrical infrastructure. Five options are proposed, and each option would include constructing an onsite substation and installing onsite transmission line. The proposed substation would occupy approximately 1.25 acres in each option. The five options would have similar air quality impacts. Therefore, their air quality discussion is consolidated into one analysis, based on Eldorado Options 1 and 2. These options would have the largest amount of transmission line installed.

The activities would generate air pollutant emissions from site-disturbing activities such as grading, filling, compacting, and trenching; operating construction and demolition equipment; and haul trucks transporting construction supplies, excavation material, and demolition debris. Construction, activities would also generate particulate emissions as fugitive dust from ground-disturbing activities and from the combustion of fuels in construction and demolition equipment. Fugitive dust emissions would be greatest during the initial site preparation activities and would vary from day to day depending on the work phase, level of activity, and prevailing weather conditions. The quantity of uncontrolled fugitive dust emissions from a construction site is proportional to the area of land being worked and the level of activity. Construction and demolition activities would incorporate BMPs and control measures (for example, frequent use of water for dust-generating activities) to minimize fugitive particular matter emissions. Additionally, the work vehicles are assumed to be well-maintained. Construction and demolition workers commuting daily to and from the job site in their personal vehicles would also result in criteria pollutant

air emissions. Based on the size of the proposed activities and the assumed duration of the activities, it is not expected that emissions from the proposed activities would contribute to or affect local or regional attainment status with the NAAQS.

Emissions from the proposed construction activities for expanding power capacity at the NWTC site would be produced only for the duration of the construction activities, which, for the purposes of the air quality analysis, is conservatively assumed to be 240 work days (that is, five days per week, four weeks per month, and 12 calendar months). While a timeline has not been proposed and the proposed construction activities could take place over multiple years, emissions have been conservatively calculated for CY 2015. Air emissions from expanding power capacity at the NWTC site are summarized in **Table 3-17**. **Appendix B** contains detailed calculations and the assumptions used to estimate the air emissions. Note that all construction emissions are not stationary sources but are classified as mobile source emissions.

Table 3-17. Estimated Air Emissions Resulting from Expanding Power Capacity at the NWTC Site, Proposed Action (CY 2015)

Activity	NO_x tpy	VOC tpy	CO tpy	SO_2 tpy	PM_{10} tpy	$PM_{2.5}$ tpy	CO_2 tpy
Project combustion	4.83	0.62	2.13	0.38	0.35	0.34	546.75
Project fugitive dust	-	-	-	-	5.74	0.57	-
Haul truck, on-road	0.28	0.07	0.20	0.00	0.01	0.01	139.68
Project commuter	0.07	0.07	0.66	0.00	0.01	0.01	119.01
Total Emissions	**5.18**	**0.76**	**2.99**	**0.38**	**6.11**	**0.93**	**805.44**
Percent of Jefferson County inventory	0.036%	0.003%	0.004%	0.013%	0.059%	0.037%	*
Percent of Metropolitan Denver Intrastate AQCR inventory	0.0055%	0.0006%	0.0007%	0.0025%	0.0089%	0.0059%	0.00076%
General conformity applicability thresholds	100	100	100	NA	100	NA	NA

Notes: * Data not available. NA = Not applicable.

Based on the emissions calculations, emissions from the proposed construction activities for expanding power capacity at the NWTC site are not expected to (1) cause or contribute to a violation of any national or state ambient air quality standard, (2) increase the frequency or severity of a violation of any ambient air quality standard, (3) expose sensitive receptors to substantially increased pollutant concentrations, (4) exceed any evaluation criteria established by a SIP, or (5) delay the attainment of any standard or other milestone contained in the SIP. In summary, localized, short-term minor effects on air quality would be expected from the proposed construction activities associated with expanding power capacity in Zone 3.

Operating the proposed power capacity enhancement is not anticipated to have an adverse impact on regional air quality. Occasional maintenance activities would occur; however, appropriate BMPs would be employed, such as minimizing vehicle trips and keeping vehicles and equipment maintained, to minimize emissions and would result in a negligible adverse impact on regional air quality.

Emission Summary

Historically, air quality in the Metropolitan Denver Intrastate AQCR has been adversely affected by man-made sources. This area has been designated by the EPA as being in marginal nonattainment for the criteria pollutant ozone, when averaged over an eight-hour period. In addition, the area has been designated as maintenance for CO and PM_{10}. Proposed construction activities could occur at the same time and in the same vicinity, which could have short-term, minor, adverse effects on air quality. The estimated emissions from implementing activities are shown in **Table 3-18** for each year. Based on the emissions calculations, emissions from the proposed construction activities at the NWTC site are not expected to (1) cause or contribute to a violation of any national or state ambient air quality standard, (2) increase the frequency or severity of a violation of any ambient air quality standard, (3) expose sensitive receptors to substantially increased pollutant concentrations, (4) exceed any evaluation criteria established by a SIP, or (5) delay the attainment of any standard or other milestone contained in the SIP.

Table 3-18. Estimated Air Emissions at the NWTC Site for each Calendar Year, Proposed Action

Activity	NO_x tpy	VOC tpy	CO tpy	SO_2 tpy	PM_{10} tpy	$PM_{2.5}$ tpy	CO_2 tpy
Total CY 2015 construction emissions	47.20	8.09	26.42	7.28	24.25	4.60	6,115.62
Total CY 2016 or 2017 construction emissions	22.07	5.29	12.06	5.38	3.68	0.97	2,435.50
General conformity applicability thresholds	100	100	100	NA	100	NA	NA

Notes: NA = Not applicable.

The CEQ has issued draft guidance on when and how federal agencies should consider GHG emissions and climate change in NEPA documents. The draft guidance includes a threshold of 25,000 metric tons per year, equivalent to 27,560 U.S. (short) tons per year of CO_2 equivalent emissions from a proposed action on an annual basis (CEQ 2010). The annual total of CO_2 emissions from all activities in the Proposed Action would range from 9 to 22 percent of the threshold GHG emissions in the CEQ guidance. Therefore, the Proposed Action would not have an adverse effect on climate change.

3.4.3.3 No Action Alternative

Under the No Action Alternative, current operations and activities at the NWTC would continue and would not allow the DOE to expand operations at the NWTC. The existing conditions, as described in **Section 3.4.2**, would remain the same. Therefore, no impacts on air quality would be expected from implementing the No Action Alternative.

3.5 Visual Quality and Aesthetics

3.5.1 DEFINITION OF THE RESOURCE

Visual resources include the natural and man-made physical features that give a particular landscape its character. Features that form the overall visual impression a viewer receives include landforms, vegetation, water, color, adjacent scenery, scarcity, and man-made modifications. These features define the landscape character of an area and form the overall impression that an observer receives of that area. Evaluating the aesthetic qualities of an area is a subjective process because the value that an observer places on a specific feature varies depending on their perspective and judgment. In general, a feature

observed within a landscape can be considered as "characteristic" (or character-defining) if it is inherent to the composition and function of the landscape. Landscapes can change over time, so the assessment of the environmental impacts of the Proposed Action on a given landscape or area must be made relative to the "characteristic" features currently composing the landscape or area.

3.5.2 EXISTING ENVIRONMENT

The NWTC is characterized by permanent facilities in the northern portion of the site and meteorological towers and wind turbines interspersed among natural conditions throughout the rest of the site. A large portion of the site is undeveloped and retains a natural feel. The permanent facilities in the northern portion of the site are primarily composed of buildings, roads, and parking areas. **Figures 3-2** to **3-4** present photographs of the existing conditions found at the NWTC from surrounding representative vantage points that would be typical of the views expected near the NWTC. Vantage point 1 is near the intersection of Hwy 93 and 128 looking south toward the NWTC from the Greenbelt Plateau Trailhead, Vantage Point 2 is from the west side of Hwy 93 looking east toward the NWTC from the Flatirons Vista Trail, and Vantage Point 3 is from Hwy 128 east of the site entrance looking west toward the NWTC. **Figure 3-5** presents a location map showing these vantage points.

Figure 3-2. View of the NWTC from the Greenbelt Plateau Trailhead (Vantage Point 1).

There are several primary offsite vantage points in the project vicinity where the general public can see the site or site facilities. Key vantage points along Hwy 93 exist for southbound motorists north of the Hwy 93/128 intersection and for northbound motorists south of the project site. However, in many instances, existing development and overhead transmission lines obscure views from the south looking northeast. Numerous vantage points for motorists also exist along Hwy 128 between the Broomfield County line and the site access road. New office buildings along Hwy 128 in the vicinity of Jefferson County Airport have views of site facilities. Building 251, turbines, and other site features are visible from Hwy 128 west of the site access intersection.

Boulder County and the City of Boulder jointly own and manage open space north of the project site. Two trailheads located near the intersection of Hwy 93 and Hwy 128 owned and maintained by the City of Boulder provide access for recreational users. The Greenbelt Plateau trailhead is located just east of the intersection along Hwy 128. This trailhead provides parking for trails to the north. The Flatirons Vista trailhead provides parking for recreational users headed west. No trailheads or trails have been provided southeast of the Hwy 93/128 intersection. The Coalton Trail is accessible on the north side of Hwy 128 about one mile east of the NWTC entrance off of Hwy 128. These trailheads and vantage points along the trails offer users views of the project site and much of the surrounding area.

Figure 3-3. View of the NWTC from the Flatirons Vista Trail (Vantage Point 2).

Figure 3-4. View of the NWTC from Hwy 128 West of the Site Entrance (Vantage Point 3).

One residence is located west of Hwy 93 across from the aggregate operations. No other residences are located within four miles of the site. The view of the NWTC from this residence is dominated by the aggregate facilities located just east of Hwy 93. Highways 93 and 128 are not formally designated scenic roadways by the State of Colorado or local governments.

3.5.3 ENVIRONMENTAL CONSEQUENCES

3.5.3.1 Evaluation Criteria

The visual resource analysis focuses on evaluating the existing conditions at the NWTC and evaluating the changes expected from implementation of the Proposed Action. This includes evaluating:

- How different the landscape would look following construction
- How clearly viewers would be able to see any changes
- How sensitive viewers would likely be to the changes in the views

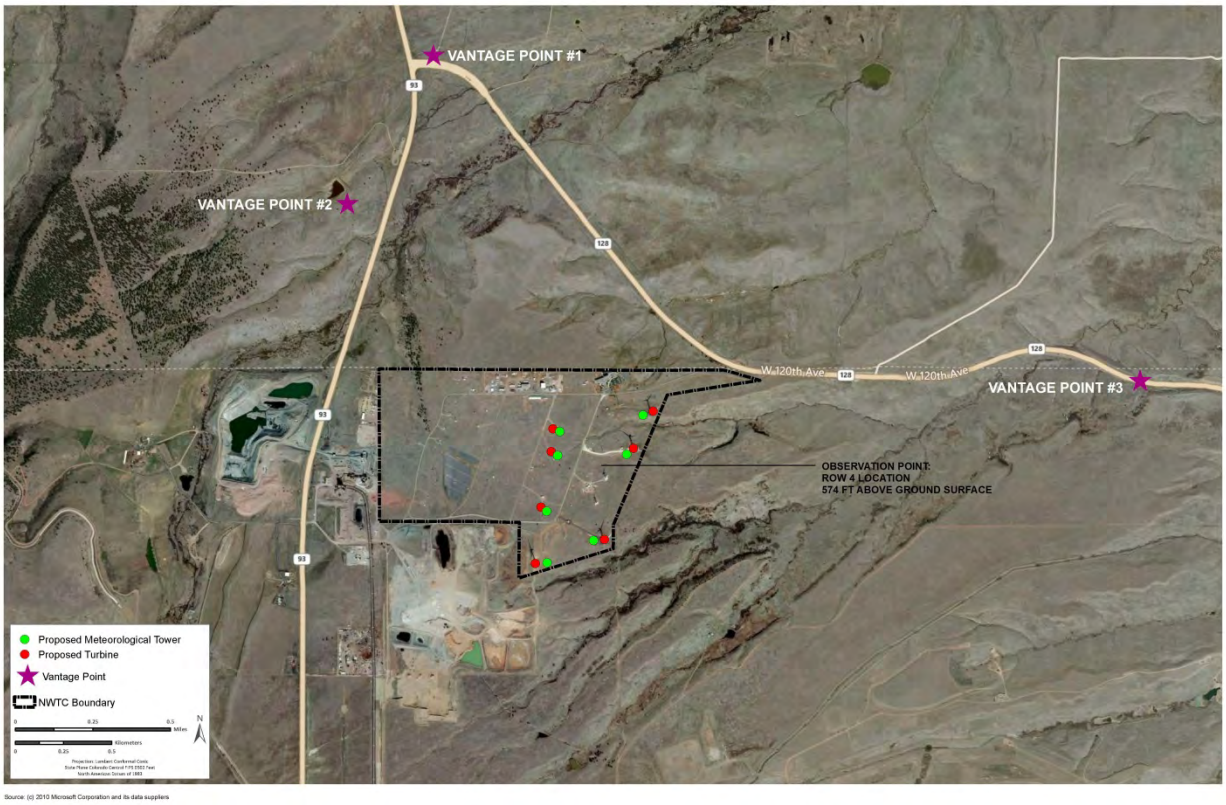


Figure 3-5. Location Map of Visual Vantage Points.

3.5.3.2 Proposed Action

Increasing and Enhancing Research and Support Capabilities (Zone 1 and Zone 2)

The Proposed Action would add new and larger features to the site that would be visible from offsite locations; however, the new features would be reasonably consistent with existing features, views would not be blocked, and NREL's building and facility design review processes would be implemented to reduce visual and aesthetic impacts. Construction of new buildings and modifications to existing buildings at the NWTC would be consistent with the existing facilities within Zones 1 and 2 and would not adversely alter the existing conditions of the NWTC. The new buildings would maintain the low profile of existing buildings and would be installed within the developed portion of the NWTC. New facilities would not be out of character with existing development.

Infrastructure upgrades would include installing a 200,000-gallon water storage tank in Zone 1 for fire suppression. The proposed water storage tank would be installed on the ground, partially buried, or elevated to a maximum height of 150 feet (46 meters). If the tank is elevated, the tank structure would be taller than the existing buildings in Zone 1; however, the top of the tower would be less than half of the hub height of the proposed utility-scale turbines. The existing turbines, because of their height and blade movement, would still be viewed as the dominant feature on the NWTC landscape.

Increasing Site Use and Density (Zone 2)

New wind turbines and meteorological towers would be visible from offsite locations; however, the new features would be reasonably consistent with existing features and views would not be blocked. The

Proposed Action would construct additional wind turbines and modify the number of existing field test sites and associated infrastructure to potentially include any combination of up to 7 (including the 4 currently onsite) large utility-scale wind turbines (1 to 5 MW), up to 7 (including the 3 currently onsite) mid-scale turbines (each rated from 100 kw to 1 MW), and up to 20 (including the 9 currently onsite) small wind turbines (each rated from 1 W to 100 kW) within Zone 2. The turbines would have a maximum hub height of 150 meters (492 feet), a maximum rotor height of 175 meters (574 feet), and a maximum meteorological tower height of 200 meters (656 feet). **Figures 3-6 to 3-8** present visual simulations of what the proposed turbines would look like from different vantage points surrounding the NWTC. The proposed turbines would be consistent with the existing turbines in the area and would not appreciably alter existing conditions.

FAA has indicated that red hazard lights similar to the fixtures on existing towers would be needed on the taller turbines and meteorological towers, and might be needed in multiple locations for these towers. No visual impact would be anticipated from these future lighting requirements because the fixtures would be the same or similar to those already on the site and the number of utility-scale turbines is not projected to increase substantially (see **Table 2-1**).

Figure 3-6. Photosimulation of proposed turbines and meteorological towers from Vantage Point 1.

Figure 3-7. Photosimulation of proposed turbines and meteorological towers from Vantage Point 2.

Expanding Power Capacity

Improving the site's electrical infrastructure would include constructing an onsite substation at one of two possible locations and an interconnection to the local utility. The five options, as described in the Proposed Action (**Section 2.1.3**), would have similar visual impacts. The onsite electrical infrastructure would be adjacent to aggregate mining facilities west of the NWTC along Hwy 93 and would parallel existing transmission lines. New facilities would not be out of character with existing development.

3.5.3.3 No Action Alternative

Under the No Action Alternative, additional site development at the NWTC would not occur and no changes to aesthetics or visual resources would be anticipated. No impacts would be expected.

Figure 3-8. Photosimulation of proposed turbines and meteorological towers from Vantage Point 3.

3.6 Cultural Resources

3.6.1 DEFINITION OF THE RESOURCE

Cultural resources include prehistoric or historic archaeological sites, buildings, structures, districts, or other places or objects considered important by the local or regional communities. Cultural resource sites can vary widely in size, ranging from a cluster of several objects or materials to structures with associated objects and features. A site may consist of redeposited cultural resource remains. Features such as hearths, fire-cracked rock, cairns (man-made piles or stacks of stone), rock alignments, masonry concentrations, burned adobe, corrals, fences, water features, and foundations are generally recorded as sites. In general, a particular resource should be older than 50 years before being considered an archaeological site. These resources are protected and identified under several federal statutes and executive orders. The federal statutes include the *National Historic Preservation Act* (NHPA) (1966), the *Archaeological and Historic Preservation Act* (1974), the *American Indian Religious Freedom Act* (1978), the *Archaeological Resources Protection Act* (1979), and the *Native American Graves Protection and Repatriation Act* (1990).

Assessing potential impacts to cultural resources under NEPA includes those that are eligible and not eligible for listing on the National Register of Historic Places (NRHP). CEQ's NEPA regulations (40 CFR 1502.25) require agencies to "…prepare draft environmental impact statements concurrently with and integrated with environmental impact analyses and related surveys and studies required by … the National Historic Preservation Act of 1966…" The NHPA requires that federal agencies assume the responsibility for preserving historic and prehistoric resources located on lands they own or control. Section 106 of the NHPA requires agencies to identify and consider historic properties that might be affected by an undertaking and to attempt to resolve any adverse effects through consultation with interested parties. Consulting parties strive to reach agreement on measures to avoid, minimize, and mitigate adverse effects on historic properties. Section 110(a)(2) of the NHPA requires each federal agency to establish a program to locate, inventory, and nominate all properties under the agency's ownership or control that appear to qualify for inclusion on the NRHP. Section 110(a)(2) further requires that "Each agency shall exercise caution to assure that any property that might qualify for inclusion is not inadvertently transferred, sold, demolished, substantially altered, or allowed to deteriorate significantly." The regulations for Protection of Historic Properties (36 CFR Part 800) outlines the Section 106 process requiring federal agencies to take into account the effects of their undertakings on historic properties and affording the Advisory Council on Historic Preservation a reasonable opportunity to comment on such undertakings. DOE Policy 141.1, *Department of Energy Management of Cultural Resources* includes requirements for compliance with these laws and regulations. NREL's Cultural Resource Management Procedure was developed to implement DOE's cultural resource management policy on NREL sites, including the NWTC (NREL 2012d).

Cultural resources addressed in this EA include known resources that are determined eligible, not eligible, or unevaluated for inclusion in the NRHP, and traditional cultural properties. Traditional cultural properties are places or objects that have religious, sacred, or cultural value for a particular cultural group. Under NHPA guidelines, cultural resources, including buildings, structures, objects, sites, and districts, are to be evaluated for NRHP eligibility using the NRHP "Criteria for Evaluation" (36 CFR 60.4). To be listed in, or considered eligible for the NRHP, a historic property must be at least 50 years old (unless it is of exceptional importance) and meet at least one of the four following criteria:

- Criterion A—Associated with events that have made a significant contribution to the broad patterns of our history
- Criterion B—Associated with the lives of persons significant in our past
- Criterion C—Embodies the distinctive characteristics of a type, period, or method of construction
- Criterion D—Yielded or may be likely to yield information important in prehistory or history

In addition to meeting at least one of these criteria, a historic property must also possess integrity of location, design, setting, materials, workmanship, feeling, and association. Integrity is defined as the authenticity of a property's historic identity, as evidenced by the survival of physical characteristics it possessed in the past and its capacity to convey information about a culture or group of people, a historic pattern, or a specific type of architectural or engineering design or technology. Location refers to the place where an event occurred or a property was originally built. Design considers elements such as plan, form, and style of a property. Setting is the physical environment of the property. Materials refer to the physical elements used to construct the property. Workmanship refers to the craftsmanship of the creators of a property. Feeling is the ability of the property to convey its historic time and place. Association refers to the link between the property and a historically significant event or person.

Cultural resources meeting these standards (age, eligibility, and integrity) are termed "historic properties" under the NHPA. Sites or structures that are not considered individually significant may be considered eligible for listing in the NRHP as part of a historic district. According to the NRHP, a historic district possesses a significant concentration, linkage, or continuity of sites, buildings, structures, or objects that are historically or aesthetically united by plan or physical development. Archaeological sites that are unevaluated are considered NRHP-eligible until determined otherwise.

Typically, cultural resources are grouped into three separate categories: archaeological, architectural, or sites that have a traditional religious or cultural significance to Native American tribes. Archaeological resources are defined as areas that have altered the landscape. Architectural resources are built structures of significance. In general, these architectural resources are typically more than 50 years old but newer structures can be evaluated under the above criteria if they are determined to be of exceptional importance. Resources of traditional, religious, or cultural significance to Native American tribes can include architectural or archaeological resources, sacred sites, neighborhoods, geographic landmarks, flora or faunal habitats, mineral localities, or sites considered essential for the preservation of traditional culture.

3.6.2 EXISTING ENVIRONMENT

Several primary sources were analyzed to identify cultural resources within the area of potential effect (APE), which encompasses all land within the NWTC boundary. Sources consulted include archaeological reports and a search of Compass, the Colorado Cultural Resources On-Line Database provided by the Colorado Office of Archaeology and Historic Preservation.

3.6.2.1 Overview of Cultural Resource Inventories and Sites

One hundred percent of the NWTC site has been surveyed for cultural resources by three separate cultural resource surveys (Burney and Associates 1989; Dames and Moore 1991; Labat-Anderson 1995). These surveys identified five cultural resources: three historic sites and two historic isolated finds. All were determined to be not eligible for inclusion into the NRHP (DOE 2001). The Labat-Anderson report identified a 6.5-acre area in the northwest portion of the NWTC as having a higher potential for prehistoric archaeological resources and recommended further inspection should ground-disturbing activity become a possibility in that area (NREL 1994). The Proposed Action does not include any activities within this area.

3.6.2.2 Architectural Resources

The NWTC was established in the 1970s and all current NWTC structures and buildings have been constructed since then. Currently, none of the buildings have reached the 50-year age threshold for NRHP consideration or have been determined to be of exceptional importance for earlier consideration.

3.6.2.3 Traditional Cultural Properties

To date, traditional cultural properties have not been identified at the NWTC. Scoping letters were sent to four tribal organizations in the fall of 2012. Section 106 requires consultation with any tribe that attaches religious and cultural significance to historic properties that may be affected as potential consulting parties. On July 17, 2013, DOE transmitted letters to the Ute Mountain Ute Tribal Council and Tribal Historic Preservation Officer, the Ute Indian Tribe, the Southern Ute Tribe, and the Oglala Sioux Tribal President and Tribal Historic Preservation Officer initiating the Section 106 consultation process. DOE also followed up with e-mail inquiries. To date, DOE has not received a response indicating that the proposed action will affect tribal lands.

3.6.3 ENVIRONMENTAL CONSEQUENCES

3.6.3.1 Evaluation Criteria

The criterion of adverse effect under Section 106 of the NHPA is defined by 36 CFR 800.5(a)(1); this also serves as a definition of impact to cultural resources under NEPA. According to the criteria of adverse effect:

> An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Consideration shall be given to all qualifying characteristics of a historic property, including those that may have been identified subsequent to the original evaluation of the property's eligibility for the National Register. Adverse effects may include reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance or be cumulative.

Impacts on cultural resources would be considered adverse under NEPA if any of the above effects were considered to be substantial, as determined by context and intensity. For evaluation under Section 106 of the NHPA, the Proposed Action effect statement could have three possible outcomes: (1) no effects on historic properties (a finding that there are no historic properties in the APE); (2) no adverse effects on historic properties; or (3) adverse effects on historic properties, based on consultation with the SHPO. Consultation letters between DOE and SHPO are provided in **Appendix F**.

3.6.3.2 Proposed Action

Increasing and Enhancing Research and Support Capabilities (Zone 1 and Zone 2)

No direct cultural resource impacts are anticipated for proposed facility and infrastructure improvements, though such improvements could have the potential for indirect impacts on historic properties within the visual APE by changing the integrity of setting or feeling. New facility construction has a limited potential to uncover, disturb, or destroy resources that are not expected but could be found in construction areas. Should any evidence of archaeological resources be discovered during construction in Zones 1 and 2, the impact would be mitigated in accordance with NREL's cultural resource management policy, which specifies stopping the work in the vicinity until a qualified archaeologist can completely evaluate the significance of the find according to criteria established by the NRHP (NREL 2012d). NREL keeps an "on call" contract with a local archaeological firm in case unexpected discoveries are made. If archaeological resources are identified, the SHPO would be contacted for resolution and further instruction regarding additional studies and potential avoidance, minimization, or mitigation measures in accordance with the NHPA. Though there are known prehistoric sites within a two-mile radius of the NWTC, no known traditional cultural properties are expected to be impacted by the Proposed Action.

Increasing Site Use and Density (Zone 2)

Increasing site use and density in Zone 2 includes constructing additional turbines, meteorological towers, and associated facilities. The effects on cultural properties from this action are expected to be similar to those for increasing and enhancing research in Zones 1 and 2. Inadvertent discoveries of cultural resources would be treated the same as for that action.

The APE for the viewshed analysis of historic properties around the NWTC was expanded to include a two-mile (3.2 kilometer) radius from a point in the center of turbine row 4 at an elevation of 574 feet (175 meter) above the ground surface. The elevation represents the height of a five MW turbine from the

ground to the tip of the rotor at the highest point of rotation (see **Table 2-1**) to simulate the rotor sweep of the largest proposed wind turbine. A review of the Colorado Office of Archaeology and Historic Preservation's Compass database, not including the five sites within NWTC boundaries, indicates there are 18 sites within the two-mile radius. Of those, one is listed on the NRHP, seven are eligible for the NRHP, and 10 are unevaluated. Five of these sites are not within the viewshed, two are partially within it, and 11 are fully within the viewshed. These sites are summarized in the table below (**Table 3-19**).

Table 3-19. Historic Properties within the Two-Mile Viewshed Radius of the NWTC

Site Number	Eligibility	Visible	Site Description
5JF318.7 5JF318.8	Eligible - official	Partial	South Boulder Diversion Canal – This site has two site numbers.
5JF475	Unevaluated	Yes	cairn
5JF476	Unevaluated	Yes	cairn
5JF478	Unevaluated	Yes	cairn
5JF479	Unevaluated	Yes	cairn
5JF1014 5JF 1227	Listed	Yes	Rocky Flats Plant – (Demolished and restored to native grassland; however, Rocky Flats is still NRHP-listed. This site has two site numbers.)
5JF2431	Eligible - field	No	stone circles
5JF2432	Unevaluated	Yes	cairns
5JF2435	Unevaluated	Yes	rubble mound
5BL3139	Unevaluated	No	historic foundation
5BL3140	Unevaluated	No	mine
5BL3141	Eligible - field	Partial	McKenzie Ditch
5BL3142	Eligible - field	No	Eggleston Reservoir Filler Ditch #3
5BL3144	Eligible - field	Yes	historic foundation
5BL3145	Eligible - field	Yes	Eggleston Reservoir Filler Ditch #4
5BL3153	Eligible - field	Yes	stone circles
5BL3428	Unevaluated	Yes	homestead
5BL4102	Unevaluated	No	historic features

In a letter dated September 9, 2013, documenting the viewshed analysis (**Table 3-19**), the Colorado SHPO concurred with the DOE's determination that the proposed undertaking would not result in an adverse effect pursuant to Section 106 of the NHPA (36 CFR 800.5(b)).

Expanding Power Capacity

Expanding the power capacity of NWTC calls for adding transmission routes along the western edge of the NWTC and the potential siting of a substation. The effects on cultural properties from this action are expected to be similar to those for increasing and enhancing research in Zones 1 and 2. Inadvertent discoveries of cultural resources would be treated the same as for that action.

3.6.3.3 No Action Alternative

Under the No Action Alternative, additional site development at the NWTC would not occur; therefore, no impacts to cultural resources would be expected.

3.7 Water Resources

3.7.1 DEFINITION OF THE RESOURCE

Water resources include surface water, stormwater, and groundwater. Surface water includes streams, creeks, ponds, and standing water. Surface water at the NWTC is described in **Section 3.7.2.1**. Stormwater is the water the site receives from precipitation and includes sheeting and runoff associated with high precipitation events. Stormwater may also include surface runoff from snow-melt if large quantities of snow melt rapidly. Stormwater at the NWTC is described in **Section 3.7.2.2**. Groundwater is the water residing in aquifers and the subsurface strata, and may be deep below the ground surface or very near (within a few feet of) the surface. Groundwater at the NWTC is described in **Section 3.7.2.3**.

3.7.2 EXISTING ENVIRONMENT

3.7.2.1 Surface Water

There are no substantial permanent surface water resources at the NWTC, and no perennial creeks or streams cross the property. The area surrounding the NWTC site is drained by five streams: Rock Creek, North Walnut Creek, South Walnut Creek, Woman Creek, and Coal Creek (NREL 2012c). Rock Creek flows eastward and is located southeast of the NWTC. North Walnut Creek and South Walnut Creek flow eastward into Great Western Reservoir. Woman Creek drains eastward into Standley Lake. Coal Creek flows in a northeasterly direction across the open space north of the NWTC. The majority of the NWTC site drains into a tributary to Rock Creek. Some of the northern portions of the site drain into Coal Creek or its tributaries (**Figure 1–1**). There are no surface water withdrawals at the NWTC.

Wetland areas have been identified at the NWTC, totaling one acre, but no floodplains have been identified within the NWTC site (NREL 2011c). Per the correspondence in **Appendix F**, the U.S. Army Corps of Engineers agrees with the wetland determination for the eastern side of the NWTC.. Any impacts to jurisdictional wetlands would require a permit under Section 404 of the Clean Water Act. Approximately 69 acres of land within the NWTC boundary are managed as conservation areas, including onsite seeps and ephemeral (only present after precipitation) drainages and standing water resulting from rain or snow events. Storms and other seasonal precipitation events may cause water to temporarily flow from seeps and collect in these ephemeral drainages and ponds.

Two areas of groundwater seep wetlands are located on the NWTC site (NREL 2012c). The first is located in the northwestern portion of the site along the northern fence line. The second occurs over a very small area on the banks of the northern drainage. Wetlands are described in greater detail under Biological Resources (**Section 3.9.2.3**).

There are two ephemeral drainages on the NWTC site (NREL 2012c). Both drainages occur in the northeastern portion of the site, one flowing east and one flowing north. Both show evidence of intermittent surface flow. The northern-most drainage is a tributary of Coal Creek and the second drainage is a tributary to Rock Creek. A seasonal pond occurs at the northwestern corner of the site.

3.7.2.2 Stormwater

The receiving waters for stormwater runoff from the NWTC site are Coal Creek and Rock Creek. The general slope of the site is toward the southeast, directing stormwater toward Rock Creek via the natural drainages on the east side of the site. Stormwater runoff from the northwestern corner of the site and stormwater reaching the drainage east of Building 251 discharge toward Coal Creek to the northeast.

The recent focus of NREL's water quality protection program has been to manage construction site runoff due to the active construction sites at the NWTC (NREL 2012c). The EPA is the regulating authority for stormwater at federal facilities. For construction sites that disturb areas greater than one acre, a Notice of Intent must be filed with the EPA under the Construction General Permit (CGP) and a site-specific Stormwater Pollution Prevention Plan (SWPPP) must be prepared. At NREL, the SWPPP implements both the requirements of the EPA's CGP and NREL-specific requirements. For construction sites less than one acre, NREL requires subcontractors to comply with basic elements of stormwater pollution prevention including preparing an abbreviated SWPPP to document basic contract, project, and BMP information, as well as a site-specific erosion and sediment control plan showing the locations of key site characteristics and BMPs.

For areas that are not under construction, the goals of NREL's water quality protection program are to minimize erosion, facilitate infiltration of rain water and snowmelt, and prevent contamination of stormwater with hazardous materials. NREL implements practices that include preventing erosion through the use of vegetation; covering dumpsters; storing hazardous materials indoors or in covered areas; and immediately cleaning up outdoor spills of fuels, hydraulic fluids, and other materials.

3.7.2.3 Groundwater

The NWTC site is located at the western edge of the Denver Basin aquifer system that supplies water to users along the Front Range of the Rocky Mountains in northeastern Colorado. The Denver Basin includes the Dawson, Denver, Arapahoe, and Laramie-Fox Hills aquifers. The shallowest aquifer is the Dawson formation, which is located between 60 and 100 feet (18 and 30 meters) below ground surface (bgs) and extends to approximately 1,000 feet (305 meters) bgs. This is followed by the Denver aquifer, the Arapahoe aquifer, and finally the deepest aquifer, the Laramie-Fox Hills aquifer, which extends from approximately 2,270 to 2,970 feet (692 to 905 meters) bgs (NREL 2009a). There are currently no sole source aquifers designated in Colorado (EPA 2013).

The NWTC site is on the edge of the Arapahoe and Laramie-Fox Hills aquifers, which are the two deeper formations in the Denver Basin. For the two shallower formations, the northwestern edges of the Denver aquifer and the Dawson aquifer are approximately 8 miles and 30 miles, respectively, to the southeast of the NWTC site (USGS 2011). The NWTC currently has no open or active groundwater wells. The State of Colorado regulates the installation of groundwater wells through the Office of State Engineers, which requires a permit for drinking water, groundwater monitoring, or geothermal installations. If activities were to be conducted that could impact groundwater, a groundwater monitoring program would be implemented at the NWTC in accordance with state regulations and NREL procedures (NREL 2012e).

Unconfined groundwater flows toward the east/southeast in the uppermost geological layer beneath the site, known as the Rocky Flats Alluvium. Precipitation, snowmelt, and water infiltrating from the drainages, seeps, and ponds located on and near the site are the primary sources of groundwater in the Rocky Flats Alluvium, and small perched zones are common. Confined groundwater occurs in the deeper Arapahoe and Laramie-Fox Hills aquifers, flowing in a general east/southeast direction below the NWTC (DOE 2002).

3.7.3 ENVIRONMENTAL CONSEQUENCES

3.7.3.1 Evaluation Criteria

Impacts on water resources would be indicated by degradation of the quality of surface water and groundwater that may occur from the Proposed Action. Impacts on water resources would also include changes in stormwater runoff or effects on water supplies.

Adverse impacts on water resources could include, but are not necessarily limited to, the following:

- Increased concentrations of contaminant chemicals in surface water or stormwater.
- Increased concentrations of sediment in surface water or stormwater.
- Increased or initiated soil erosion due to increased surface water or stormwater flows or changes in surface water flow patterns. Soil erosion could contribute to increased sediment in surface water.
- Depletion of groundwater resources either directly at the site through pumping from wells or through increased use of utility-supplied water from a regional aquifer source.
- Increased concentrations of contaminant chemicals in groundwater through direct discharge of contaminants.
- Rising levels of shallow groundwater resources resulting from increased infiltration of surface water. Rising water tables can affect utilities and structures if close to the surface.
- Lowering of local groundwater levels through decreased recharge as a result of reduced permeable surface area.

3.7.3.2 Proposed Action

Increasing and Enhancing Research and Support Capabilities (Zone 1 and Zone 2)

Impacts to Surface Water and Stormwater

The Proposed Action would be implemented in accordance with all federal and state water quality, wetlands and floodplains statutes and regulations (**Tables 1-2** and **1-3**). No proposed construction activities would occur at the wetlands, seeps, and ephemeral drainages and ponds on the site. The main focus of NREL's water quality protection program is to protect the water quality of the receiving waters (Coal Creek and Rock Creek) by managing stormwater runoff from construction sites and impervious surface areas.

NREL implements standard procedures and practices to minimize potential impacts of stormwater runoff, not only from construction sites but also from areas that are not under construction. There would be a small increase in impervious surface areas (approximately five acres or 1.6 percent of the total NWTC land area) if the Proposed Action was implemented. NREL's water quality protection program seeks to reduce stormwater runoff and protect receiving waters by minimizing erosion, detaining stormwater runoff with detention basins, and preventing contamination of stormwater from release of hazardous materials. These procedures and practices ensure minimal impacts from stormwater runoff on surface water during construction and site operation at the NWTC.

Impacts to Groundwater

The Proposed Action would be implemented in accordance with all federal and state water quality, wetlands, and floodplains statutes and regulations (**Tables 1-2 and 1-3**). There are no open or active groundwater wells at the NWTC site. If activities were to be conducted that could impact groundwater, a groundwater monitoring program would be implemented by NREL at the NWTC in accordance with state regulations.

For the unconfined groundwater that occurs in the Rocky Flats Alluvium beneath the NWTC, site development would increase the amount of impervious surface on the site, thereby limiting infiltration of

precipitation. However, through NREL's general efforts in preventing erosion, facilitating infiltration, and incorporating low-impact design elements, the impacts on recharge or groundwater availability beneath the NWTC would be negligible. NREL follows both county and federal requirements to implement stormwater management practices that enhance groundwater infiltration.

Groundwater could be encountered during excavation of the alluvium for foundation and building construction, depending on seasonally and geographically fluctuating groundwater levels. It is expected that most of the construction activities would be unlikely to disturb groundwater. In the event that the water table is encountered, water would be pumped out of the excavation into a settling tank or designated area (to reduce suspended sediment) and then onto the ground and returned to the alluvium via seepage through the soil. All proposed activities would be performed in accordance with the NREL management program procedures for stormwater and groundwater (NREL 2012e; NREL 2012f) that specify steps to be taken during construction and operation of facilities to protect water resources. The impact to the unconfined groundwater from this water removal and subsequent discharge would be short-term and would be negligible in the long term.

Wastewater output would increase as the site population at the NWTC is anticipated to increase. The increase would be handled by potential additional septic systems and leach fields, or a possible addition of a package treatment plant. Septic tank and leach field sizes would be based on projected loads from maximum anticipated staffing levels and soil characteristics. The adequacy of the systems would be verified by the Jefferson County through their permitting process. Compliance with the state and county standards ensures that septic systems and leach fields are adequate to meet the needs of the proposed wastewater output. Consequently, impacts to groundwater would be negligible.

A major administrative improvement for groundwater protection was made in 2011 when NREL amended its procedure for managing aboveground storage tanks (ASTs) and revised spill prevention, control, and countermeasure (SPCC) plans for sites such as the NWTC (NREL 2011d, 2012f). The SPCC plans describe in detail all areas where petroleum oil products are stored, potential pathways should there be a release, and the immediate actions to be taken in such an event. Careful planning and preparation for events such as spills from ASTs minimize impacts from environmental releases.

No long-term adverse impacts on water resources, as identified in **Section 3.7.3.1**, would be anticipated from implementation of the Proposed Action.

Increasing Site Use and Density

Impacts to Surface Water and Stormwater

The Proposed Action would be implemented in accordance with all federal and state water quality, wetlands, and floodplains statutes and regulations (**Tables 1-2 and 1-3**). No proposed construction activities would occur at any wetlands, seeps, and ephemeral drainages and ponds on the site. The main focus of NREL's water quality protection program is to protect the water quality of the receiving waters (Coal Creek and Rock Creek) by managing stormwater runoff from construction sites and impervious surface areas.

Installing wind turbine towers and associated structures would result in a slight increase in impervious surface area (approximately 7.5 acres or 2.5 percent of the total NWTC land area). NREL implements standard procedures and practices to minimize potential impacts of stormwater runoff not only from construction sites, but also from areas that are not under construction. NREL's water quality protection program seeks to reduce stormwater runoff and protect receiving waters by minimizing erosion and preventing contamination of stormwater from releases of hazardous materials. These procedures and

practices ensure minimal impacts from stormwater runoff on surface water during construction and site operations at the NWTC.

No long-term adverse impacts to surface water and stormwater, as identified in **Section 3.7.3.1**, would be anticipated from implementation of the Proposed Action.

Impacts to Groundwater

The Proposed Action would be implemented in accordance with all federal and state water quality, wetlands and floodplains statutes and regulations (**Tables 1-2 and 1-3**). There are no open or active groundwater wells at the NWTC site, and should the NWTC conduct activities that could impact groundwater, a groundwater monitoring program would be implemented in accordance with state regulations.

For the unconfined groundwater that occurs in the Rocky Flats Alluvium beneath the NWTC, site development would increase the amount of impervious surface on the site. However, through NREL's efforts in preventing erosion, facilitating infiltration, and incorporating low-impact design elements, no adverse impacts on recharge or groundwater availability, as identified in **Section 3.7.3.1**, at or in the vicinity of the NWTC are expected.

Groundwater could be encountered during excavation of the alluvium for installing wind turbine towers and associated structures, depending on seasonally and geographically fluctuating groundwater levels. It is expected that most of the construction activities would not encounter groundwater. In the event that the water table is encountered, water would be pumped out of the excavation into a settling tank (to reduce suspended sediment) and then onto the ground and returned to the alluvium via seepage through the soil. All proposed activities would be performed in accordance with the NREL stormwater and groundwater protection requirements (NREL 2012e; NREL 2012f) that specify steps to be taken during construction and operation of facilities to protect water resources. The impact to the unconfined groundwater from this water removal and subsequent discharge would be short-term, and no long-term adverse impacts are expected because protective measures would be used.

No long-term adverse impacts on groundwater resources, as identified in **Section 3.7.3.1**, would be anticipated from implementation of the Proposed Action.

Expanding Power Capacity

Impacts to Surface Water and Stormwater

Installing an electrical substation would increase the impervious surface area by a maximum of approximately 1.25 acres (0.5 hectares). Up to 5.75 acres (1.5 hectares) might be disturbed during construction of the substation. This slight increase in impervious surface area could result in a slight increase in stormwater runoff.

NREL's water quality protection program seeks to reduce stormwater runoff and protect receiving waters by minimizing erosion and preventing contamination of stormwater from release of hazardous materials. These procedures and practices ensure minimal impacts from stormwater runoff on surface water during construction and operation at the NWTC.

No long-term adverse impacts to surface water and stormwater, as identified in **Section 3.7.3.1**, are likely from implementation of the Proposed Action.

Impacts to Groundwater

During installation of an electrical substation, shallow groundwater would not likely be encountered. This activity would be governed, where applicable, by NREL's groundwater protection procedure, "Groundwater Protection and Maintenance" (NREL 2012e). The substation would represent a slight increase (no more than 0.4 percent) in the impervious surface area at the NWTC site. This increase could result in a slight potential decrease in infiltration to shallow groundwater.

No long-term adverse impacts to groundwater, as identified in **Section 3.7.3.1**, are likely from implementation of the Proposed Action.

3.7.3.3 No Action Alternative

The No Action Alternative would have no impacts to surface water or groundwater resources, as identified in **Section 3.7.3.1**, beyond those resulting from the continued operation of currently existing facilities.

3.8 Geology and Soils

3.8.1 DEFINITION OF THE RESOURCE

Geological and soil resources include the topography, geology, soils, mineral resources, and geological hazards of a given area. Topography refers to the elevation, slope, aspect, and surface features found within a given area. The geology of an area includes bedrock materials, mineral deposits, and any unique geological features. Bedrock refers to consolidated earthen materials that may be made up of either interlocking crystals (igneous and metamorphic rocks) or fragments of other rocks compressed and cemented together over time by pressure and dissolved minerals that have hardened in place (sedimentary rocks). Soil lies above bedrock and usually consists of weathered bedrock fragments and decomposed organic matter from plants, bacteria, fungi, and other living things. Mineral resources are metallic or non-metallic earth materials that can be extracted for a useful purpose, such as iron ore that can be refined to make steel, or gravel that can be used to build roads. The principal geologic hazard that could affect man-made structures is soil stability (for example, landslide potential or soils that shrink and swell and could crack foundations).

3.8.2 EXISTING ENVIRONMENT

The NWTC is located on the gently sloping terrain of the Rocky Mountain Front Range between the Southern Rocky Mountain Province to the west and the Great Plains Province to the east. The Front Range trends north-south at elevations of approximately 9,800 feet (2969 meters), with elevations increasing to 14,000 (4,268 meters) feet along the Continental Divide, approximately 16 miles west of the site. The elevation of the NWTC is approximately 6,000 feet (1,830) above sea level. The site area consists of a broad, eastward sloping pediment surface developed on coalescing alluvial fans at the mouth of Eldorado Canyon. The NWTC site is located on the western edge of the Denver Basin, an asymmetrical, north-south trending syncline with a steeply dipping western limb and a shallowly dipping eastern limb. Bedrock layers underneath the site dip to the east or northeast at 30 to 90 degrees from horizontal.

The topography in the immediate vicinity of the site exhibits an approximate 2 percent slope to the east-northeast. No streams or creeks cross the NWTC site. A minor drainage channel begins near the eastern boundary. Geologic units beneath the NWTC consist of unconsolidated Quaternary age (approximately three million years ago to the present time) alluvial surface materials that lie atop the Cretaceous

(approximately 144 to 65 million years ago) claystone bedrock of the Laramie Formation. The Laramie Formation includes two members. The upper member of the Laramie Formation consists of horizontally interbedded siltstone, sandstone, and claystone layers ranging from 300 to 550 feet (91 to 167 meters) thick. The lower member is composed of sandstone layers containing coal seams and is approximately 250 feet (76 meters) thick beneath the NWTC site. The Rocky Flats Alluvium dominates the surface of the NWTC and consists of unconsolidated surface materials. The Rocky Flats Alluvium is composed of dense, poorly stratified clayey gravels and cobbles with some interbedded hard clays and clayey sands. The alluvium-bedrock contact occurs at approximately 40 feet (12 meters) below the surface at the NWTC.

The NWTC is located in a Jefferson County "Designated Dipping Bedrock Area," where steeply dipping beds of expansive claystone bedrock are found near the ground surface. When exposed to water, layers of bedrock display different potentials for expansion, resulting in damage to roads and lightly loaded structures. The Jefferson County Designated Dipping Bedrock Area Guide identifies special requirements and recommendations for construction within the area, including minimum soil or overburden thickness, minimum foundation design requirements, and design requirements for infrastructure systems (Jefferson County 2009). Natural alluvial deposits may reduce the heaving potential of the bedrock at the site. Landslides and other mass earth movements can be present as shallow features where slopes are steep; however, because the slope of the surface at the site averages about 2 percent, landslides are not characteristic or expected there.

The NWTC is located near the western edge of the Colorado Piedmont section of the Great Plains physiographic province (USGS 1961), adjacent to the eastern foothills of the Front Range (USGS 1955). There are several faults in the vicinity of the NWTC, but no faults have been identified under the site itself. The Precambrian-age Golden and Livingston Faults and Idaho Springs-Ralston Shear Zone are northwest trending faults located to the west of the NWTC. The Golden Fault separates the Front Range to the west from the Denver Basin to the east. Northeast-trending faults have been mapped north of the site in the Marshall-Superior-Louisville area. The northwest-trending Eggleston fault lies approximately one mile east of the site's northeast corner.

The greatest amount of recent earthquake activity in the region occurred as a result of deep injection of fluid at the Rocky Mountain Arsenal near Commerce City, located east of the City of Denver. Approximately 1,800 earthquakes occurred between 1962 and 1972 as a result of the injection, with a maximum magnitude event of 5.2 on the Richter scale occurring in 1967 after injection was discontinued. The strongest recorded seismic event in the region took place in 1882, with the epicenter located approximately 13 miles (21 kilometers) east of the NWTC (DOE 1996). Faults in the region have a 30 to 40 percent probability of undergoing motion that could generate earthquakes (DOE 2002).

Based on available U.S. Geological Survey (USGS) data, the statistical probability of an earthquake with magnitude greater than 5.0 within the next 100 years and within 31 miles (50 kilometers) of the NWTC is three to four percent (USGS 2013a). USGS data also indicate that an earthquake with a two percent likelihood in the next 50 years would have a peak ground acceleration of 0.08 to 0.10 g (0.08 to 0.10 times the acceleration of gravity), a relatively low seismic hazard (USGS 2013b).

3.8.2.1 Mineral Resources

Known mineral resources in the immediate vicinity of the NWTC include sand and gravel, clay, rock for concrete aggregate and riprap, and coal. DOE owns surface rights at the site. The mineral rights for the western 160 acres of the site were historically owned by Rocky Mountain Fuel, but were transferred to NRC-CO, LLC (a private entity) in 2008. Those mineral rights apply to the extraction of coal, shale, oil, and natural gas.

3.8.2.2 Soils

Soil Properties

The soils at the NWTC are derived from surficial formations eroding from the Rocky Mountains during the Quaternary age. At the site, these poor-to-moderately sorted deposits overlie the Laramie Formation. Although the deposits consist largely of cobble and gravel, a subsoil that occurs between 13 and 47 inches (33 to 120 centimeters) below the surface is predominantly clay. The permeability of the subsoil is very low, measured at 0.06 to 0.2 inches (1.5 to 5 millimeters) per hour. The clay has a moderate shrink-swell potential. Borings taken at Rocky Flats south of the NWTC indicate that groundwater is sometimes perched on top of clay in the alluvium, and that this perched layer may occur at depths as shallow as approximately 3.5 to 8 feet (1 to 2.4 meters) below the surface, although groundwater at such shallow depths is not common at Rocky Flats or the NWTC (DOE 2002).

The soils at the NWTC site are dominated by the Flatirons very cobbly sandy loam, which is formed in the noncalcareous, stony to gravely, loamy material of the Rocky Flats Alluvium. The Flatirons very cobbly sandy loam is found on slopes of 0 to 3 percent and exhibits a low available water capacity. It is used mainly for grazing and wildlife habitat. The Yoder Variant-Midway complex characterizes the hill slopes and ridges located in the west-northwestern areas of the site. The soils in this complex exhibit low water capacity and are used for pasture and wildlife habitat. The Veldkamp-Nederland very cobbly sandy loams are found at the extreme northwestern area of the site. Rock fragments comprise approximately 35 to 75 percent of this complex. It is primarily used for pasture and wildlife habitat. Soil at the extreme northeastern boundary of the site is known as the Valmont clay loam and is considered to be a "high potential cropland," requiring only irrigation to support agricultural activities. It is found on slopes ranging from 0 to 3 percent. The Valmont soil exhibits moderate water capacity and a slight erosion hazard if overgrazed. It is used primarily for crop growth, pasture, and sometimes for community development (USDA 1984). Some typical uses of the soils (particularly crop growth and pasture) are not applicable to the NWTC site, although the site is available for wildlife habitat. Each of the soils found at the NWTC exhibits only a slight wind erosion hazard except for the Valmont clay loam, which exhibits a moderate wind erosion hazard that may be readily controlled by use of plant cover (USDA 1984).

Two areas of ancient soils have been identified recently along the eastern edge of the NWTC. These soils are significant because they have remained geologically undisturbed for nearly two million years (ESCO 2002) and they are associated with native vegetation representing two biomes (the central plains of North America and the Rocky Mountains). This assemblage of vegetation and ancient soils has unique qualities such as exceptional stability and resistance to weed invasion.

Environmental Soil Sampling

Results of a 1994 geotechnical investigation for NWTC facility expansion indicated that the onsite soils are capable of supporting structures including new site buildings and turbine foundations. However, foundations could be at risk of heaving caused by wetting and subsequent swelling of the clay portion of the underlying soils (DOE 2002). Additional geotechnical borings were performed and percolation tests were conducted in 1995 to determine subsurface conditions at the NWTC in preparation for construction. The results indicated that subsurface soils at the NWTC exhibited variable swell potentials that could be compensated for by using specified engineering excavation and construction techniques for foundations (DOE 2002).

Soil samples for laboratory analysis were collected from the NWTC in 1993. The objective of this sampling program was to determine the existing characteristics of site soil prior to the construction of a leach field. The soils were analyzed for VOCs, petroleum hydrocarbons, PCBs, and radionuclides.

Analytical results indicated that detectable quantities did not exceed State of Colorado regulatory limits and were representative of environmental background concentrations (DOE 2002).

Additional samples for laboratory analysis were subsequently collected in 1994 in order to develop a more thorough baseline assessment of site soils. The analytical results for the majority of these samples were below method detection limits and, therefore, below regulatory thresholds for all analyzed chemicals and radionuclides (DOE 2002).

Airborne radionuclide soil contamination was historically transported to the east and southeast of the central operating unit and the 903 Pad of the former Rocky Flats Industrial Area where radionuclide soil contamination was detected. Soil from the Central Operable Unit, or "active area" at the former Rocky Flats site, would tend to be eroded and deposited east of Rocky Flats.

The potential effects of wind erosion of soils with residual radionuclide contamination at the former adjacent RFETS, to the south, were modeled to estimate the effective dose equivalents (EDEs) to RFETS workers and the public (DOE 2006a). Scenarios were modeled including soil disturbance (such as might be expected at construction sites) and post-fire erosion at the former 903 Pad (the area of the most significant soil contamination contributing to airborne radionuclides at RFETS). The maximum EDE for plutonium-239/240 was found to be 0.80 millirem per year, and the doses from other radionuclides were found to be much lower than that. The estimated EDE of 0.80 millirem per year is below the EDE of 10 millirem per year established by EPA to protect the public.

Plutonium in soil samples was generally below background or human health-based preliminary remediation goals in the northwestern portion of the RFETS study area (DOE 2006a). In general, little or no dose from radionuclides is expected to the northwest of RFETS where the NWTC is located, because prevailing winds are generally from the northwest to southeast, blowing from Eldorado Canyon across the NWTC towards the RFETS area. Because soils at the NWTC were not contaminated by Rocky Flats activities, wind erosion of soil or construction disturbances at the NWTC would not result in movement of contaminated soil. In addition, the characteristics of the specific soils at the NWTC result in only slight to moderate potential for wind erosion (USDA 1984).

3.8.3 ENVIRONMENTAL CONSEQUENCES

3.8.3.1 Evaluation Criteria

The Proposed Action could have adverse effects on geological and soil resources if any of the following were to occur:

- Permanent or long-term loss of mineral resources
- Permanent or long-term loss of soil resources, or reduction in productivity or suitability of soils for use
- Increases in soil erosion through increased susceptibility to water or wind erosion during or after construction activities, or through a large increase of impervious surface area that would increase the amount of surface water runoff during rain or snow events
- Initiation of seismic activities by facility activities

Geological and soil resources could have adverse effects on the Proposed Action in the following ways:

- Seismic activity of sufficient magnitude could result in damage to proposed structures, potentially with resultant injuries or loss of life, unless structures are designed and built to withstand reasonably foreseeable seismic events.
- Soil properties such as high shrink-swell capacity could result in damage to structure foundations unless measures are taken to mitigate the effects.
- Severe erosion of soil could result in damage to foundations, roads, or other structures.

3.8.3.2 Proposed Action

Increasing and Enhancing Research and Support Capabilities (Zone 1 and Zone 2)

Constructing new facilities and expanding existing facilities and infrastructure would affect approximately five acres of land by the placement of new buildings, walkways, or pavement. This represents about 1.6 percent of the total area at the NWTC site. Some additional areas could be affected temporarily during construction or installation of infrastructure upgrades.

This component of the Proposed Action would have no adverse impacts on mineral resources under the site. Constructing new buildings and structures would limit surface access in a few locations, representing a very small proportion of the area available for future mineral extraction.

Resources such as concrete aggregate, crushed rock, and asphalt would be required during construction at the expanded facility. These materials could easily be obtained through local commercial sources.

Construction or operational activities under the Proposed Action would not cause seismic activity in the vicinity of the site since there would be no deep injection of fluids. Excavation for new structures would not occur below the alluvial surface deposits (approximately 40 feet (12 meters) deep), eliminating or minimizing the need to blast for construction purposes.

The relatively flat terrain at the site would not promote the occurrence of landslides on areas temporarily disturbed during construction activities. It is likely that any excavated soils would be placed and graded to minimize the loss of soil through wind and water erosion. Precautions would be taken during construction to minimize wind or water erosion of stockpiled soils. Although the wind erosion hazard for most soils at the NWTC site is slight, use of native vegetation to stabilize the soil surface would reduce the erosion hazard even further. As part of the NREL stormwater program, stockpiled soils are routinely covered to reduce wind and water erosion. Most of the soils at the site are not well suited for agricultural use but could support native plants for erosion control.

The relatively low seismic hazard at the NWTC site indicates that new construction would not be adversely affected by seismic events, provided all applicable building code requirements for seismic design are met. Building codes applicable for the area would also ensure that construction techniques are used to avoid or mitigate any hazards associated with high shrink-swell capacity soils that may be encountered at the site.

The increased impervious surface could result in a slight increase in surface water runoff during rain and snowmelt events. It is unlikely that this small increase would result in increased soil erosion, particularly when applicable standards for landscaping and erosion control are used. No long-term adverse impacts to geological and soil resources, as identified in **Section 3.8.3.1**, are likely from construction of new facilities and infrastructure in Zones 1 and 2.

Increasing Site Use and Density (Zone 2)

Installing new wind turbines and related structures would affect approximately 7.5 acres (3 hectares) of land. This area would likely be covered with impervious surfaces, and represents about 2.5 percent of the total area at the NWTC site. Some additional area could be affected temporarily during construction or installation of infrastructure upgrades.

This component of the Proposed Action would likely have no adverse effect on geological or soil resources, as discussed for the Increasing and Enhancing Research and Support Capabilities component. While the increase in impervious surface area is slightly greater for the Increasing Site Use and Density component (about 2.5 percent of total area), it is unlikely that the increase would result in increased soil erosion. Thus, no long-term adverse impacts to geological and soil resources, as identified in **Section 3.8.3.1**, are likely from construction of new facilities and infrastructure in Zones 1 and 2.

Expanding Power Capacity

The Expanding Power Capacity component of the Proposed Action would involve installation of an electrical substation near the perimeter of the NWTC site. In each expansion option, the proposed substation would occupy an area up to 1.25 acres (0.5 hectares), and up to 5.75 acres (2.3 hectares) might be disturbed during construction. The actual impervious surface for the substation installation would likely be less than the total of 1.25 acres (0.5 hectares).

The maximum increase in impervious surface represents only 0.4 percent of the total area of the NWTC site. It is unlikely that the increase would result in increased soil erosion. It is unlikely that any adverse effects to geological or soil resources would result from the Expanding Power Capacity component of the Proposed Action.

3.8.3.3 No Action Alternative

The No Action Alternative would result in no additional impacts to geological resources. Minor impacts to soil resources from ongoing site activities would be expected.

3.9 Biological Resources

3.9.1 DEFINITION OF THE RESOURCE

Biological resources include native or naturalized plants and animals and the habitats (for example, wetlands and grasslands) in which they exist. Sensitive and protected biological resources include species listed as threatened or endangered by the federal government or a state agency. Wildlife, vegetation, and wetland resources provide aesthetic, recreational, and socioeconomic benefits to society. They also provide key ecological functions, with each species performing related ecological roles in its ecosystem.

This section describes the existing biological environment of the NWTC. The focus is on elements (for example, vegetation, wildlife, and protected and sensitive species known or likely to occur within the Proposed Action area) that would be affected by the Proposed Action should it be implemented. These topics were selected on the basis of federal and state laws and regulations, executive orders, and concerns expressed during the project scoping process.

Threatened, Endangered, and Special Status Species. Protected and sensitive biological resources include federally listed (endangered or threatened), proposed, and candidate species, and designated or proposed critical habitat; species protected under other federal laws; species of concern managed under

conservation agreements or management plans; and state-listed species. The *Endangered Species Act* (ESA) (16 U.S.C. 1536) of 1973 established a federal program to conserve, protect, and restore threatened or endangered plants and animals and their habitats. Under the ESA, an "endangered species" is defined as any species in danger of extinction throughout all or a significant portion of its range. A "threatened species" is defined as any species likely to become an endangered species in the foreseeable future. All federal agencies must ensure any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction of critical habitat for these species, unless the agency has been granted an exemption.

The USFWS also maintains a list of species considered to be candidates for possible listing under the ESA. These species are being considered for listing due to public petitions or previous "warranted for listing" determinations, which require the species status to be reviewed. Candidate species receive no statutory protection under the ESA; however, in most government agency planning efforts and industry considerations, candidate species are typically treated as though they have protection and are considered when discussing environmental impacts.

Although not defined by the ESA, the USFWS, state wildlife agencies, and natural heritage programs also designate species of special concern, a status that refers to species that are declining or appear to be in need of conservation. The Colorado Parks and Wildlife department designates species as State Special Concern (SC), which is not a statutory category but indicates that it may be experiencing population declines or range restrictions, and may have a high susceptibility to population risks.

Migratory Birds. Migratory birds are protected under the *Migratory Bird Treaty Act* (MBTA) of 1918 (16 U.S.C. 703–712) as amended, and EO 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds." The MBTA protects migratory birds and implements the United States' commitment to international conventions for the protection of migratory birds. MBTA is the domestic law that governs taking, killing, possessing, transporting, and importing migratory birds, their eggs, parts, and nests. The take of all migratory birds is governed by the MBTA's regulation of taking migratory birds for educational, scientific, and recreational purposes and requiring harvest to be limited to levels that prevent overutilization. The statute protects 1,007 species within the United States (outside of introduced species, and migratory and non-migratory game birds).

The MBTA prohibits activities that, in effect, result in direct taking or nest destruction, but does not extend to their habitat. The MBTA protects migratory birds from activities that "pursue, hunt, take capture, kill, attempt to take, capture or kill, possess, offer for sale, sell, offer to purchase, purchase, deliver for shipment, ship, cause to be shipped, deliver for transportation, transport, cause to be transported, carry, or cause to be carried by any means whatsoever, receive for shipment, transportation or carriage, or export, at any time, or in any manner, a migratory bird."

Bald and Golden Eagles. The *Bald and Golden Eagle Protection Act* of 1940, as amended (16 U.S.C. 668-668c), prohibits anyone without a permit to "take" bald or golden eagles. "Take" is defined as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb." "Disturb" is defined as "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available: (1) injury to an eagle, (2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior" (USFWS 2009a). In accordance with the National Bald Eagle Management Guidelines, no activities can be conducted within 660 feet of a bald eagle nest (USFWS 2007).

The information provided in the following sections is based upon recent biological surveys conducted at the NWTC from 2010 to 2011 (Walsh 2011; Tetra Tech 2011a, 2011b; Eco-Logic 2011). Other data

sources regarding terrestrial biological resources included prior NWTC biological surveys (Plantae 2000; Monahan 1996; Schmidt et al. 2003) and regional databases from the Colorado Natural Heritage Program (CNHP 2012, 2013), NatureServe Explorer (NatureServe 2013), and USFWS (USFWS 2009b, 2013a, 2013b).

3.9.2 EXISTING ENVIRONMENT FOR VEGETATION

3.9.2.1 Vegetation Types

Based on the EPA's classification of ecoregions in the U.S., the NWTC lies within the High Plains (Level III) and South Central, Semi-Arid Prairies (Level II) of the Great Plains (Level I) classification system. The high plains are categorized as a dry, mid-latitude steppe climate with hot summers and cold winters. Mean annual precipitation ranges from 12 to 21 inches (Chapman et al. 2006).

Historically, vegetation in the region was characterized as mostly short- and mid-grass prairie vegetation (Chapman et al. 2006). The vegetative cover is influenced by local site conditions, hydrology, soils, topography, elevation, and aspect. Vegetation types currently within the NWTC include grasslands, shrublands, ponderosa pine woodlands, wetlands, and ornamental plantings around buildings, as shown in **Figure 3-9**. **Table 3-20** lists the vegetation types and associated acreages, as described in the following sections. **Appendix C** lists all plant species identified during the 2010-2011 vegetation survey (Walsh 2011).

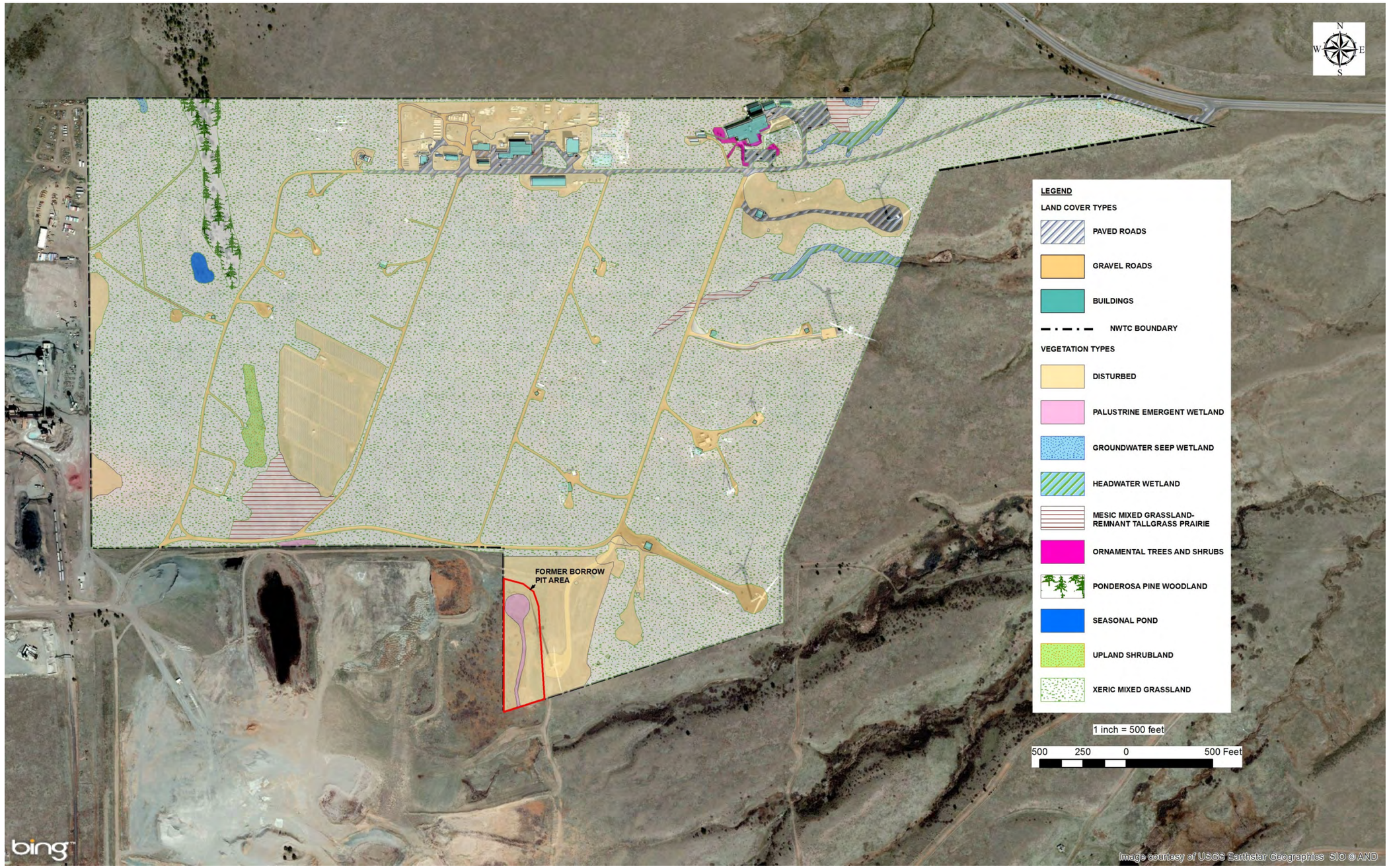


Figure 3-9. Vegetation Cover at the NWTC, Golden, Colorado

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Table 3-20. NWTC Land Cover Types Including Vegetation Communities, 2012

Cover Type	Community	Area (acres)
Gravel roads	Not applicable	11.6
Paved roads	Not applicable	6.4
Buildings	Not applicable	2.2
Vegetation	Disturbed	34.9
Vegetation	Groundwater seep wetland	0.2
Vegetation	Headwater wetland	1.7
Vegetation	Mesic mixed grassland	4.9
Vegetation	Ornamental trees and shrubs	0.4
Vegetation	Palustrine emergent wetland	0.8
Vegetation	Ponderosa pine woodland	3.6
Vegetation	Seasonal pond	0.4
Vegetation	Upland shrubland	1.2
Vegetation	Xeric mixed grassland	236.9
	Total	**305.2**

Grasslands. Mixed-grass prairie associations (including components of xeric and mesic tallgrass, shortgrass, and intermediate grass communities) comprise the majority of vegetation on the NWTC, totaling 241.8 acres. These areas are characterized by the presence of grass species typical of the tallgrass prairie such as big bluestem, little bluestem, and sand dropseed. Typical shortgrass prairie species in this area include blue grama and buffalo grass. Intermediate grasses such as the needle grasses, wheatgrasses, and bluegrasses are also important elemental species of the xeric-mixed grassland (Walsh 2011).

Xeric-mixed grassland is the largest and most widespread vegetation community type on the NWTC, totaling 236.9 acres. Due to limited moisture, these areas are dominated by typical short and mixed grass prairie species tolerant of drier conditions, including a large variety of native grass species as well as a diverse forb component. Dominant species include yucca, crested wheatgrass, cheatgrass, smooth bromegrass, and little bluestem. Other species include sand lily, wild iris, Lambert locoweed, mouse-ear, western wallflower, and prairie goldenpea (Walsh 2011). In addition, there are xeric tallgrass prairie plant associations with big bluestem and little bluestem, similar to the widespread plant community on the adjacent Rocky Flats National Wildlife Refuge and surrounding City of Boulder OSMP parcels. Nearly all the undisturbed portions of the NWTC support good-quality, xeric-mixed grassland.

A 3.7-acre plant community in the conservation management area southwest of the solar PV array was historically classified as mesic mixed grassland, containing a remnant tallgrass prairie component (Plantae 2000; Walsh 2011), a plant community classified as "rare/imperiled" by the Colorado Natural Heritage Program (CNHP 2013). Recent surveys and annual monitoring of the area indicate that changing hydrologic conditions may have caused changes in the plant community composition (Walsh 2011). Specifically, a large stand of cattails is no longer present while Canada thistle, big bluestem, and Canada bluegrass now dominate the area. Such changes could be the result of recent drought conditions. This area still supports many different species and contributes to the plant diversity of the NWTC, warranting continued protection to minimize impacts from site operations. For the purposes of this EA, the term mesic mixed grassland will continue to be used for this conservation management area, as shown on **Figure 3-9**. Monitoring of this plant community would continue in the future in accordance with the

MOU between DOE and the Rocky Flats Trustee Council (Rocky Flats Trustee Council 2009). The other 1.2 acres of mesic mixed grasslands are located in the upper portion of the Rock Creek tributary and within the groundwater seep, northeast of Building 251 (**Figure 3-9**).

Ponderosa Pine Woodlands. One wooded area, a ponderosa pine woodland, occurs in the northwestern corner of the NWTC and occupies 3.6 acres. Besides ponderosa pine, other dominant species include smooth bromegrass, crested wheatgrass, and green needlegrass. Other species include western snowberry, groundsel, and wax current. A dense and widespread diffuse knapweed population was identified in that area in 2000 (Walsh 2011), and that species has since become present throughout NWTC upland communities (DOE 2002).

Upland Shrublands. A small (1.2-acre) upland shrubland plant community exists to the southeast of the ponderosa pine woodland. Dominant species include western snowberry, wax currant, Canada wild rye, Canada bluegrass, Kentucky bluegrass, little bluestem, and goldenpea. Approximately eight hawthorn shrubs occur in an isolated area within this plant community.

Ornamental Trees and Shrubs. A total of 0.4 acres of disturbed areas around Building 251 at the NWTC has been landscaped and planted with a combination of native and ornamental trees and shrubs. Plantings include multiple species of junipers and pines interspersed with ornamental deciduous trees. Chokecherry and rose bushes are the main shrubs in this area.

Disturbed. Disturbed areas include roads, parking lots, construction sites, storage areas, and a previous gravel mine area. Surrounding natural plant communities interspersed with reclamation species, non-native species, and pioneer species comprise 34.9 acres of disturbed areas on the NWTC site. While common reclamation species (for example, smooth bromegrass) were historically used to revegetate disturbed areas at the NWTC, a native seed mix is now used, as required by NREL conservation management procedures (NREL 2012g).

3.9.2.2 Conservation Management Areas

The Colorado Natural Heritage Program's database classifies the NWTC as occurring within the Rocky Flats Grassland Network of Conservation Areas and, more specifically, within the Rocky Flats Potential Conservation Area (CNHP 2012). This area is characterized by its native grasslands with a mix of ponderosa pine woodlands and shrubs. The area includes an ancient soil type and Rocky Flats alluvium (see **Section 3.8**) that support xeric tallgrass prairie communities.

Within the NWTC, seven sites totaling approximately 69 acres are designated as conservation management areas (**Figure 3-10**). Conservation management areas have been designed to protect critical wind corridors to the west, while simultaneously protecting the site's natural resources. Conservation management areas are managed in accordance with NREL's Natural Resource Conservation Program (NREL 2012g). Development at the NWTC is not allowed in drainages, hillside seeps, a seasonal pond, remnant tallgrass prairie within mesic mixed grassland, a prairie dog re-location area, areas designated as ancient soils, or an area designated as critical habitat for the Preble's meadow jumping mouse (the Preble's mouse), a federally listed threatened mammal species.

Conservation management areas occupy a large portion of the western side of the NWTC and include a seasonal pond and ponderosa pine woodlands. These conservation management areas also serve to protect wind corridors located west of the access road for Row 1.

Six additional conservation management areas are located east of the access road for Row 4. These include the following features:

- A groundwater seep wetland located east of Building 251 near the northern site boundary and adjacent mesic mixed grasslands
- A headwater tributary to Coal Creek, including its headwater wetlands
- A headwater tributary to Rock Creek, including its headwater wetlands and adjacent mesic mixed grasslands
- Two areas of ancient soils located along the eastern edge of the property
- An area in the southwestern portion of the NWTC designated to protect a mesic mixed grassland containing a remnant tallgrass prairie component, as described in the Grasslands section.
- An area in the southeastern corner of the site, designated as critical habitat for the Preble's mouse (**Figure 3-10**)

Protection of areas such as ancient soils provides an opportunity to study and understand the physical, biological, and temporal details of the long-term stability of ecosystems. Such studies may contribute to developing practical advances in ecosystem reconstruction and restoration (also see **Section 3.8**).

NREL has made a number of commitments to conserve these areas, including performing annual assessments to document environmental conditions; preparing and maintaining a natural resource conservation management plan; avoiding activities in areas containing sensitive natural resources, such as natural drainages, wetlands, a remnant prairie community, and other wildlife habitat; minimizing or avoiding development in the western portion of the NWTC site to preserve upwind conditions; and consulting with the NREL environmental group prior to any development in these areas. Examples of minimizing impacts include: parking vehicles on existing road ways, staging equipment/laydown areas for construction on roadways; and, preferential use of previously disturbed land (NREL 2011c). These commitments include numerous NREL policies and procedures that in part are based on a series of regulations, executive orders, and MOUs between DOE and other entities (see **Section 4.6**).

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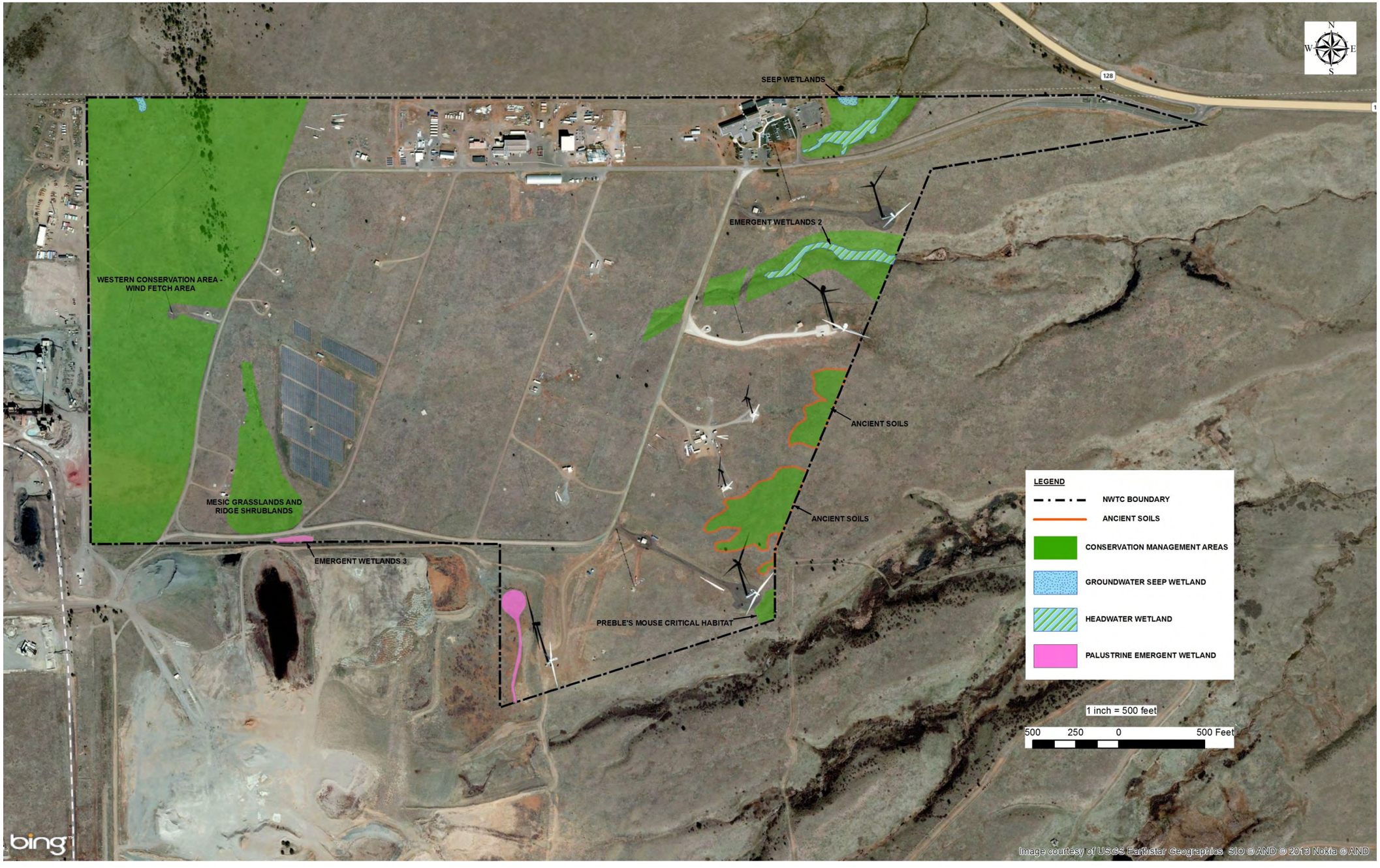

Figure 3-10. Conservation Management Areas within NWTC Boundaries

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3.9.2.3 Wetlands

Wetlands are important transitional lands between terrestrial and aquatic systems, and are typically found along streams, rivers, springs, ponds, and drainage ditches. The associated vegetation in these areas supports a variety of habitats and associated plant and wildlife species. Wetland areas serve as nutrient and contaminant filters, sediment traps, climatic regulators, and wildlife refuges. Thus, their disturbance can have far-reaching effects on the structure and function of the aquatic and adjacent ecosystems.

Wetlands are protected as "waters of the United States" under Section 404 of the *Clean Water Act*. Section 404 regulates the discharge of dredged or fill material into navigable and interstate waters, including tributaries of those waters and adjacent wetlands. Wetlands and other waters at the NWTC appear to be hydrologically connected to waters of the U.S. and are currently under review by the U.S. Army Corps of Engineers for jurisdictional status.

Wetlands onsite, whether isolated or jurisdictional, are protected under EO 11990, "Protection of Wetlands" (43 *Federal Register* 6030). This executive order requires that federal agencies provide leadership and take actions to minimize or avoid the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands. Federal agencies are to avoid new construction in wetlands, unless the agency finds there is no practicable alternative to construction in the wetland, the proposed construction incorporates all possible measures to limit harm to the wetland, and the agency coordinates with the U.S. Army Corps of Engineers. The federal government, including the DOE, operates on a policy of "no net loss" of wetlands, meaning that operations and activities shall avoid the net loss of size, function, or value of wetlands.

During vegetation surveys conducted in 2010 to 2011, the wetlands described below were identified on the NWTC. Because of dry conditions during that period, the borders of wetland communities could not be confirmed (Walsh 2011).

Palustrine Emergent Wetlands. Natural, depressional wetlands are commonly found within shortgrass prairie communities. Palustrine emergent wetlands are characterized by erect, rooted, herbaceous hydrophytes (plants adapted to hydric or saturated soil conditions that have roots below water but grow above the surface). At the NWTC, two wetlands are categorized as palustrine emergent: a small linear depression on the southern side of the NWTC, which supports sedge species; and along the southern boundary, west of test site 4.5, in a previously disturbed area that now contains cattails and sandbar willow (**Figure 3-9**).

An additional two palustrine emergent wetlands were mapped in the mesic mixed grassland in the southwestern portion of the site in 2010. Due to considerable drying periods over the last decade, the small wetland pockets of cattails that occurred in the southern portions of this area are no longer present and most of the tallgrass species are also absent (Plantae 2000; Walsh 2011). Baltic rush in the area has been largely replaced by large stands of Canada thistle. North of this area, within the conservation management area, there exists a large stand of spikerush, which has wetland indicators of either obligate (that is, plants that almost always occur in wetlands, greater than 99 percent of the time) or facultative (that is, plants that usually occur in wetlands, 67 to 99 percent of the time). This classification indicates that there is likely still shallow, perched groundwater in that area of the site.

Headwater Wetlands. Headwater wetlands, totaling 1.7 acres, occur along two ephemeral drainages and support wetland plant species not found in other locations on the NWTC. This community contains a mixture of typical grassland species often observed in wetland areas, but also contains introduced species and some noxious weeds. The two drainages occur in the northeastern portion of the NWTC. The

northernmost drainage is a tributary of Coal Creek and the second is a tributary to Rock Creek (**Figure 3-9**).

Groundwater Seep Wetland. During the 2000 vegetation survey, two groundwater seep wetlands were identified. Of those, only one groundwater seep wetland (totaling 0.2 acres) in the northeast corner of the NWTC site was identified during the 2010 to 2011 survey. Native species diversity has decreased since 2000, reducing this area to 0.14 acres (Walsh 2011; DOE 2002), but noxious weed management is aiding this area to recover.

Seasonal Pond. One pond (0.4 acres), located in the western portion of the NWTC site, is an unusual habitat feature in the surrounding xeric mixed grasslands. The area only holds water during seasonal surface runoff events. During the 2010 to 2011 site visits, saturated soils were not observed due to lack of precipitation. The lack of moisture appears to have caused a shift in dominant vegetation from hydric (moist) species such as sedges, spikerush, and rushes (Plantae 2000) to more upland grasses and forb species (prairie or field species) such as western wheatgrass, junegrass, and yarrow. Additionally, many weed species have invaded, including common mullein, Canada thistle, and musk thistle (Walsh 2011). When the area does hold water (usually in the springtime), it supports a population of boreal chorus frogs.

3.9.2.4 Nonnative Species

Noxious or invasive weeds are nonnative plant species that have been designated by regulatory agencies as being harmful, and meet one or more of the following criteria: (1) aggressively invades or is detrimental to economic crops or native plant communities; (2) is poisonous to livestock; (3) is a carrier of detrimental insects, diseases, or parasites; or (4) the direct or indirect effect of the presence of this plant is detrimental to natural ecosystems or agricultural areas (CDA 2013a).

The *Federal Noxious Weed Act of 1975* (7 U.S.C. 2801 et seq.) established a program to control the spread of noxious weeds. These undesirable plant species are defined as "plant species that are classified as undesirable, noxious, harmful, exotic, injurious, or poisonous pursuant to state or federal law." With the exception of a 1990 amendment requiring federal agencies to manage noxious weeds on their lands, it was replaced by the *Plant Protection Act* (7 U.S.C. 7701 et seq.), which, among other plant pest-related provisions, established a federal program for funding noxious weed control and eradication projects. The *Colorado Noxious Weed Act* (35-5.5-101-119 C.R.S.), revised in 2003, enables county and city governments to implement management programs aimed at noxious weeds in order to reclaim infested areas and protect weed-free zones (CDA 2013a). In Colorado, noxious weeds are classified by the Colorado Department of Agriculture as either List A, List B, or List C species, defined as follows:

- List A - Newly arrived and/or less common in Colorado and must be eradicated.
- List B - Continued spread in Colorado should be halted.
- List C - Local governments have authority to decide their management strategy.

Eleven noxious weed species (**Table 3-21**) were identified during 2010 to 2011 field surveys of the NWTC. Of these, no List A species were identified while nine List B species were observed, meaning that control of these species is required, but that eradication is not likely given the ubiquitous distribution throughout the state.

Table 3-21. Noxious Weed Species Observed at the NWTC, Golden, Colorado

Common name	Scientific Name	Estimated Area (acres)	Priority Rating*
Canada thistle	*Cirsium arvense*	6.0	B
Cheatgrass	*Bromus tectorum*	**	B
Common mullein	*Verbascum thapsus*	0.8	C
Common teasel	*Dipsacus fullonum*	1.8	B
Chicory	*Cichorium intybus*	0.05	C
Dalmatian toadflax	*Linaria dalmatica*	3.5	B
Diffuse knapweed	*Centaurea diffusa*	10.5***	B
Leafy spurge	*Euphorbia esula*	0.1	B
Musk thistle	*Carduus nutans*	3.2	B
Scotch thistle	*Onopordum acanthium*	0.3	B
Hoarycress (Whitetop)	*Cardaria draba*	0.03	B

Sources: Walsh 2011; CDA 2013b
Notes:
* Priority rating based on the Colorado Department of Agriculture's Noxious Weed Management Program assessment
** Cheatgrass was pervasive throughout the NWTC and was not mapped.
*** Diffuse knapweed was ubiquitous throughout the NWTC. This table only includes the higher densities of plants per square meter.

The Jefferson County Nature Association coordinates with 16 land owners that surround the Rocky Flats National Wildlife Refuge on control measures for noxious weeds and oversees the land owner's weed management activities. The NWTC shares their border with the Rocky Flats National Wildlife Refuge. The Jefferson County Nature Association provides an annual report to the Rocky Flats Trustee Council. NWTC land managers have worked closely with the Jefferson County Nature Association and have met with the Jefferson County Weed Coordinator regarding the weed control program at NREL. After four years of aggressive management, NREL has made positive strides in weed control and has received the highest ranking from the Jefferson County Nature Association for weed control efforts. Diffuse knapweed populations have been greatly reduced throughout the site, giving native grassland species a competitive advantage. Areas of chief concern have been managed in accordance with NREL's weed control procedure (NREL 2012h).

3.9.3 EXISTING ENVIRONMENT FOR WILDLIFE

At the NWTC, much of the site is habitat for native wildlife. The mesic mixed grasslands located in the southwestern portion of the NWTC and drainages, the ponderosa pine woodland, the upland shrublands, and the wetlands described above provide habitats for a variety of wildlife.

Periodic surveys are performed to assess biological resources at the NWTC. Surveys are used to document resources onsite and to determine if there are impacts from site operations. Four seasons of site-wide wildlife surveys were conducted during 2010 to 2011 for large mammals, mammalian predators, reptiles, amphibians, and terrestrial arthropods. Prior to commencement of surveys, researchers reviewed prior studies and queried the Colorado Natural Heritage Program database for species specific to the NWTC area (Walsh 2011). **Appendix D** contains a complete list of the wildlife encountered during the surveys. In addition, bird and bat use and mortality surveys were performed, as well as breeding bird surveys. NREL will continue to periodically assess and monitor wildlife site use and mortality.

3.9.3.1 Invertebrates

Common invertebrates identified on the NWTC, such as western white, dainty sulphur, and orange sulphur butterflies, occur mostly in xeric mixed grassland communities. Other butterflies such as the gray hairstreak, checkered white, Aphrodite fritillary, cabbage white, and common wood nymph were observed in headwater wetland habitats during the same surveys (Walsh 2011).

3.9.3.2 Reptiles and Amphibians

Two species of herpetofauna were identified during the surveys, Woodhouse's toad and boreal chorus frog. Bullsnakes are observed along roads and the rocky terrain of the ponderosa pine woodlands.

3.9.3.3 Birds

Migratory Birds. Of the 2,055 bird species that have been recorded in North America (including Canada, Central America, and Mexico), 1,007 of these occur in the United States, and are protected under the *Migratory Bird Treaty Act*, administered by the USFWS. Many North American migrants annually fly south to the southern United States, Central America, South America, and the Caribbean to winter, returning north to their nesting regions each spring. Other migrants move to different altitudes within a region. Colorado's eastern Southern Rocky Mountain Front Range is a linear path in the western portion of the Central Flyway that birds, including raptors, follow during migration (Eco-Logic 2011). Site use by migratory birds has been documented in periodic surveys conducted since 1994. All studies included raptor surveys and two surveys also surveyed small birds (non-raptor bird species). The surveys are summarized in **Table 3-22.**

Raptor and Vulture Surveys. Migratory raptor surveys conducted at the NWTC demonstrate annual variability in species composition and abundance, as described in **Table 3-22**. One explanation for site use by migratory raptors is the annual variability observed in spring migratory raptor routes along the Front Range of Colorado. Variable wind and storm patterns can result in migration routes that can concentrate over the western foothills, over the hogback, or east of the hogback out to the eastern plains. Nearby nesting location, large home range and hunting territories, winter roosting territories, and onsite observations indicate that the site is used by raptors and vultures. In both spring raptor surveys (Monahan 1996; Eco-Logic 2011), the stream of migrating raptors tended to be west of the NWTC.

Table 3-22. Bird Surveys at the NWTC, Golden, Colorado

Type of Survey and Duration	Locations	Summary & Findings
Raptor Surveys (Monahan 1996) 17 months	Various vantage points on perimeter or interior roads	16 species of raptors were observed in the vicinity of the NWTC including the bald eagle, golden eagle, osprey, turkey vulture, northern harrier, sharp-shinned hawk, ferruginous hawk, Cooper's hawk, Northern goshawk, broad-winged hawk, red-tailed hawk, rough-legged hawk, American kestrel, merlin, prairie falcon, and peregrine falcon. Four species (red-tailed hawk, prairie falcon, American kestrel, and rough-legged hawk) were observed regularly and were determined to be resident to the area. Turkey vultures (56%) and American kestrel (29%) accounted for most of the sightings recorded during spring migration. Of the remaining raptors recorded, the most observed were falcons and hawks.

Type of Survey and Duration	Locations	Summary & Findings
Bird and Bat Use and Fatalities Survey (Schmidt et al. 2003) One year	Six locations on the NWTC Five locations on Rocky Flats Seven locations on City of Boulder OSMP lands	The most abundant species observed onsite within the grassland habitats were western meadowlark, vesper sparrow, European starling, mourning dove, and black-billed magpies. Raptor abundance and behavior were recorded in addition to similar observations for smaller birds. Of 2,453 individual birds counted, 212 were raptors. Of 12 species observed in grassland habitat, the most common raptor or other large birds observed included the American kestrel, red-tailed hawk, and northern harrier. In the onsite ponderosa pine woodlands, the American kestrel was observed more often than in similar offsite control plots. During this year-long mortality survey, four bird carcasses were found onsite: a black-billed magpie, a western meadowlark, a Wilson's warbler, and a chickadee. The black-billed magpie was found at the base of a large turbine while the other three carcasses appeared to be associated with collisions with guy wires for the meteorological towers rather than the turbines. Searcher efficiency and carcass removal trials were done to validate the carcass search data. Based on the estimated percentage of the birds that were scavenged or missed by the observer, the data were adjusted accordingly to provide an estimate of mortalities. Based on adjustments, approximate annual bird mortality was 24 individuals, all songbirds (Passeriformes). No large raptors were found dead during this survey, and no carcasses were found on search plots off the NWTC site. Bird mortality associated with the site appears to be minor.
Avian Use of the NWTC - Fixed Point Survey (Tetra Tech 2011a) One year	Six locations on the NWTC Three locations on Rocky Flats National Wildlife Refuge Three locations on City of Boulder OSMP lands	The western meadowlark, red-winged blackbird, vesper sparrow, horned lark, and Brewer's blackbird were the most abundant onsite grassland species during the 2010–2011 surveys. In the ponderosa pine woodlands, 29 species were observed, with the western meadowlark, vesper sparrow, barn swallow, American robin, and grasshopper sparrow seen in the most abundance. In the onsite grassland habitat, six species of raptors were seen, with American kestrel being the most abundant. Three pairs of resident raptors (one pair of American kestrels and two pairs of red-tailed hawks) made frequent visits to the NWTC to perch, mate, and hunt. In addition, local turkey vultures periodically flew over the site. Bald and golden eagles were observed from an offsite reference location to the south of the NWTC. No eagles were observed at the NWTC or in Boulder County open space reference areas to the north.

Type of Survey and Duration	Locations	Summary & Findings
Bird and Bat Mortality Surveys (Tetra Tech 2011a, 2011b) One year	Around all aerial structures at the NWTC	During these standardized surveys, a total of five avian carcasses were found. These fatalities were a black-billed magpie, mourning dove, red-winged blackbird, an unknown sparrow, and an unknown passerine. Except for the unknown passerine beneath a turbine on the eastern part of the site, all other species were discovered underneath meteorological towers. Avian fatalities were found in every season except winter (fall – one fatality, spring – one fatality, summer – three fatalities). No raptor carcasses were found during this survey. Further, no avian species federally listed as endangered or threatened, state-listed as endangered or threatened, or that are state species of concern were discovered injured or found as fatalities during the project surveys.
Breeding Bird Surveys (Tetra Tech 2011a) Two months	East-west transects, 100 meters apart, across the entire NWTC site	Grassland bird species observed at the NWTC during this survey included grasshopper sparrow, horned lark, savannah sparrow, vesper sparrow, and western meadowlark. Due to small sample sizes, analyses on the distribution of grasshopper sparrows and horned larks with respect to installed wind turbines could not be conducted. Only vesper sparrow showed significant patterns with few observations within 164–328 feet (50–100 meters) of the nearest turbine and more observations further from the turbines at distances over 492 feet (150 meters).
April 2010 Fixed-Point Raptor Migration Survey (Eco-Logic 2011) One month	One point at western edge of the NWTC	378 observations of 10 different raptor species were recorded. Resident raptors often made multiple appearances daily, particularly a pair of American kestrels and two pair of red-tailed hawks. Of the 10 species observed, the most abundant migrant observed was the turkey vulture (114), followed by American kestrel (85), the red-tailed hawk (65), golden eagle (7), osprey (3), and 1 each: sharp-shinned hawk, Cooper's hawk, merlin, prairie falcon, and bald eagle. In addition, 97 unidentified migrant raptors were observed. Five migrant raptors entered the NWTC airspace during four observation events. These included one unknown raptor, one Coopers hawk, one merlin, and a pair of osprey. While only five migratory raptors were observed onsite, resident raptors were observed using the site nearly 10 percent of the observation time.
Incidental Observations 2001-2014	Site-wide	NWTC personnel have incidentally observed carcasses in the vicinity of aerial structures since 2001 while performing field work or conducting security rounds. While these observations were not part of a formalized mortality survey, any birds found dead were reported to NREL's EHS Office, and the information recorded. Some years, no carcasses were reportedly observed. One year, five carcasses were observed. From 2008 to 2014, three raptor fatalities occurred on the western portion of the NWTC, two nocturnal raptors (great horned owls) and one diurnal raptor (red-tailed hawk). These mortalities were likely caused by guy-wire collisions and not large turbines located on the eastern portion of the NWTC. In addition, an injured Swainson's hawk was found beneath one of the utility-scale turbines on the eastern edge of the site.

3.9.3.4 Mammals

Large Mammals. Large vertebrates identified on the NWTC include mule deer, desert cottontail, and coyote. Signs of American elk have been observed during periodic surveys. The NWTC staff has observed elk on the site over the last 10 years. In early spring 2013, NWTC office staff photographed a bobcat on two occasions outside of Building 251. A bobcat was also captured on film by NWTC personnel using a motion-detector camera in the ponderosa pine woodlands in the fall of 2012.

Small Mammals. Six species of small mammals were trapped and then released during the biological surveys of 2010 to 2011: masked shrew, deer mouse, meadow vole, prairie vole, western harvest mouse, and Mexican woodrat. Although not captured during these surveys, burrow holes and runways of the thirteen-lined ground squirrel were observed in the xeric mixed grassland (Walsh 2011).

Although black-tailed prairie dogs were not observed during the recent surveys, current and historic burrow locations occur on or near the NWTC site (Walsh 2011). The black-tailed prairie dog is considered a "keystone species" and is a point of conservation management concern because their colonies create habitat that benefits numerous other species such as the burrowing owl, black-footed ferret, ferruginous hawk, snakes, rabbits, and bald eagle. Burrowing owls are a state-listed threatened species and protected species under the MBTA. Burrowing owls do not excavate their own burrows, but nest and roost in abandoned rodent burrows and more commonly within prairie dog colonies. In addition, the federally listed endangered black-footed ferret eats, sleeps, and raises their young in prairie dog burrows, and 90 percent of their diet is made up of prairie dogs. In Colorado, the ferret only exists at one experimental colony location near Rand, Colorado. The USFWS developed a block-clearance area for Colorado that excludes all of Jefferson County from further consideration regarding this species (USFWS 2009b).

Bats. Occurrences of bats at the NWTC were documented using an acoustical bat use survey conducted from July 6, 2010, to November 7, 2010 (Walsh 2011). This survey showed that bat activity at the NWTC was highest from mid-July to mid-September. Other bat studies include mortality surveys (Schmidt et al. 2003; Tetra Tech 2011a, 2011b), as discussed in **Table 3-23**. NREL is continuing an ongoing program to monitor bat occurrence at the NWTC using acoustic monitoring devices.

No special status species were identified during acoustical bat surveys at the NWTC. Townsend's big-eared bat is the only state-listed bat species and is restricted to foothills and mountain habitats. Maternity roosts (areas where females congregate when giving birth and raising young) for Townsend's big-eared bat have been identified and are protected on City of Boulder OSMP land roughly five miles to the north/northwest (Walsh 2011). Townsend's big-eared bats have not been identified at the NWTC.

Table 3-23. Bat Surveys at the NWTC, Golden, Colorado

Type of Survey and Duration	Locations	Summary & Findings
Bird and Bat Use and Fatalities Survey (Schmidt et al. 2003) One year	Ten carcass search plots at the NWTC near wind turbines and met towers Five locations on Rocky Flats Five locations on City of Boulder OSMP lands	The NWTC does not support a large diversity or abundance of bat species (possibly six species of bats use the site), but an area on the northwest side of the site, with trees close to a rocky outcrop, provides foraging and perhaps roosting habitat. No evidence of bat fatalities was found at the site. No bat carcasses were found at the NWTC search plots. At that time, turbines did not exist at Sites 4.1 or 4.4.
Bird and Bat Mortality Surveys (Tetra Tech 2011a, 2011b) One year	Fatality monitoring surveys at 12 turbines and 19 associated meteorological towers within the NWTC	Thirteen bat carcasses were found representing three identified species and two bats that could not be identified. The bat species found were five hoary bats, three silver-haired bats, and three big brown bats. Bat fatalities had a limited distribution and were only found at Site 4.4 and at Site 4.1. Searcher efficiency and carcass removal trials were done to validate the carcass search data. Based on the estimated percentage of the bats that were scavenged or missed by the observer, the data were adjusted accordingly to provide an estimate of bat mortalities. As a result, 16 bat fatalities were estimated to occur onsite during fall/winter seasons. During spring/summer seasons, 17 bat fatalities were estimated to occur. In general, bat fatalities were found in the vicinity of large turbines.
2010-2011 Vegetation and Wildlife Surveys (Walsh 2011) Four months	Acoustical bat survey from one monitoring point in the northwest portion of the NWTC	Of the 18 bat species documented in Colorado, 6 species were identified on the NWTC. A total of 12,425 bat passes were recorded during the survey period, of which 8,772 identified bat species. Species composition included 50 percent myotis, 36 percent big brown bat, 7 percent fringed myotis, 5 percent silver-haired bat, 2 percent hoary bat, and less than 1 percent thought to be the eastern red bat. No federally or state-listed threatened, endangered, or candidate species or species of special concern were identified.

In general, direct bat mortalities observed at commercial wind facilities result from bats colliding with turning rotor blades on turbines (Horn et al. 2008) and could also be caused by rapid decompression (barotrauma), when bats encounter sudden drops in atmospheric pressure in the area of the rotor tip vortex (Baerwald et al. 2008; Cryan and Barclay 2009). Also a study suggested that traumatic injury is the major cause of bat fatalities at wind energy facilities and that barotrauma contributed to only a small fraction of bat mortalities (Rollins et al. 2012). Although bat fatalities could also be caused by mortality from barotrauma, this cannot be confirmed except with an autopsy (necropsy), which was not done; therefore, all carcasses at the NWTC are attributed to collisions with turbines (Tetra Tech 2011a).

Thirteen bat carcasses were found during the most recent year-long mortality survey (Tetra Tech 2011a, 2011b). No bat species federally listed as endangered or threatened, state-listed as endangered or threatened, or that are state species of concern were found as fatalities during the projects.

3.9.3.5 Threatened, Endangered, and Special Status Species

The USFWS has identified four birds, two fish, three plants, one invertebrate, and four mammal species federally classified as threatened, endangered, proposed, or candidate species under the ESA that could potentially occur in Jefferson and Boulder Counties (USFWS 2013a). Furthermore, the State of Colorado Parks and Wildlife lists an additional two birds and one mammal that are protected at the state level – threatened, endangered, or State Special Concern. The species that could occur at the NWTC are shown on **Table 3-24**, and discussed in detail in the text that follows.

Table 3-24. Federally and State-Protected and Sensitive Species Found in Jefferson and Boulder Counties, Colorado

Common Name	Scientific Name	Status	Potential to occur at the NWTC
Plants			
Ute ladies'-tresses orchid	*Spiranthes diluvialis*	FT	Yes
Colorado butterfly plant	*Gaura neomexicana* ssp. *coloradensis*	FT	Yes
Western prairie fringed orchid	*Platanthera praeclara*	FT	No
Invertebrates			
Pawnee montane skipper	*Hesperia leonardus montana*	FT	Yes
Fish			
Greenback cutthroat trout	*Oncorhynchus clarki stomias*	FT, ST	No
Pallid sturgeon	*Scaphirhynchus albus*	FE	No
Birds			
Burrowing owl	*Athene cunicularia*	ST	Yes
Least tern	*Sternula antillarum*	FE, SE	No
Mexican spotted owl	*Strix occidentalis lucida*	FT, ST	No
Piping plover	*Charadrius melodus*	FT, ST	No
Whooping crane	*Grus americana*	FE, SE	No
Bald eagle	*Haliaeetus leucocephalus*	BGEPA, SC	Yes
Golden eagle	*Aquila chrysaetos*	BGEPA, FSOC	Yes
American peregrine falcon	*Falco peregrinus anatum*	SC	Yes

Common Name	Scientific Name	Status	Potential to occur at the NWTC
Mammals			
Preble's meadow jumping mouse	*Zapus hudsonius preblei*	FT, ST	Yes
Canada lynx	*Lynx canadensis*	FT, SE	No
Black-tailed prairie dog	*Cynomys ludovicianus*	SC	Yes
North American wolverine	*Gulo gulo luscus*	PT	No

Sources: USFWS 2013a; CDOW 2013
Status Codes: FE = Federally Listed Endangered; FT = Federally Listed Threatened;
PT = Proposed Threatened; BGEPA = Bald and Golden Eagle Protection Act; FSOC = Federal Species of Concern
SE = State Endangered; ST = State Threatened; SC = State Special Concern

Although not found in Jefferson and Boulder counties, five federally listed species in **Table 3-24** are found primarily in Nebraska and have the potential to be affected by depletions of water from the South Platte River and its tributaries in Colorado. These species are the western prairie fringed orchid, the pallid sturgeon, the least tern, the piping plover, and the whooping crane. A summary of DOE's consultation with the USFWS on the potential effects on these federally listed species or critical habitat in downstream water-depleted regions is found at the end of Section 3.9.4.2.

As shown in **Table 3-24**, two federally listed threatened plant species, Ute ladies'-tresses orchid and Colorado butterfly plant, and one federally listed invertebrate, the Pawnee montane skipper, have some potential to occur at the NWTC. Although not federally listed under the ESA, bald and golden eagles remain protected under the *Bald and Golden Eagle Protection Act* and have the potential to occur at the NWTC. Occurring only in Colorado and Wyoming, the threatened Preble's mouse is the only federally listed species known to occur near the NWTC. All these species are discussed below.

Ute ladies'-tresses orchid. A member of the Orchidaceae family, Ute ladies' tresses orchid is a perennial herb. Ute ladies' tresses orchids are found at elevations between 4,500 and 6,800 feet in sub-irrigated alluvial soils along streams, and in open meadows in floodplains. The orchid blooms from late July through August, and may persist into early September, barring frost or drought. The seed is ellipsoidal and dust-like, well-adapted to wind dispersal (NatureServe 2013).

According to the Colorado Natural Heritage Program, Ute ladies' tresses orchids are known to occur in Jefferson County and neighboring Boulder County. The last survey for these individuals, utilizing the USFWS survey requirements, did not identify any individuals on the NWTC. Ephemeral drainages and wetlands on the NWTC generally have dense, overgrown vegetation and are not suitable habitat for this species (DOE 2002).

Colorado butterfly plant. The Colorado butterfly plant is a short-lived, perennial herb with one to several reddish stems two to three feet tall. Flowering begins in late June or early July and continues until the first hard freeze, typically late September to early October. The Colorado butterfly plant prefers subirrigated, alluvial soils on level or slightly sloping floodplains and drainage bottoms at elevations of 5,000 to 6,400 feet. Colonies are often found in low depressions or along bends in wide, meandering stream channels, a short distance upslope of the actual channel (NatureServe 2013). The Colorado butterfly plant is not known to occur in Jefferson County, but it has been found in neighboring Boulder County.

Although marginal habitat for both Ute ladies' tresses orchids and the Colorado butterfly plant occur at the NWTC, no individuals were found during the 2000 survey (DOE 2002) or the subsequent 2010-2011 vegetation surveys (Walsh 2011).

Pawnee Montane Skipper. One federally listed invertebrate, the Pawnee montane skipper, has the potential to occur at the NWTC. A member of the butterfly family, the Pawnee montane skipper is a subspecies only occurring in the South Platte Canyon River drainage system in Colorado, which includes portions of Jefferson County, south of the NWTC. The small, brownish-yellow butterfly has a wing span slightly over one inch, and has distinct spots occurring near the outer margins of the upper surface of the wings. Additionally, one to four distinct brownish to off-white spots occur on the lower surface of the wings. Listed as threatened under the ESA in 1987, this skipper occurs in dry, open, ponderosa pine woodlands and has the potential to occur in the northwestern portion of the NWTC. This area is protected within the designated conservation management area onsite and no activities are being proposed in this area.

Bald Eagle. The bald eagle is among the largest raptors in the United States, with a wingspan ranging from five to seven feet. The color of the adult bald eagle is dark brown with a white head and tail.

Although not federally listed under the ESA, the bald eagle remains protected under the *Bald and Golden Eagle Protection Act* and is a state species of special concern. The eagle has the potential to occur at the NWTC. The bald eagle migrates during the spring and fall, but generally it follows the major river systems of the state or the hogback (a steep ridge) west of the NWTC. Eagles are typically attracted to large open-water bodies and, due to lack of current suitable habitat at the NWTC, any occurrences would likely involve transient or hunting individuals. Historically, bald eagles have been observed in transit to roosting areas, as described in **Section 3.9.3**. In addition, a pair of bald eagles was observed nesting in a plains cottonwood stand in the Coal Creek drainage channel approximately 2.5 miles northeast of the NWTC. Local ornithologists report five breeding bald eagle pairs existed in Boulder County during 2008-2010 surveys, including the Coal Creek pair (Hallock and Jones 2010). A nesting pair also exists at Standley Lake located 3.8 miles from the NWTC in Jefferson County.

Golden Eagle. The golden eagle is a very large, dark brown raptor with broad wings. This species' wingspan is the fifth largest among eagle species. Golden eagles use their agility and speed combined with extremely powerful feet and massive, sharp talons to snatch up a variety of prey (mainly hares, rabbits, marmots, and other ground squirrels). They build large nests in high places (mainly cliffs) to which they may return for several breeding years.

Although not federally listed under the ESA, the golden eagle remains protected under the *Bald and Golden Eagle Protection Act* and is a federal species of special concern. Golden eagles use a wide range of habitats including pinyon-juniper woodlands, sagebrush, and grasslands, usually in higher elevations of the western U.S. Although golden eagles breed primarily in mountainous habitats in Colorado, there is some limited breeding in the northeastern portion of the state. In winter, golden eagles range widely and occur commonly throughout Colorado (refer to **Section 3.9.3.3**). During April 2010, Dinosaur Ridge Raptor Migration Station observers tallied seven golden eagles in migration over the I-70/Morrison Hogback viewing station, located approximately 16 miles southwest of the NWTC.

As previously discussed, variable wind and storm patterns can result in migration routes that can concentrate over the western foothills, over the hogback, or east of the hogback (including the airspace over the NWTC) out to the eastern plains. Nearby nesting location, large home range and hunting territories, winter roosting territories, and onsite observations outside of survey periods, indicate that there is the potential for site use by golden eagles.

Preble's Meadow Jumping Mouse. Occurring only in Colorado and Wyoming, the Preble's mouse is the only federally listed threatened species known to occur near the NWTC. Historically, this species occurred from the Front Range of Colorado east to the South Platte River, and from Colorado Springs north to the North Platte River in Wyoming. Although they still occur throughout this range, habitat loss and degradation has resulted in smaller populations sizes.

The Preble's mouse has large hind feet and a long, sparsely haired tail that is usually longer than the body. The dorsal color is yellowish-brown, and there is usually an indistinguishable, dark, mid-dorsal band running the length of the body. The sides of their body are paler than the dorsal portions, and the ventral region is generally white. They are small, 12 to 17 inches in length, and weigh between 0.5 and 0.9 ounces (USFWS 2013b). The Preble's mouse prefers dense multi-story, herbaceous and woody vegetation and adjacent upland habitats. Upland habitat is especially important for the Preble's mouse and can be characterized as a mosaic of grasslands, oak scrub, and ponderosa pine woodlands (USFWS 2013b).

Listed as threatened in May 1998, the decline of the Preble's mouse is theorized to be primarily due to habitat loss, degradation, and fragmentation. Additionally, other factors affecting the Preble's mouse include pesticide and herbicide use, livestock grazing, urban development, and inadequacy of existing regulations. Loss of riparian habitat may be the largest cause of the decline of this species (USFWS 2013b).

Although the Preble's mouse has not been captured or detected on the NWTC, it does have the potential to occur on one of the two headwater wetland areas on the eastern portion of the NWTC, the tributaries of Coal Creek and Rock Creek. The draw in the conservation management area on the west side of the NWTC may also contain habitat for this species, especially during wet years. Both of these creeks are known to be inhabited by the Preble's mouse but only in reaches farther downstream offsite, located on the adjacent Rocky Flats National Wildlife Refuge and along Coal Creek in Boulder County. Critical habitat for the Preble's mouse was designated in the southeastern portion of the NWTC; this area is under protection as a conservation management area. The habitat includes the stream width plus 394 feet on either side.

Three non-federal special status species have been documented at or near the NWTC, the American peregrine falcon, burrowing owl, and black-tailed prairie dog.

American peregrine falcon. A Colorado species of special concern, the American peregrine falcon prefers open spaces usually associated with high cliffs and bluffs overlooking rivers and coasts. They feed on small rodents and small to medium-sized birds, and may often work together to confuse prey and secure a kill (CPW 2013a).

Breeding habitat is not present at the NWTC, although the peregrine falcon has been occasionally documented there as a transient (DOE 2002). Historically, nesting peregrine falcons have been documented in nearby Standley Lake (3.8 miles), Eldorado Canyon (5 miles), and the Flatirons (6.9 miles) (DOE 2002; Walsh 2011). In 2011, three to five breeding pairs of peregrine falcons occurred in Boulder County.

Burrowing owl. The burrowing owl is a small, diurnal, ground-dwelling bird. Burrowing owls are frequently found around prairie dog burrows from late March or early April through October. They are usually found in grasslands and mountain parks, but also use well-drained steppes, deserts, prairies, and agricultural lands. The burrowing owl is listed as threatened in Colorado with habitat loss due to housing, suburban development, and agriculture activities (CPW 2013b). Although historically documented on RFETS (DOE 2002), the burrowing owl has not been observed at the NWTC.

Black-tailed prairie dog. The black-tailed prairie dog is tan or light brown with reddish coloration, 14 to 17 inches long. Members of the squirrel family, the prairie dog lives communally on grassy plains or prairies with as few as 10 individuals and as many as several hundred. Prairie dog "towns" are an integral part of the ecosystem, with many other wildlife species interacting and dependent upon the prairie dog town. Eagles, hawks, falcons, snakes, badgers, and coyotes will consume prairie dogs, while their burrows provide habitat for other species such as burrowing owls, bullsnakes, and tiger salamanders.

In Colorado, the black-tailed prairie dogs have been a point of management concern recently because of their associated habitat with the burrowing owl, a state-listed threatened species and protected species under the MBTA and because it was petitioned for listing in 2008. In the past 15 years, plague and new development along Rock Creek have nearly eliminated prairie dogs in the area (DOE 2002). As recently as 2008, a prairie dog colony was present on the NWTC. The colony was re-located to the northwestern portion of the NWTC, west of the ponderosa pine woodlands. Within a year, this colony, and all the colonies on the adjacent and nearby City of Boulder OSMP property, died from plague. City of Boulder OSMP areas to the north and west of the NWTC have been designated as prairie dog habitat. The City of Boulder has recently applied and received a permit with Colorado Wildlife and Parks to allow for prairie dog re-location in these areas.

3.9.4 ENVIRONMENTAL CONSEQUENCES

3.9.4.1 Evaluation Criteria

The analysis of environmental consequences to biological resources (vegetation and wildlife) considers the intensity, duration, and type of impact. Major impacts are those that are severely adverse or exceptionally beneficial and would affect a substantial area of vegetation and the majority of the inhabiting wildlife community. The severity and timing of changes due to major impacts are expected to be outside natural variability, both spatially and temporally, meaning key ecosystem processes and community structure would be disrupted. In addition, habitat for wildlife species would be rendered nonfunctional on a large scale (for instance, ecosystem impacts beyond those in protected areas). Impacts on terrestrial habitat and species are based on resource availability and use, existence of sensitive habitats and species therein, and associated regulations. A proposed action would have a major impact on terrestrial habitats and species if it were to do one or more of the following:

- Threaten, damage, or destroy sensitive terrestrial habitats and species
- Violate established laws or regulations adopted to protect terrestrial habitats and species
- Reduce the population size or change the distribution of a species or resource
- Affect a large proportion of a resource
- Result in cascading ecological effects (for example, food web impacts)

Biological resources might be affected directly by ground disturbance, driving off-road, construction of additional aerial structures onsite, or wind turbine operations; or indirectly through changes such as increased construction noise. A proposed action would have a major impact on birds and bats if mortalities from collisions with wind turbines and meteorological towers reduced the local numbers of the affected species to the point where there are measurable population declines or where a species would need protection under state or federal law.

Biological resources are also evaluated in terms of compliance with Section 7 of the ESA and other applicable laws and authorities. Emphasis is placed on species with legal, commercial, recreation, ecological, or scientific importance.

Additionally, potential adverse impacts to migratory birds and eagles protected under the MBTA, the *Bald and Golden Eagle Protection Act*, and EO 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds" – would require consultation with the USFWS.

Evaluation criteria for impacts on wetlands are based on the U.S. government's "no net loss" policy (NRCS 2013). A loss of a wetland includes degradation of size, functionality, quality, and connectivity of wetlands. A proposed action would have a major impact on wetlands if it were to do one or more of the following:

- Violate established laws or regulations adopted to protect wetlands
- Substantially adversely affect water quality in wetlands
- Threaten or damage unique hydrologic characteristics
- Cause irreparable harm to wetland flora or fauna or beneficial uses of wetland ecosystems

Adverse effects include any adverse ecological effect on wetlands or areas of open water, including filling, grading, excavating, flooding, draining, clearing, changes in water levels, or similar activities. Most disturbances that result in impacts on wetlands are controlled by state and federal wetland regulatory programs. Other impacts on wetlands can result from disturbances that occur in areas outside of the wetland, such as uplands and other wetlands or waterways, but that could impact the wetland. These impacts include an influx of surface water and sediments, fragmentation of a wetland from a contiguous wetland complex, loss of recharge area, or changes in local drainage patterns.

All impacts on wetlands would be avoided or minimized to the maximum extent possible and any unavoidable impacts would be mitigated as consistent with U.S. Army Corps of Engineers requirements.

3.9.4.2 Proposed Action

Increasing and Enhancing Research and Support Capabilities (Zone 1 and Zone 2)

The Proposed Action includes increased and enhanced research and support capabilities onsite which includes new buildings and modifications to existing buildings. Associated infrastructure upgrades would also be required. As stated earlier, proposed construction activities may or may not be completed, based on funding.

Vegetation. Constructing new facilities in Zone 1 and Zone 2 would result in short- and long-term minor adverse impacts on vegetation due to loss of vegetative cover and plant abundance. Reduction in abundance and diversity of vegetation would have long-term minor adverse effects on the grassland ecosystem. The construction footprint could also cause minor adverse impacts on wildlife species that depend on the xeric mixed grasslands, through habitat loss and fragmentation.

Modifications and upgrades to most existing buildings in Zones 1 and 2 would not impact vegetation, as construction would occur in previously disturbed habitat. Long-term adverse impacts on grassland vegetation would be expected for the proposed addition of the 5,000-square-foot office wing to Building 251, if the option on the north side of the building were chosen, due to the presence of undisturbed xeric mixed grassland; however, impacts would be negligible based on a footprint of less than one acre.

Infrastructure upgrades to the drinking water system, fire suppression system, sanitary waste system, roadways, and telecommunication improvements would not result in long-term adverse impacts on vegetation. During repairs and upgrades, short-term negligible adverse impacts on vegetation would be expected due to localized trampling, clearing, grading, trenching, and equipment use. Following

construction activities, disturbed areas would be revegetated in accordance with NREL's stormwater pollution prevention procedures for construction activities at the NWTC (NREL 2012f).

Wetlands. Wetland areas identified in Zone 2— including the palustrine emergent wetland, the Rock Creek drainage, and the groundwater seep wetland—are within conservation management area protection zones. These areas and the Coal Creek drainage in Zone 1 would not be affected by construction and infrastructure upgrades.

Indirect impacts on wetlands might include runoff of sediments and contaminants from construction activities and the invasion of noxious weeds from disturbances. NREL has a stringent stormwater management program for all disturbances. In addition, NREL follows EPA requirements to prepare a formal stormwater plan for impacts greater than one acre. Erosion control devices would be installed and other BMPs implemented to avoid or minimize erosion.

Invasive and Nonnative Species. Site grading and excavation activities would increase susceptibility to noxious weed invasion. As part of NREL's stormwater pollution prevention and reseeding procedures (NREL 2012h), a native seed mix is used following site disturbance activities to help control invasive weeds. Diffuse knapweed, Canada thistle, hoary cress, leafy spurge, and musk thistle occur on the site and are among the most widespread noxious weeds in the State of Colorado. These and other noxious weeds found at the NWTC could potentially spread into disturbed areas, and cause long-term but negligible impacts on the native vegetation since NREL addresses and actively manages infestations onsite.

Wildlife. Short-term negligible impacts on wildlife species presently inhabiting the NWTC would be expected from the implementation of the Proposed Action. Noise disturbances during construction, including clearing, grading, excavation, and pouring concrete foundations, would be expected to temporarily affect the behavior of wildlife. Noise from the new construction would create temporary short-term adverse impacts on the wildlife that reside there.

Long-term negligible impacts on wildlife would be expected from implementing the Proposed Action due to loss of foraging, nesting, and burrowing habitat within the project area. There would be a small increase in impervious surface areas (approximately five acres or 1.6 percent of the total NWTC land area) if the Proposed Action was implemented. A minimal loss of habitat for birds, reptiles, rodents, and other small mammals would decrease prey availability for raptors and larger mammalian predators in the Proposed Action area. Impacts to ground nesting birds would be minimized by BMPs established in NREL's Natural Resource Conservation Program, which includes procedures for conducting pre-construction nest surveys and re-locating or curtailing proposed activities until young have fledged the nest (NREL 2012g).

Birds and Raptors. The Proposed Action could have long- and short-term, direct and indirect, negligible adverse impacts on migratory birds and raptors due to construction projects in Zone 1 and Zone 2. Direct impacts could include permanent loss of habitat in the Proposed Action footprint and potentially direct mortality of eggs and chicks and nest abandonment if ground-disturbing activities occur during the nesting season. However, NREL has nesting bird survey procedures to avoid impacts on migratory birds; pre-construction surveys would be conducted and, if nesting birds were present, construction activities would not take place within an appropriate buffer zone until the young fledge the nest (NREL 2012g). The loss of approximately three acres of xeric mixed grassland and potential foraging habitat that supports prey species could cause additional direct impacts on raptors.

Bats. Constructing new facilities and modifications to existing facilities in Zone 1 and Zone 2 could cause long- and short-term, direct and indirect, negligible adverse impacts on bats due to alteration of foraging habitat inducing changes in bat behavior. Anticipated impacts include the disruption of normal bat

roosting and foraging behavior due to noise and lighting associated with construction activities. The effects of the Proposed Action on foraging activities would likely have less of a direct effect due to the large distances bats can travel to forage in relation to the size of the Proposed Action footprint. Implementing general and species-specific BMPs would minimize impacts.

No impacts on bats are anticipated to occur in association with the upgrades to the DERTF and the 2.5 MW Dynamometer, as these activities would not involve land disturbance.

Sensitive and Protected Species. The NWTC only contains marginal habitat for the Colorado butterfly plant and Ute ladies' tresses orchid, and it is very unlikely that undocumented populations exist on the site (Walsh 2011). Therefore, the Proposed Action would not adversely affect those species.

The Preble's mouse has not been documented on the NWTC. Potential habitat exists in the southeast corner of the NWTC adjacent to Site 4.4 and downstream along the headwaters to the Coal Creek and Rock Creek drainages. However, the habitat is protected as a conservation management area and would be avoided. No ground-disturbing activities are proposed within 2,500 feet of the critical habitat. Therefore, no long-term direct or indirect adverse impacts on the Preble's mouse or its habitat would be expected from the Proposed Action.

Long-term adverse impacts are not expected for other sensitive species that could be encountered as transients at the NWTC. However, if impacts on transient species are experienced, they would be due to noise, construction activities, dust, and other localized disturbances and would be expected to be short-term and negligible.

Increasing Site Use and Density (Zone 2)

Vegetation. Impacts on vegetation would be similar to those described above for construction and building modification activities in Zones 1 and 2. The NREL EHS office would ensure that proposed communication lines would be placed outside the mesic mixed grassland community or along established and disturbed roadways in the area. As such, no direct impacts on areas designated as remnant tallgrass prairie would be expected, as these areas would be avoided. Impacts to the conservation management areas on the eastern portion of the site would also be avoided. Additionally, infrastructure installations at existing and new field test sites within Zone 2 would produce short-term, negligible, adverse impacts on vegetation due to localized trampling, equipment use, and trenching. These disturbed areas would be revegetated with native seed mixes as outlined in procedures for stormwater pollution prevention for construction activities. The vegetation would be expected to recover following upgrades.

***Wetlands*.** No direct impacts on wetlands would be expected from increasing site use and density in Zone 2, as these areas would be avoided during construction and installation activities. No indirect adverse impacts on wetlands would be expected since proper BMPs would be used.

Invasive and Nonnative Species. Impacts would be similar to those described above for construction and building modification activities in Zones 1 and 2.

***Wildlife*.** Short-term negligible adverse impacts on wildlife would be expected from adding wind turbines, meteorological towers, and associated infrastructure. Disturbances to wildlife from these activities are expected to be similar to those described above for Increasing and Enhancing Research and Support Capabilities.

Birds and Raptors. The Proposed Action for constructing additional wind turbines and meteorological towers in Zone 2 could have long- and short-term adverse impacts on migratory birds.

Two types of direct impacts could affect avian species: collisions with the wind turbines and meteorological tower guy wires causing mortality, and permanent loss of habitat in the Proposed Action footprint. Direct impacts from habitat loss would be similar to those impacts described for Increasing and Enhancing Research and Support Capabilities.

As the number, size, and overall operational time of turbines increases and more and taller meteorological towers and guy wires are added at the NWTC, the annual rate of fatalities could increase incrementally relative to current conditions. Development of the site could increase fatalities in proportion to the numbers of turbines. However, for comparison purposes, wind turbines have been considered less significant than other human-caused deaths of birds. Mortalities caused by house cats and collisions with buildings, vehicles, and communication towers are all estimated to have caused billions of avian deaths while wind turbine collisions remain in the thousands. As a reference, airplane strikes have been estimated to be just less than wind turbines in terms of numbers of avian mortalities (Firestone and Lilly 2008). Several variables are involved when considering avian mortality rates for commercial wind farms. The NWTC is a research site with relatively small numbers of turbines compared to many commercial wind farms. In addition, red or dual red and white strobe-like or flashing lights, not steady burning lights, would be added to some wind turbines and permanent met towers in accordance with FAA safety requirements and the USFWS land-based wind energy guidelines (USFWS 2012). The aerial structures at the NWTC pose a negligible threat to resident and migratory birds, including raptors.

In surveys conducted on NWTC in 2010 to 2011, a total of five avian carcasses were found. Avian fatalities were found in every season except winter. These fatalities included black-billed magpie, mourning dove, red-winged blackbird, an unknown sparrow, and an unknown passerine. No raptors carcasses were observed.

No long-term or sustained avian population impacts are likely given industry history and available NWTC site mortality data. For these reasons, long- and short-term, negligible adverse impacts on the bird population would be anticipated from implementing the Proposed Action.

Bats. The Proposed Action for constructing additional wind turbines and meteorological towers in Zone 2 could adversely affect bats through direct mortality; destruction of day and night roosting sites, maternity roosts, and hibernacula; and alteration of foraging habitat and behavior. While environmental impacts of wind generation have traditionally focused on avian mortality, recent studies have documented high levels of bat mortality at commercial, large-scale wind facilities in North America (Kerns and Kerlinger 2004, Barclay et al. 2007, Fiedler et al. 2007, Arnett et al. 2008, Jain et al. 2011). Because bats are relatively long-lived and have low reproductive rates (Barclay et al. 2004), the cumulative impacts of bat mortality may have long term detrimental population effects across the U.S. on some species (Kunz et al. 2007, Cryan 2011).

Hein et al. (2013) examined the relationship between pre-construction acoustic activity and post-construction fatality from a total of 169 wind energy projects (75 pre-construction bat acoustic studies and 94 post-construction bat mortality studies) across four regions in the United States and Canada. They reported that, except for the Great Plains region, consistent patterns of fatalities do not exist across landscape types (e.g. fatality rates can be equally high in forested and agricultural landscapes, or in a matrix of those landscape types). Fatality rates were significantly lower at facilities in the western U.S. The Great Plains region appears to have relatively low and consistent activity, presumably due to similar conditions within the region (Hein et al. 2013).

Overall, mortality data indicate that migratory tree bats, such as hoary bats, Eastern red bats, and silver-haired bats, comprise the majority of turbine induced bat fatalities (Johnson et al. 2003, Arnett et al. 2008). It has also been reported that most fatalities occur during late summer and early fall, corresponding

to the period of southward migration for tree bats (Johnson et al. 2003, Kunz et al. 2007, Jain et al. 2011). The reason for these species being at higher risk of collision mortality is still unclear. Some researchers have proposed that their broad geographic distribution, long-distance migratory behavior, as well as their mating strategies may expose them to higher risks (Cryan and Brown 2007, Cryan 2008, Cryan and Barclay 2009).

Of the 45 bat species in the United States, 19 bat species are known to occur in Colorado (Schorr and Navo 2012). Of these 19 species, nine species could potentially occur on the NWTC (Walsh 2011). No special status or endangered bat species have been identified at the NWTC. Townsend's big-eared bat, the only state-listed bat species, is known to exist at a maternity colony roughly five miles to the north/northwest. The Townsend's big-eared bat has not been identified during surveys at the NWTC (Walsh 2011). The most commonly detected bat group on the NWTC is the *Myotis* group, i.e. western small footed, western long-eared, long-legged, and little brown bats. Big brown bats were the second most commonly detected group (Walsh 2011).

Certain *Myotis* bats have suffered serious declines in recent years from White-nose syndrome (WNS), a cold-loving fungus which has affected cave dwelling bats in the eastern and central United States (Thogmartin et al. 2013). WNS has been confirmed in 22 states and five Canadian provinces, and has been detected as far west as Oklahoma (USGS 2014).

Since its discovery near Albany, New York in 2006, WNS has killed more than 5.7 million bats (Frick et al. 2010, Turner et al. 2012, Hayes 2012) and has greatly impacted cave-dwelling Myotis species such as the northern long-eared bat, Indiana bat, and little brown bats (Frick et. al. 2010, Thogmartin et al. 2013). Recently, the northern long-eared bat was proposed to be federally listed as endangered (USFWS 2013c) due to population declines associated with WNS. The little brown bat has also suffered severe population declines from WNS (Cohn 2012) and a status assessment for this species is currently being evaluated to determine if the threat posed by WNS warrants listing.

It is anticipated that WNS will continue spreading through the Midwest and South and eventually reach the Great Plains and beyond over the next few years (Ihlo 2013). Natural barriers, such as the Great Plains region, have the potential to slow the westward migration of WNS (Cohn 2012). DOE will continue to track the potential spread of WNS into western bat populations, including species such as the little brown bat.

In the 2010 to 2011 mortality surveys at the NWTC, a total of 13 bat carcasses were found. Bat fatalities had a limited distribution and were only found at Site 4.4 (6 carcasses) and at Site 4.1 (7 carcasses) in the vicinity of large turbines. Of the bat carcasses found, all were found during mid-summer to early fall, during peak bat migration. No bat species classified as federal endangered or threatened, state endangered or threatened, or state species of concern were found as fatalities during the surveys. Although bat fatalities could also be caused by barotrauma, this cannot be confirmed except with an autopsy, which was not done; therefore, all carcasses are attributed to collisions with turbines (Tetra Tech 2011a).

Locations that bats regularly visit to rest are called roosts and can serve a variety of purposes. A day roost is generally used for sleeping, protection, and social interaction during the daylight hours. Night roosts are separate from the day roosts and are often used as a place to rest between rounds of foraging, or as a place to bring food items for consumption. Females often congregate together in maternity roosts when giving birth and raising young where environmental factors aid in raising young. During the winter, some species seek out locations with particular environmental factors such as favorable temperature and humidity and airflow in which to hibernate. These roost sites are known as hibernacula. On NWTC, the ponderosa pines, the rocky ridgeline of the foothills that is roughly two miles to the west, and vacant buildings at the mining site may provide good roosting habitat (Walsh 2011).

Foraging habitat for bats occurs on the NTWC in the ponderosa pines and shrubs. Additionally, the large pond at the mining site immediately adjacent to the NWTC southern boundary offers the best quality water source for bats and is available through the summer, when smaller water sources become dry (Walsh 2011). Few studies to date have evaluated the effects of specific landscape features (such as wooded areas and water sources) on fatalities at individual turbines. In Iowa, Jain et al. (2007) noted a weak negative relationship between fatalities and distance to wetlands; and Piorkowski (2006) noted a similar relationship with distances to woodlots in Oklahoma. Piorkowski and O'Connell (2010) reported higher fatalities at turbines closer to ravine edges. However, when examining the Buffalo Ridge wind resource area in southwest Minnesota, Johnson et al. (2003) found no relationship between the number of fatalities at turbines and their distances to woodlots or wetlands. In a later review, Arnett et al. (2008) recommend that when siting turbines, one should avoid placement of turbines near water sources or open cave roosts, though they did not make specific recommendations for setback distances.

Some research has shown that modifications to the landscape, such as clearing vegetation for access roads, power line corridors, and wind turbine sites creates edge habitat that may alter bat foraging habitat and behavior. These cleared areas may create favorable conditions for aerial insects on which the bats feed (Grindal and Brigham 1998). Bats taking advantage of the change in habitat, foraging or commuting along cleared edge habitat may be at an increased risk of encountering and striking a wind turbine (Kunz et al. 2007; Menzel et al. 2005). The effects of the Proposed Action on foraging activities would likely have less of a direct effect due to the large distances bats can travel to forage in relation to the size of the Proposed Action footprint.

Given industry history and available NWTC site mortality data, long- and short-term, direct, negligible adverse impacts on the bat population are anticipated from implementing the Proposed Action.

Sensitive and Protected Species. No Ute ladies' tresses orchids or Colorado butterfly plants occur on the NWTC site based on recent biological surveys (Walsh 2011). The Proposed Action would not cause adverse impacts on the Colorado butterfly plant or Ute Ladies' tresses orchid.

Within Zone 2, the Preble's mouse has the potential to occur along the Rock Creek and Coal Creek drainages, areas that are each protected within the conservation management area. However, as noted earlier, no construction would be allowed within 2,500 feet of these protected areas. Thus, no long-term, direct or indirect adverse impacts on the Preble's mouse or its habitat would be expected from the Proposed Action.

The closest bald eagle nest is 2.5 miles (or 13,200 feet) northeast of the NWTC and natural landscape buffers exist between the NWTC and the nesting site. In accordance with the National Bald Eagle Management Guidelines (USFWS 2007), no activities can be conducted within 660 feet of a bald eagle nest; therefore, no impacts are expected as a result of the Proposed Action.

Long-term adverse impacts to other sensitive species that could be encountered as transients at the NWTC are not expected. However, effects on transient species due to noise, dust, and other localized disturbances may be short-term and negligible.

Expanding Power Capacity

Vegetation. During construction of the substation and transmission lines and upgrades on the NWTC, direct short-term minor adverse impacts on vegetation would be expected due to localized trampling, equipment use, and trenching. Because all of the options discussed below would disturb up to 5.75 acres, direct long-term minor adverse impacts on vegetation due to the permanent footprint of the substation and a decrease in abundance of individual species would be expected from construction within the

conservation management area. NREL EHS office personnel would collaborate with project designers to minimize the area of disturbance. Applicable BMPs would be followed, including consolidating construction laydown areas, storing equipment on roadways, avoiding prairie grassland vegetation, minimizing the amount of heavy equipment, and using previously disturbed areas for activities. Noxious weeds would be controlled, as required, in accordance with the NWTC's noxious weed control program.

- **Eldorado Option 1**: Direct, short and long-term, minor adverse impacts would be expected from the loss of xeric mixed grasslands in the western conservation management area due to gravel road upgrades and new underground distribution line for the Option 1 electrical substation choice. Localized trampling, equipment use, and trenching would cause short-term adverse impacts to the vegetation.
- **Eldorado Option 2**: Similar to Eldorado Option 1, Option 2 would result in short-and long-term minor adverse impacts on vegetation.
- **Eldorado Option 3**: Impacts on vegetation would be less than those for Eldorado Options 1 and 2, as less land would be disturbed for the shorter length of transmission line. Long- and short-term impacts on vegetation within the conservation management area would be negligible.
- **Plainview Option 1**: Plainview Option 1 would produce similar impacts on vegetation as Eldorado Option 3. The proposed substation would be built on NWTC land, disturbing up to 5.75 acres of plant communities within the western conservation management area; however, the transmission length would be less as it enters the NWTC site from the west. Long- and short-term impacts on the vegetation community would be negligible.
- **Plainview Option 2**: Plainview Option 2 would disturb up to 5.75 acres during the substation construction phase, resulting in long- and short-term minor impacts to the grasslands within the conservation management area. Long-term minor impacts on vegetation would be expected from the underground option due to increased vegetative disturbance and loss during construction of the substation. Short-term minor impacts on vegetation would be expected from the aboveground electrical interconnect.

***Wetlands*.** No direct or indirect impacts on wetlands would occur from any of the options listed above.

***Invasive and Nonnative Species*.** Direct long-term minor adverse impacts on the spread of noxious weeds would be expected from the electrical interconnect and data/telecommunication cabling. Impacts would occur if native plant communities were displaced by noxious weeds and would be similar to those described for other elements of the Proposed Action. Displacement of remnant tallgrass prairie within mesic mixed grasslands by nonnative species would cause long-term, moderate adverse effects on these grassland species; however, utilization of BMPs such as weedwash stations would prevent long-term adverse impacts to native plant communities.

***Wildlife*.** Direct negligible adverse impacts on wildlife would be expected from expanding the NWTC's power capacity. Disturbances to wildlife are expected to be short-term and similar to those described above for the other infrastructure upgrades proposed in Zone 1 and Zone 2. Impacts could result from noise, dust generation, direct mortality from equipment, and loss of foraging, nesting, and burrowing habitat during construction; however, these impacts would be temporary in nature.

***Birds and Raptors*.**

- **Eldorado Options 1, 2, and 3:** The Proposed Action could have short-term direct negligible impacts on migratory birds and raptors under the Eldorado Options. Two types of direct impacts could affect avian species: collisions with the transmission lines causing mortality and permanent loss of habitat in the Proposed Action footprint. The substation would occupy up to 1.25 acres,

including fencing, and the total land disturbance during construction would be up to 5.75 acres of xeric mixed grassland in conservation management area Zone 3. Direct impacts from habitat loss would be similar to those impacts described for other elements of the Proposed Action.

Some collision mortality is considered unavoidable with transmission lines; however, estimates on severity are difficult to predict. Recent studies of avian mortalities at electrical energy generation and transmission facilities have documented various levels of impact, but population-level declines have not been recorded for any avian species (Sovacool 2009). Electrocution is not expected to be a substantial hazard within the project area because the lines would be spaced wider than the wing span of the largest raptors that are known to occasionally occur in the area (golden and bald eagles). On December 20, 2012, the Avian Powerline Interaction Committee and the USFWS released an updated state-of-the-art guidance document with specific guidance for reducing bird collisions with power lines based on the most current published science and technical information. Line marking devices on above-ground transmission wires have been shown to reduce collisions by up to 60 percent (APLIC 2012). Implementing general and species-specific BMPs would minimize impacts as a result of the Proposed Action.

- **Plainview Option 1:** Impacts on birds from Plainview Option 1 would be the same as under the Eldorado Options; however, the distance of the transmission wire would be considerably less.

- **Plainview Option 2:** Impacts on birds from Plainview Option 2 would be the same as Eldorado Option 1; however, the distance of the transmission wire would be considerably less for the southwestern substation and far greater for the western substation.

Bats.

- **Eldorado Options 1, 2, and 3:** Short-term, direct, negligible adverse impacts on bats would occur under the Proposed Action for the Eldorado Options. Two types of direct impacts could affect bat species: collisions with the transmission lines causing mortality and permanent loss of foraging habitat in the Proposed Action footprint. Little data are available addressing bat collisions with transmission lines. There is the potential for the corona effect (noise made by power lines) to have a disruptive effect on a bat's ability to echolocate; however, it is un-studied in the scientific literature and no data are available. During the 2010-2011 mortality surveys, 13 bat carcasses were observed, but none of these were associated with collisions with transmission lines. The substation would occupy up to 1.25 acres, including fencing, and the total land disturbance during construction would be up to 5.75 acres of xeric mixed grassland in conservation management area Zone 3. Direct impacts from habitat loss would be similar to those impacts described for other elements of the Proposed Action. Implementing general and species-specific BMPs would minimize impacts as a result of the Proposed Action.

- **Plainview Option 1:** Impacts on bats from Plainview Option 1 would be the same as under the Eldorado Options; however, the distance of the transmission wire would be considerably less.

- **Plainview Option 2:** Impacts on bats from Plainview Option 2 would be the same as Eldorado Option 1; however, the distance of the transmission wire would be considerably less for the southwestern substation and greater for the western substation.

Sensitive and Protected Species. No Ute ladies' tresses orchids or Colorado butterfly plants occur on the NWTC site based on recent biological surveys (Walsh 2011). No critical habitat for the Preble's mouse exists in the vicinity of the proposed substation and transmission lines. Therefore, the Proposed Action would not cause adverse impacts to any of these species.

Other sensitive species that could be encountered as transients at the NWTC would not be expected to experience long-term adverse impacts. Effects may also occur due to noise, dust, and other localized disturbances, and would be short-term and negligible.

Consultation with the U. S. Fish and Wildlife Service. Under the ESA, federal agencies are required to provide documentation that ensures that agency actions will not adversely affect the existence of any federally listed threatened or endangered species. The ESA requires that all federal agencies avoid "taking" threatened or endangered species (which includes jeopardizing threatened or endangered species habitat). Section 7 of the ESA establishes a consultation process with USFWS that ends with concurrence on a determination of the risk of jeopardy from a federal agency project. Consultation letters between DOE and USFWS are provided in **Appendix F**.

On October 22, 2013, DOE initiated informal consultation with the USFWS, Region 6 Mountain-Prairie Region, for compliance with Section 7 of the ESA, the Migratory Bird Treaty Act, and the Bald and Golden Eagle Protection Act. The USFWS concurred with DOE's determination that the Proposed Action would not likely impact the federally threatened Ute ladies'-tresses orchid, Colorado butterfly plant, or Pawnee montane skipper. The USFWS also concurred with DOE's finding that the Proposed Action would not adversely affect the federally threatened Preble's meadow jumping mouse.

On January 15, 2014, DOE initiated formal consultation with the USFWS and submitted a streamlined biological assessment addressing the effects of Colorado water depletions on Platte River species in Nebraska. Water use at the NWTC was determined to be greater than the 0.1 acre-feet per year *de minimus* quantity for consultation. The USFWS issued a biological opinion to DOE on April 25, 2014. The USFWS determined that the flow-related adverse effects of the Proposed Action are consistent with those evaluated in the Tier 1 programmatic biological opinion for the whooping crane, interior least tern, piping plover, pallid sturgeon, western prairie fringed orchid, and whooping crane critical habitat and that these effects on flows are being addressed in conformance with the Colorado Plan for Future Depletions of the Platte River Recovery Implementation Program.

3.9.4.3 No Action Alternative

Under the No Action Alternative, the NWTC would not continue to develop the NWTC site with new construction, modifications to existing facilities, upgrades to infrastructure, and site maintenance. They would not add wind turbines or meteorological towers and would not expand their power capacity to 50 MW.

Vegetation and Wildlife. No additional impacts on vegetation and wildlife would be expected. Ongoing noxious weed management activities would continue. Wetland hydrology would be dynamic but not due to man-made causes. Conditions would remain as described in **Section 3.9.3**.

Wetlands. No impacts to wetlands resulting from project development would occur.

Invasive and Nonnative Species. No impacts resulting from the potential spread of invasive or nonnative species associated with project development would be expected.

Sensitive and Protected Species. No impacts on federally or state-listed threatened or endangered species, or Colorado species of special concern, would occur.

3.10 Hazardous Materials and Waste Management

3.10.1 DEFINITION OF THE RESOURCE

Current activities at the NWTC involve the use of hazardous materials and the generation of non-hazardous, hazardous, and universal wastes. A hazardous material is any material that poses a potential hazard to human health or the environment. The EPA defines solid waste as garbage, refuse, sludge, or other discarded material (including solids, semisolids, liquids, and contained gaseous materials). Solid waste is defined as hazardous waste by the EPA if it is specifically named on one of four hazardous wastes lists (F, K, P, or U) or exhibits one of four characteristics specified in 40 CFR Part 261, "Identification and Listing of Hazardous Waste." Universal waste is a federally designated subset of hazardous waste that includes batteries, pesticides, mercury-containing equipment, and bulbs (lamps).

At the NWTC, management programs for hazardous materials and wastes are aimed at reducing impacts to human health and the environment by using environmentally friendly products to the greatest extent possible, minimizing the use of chemicals that contain hazardous materials, and minimizing the amount of hazardous waste generated. The management of hazardous materials and waste generation and disposition at the NWTC are summarized below.

3.10.2 EXISTING ENVIRONMENT

3.10.2.1 Hazardous Materials

The foundations for hazardous materials management at the NWTC are outlined in NREL Policy 6-6, Environment, Health, and Safety Risk Assessment. This policy requires all workers to evaluate new or substantially modified activities by identifying and mitigating or eliminating environmental hazards and their potential impacts. All hazardous materials at the NWTC are managed through a network of integrated programs centrally managed by NREL. The programs are developed to minimize or eliminate adverse effects on human health and the environment. The programs include chemical acquisition, hazardous chemical training, use monitoring, and disposal tracking. All programs are managed in accordance with applicable federal, state, and local laws and regulations and DOE/NREL requirements (NREL 2012i).

Hazardous materials are centrally tracked through NREL's chemical management system. The system tracks hazardous materials according to type, quantity, location, and user. A separate system, the WasteLog Database, is used to document disposition of wastes. Together the two systems provide complete tracking of NWTC hazardous materials and hazardous wastes. In addition, the NWTC actively promotes solid waste recycling. NREL has also taken steps to plan for emergency responses in the event there is a spill or release of a hazardous material; these plans are coordinated with local emergency responders, such as the Rocky Mountain Fire Protection District and the Jefferson County Local Emergency Planning Committee (NREL 2012c).

NREL maintains a comprehensive list of chemicals present at the NWTC. These chemicals include flammable liquids; compressed gases; and common products such as adhesives, caulks, lubricants, and thinners.

There are currently five ASTs located at the NWTC for emergency generator and research use. The ASTs are capable of storing a total of 1,056 gallons of diesel fuel. Tank capacity details are shown in **Table 3-25**. NREL's tank management program includes safeguards that prevent accidental releases and include use of structural controls and operational and inspection procedures.

Table 3-25. NWTC Aboveground Storage Tank Inventory

AST NAME	Capacity (gallons)	Content	Spill Containment
IUF Emergency Generator	400	Diesel	Double-walled tank
251 Emergency Generator	200	Diesel	Double-walled tank
Site 4.4 Emergency Generator	100	Diesel	Double-walled tank
Site 1.8 Emergency Generator	50	Diesel	Double-walled tank
Site 4.0 Emergency Generator	306	Diesel	Double-walled tank

Source: NREL 2012j

Management of ASTs at the NWTC is covered under NREL's policies and procedures for AST Management and the SPCC plan (NREL 2011d, 2012f). The ASTs are operated in accordance with the Colorado Department of Labor and Employment's Division of Oil and Public Safety. The NWTC does not have any underground storage tanks. The NWTC also does not have any State of Colorado registered ASTs since all are below the 660-gallon threshold. Several mechanical and procedural safeguards have been incorporated into NREL's tank management program to prevent any accidental releases. This includes visual inspection of tanks larger than 110 gallons at least once per month (NREL 2006).

3.10.2.2 Waste Management

The NWTC generates four major types of waste: nonhazardous municipal solid waste, industrial nonhazardous waste, hazardous waste, and universal waste. The NWTC recycles as much of these wastes as possible. In 2012, the NWTC recycled 216,185 pounds of material at Waste Management Recycle America and 11,700 pounds of compost at A1 Organics (NREL 2013e). Regulated waste handling and disposal activities at the NWTC comply with the requirements and regulations of RCRA, DOE, and the Colorado Hazardous Waste Control Act, Title 25 Article 15 Parts 1, 2, 3, and 5.

The types of hazardous wastes generated at the NWTC are corrosive, ignitable, or toxic. The NWTC is a conditionally exempt small quantity generator (CESQG), which means that the facility generates less than 100 kilograms of hazardous waste and less one kilogram of acutely hazardous waste per month. The site EPA identification number, issued by the CDPHE, is COD983802448 (DOE 2002). Hazardous, industrial non-hazardous, and universal wastes generated at the NWTC are packaged and labeled in accordance with all applicable Department of Transportation regulations. All applicable shipping papers are then completed prior to any waste being offered for transportation, disposal, or recycling via fully permitted facilities. Wastes are then disposed through offsite commercial treatment and disposal firms (NREL 2006).

Nonhazardous waste at the NWTC consists of used oil, used hydraulic fluids, some absorbents, and occasional petroleum-impacted soils from small spills. Nonhazardous municipal solid waste generated at the NWTC is managed by NREL's Site Operations Center and deposited in local landfills through contracts with solid waste handling companies (NREL 2006). In 2012, the NWTC disposed of 88,648 pounds of nonhazardous municipal solid waste at the Republic Foothills Landfill off Colorado Hwy 93 in Golden, CO (NREL 2013e). The amount of hazardous and industrial non-hazardous wastes generated in recent years is shown in **Table 3-26**.

Table 3-26. Waste Generation at the NWTC

Year	2007	2008	2009	2010	2011	2012
Amount of hazardous waste (pounds)	2	0	164	50	135	0
Amount of nonhazardous industrial waste (pounds)	6,225	0	24.25	4,215	*27,535	134

Source: NREL 2013e

*clean-up of petroleum-impacted soils due to a broken hydraulic line during mowing operations at the solar array (manifested 12 cubic yards of soil for disposal)

NWTC spills are tracked in a spill-tracking log. Spills exceeding a reporting threshold are reported in the Occurrence Reporting and Processing System, which is part of DOE's emergency notification system. These procedures are integrated into NREL's Emergency Management Program (DOE 2002).

3.10.3 ENVIRONMENTAL CONSEQUENCES

3.10.3.1 Evaluation Criteria

If implementation of the Proposed Action were to increase the generation of wastes or the use of hazardous materials at the NWTC, it could represent an adverse impact. Impacts were assessed based on potential waste generation and hazardous material use resulting from construction activities and increased operational activities.

3.10.3.2 Proposed Action

Increasing and Enhancing Research and Support Capabilities (Zone 1 and Zone 2)

The Proposed Action would not substantially increase the amount of hazardous waste generated or hazardous materials used at the NWTC. The status of the facility would remain as a CESQG. The amount of nonhazardous waste would not substantially increase as a result of construction activities. The NWTC would recycle most of the material generated as a result of replacing data and communication lines and concrete foundations from existing turbines. The NREL procedures defined in the NREL SPCC Plan would be implemented to respond to any spill or release of chemicals or hydrocarbons during construction activities. This response and materials handling would minimize impacts to surface water and soils that could result from an accidental spill (NREL 2012f).

Increasing Site Use and Density (Zone 2)

The Proposed Action would result in more site activity, which presents the potential to increase the demand for and use of existing hazardous materials and could result in requests for new hazardous materials. The Proposed Action would cause an expansion of the site population, which would increase the generation of sanitary waste and municipal solid waste. These issues are not expected to increase environmental risk because:

- the nature of the research to be performed on the site would not change substantially
- chemical manufacturing and processing is not proposed

- no laboratory wet methods are proposed that would materially increase chemical use, and no radiological or other new or substantial risks are anticipated
- hazardous materials would continue to be handled centrally through NREL and tracked through the Chemical Management System
- aggressive waste minimization training and implementation would continue to ensure that the amounts of hazardous materials used onsite would be the least possible consistent with research objectives
- substantial changes would be reviewed by NREL's Risk Assessment Program, and stringent management and procedural practices would continue to be implemented at the NWTC

If new ASTs are needed for future activities, NREL would ensure that they are constructed and managed consistent with state, federal, and NREL tank requirements.

Hazardous waste generation would be expected to increase if the quantities of hazardous materials used increases. However, based on planned improvements and future activities, the amount of hazardous waste generated is not expected to exceed the CESQG criteria limits. It is anticipated that the NWTC would remain a CESQG. NREL's pollution prevention program and other efforts would minimize the amount of hazardous waste generated at the NWTC.

Solid waste levels are expected to increase only slightly and in proportion to increased program activity and higher levels of personnel. The increase in solid waste would not affect current disposal agreements.

Expanding Power Capacity

Expanding power capacity at the NWTC would have the same impacts to waste generation and hazardous materials use as increasing and enhancing research and support capabilities. The Proposed Action would not substantially increase the amount of hazardous waste generated or hazardous materials used at the NWTC.

3.10.3.3 No Action Alternative

If the No Action Alternative were implemented, the existing quantities and types of hazardous materials and hazardous wastes associated with the NWTC would remain at current levels, with impacts minimized or prevented by federal, state, and DOE/NREL requirements; no impacts would be expected.

3.11 Utilities and Infrastructure

3.11.1 DEFINITION OF THE RESOURCE

Public services and utilities consist of the systems, services, and physical structures that enable modern communities and lifestyle. These systems are wholly human-made, with a high correlation between the type and extent of infrastructure and the degree to which an area is characterized as urban or developed. The availability of infrastructure and its capacity to support growth are generally regarded as essential to the economic growth of an area. Public services include police, fire, and emergency response capabilities. Utilities include telecommunications; power, gas, and water supplies; and stormwater, sewer, and wastewater systems.

3.11.2 EXISTING ENVIRONMENT

Electrical Power. Electrical power is provided to and from the NWTC via overhead lines from Xcel Energy operating at a distribution-level voltage of 13.2 kV. Xcel Energy is a natural gas and electric company based in Minneapolis, MN and operating in eight states. An interconnection agreement was negotiated between the DOE Golden Field Office and Xcel Energy on December 20, 2010 that limits the NWTC to no more than 10 MW of generating capacity at any one time. Currently, 11.2 MW of capacity is onsite and the NWTC cannot run at full capacity, in accordance with the interconnection agreement. The property easement for electric power is 20 feet (6 meters) wide and runs from Hwy 93 along the northern boundary of Texas Industries, Inc. Boulder plant and extends approximately 900 feet (274 meters) before crossing onto NWTC property (Public Service 2001).

Upon entering NWTC property, the electrical line is then owned by DOE. The power line drops underground and then runs diagonally northeast to a junction parallel with the northern boundary, and from there, eastward, to a pad-mounted switch west of Building 251. Adjacent to this pad mounted switch is a switchgear building that contains additional electrical control equipment such as switches, fuses, and circuit breakers that are used to further distribute electrical power to other buildings, turbine field test sites, and test-site support structures across the NWTC. Also in the switchgear building, the electrical service is split into two electrical buses (circuits) – one for the turbine side (turbine bus) and one for the building side (building bus), and energy for each circuit is metered via two master meters from Xcel Energy. The turbine bus transmits power generated from the onsite turbines. The building bus serves the NWTC site with Xcel-generated power and with power generated onsite from a 1.08 MW SunEdison photovoltaic array described below (DOE 2002).

SunEdison installed and currently owns and operates an eight-acre PV solar array on an easement provided by DOE on the western portion of the NWTC site. The 1.08 MW PV solar array provides power to the building bus of the NWTC's electrical system circuit. The PV array is net metered and the power produced offsets a portion of NREL's energy consumption. A 20-year Solar Power and Services Agreement between SunEdison and the DOE Western was established on December 31, 2008. Through this agreement, power generated from the PV array is purchased by Western. Western then sells the power to the DOE Golden Field Office for use at the NWTC, through a 30-year Intra-Agency Agreement that was executed on December 29, 2008. The location of the solar array is presented in **Figure 1-2**.

In 2012, electricity consumption at the NWTC was approximately 1,601 megawatt-hours or approximately 133,000 kilowatt-hours per month. A total of 7,218 megawatt-hours were produced onsite, with 5,437 megawatt-hours from the wind turbines and 1,781 megawatt-hours from the PV array.

Natural Gas. Natural gas is provided to the site via an Xcel Energy natural gas pipeline that enters the southwestern corner of the NWTC from a pipeline along the east side of Hwy 93. In December 2003, DOE granted a 20 (6 meter) foot easement to Public Service Company of Colorado (now Xcel Energy) for an onsite natural gas line (DOE 2002). The natural gas line runs approximately 6,800 feet (1,830 meters) from the southwestern corner of the NWTC, parallels the access road for Row 1 to the northern boundary, then runs east along the northern boundary to Building 251 (Administration Building). Along the way, separate taps provide natural gas to Building 251 (Administration Building), Building 255 (2.5-MW Dynamometer) and Building 258 (5-MW Dynamometer). In addition, a manifold has been installed at the DERTF to accommodate various research projects requiring different gas capacities for research use (not building use). The natural gas line is shown on **Figure 1-2**.

Telecommunications. The site telecommunications distribution is served by CenturyLink voice and fiber optic services. These services enter on the northeast side of the site near Building 251 (NREL 2011b).

Domestic Water. The NWTC is not serviced by a municipal drinking water line. Water is purchased from the City of Boulder and trucked to the site by a licensed contractor. The annual demand onsite for domestic water was approximately 614,500 gallons (1.89 acre-feet) in 2013. To accommodate a potential population growth of up to 300 people, the projected water demand would increase to 937,000 gallons (2.88 acre feet) by 2020. Currently, one onsite domestic water storage tank with a capacity of 15,000 gallons supplies drinking water to the site. The drinking water distribution system onsite consists of a two-inch polyvinyl chloride pipe that connects via underground piping to two buildings (Buildings 251 and 254). NREL personnel and certified contractors maintain the system and collect drinking water samples for offsite analysis. The distribution system is in good condition (NREL 2011b).

Sanitary Sewer. The NWTC is not serviced by a municipal sewer line. Wastewater disposal is provided by two onsite septic systems that include tanks and leach fields for wastewater treatment, connected to facilities at Buildings 251 and 254. Septic system locations and relative sizes are presented in **Figure 1-2**. Both systems have the capacity to support the existing buildings onsite; however, there is limited additional capacity to support new construction (NREL 2011b). It is NREL's policy to comply with all state rules and regulations on wastewater discharges. Improvements were made to one of the NWTC septic systems in 2011. The system received a larger tank and an expanded leach field. The system upgrades improved flow through the system and increased the capacity of the leach field (NREL 2012c).

Emergency Response and Fire Protection. In the event of a crime or other requirement for assistance at the NWTC, onsite security would act as the first responders. If additional offsite support is required, the Jefferson County Sheriff would be contacted. In the event of a fire on the project site or on adjacent lands, Rocky Mountain Fire would provide emergency service equipment and personnel. Ambulance service in the event of a medical emergency would also be provided by Rocky Mountain Fire.

The fire suppression water system at the NWTC is fed from three 25,000-gallon water tanks dedicated to fire protection. Once every three to six months, water to fill the fire tanks is trucked to the site. The water is piped underground from the storage tanks through an independent system to the onsite hydrants within the Research and Support Facilities area. Hydrants are located to provide sufficient fire protection and coverage for buildings located within the Research and Support Facilities (Zone 1). To protect the site from wildfire, NREL applies its Fire Protection Program to the site. NREL and the Colorado State Forest Service conduct periodic wildfire assessments to assess the hazards from wildfires and to determine if appropriate controls have been established to eliminate or minimize these hazards (NREL 2011b).

Stormwater Drainage. The storm drainage system at the NWTC consists of a series of culverts, swales, and ditches that convey stormwater into receiving surface waters (NREL 2012c). Stormwater systems convey precipitation away from developed sites to appropriate receiving surface waters. Stormwater at the NWTC drains into two streams: Rock Creek and Coal Creek. The majority of the site from approximately 119th Avenue to the southern border of the site drains into Rock Creek; everything in the northern portion of the site drains into Coal Creek.

3.11.3 ENVIRONMENTAL CONSEQUENCES

3.11.3.1 Evaluation Criteria

The identification of potential effects relies on identifying the current levels of service and capacity for existing public services and utilities and comparing those to the expected infrastructure requirements from implementing the Proposed Action. Spatially, the analysis extends to the broader infrastructure systems that would be required to support the new facilities. Temporally, the effects analysis considers those effects that would occur in the short term (construction of facilities) and those that would occur in the long term (operation of the facilities). Impacts on utilities would be considered adverse if the Proposed

Action would result in a substantial disruption of existing utility systems, require the construction of new public service facilities, or require the substantial expansion of existing utility infrastructure to accommodate an increased need for utilities.

3.11.3.2 Proposed Action

Increasing and Enhancing Research and Support Capabilities (Zone 1 and Zone 2)

Electrical Power. Under the Proposed Action, the NWTC would construct new buildings and upgrade and expand existing facilities. This expansion of the NWTC site would require upgrading the existing electrical infrastructure onsite, including constructing a new onsite substation; and adding a new interconnection to the local utility, including a new transmission line to accommodate up to 50 MW of onsite electrical generation capacity. With this upgrade to the existing electrical infrastructure, no impacts to electrical service at the NWTC would be anticipated. The electrical system at the NWTC is currently at or near capacity and demand for electricity would increase; however, because the Proposed Action includes upgrades to the electrical system, no adverse impacts would be anticipated.

Natural Gas. Natural gas would continue to be supplied to the NWTC from the existing Xcel Energy pipeline onsite. New facilities proposed under site expansion would connect to the existing pipeline as needed; however, any additional demand for natural gas is not anticipated to exceed the capacity of the existing system.

Telecommunications. The Proposed Action would improve and extend the onsite telecommunications infrastructure to support new research and development activities, facilities, and an increasing number of employees on the site. No offsite infrastructure requirements are needed and the capacity of local service would not be adversely impacted by the proposed improvements.

Domestic Water. The Proposed Action would include establishing an interconnection with an existing domestic water source offsite. Currently, water is brought onsite via water trucks which periodically refill a 15,000-gallon water storage tank. To accommodate the increased water demand associated with the proposed site enhancements, a new water line would be constructed from the NWTC to the City of Arvada's municipal water system. This would result in a long-term, beneficial impact on the water supply system at the NWTC by providing a reliable water source. Future consultation with USFWS will be initiated, if funding and plans are approved for connecting to the City of Arvada water supply.

Sanitary Sewer. The Proposed Action would increase demand on the sanitary sewer system at the NWTC. The existing system is at or near capacity; therefore, additional septic/leach systems may be added for each new building constructed, or the NWTC may construct a package plant with a peak daily flow of 6,000 gallons. The size of the additional septic/leach systems would be based on the maximum staffing levels at each facility. Construction of the additional sanitary sewer facilities would result in a long-term, beneficial impact on the sanitary sewer system at the NWTC.

Emergency Response and Fire Protection. The Proposed Action includes installation of a 200,000-gallon water storage tank to provide adequate water supply and pressure for fire suppression. The existing fire suppression system provides limited firefighting capabilities. The Proposed Action would more than double the available water in case of an emergency; therefore, the Proposed Action would result in a long-term, beneficial impact. Site expansion would not result in adverse impacts on the fire suppression infrastructure at the NWTC. The new facilities and additional staff associated with the Proposed Action would incrementally increase demand for police, fire, and ambulance services, but the increases would be considered minor given site use and anticipated needs for emergency service providers.

Stormwater Drainage. The Proposed Action would result in an incidental net increase in impervious surface area at the NWTC. This could result in an adverse impact on the ability of the site to handle stormwater due to increased runoff, which can cause flooding and erosion issues. However, storm drainage features to handle changes in impervious surfaces constructed with new facilities would minimize these impacts.

Increasing Site Use and Density (Zone 2)

Long-term, beneficial impacts would result from the additional power that would be generated onsite from the new turbines. This power would be transmitted to Xcel Energy and would increase the amount of power in the state that is generated via renewable resources.

The Proposed Action would result in an incidental net increase in impervious surface area at the NWTC. This could result in an adverse impact on the ability of the site to handle stormwater due to increased runoff, which can cause flooding and erosion issues. However, storm drainage features to handle changes in impervious surfaces constructed with new turbines and meteorological towers would minimize these impacts.

Increasing Site Use and Density in Zone 2 would not have impacts on emergency response and fire protection, sanitary sewer service, domestic water supply, telecommunications, or natural gas.

Expanding Power Capacity

Assuming wind technology development continues its current trend toward larger turbines, the maximum combined rated electrical generation capacity for the NWTC site for the next five years is estimated to be up to 30 MW. In the next 5 to 10 years, electrical generation capacity is estimated to be up to 50 MW, as additional turbines and energy storage technologies are added and smaller-scale turbines are replaced with larger units.

Under the Proposed Action, the NWTC would construct new facilities and upgrade existing facilities. New facilities and upgrades at the NWTC site would require upgrading the existing electrical infrastructure onsite, including constructing a new onsite substation, and adding a new interconnection to the local utility, including a new transmission line to accommodate up to 50 MW of onsite electrical generation capacity. With this upgrade to the existing electrical infrastructure, no impacts to electrical service at the NWTC would be anticipated. The electrical system at the NWTC is currently at or near capacity and demand for electricity would increase; however, because the Proposed Action includes upgrades to the electrical system, no adverse impacts would be anticipated.

Long-term, beneficial impacts would be expected as improvements in the electrical system would provide a modern electrical system to support site improvements and existing turbines, which are currently curtailed, thus allowing the site to run at full capacity. The output for electricity at the NWTC under the Proposed Action would not be expected to exceed Xcel Energy's overall capacity or local infrastructure. The new demand would not contribute substantially to peak period power demand and associated power generation capacities. An additional long-term benefit would result from the additional power that would be generated onsite from the additional constructed turbines. This power would be transmitted to Xcel Energy and would increase the amount of power in the state that is generated via renewable resources.

Expanding Power Capacity would not have impacts on emergency response and fire protection, sanitary sewer service, domestic water supply, telecommunications, or natural gas.

3.11.3.3 No Action Alternative

Under the No Action Alternative, existing development and employment levels would continue unchanged at the NWTC; therefore, the demand for public services and utilities would remain the same. The electrical and sanitary sewer systems would continue to operate at or near capacity. Wind turbines and other energy generating facilities at the NWTC would continue to contribute power to the local electrical distribution system as a natural byproduct of the research and testing activities onsite. The domestic water and telecommunications systems would continue to operate at less than full capacity. The fire suppression system would continue to be undersized to provide adequate water supply during a fire emergency.

3.12 Human Health and Safety

3.12.1 DEFINITION OF THE RESOURCE

A safe environment is one in which there is an optimally reduced or no potential for death, serious bodily injury or illness, or property damage. Human health and safety addresses both workers' health and public safety during construction and demolition activities, and during subsequent operations of those facilities.

Construction site safety is largely a matter of adhering to regulatory requirements imposed for the benefit of employees and implementing operational practices that reduce risks of illness, injury, death, and property damage. The health and safety of NWTC onsite workers is safeguarded by federal, state, and local worker safety requirements and compliance with standards issued by OSHA and EPA. These standards specify engineering controls, the amount and type of training required for workers, the use of protective equipment and clothing and the maximum exposure limits for workplace stressors. Additionally, the DOE regulation on Worker Safety and Health (10 CFR Part 851), is the primary safety regulation that governs worker safety and health requirements, and the conduct of contractor activities at DOE sites. This regulation requires each DOE contractor to develop and implement a Worker Safety and Health Program.

NREL, including the NWTC, was issued a certificate of registration initially in 2011, and a continued registration in February 2013 that certifies their Occupational Health and Safety Management System is in compliance with Occupational Health and Safety Assessment Series (OHSAS) Specification 18001:2007, which is an international occupational health and safety management system (Orion Register Inc. 2013). NREL has also issued several policies to manage health and safety, including Integrated Safety Management; Worker Safety and Health; Occupational Health; and Environment, Health, and Safety Risk Assessment. The NWTC maintains a Safe Operating Procedure (SOP) that covers general activities and operations by NWTC field and laboratory workers and provides general guidance in addition to other NWTC-specific SOPs (NREL 2012k).

Safety hazards can often be identified and reduced or eliminated. Accidents occur when a hazard is present together with an exposed (and possibly susceptible) population. The degree of exposure depends primarily on the proximity of the hazard to the population. Activities that can be hazardous include transportation; construction, maintenance, and repair activities; and work in extremely noisy environments. The proper operation, maintenance, and repair of wind turbines, vehicles, and equipment carry important safety implications. Safety hazards associated specifically with the operation of wind turbines include shadow flicker, ice throw, blade throw, and turbine collapse. NREL has formal processes in place, included within the Integrated Safety Management Process, that identify and manage work-related hazards.

Shadow Flicker. As wind turbine blades rotate, alternating changes in light intensity caused by rotating blades cast shadows on the ground and stationary objects below. The flickering shadows can cause an annoyance when they are cast on nearby receptors such as residences, schools, and hospitals. Landscape elements such as terrain, trees, or buildings between the wind turbine and a potential shadow flicker receptor can substantially reduce or eliminate shadow flicker effects. Changes in elevation can either reduce or increase the effects.

Ice Throw. Ice throw, or ice shedding, refers to the situation that can occur when ice accumulates on turbine rotor blades and subsequently breaks free or melts and is thrown to the ground. Falling ice can injure workers or members of the public and cause damage to structures or vehicles below. The rotation of the turbine blades can throw the ice some distance from the wind turbine. Refer to **Section 3.13**, Accident Risk, for more information about ice throw.

Blade Throw. Blade throw occurs when one or more of the turbine blades breaks and is thrown to the ground. The possibility of blade throw is very unlikely; however, it has the potential to injure personnel or the public when the blade is thrown to the ground. Refer to **Section 3.13**, Accident Risk, for more information about blade throw.

Turbine Collapse. Turbine collapse is extremely rare and occurs when a utility-scale turbine folds or collapses, or a small turbine falls or is blown over, causing damage, injury, or death. The fall zone is defined as the circular area (centered at the proposed wind turbine location) with a radius equal to the height of the wind turbine. In the event of a wind turbine collapse, wind turbine towers tend to buckle or bend prior to collapse and, therefore, the fall zone does not necessarily include the full height of the structure (DOE 2011).

3.12.2 EXISTING CONDITIONS

Human health and safety is managed at NREL and the NWTC under applicable federal and state health and safety policies including those identified by the DOE Worker Safety and Health regulation (10 CFR Part 851), OSHA, EPA, and within OHSAS 18001:2007 and the NWTC site-specific SOP for General Activities (Orion Register, Inc. 2013; NREL 2012k). The SOP describes specific requirements for working at heights, hazards from falling or thrown objects, rotating machinery and equipment hazards electrical hazards, hot work hazards, hazardous materials, environmental hazards, personal protection equipment (PPE), general [safety] operation procedures, personnel training, and emergency notification (NREL 2012k).

3.12.2.1 Construction and Contractor Safety

All contractors performing construction activities at the NWTC are responsible for following safety regulations and are required to conduct those activities in a manner that does not pose an undue risk to workers or personnel. The NWTC conducts a site-specific EHS orientation process for all outside workers (such as subcontractors and industrial partners) performing construction, operations and maintenance (O&M) and decommissioning services onsite. Contractor responsibilities include, but are not limited to:

- Preparing and submitting site-specific health & safety (H&S) plans for all wind turbine construction, modification projects, and decommissioning for wind turbine manufacturers, industrial partners and construction contractors who perform work at the NWTC. The site-specific H&S plan must be reviewed and accepted by NREL prior to the start of work (NREL 2013e).

- Developing and submitting written procedures and safety documentation for industrial partners involved in providing O&M activities of wind turbines. The site-specific documentation must be reviewed and accepted by NREL prior to the start of work (NREL 2013e).
- Providing training and worker qualification documentation for a wide variety of H&S elements including electrical safety, lockout/tagout, fall protection, tower climbing and rescue, confined space entry, chemical safety, crane operation, powered industrial truck and aerial lift operations, and wind turbine O&M. This training documentation is reviewed and verified by onsite EHS staff (NREL 2013e).
- Completing a comprehensive, site-specific EHS orientation process and hazard awareness training, including weather hazard awareness. Contractors that are onsite at the NWTC to perform specific operations addressed by the SOP must be briefed in the SOP guidelines and supervised by qualified NREL workers at all times (NREL 2012k; NREL 2013e).
- Providing for NWTC inspection of operating equipment brought onsite to verify condition and the presence of required safety equipment (NREL 2013e).
- Using PPE such as climbing harnesses, shock-absorbing lanyards, connecting devices, shock and arc flash protective wear, and providing for inspection of such equipment by NREL EHS personnel are to verify condition and compliance with NREL and consensus safety standard requirements (NREL 2013e).
- Demonstrating proficiency in climbing or aerial lift operation and obtaining approval from the NWTC EHS POC (NREL 2012k).

In addition to the contractor responsibilities listed above, Safe Work Permits (SWPs) are prepared and issued for all wind turbine construction, modifications, and decommissioning. These permits incorporate the sequence of work, identify the associated EHS hazards, and delineate the engineering controls, work practices and PPE requirements established to achieve and maintain an acceptable level of risk. Specialized SWPs that address energized electrical work, the conduct of hot work, or confined space entry are also prepared and issued to augment the work control package (NREL 2013e).

3.12.2.2 NWTC Personnel Safety

The current workforce at the NWTC is approximately 159 people, and could grow to as many as 300 people. In additional to federal and state safety regulations, NREL procedures govern personnel safety at the NWTC. Safety is also managed by the NWTC SOP, which covers general activities and operations by NWTC field and laboratory workers and requires annual NWTC Hazard Awareness Training for all NWTC personnel with periodic updates and emphasis (NREL 2012k). Processes are also in place for research-based personnel who work at the NWTC. In addition to the NWTC Hazard Awareness Training, NWTC personnel have several annual training courses. There are also numerous policies and procedures that govern all types of routine work performed at the NWTC. These site-wide procedures cover all environmental, health, and safety aspects. Personnel providing onsite work are also required to complete annual NWTC General Activities SOP Training and Designated Area Representative Training.

Weather conditions that may pose a safety risk to personnel include strong, unpredictable winds, resulting in blowing sand, gravel, and other debris. In the winter, ice and snow can cover walkways or form drifts, making it difficult to walk. Onsite, there are no sidewalks along the main road. Therefore, employees walking or biking must be vigilant regarding onsite traffic, especially since drivers may be distracted while looking at turbines or other onsite activities, or from sun glare. Additional weather conditions that play an important role at the NWTC include heat, extreme cold, and lightning. Rules governing working

in these conditions are delineated in the SOP. The NWTC has installed two lightning detection systems to assist in the evaluation of lightning hazards. NWTC personnel are directed to monitor weather conditions or designate another NWTC worker as a weather spotter and to notify them if a weather threat is identified. Additionally, weather hazard awareness safety training is provided to all NWTC personnel and weather tracking system is displayed in the NWTC offices and online for employees (NREL 2012k).

Wind turbines are currently located in Zone 2 and NWTC personnel are familiar with the safety hazards associated with the operation of these turbines. The NWTC conducts a site-specific EHS orientation process for all outside workers and includes classroom instruction for all personnel and contractors working at the NWTC (NREL 2013e). The NWTC manages hazards through the Occupational Health and Safety Management System, SOPs, and compliance with federal and state health and safety regulations. Specific management requirements related to turbines for personnel include:

- Performance of lifting and handling of turbines, towers, or any other heavy components only by qualified workers who have received NREL Hoisting and Rigging training and are approved to do so (NREL 2012k).
- Completion of Fall Protection Training and demonstrated proficiency prior to any climbing or ascending (except when using ladders). This training includes the use of self-rescue abseiling (a controlled descent using ropes and carabiners) systems that enable workers to escape from wind turbines and development of first responder high angle training capabilities (NREL 2012k).
- Development of site-specific SOPs for wind turbine installations to address day-to-day O&M operations once construction and commissioning are completed. The SOPs augment the operating manuals from the manufacturer and address the site-specific EHS issues presented by each turbine. These SOPs must be reviewed and signed by each authorized worker and are updated as necessary to keep pace with any modifications made to the installation (NREL 2013e).

3.12.2.3 Public Safety

The NWTC is fenced around its entire perimeter and the only point of access is the security gate at the northeast corner of the site, allowing access off Route 128. In addition, a security camera and invisible fence system monitors the site perimeter and notifies NREL security of any trespass. NWTC security is managed in accordance with NREL Policy 8-1, Access Control. Visitors to the NWTC must check in at the NWTC Site Entrance Building and provide government-issued photo identification to obtain a security badge before entering the site (NREL 2013e). The public is not allowed on the NWTC without a pass. However, it is impossible to physically barricade all NWTC designated areas and hazard zones, especially field test sites. NWTC personnel are required to be aware of members of the public who purposely or inadvertently enter these areas without authorization or permission, as they are likely to be unfamiliar with hazards and safety requirements and may be at risk of harm or injury (NREL 2012k).

Annual NWTC Hazard Awareness Training identifies NWTC-specific visitor and tour hosting requirements. NWTC personnel must ensure their visitors follow all requirements specified in this SOP and any other relevant SOPs and SWPs. An abbreviated hazard awareness training version is also provided to visitors (NREL 2012k).

There are several medical facilities within five miles of the NWTC, which include the Avista Adventist Hospital, Centennial Peaks Hospital, and Rocky Mountain Urgent Care. In the event of a crime or other requirement for assistance at the NWTC, onsite security personnel would respond. When offsite support is required, the Jefferson County Sheriff would be contacted. The onsite fire protection system consists of

three 25,000-gallon insulated tanks, a 1,000-gallon-per-minute pump, a small pressurizing jockey pump, an emergency diesel generator, an underground water distribution pipeline, and fire hydrants. The underground pipeline extends around all buildings in a loop and fire hydrants are spaced along the main NWTC road (DOE 2002).

The NWTC is subject to wildland fire due to the presence of dry, native vegetation and high winds. Wildland fires can be started by lightning, improper handling or disposal of smoking materials, or by the careless conduct of hot work (NREL 2012k). To protect the NWTC from wildfire, NREL applies its Fire Protection Procedure to the site, which calls out NREL-wide requirements for establishing and maintaining defensible space around all buildings, along roadways, and around wind turbines, meteorological towers, yard switchgear, and similar installations. These requirements exceed National Fire Protection Association recommendations and are implemented at the NWTC to mitigate the risk of damage caused by wildfire. NREL and the Colorado State Forest Service conduct periodic wildfire assessments to assess the hazards from wildfires and to determine if appropriate controls have been established to control potential hazards of a wildfire occurring at the NWTC and affecting surrounding lands. The NWTC would conduct operations in a manner that would minimize the occurrence of wildland fire (NREL 2012k).

In the event of a fire at the NWTC or on adjacent lands, Rocky Mountain Fire is under contract to provide Fire and Emergency Services to the NWTC. Specific services provided by Rocky Mountain Fire include fire, emergency medical, confined space, and high angle rescue services. In the event of an onsite injury, illness or other situation requiring an ambulance, District personnel and equipment would be dispatched to the site (DOE 2002).

3.12.3 ENVIRONMENTAL CONSEQUENCES

3.12.3.1 Evaluation Criteria

If implementation of the Proposed Action were to increase risks associated with the safety of construction personnel, contractors, NWTC personnel, or the local community, or hinder the ability to respond to an emergency, it would represent an adverse impact. Impacts were assessed based on the potential impacts of construction and operational activities.

3.12.3.2 Proposed Action

Increasing and Enhancing Research and Support Capabilities (Zone 1 and Zone 2)

Construction and Contractor Safety. All contractors performing construction activities are responsible for following ground safety and federal OSHA regulations, and are required to conduct construction activities in a manner that does not increase risk to workers or the public. Occupational health and safety is the responsibility of each contractor, as applicable. Contractor responsibilities and requirements would be the same as they currently are at the NWTC as described in **Section 3.12.2**. In summary, short-term impacts on construction and contractor safety would be negligible during facility construction and modification and upgrades to infrastructure and utilities under the Proposed Action.

NWTC Personnel Safety. Implementing the Proposed Action would slightly increase the short-term risk to NWTC personnel during construction activities. Signs would be used to warn NWTC personnel when entering construction areas and to warn personnel about potential hazardous working conditions. Once construction activities have ceased, no impacts on personnel safety would be expected.

The unpaved NWTC site roads that provide access to the turbine field test sites located in Zone 2 and other research facilities are currently gravel or reclaimed asphalt and present a hazard during high wind events. Under the Proposed Action, these roads would be paved and would include selectively reinforcing problem areas with a geogrid and 10 to 15 inches of recycled asphalt. By paving these roads, the hazards associated with blowing gravel would be reduced in this area.

In summary, short-term, negligible impacts on personnel safety would be expected due to facility construction and modification and from infrastructure and utilities upgrades related to increasing and enhancing research and support capabilities under the Proposed Action. Long-term minor beneficial impacts on personnel safety would be expected as a result of onsite road improvements and upgrades that would maintain safety as well as develop suitable capabilities for R&D and industry support. Additionally, long-term minor to moderate beneficial impacts to personnel safety would be expected due to the construction and installation of a 200,000-gallon water storage tank to provide adequate water supply and water pressure for fire suppression under the Proposed Action.

Public Safety. During construction, members of the public and visitors would continue to be required to access the site with a badge through the site entrance gate. Constructing and modifying facilities associated with increasing and enhancing research and support capabilities in Zones 1 and 2 would slightly increase demand for police, fire, and ambulance services, but these would be considered negligible indirect impacts given site use and anticipated needs for emergency service providers. The capacity of onsite and local infrastructure and local service would not be disrupted by the proposed improvements.

In summary, no impacts are expected on public safety related to public access to the site during facility construction and upgrade. Additionally, long-term minor to moderate beneficial impacts to public safety would be expected due to the construction and installation of a 200,000-gallon water storage tank to provide adequate water supply and water pressure for fire suppression for improved property protection of DOE assets under the Proposed Action.

Increasing Site Use and Density (Zone 2)

Under the Proposed Action, the construction and operation of wind turbines would occur in Zone 2, where existing turbines are currently located and operated. The density of wind turbines at the site would increase, which would increase the hazards specifically related to wind turbine operation, including shadow flicker, blade and ice throw, and turbine collapse. Because turbines would be constructed and designed to ensure structural safety under the specific conditions at the proposed site, the risk of blade throw or turbine collapse is expected to be low. Because temperatures at the NWTC fall below freezing during many months of the year, ice throw and ice shedding are potential hazards. The risk of ice or snow being thrown from turbine blades would increase with the increased number of turbines present onsite. However, the NWTC site-specific SOP specifically addresses hazards from falling or thrown objects. The NWTC also sites new and re-started turbines in compliance with the Turbine Operational Safety Strategy (TOSS) provided in its site-specific SOP. The TOSS objective is to ensure that a turbine is operated in a safe way to obtain needed results, while simultaneously anticipating and accepting the risk of turbine failure. Turbines are currently operated in Zone 2 in compliance with TOSS, in addition to other DOE regulations and NREL safety and management systems. The new turbines would be located within the zone onsite where turbines are currently located, and hazards related to turbine operation would not be introduced to other zones of the NWTC.

Construction and Contractor Safety. All contractors performing construction activities are responsible for following safety and OSHA regulations, and are required to conduct construction activities in a manner that does not increase risk to workers or the public. Occupational health and safety is the

responsibility of each contractor, as applicable. Contractor responsibilities also include review of potential physical hazards specifically related to construction and operation of wind turbines, including turbine collapse and ice throw, to ensure that personnel are properly protected. Contractors would be responsible for following a H&S Plan that addresses issues related to construction of the project elements, such as confined space entry, hoisting and rigging operations, and proper handling and disposal of hazardous substances. Contractor responsibilities and requirements would be the same as they currently are at the NWTC as described in **Section 3.12.2**, and include preparing and submitting site-specific H&S plans for all wind turbine construction or modification projects and preparing and submitting SWPs.

In summary, short-term, negligible impacts on construction and contractor safety would be expected from constructing and operating additional wind turbines, meteorological towers, and associated infrastructure at existing and new field test sites under the Proposed Action.

NWTC Personnel Safety. Implementing the Proposed Action would slightly increase the short-term risk to NWTC personnel during construction activities. Signs would be used to warn NWTC personnel when entering construction areas and to warn personnel about potential hazardous working conditions. Once construction activities have ceased, the increased density of wind turbines onsite would result in a slight increase in risk to NWTC personnel. NREL would develop site-specific SOPs for the wind turbine installations to address day-to-day O&M operations once construction and commissioning are completed in accordance with NWTC safety operation procedures. With the safety procedures described in **Section 3.12.2** and the NWTC SOP, no adverse impacts on personnel safety would be expected. As stated previously, no new hazards are expected from the operation of wind turbines because turbines are currently operated and managed within Zone 2.

Public Safety. During construction, members of the public and visitors would continue to be required to access the site with a badge through the site entrance gate. Constructing and operating additional wind turbines, meteorological towers, and associated infrastructure at existing and new field test sites in Zone 2 would incrementally increase demand for police, fire, and ambulance services in the event of an accident, but the increases would be considered negligible indirect impacts, given site use and anticipated needs for emergency service providers. Additionally, increasing site density of turbines would slightly increase the risk of wildfire on the site; the NREL Fire Protection Program currently addresses risks of wildfire. No direct impacts on public safety are expected due to the site security measures that restrict public access to the site. Because additional turbines would be located in Zone 2 where the NWTC currently operates turbines, no additional impacts on public safety associated with turbine operation would be expected.

Expanding Power Capacity

Construction and Contractor Safety. All contractors performing construction activities are responsible for following ground safety and federal OSHA regulations, and are required to conduct construction activities in a manner that does not increase risk to workers or the public. Occupational health and safety is the responsibility of each contractor, as applicable. Contractor responsibilities and requirements would be the same as they currently are at the NWTC, as described in **Section 3.12.2**. Additionally, electrical work performed at the NWTC by contractors or site personnel is subject to a safety assessment specifically described in the NWTC SOP (NREL 2012k). Short-term impacts on construction and contractor safety would be negligible during installation of the onsite substation and transmission line interconnect under any of the onsite transmission line options in Zone 3.

NWTC Personnel Safety. Because substation and transmission line construction is proposed along the western border of the NWTC, it is unlikely that NWTC personnel would be exposed to any hazards during construction. Signs would be used to warn NWTC personnel when entering construction areas and to warn personnel about potential hazardous working conditions. Once construction activities have

ceased, no adverse impacts on personnel safety would be expected because signs and fences would be also used to warn NWTC personnel when entering the substation fenced area. Additionally, electrical work performed at the NWTC by contractors or site personnel is subject to a safety assessment specifically described in the NWTC SOP (NREL 2012l). In summary, short-term, negligible impacts on personnel safety would be expected due to the construction of an onsite substation and transmission interconnect under any of the onsite transmission line options in Zone 3.

Public Safety. No direct impacts on public safety are expected due to the site security measures that restrict public access to the site. Construction of an onsite substation and transmission line under any of the options would slightly increase demand for police, fire, and ambulance services, but these would be considered negligible indirect impacts given site use and anticipated needs for emergency service providers. The capacity of onsite and local infrastructure and local service would not be disrupted by the proposed improvements.

3.12.3.3 No Action Alternative

Under the No Action Alternative, NREL would not increase and enhance research and support capabilities in Zone 1 and 2, increase site use and density in Zone 2, or expand power capacity. Short-term, minor adverse impacts to workers during construction and long-term minor adverse impacts to workers and the public would not occur. However, gravel roads would not be paved and the fire suppression system would not be upgraded at the site, and a new 200,000-gallon water storage tank would not be installed to provide water supply for fighting fires. Therefore, the No Action Alternative would result in long-term, negligible, adverse impacts on personnel at the NWTC associated with the lack of infrastructure to maintain personnel safety.

3.13 Accident Risk

NWTC operations under the Proposed Action or the No Action Alternative would require attention to safety due to site conditions, research activities, construction activities, frequent extreme weather conditions, the materials to be stored and processed at the facility, and a number of activities to be performed that involve some level of risk to workers. The goal of this analysis is to identify the bounding event(s) relating to life safety and property protection for current and proposed activities and facilities at the NWTC. Once established, these bounding events would represent the upper boundary of risk that would be presented by activities proposed for the facility.

Installing, operating, and maintaining energy systems facilities and equipment such as those at the NWTC includes activities with inherent risks. Many of the risks are common to numerous industrial activities and are not unique to wind turbines or other systems operated at the NWTC. These activities include, but are not limited to operating heavy equipment (excavators, forklifts, specialized transport vehicles, and similar equipment); hoisting and rigging using cranes or other equipment; working with medium voltage electrical systems (for example, 13.2 kV) including switching, installation and removal of test articles, and troubleshooting with electrical test equipment; electrical equipment maintenance; hot work (such as welding, brazing, and cutting); using hand and power tools, including hydraulic torque tools; working at heights using fall arrest or fall protection systems; and general work under varying environmental conditions. Industrial activities are generally well understood and can be performed safely through systematic work controls, training, standard operating procedures, and other common worker health and safety practices. Industrial and construction activities are subject to the requirements of OSHA's Occupational Safety and Health Standards (29 CFR Part 1910) and Safety and Health Regulations for Construction (29 CFR Part 1926). In addition, NREL develops and maintains site-specific procedures for various activities, including fall protection, hoisting and rigging, lockout/tagout, safe work permits, electrical safety, confined space entry, and other hazardous activities.

Safety and accident concerns surrounding the Proposed Action relate primarily to operation of wind turbines and energy storage or conversion systems, including the Wind2H2 demonstration project, part of the DERTF, and grid storage test equipment such as batteries and flywheels (and associated electrical and mechanical equipment) located at grid storage test pad areas within Zone 2.

The safety staff at NREL would apply their Hazard Identification and Control Procedure (NREL 2006) throughout the design/build process for new and expanded facilities to ensure that the safety features incorporated into the facilities would provide adequate protection to workers and the general public during facility construction and operations. In accordance with the Hazard Identification and Control Procedure, a Readiness Verification is conducted for purposes of confirming that the hierarchy of controls identified for an activity is functional and effective. This process officially culminates with Authorization to Operate. Moreover, Golden Field Office would provide independent oversight and verification reviews to ensure that NREL-NWTC has met its commitments to identify, mitigate, and manage risk to an acceptable level.

The basis for the preliminary bounding events analysis is the risk matrix contained in Appendix A of the NREL Hazard Identification and Control Procedure (NREL 2006). The risk matrix is shown in **Table 3-27**.

Table 3-27. Risk Assessment Matrix

Failure	Failure Frequency (per year)	Failure Consequence Severity			
		Catastrophic	Critical	Marginal	Negligible
Frequent	>1	High Risk	High Risk	Moderate Risk	Routine Risk
Reasonably probable	1 to 0.1	High Risk	High Risk	Moderate Risk	Routine Risk
Occasional	$0.1 – 10^{-2}$	High Risk	Moderate Risk	Low Risk	Routine Risk
Remote	$10^{-2} – 10^{-4}$	Moderate Risk	Low Risk	Low Risk	Routine Risk
Extremely remote	$10^{-4} – 10^{-6}$	Low Risk	Low Risk	Routine Risk	Routine Risk
Impossible	$< 10^{-6}$	Routine Risk	Routine Risk	Routine Risk	Routine Risk

Source: Appendix A of NREL Procedure No. 6-6.2, Hazard Identification and Control, 06/30/2006.

Even though it is not possible to identify all possible events, the goal of this analysis is to consider many classes of events—for example, equipment failures, process upsets, and procedural errors as they are currently understood and to identify the representative and bounding events for the facility under the Proposed Action and the No Action Alternative.

The following potential events have been considered as representative hazards that may be beyond the normal range of industrial activities and would likely encompass the bounding accident scenario for the NWTC:

- Wind turbine failure including the partial or complete loss of one or more turbine blades through manufacturing defects, off-normal situations such as over-speed operation, or extreme weather conditions. This event is considered bounding for the similar event of complete turbine tower collapse, because tower collapse would likely affect a smaller potential hazard area (within a radius of the tower height plus the blade length) but would have similar effects as blade throw events.

- Ice throw from turbine blades during cold weather / icing conditions.
- Accidents involving utility-scale energy storage system testing, including
  - battery energy storage systems
  - flywheel energy storage (FES) systems
- Loss of integrity of hydrogen containment equipment associated with the Wind2H2 demonstration project and the use of compressed hydrogen for energy storage/conversion and hydrogen-powered vehicle fueling.

Each of the potential events evaluated are possible under current operating conditions, and would be possible under each component of the Proposed Action.

The potential events are therefore not discussed separately with regard to the three components of the Proposed Action.

3.13.1 WIND TURBINE BLADE FAILURE

In the literature, documented wind turbine blade failures have included complete blade failures, in which an entire rotor blade separates from its hub, partial failures in which some portion of the blade is damaged and separates from the blade structure, and buckling of blades without detachment from the hub. The trajectory of detached blades and blade pieces has been modeled, but detailed data from actual blade failures have been difficult to obtain (Larwood and van Dam 2006). Based on reported data and studies from California and Europe, some general conclusions can be drawn concerning failure frequency for turbine blades and throw distances:

- The probability of rotor failure is likely in the range of 1 in 1,000 (1×10^{-3}) per turbine per year, and is likely to continue to decrease as manufacturing techniques improve, operational requirements become better understood, and safety protocols evolve.
- The range of the throw for failed blades or parts is highly dependent on the release velocity, which is a function of the turbine blade tip speed; the tip speed of wind turbines does not tend to increase with turbine size.
- Based on European data, the maximum whole-blade throw distance is limited to 150 meters (492 feet) from the tower, while maximum throw distances for blade tips or pieces of blades can extend to 500 meters (1,640 feet) from the tower. The risk of impact from thrown blades and pieces is highest beneath the rotors, and decreases outward with a slight increase at the maximum throw distance. Failure resulting in throw of blade tips or pieces has a somewhat lower probability than whole-blade failure.

Modeling results suggest that for a three-bladed 2 MW turbine that fails at twice the rated rotor speed, the whole-blade throwback distance is 150 meters (492 feet) and the risk of a fatal impact from such a failed rotor blade at that distance is one in one million (1×10^{-6}) per year for an individual permanently located at the site without protection (Kammen 2003). The Proposed Action would include installing small-scale, mid-scale, and utility-scale wind turbines with a maximum rotor diameter of 150 meters (492 feet) and maximum rotor height of 175 meters (574 feet). Currently, utility-scale turbines at the NWTC are no closer than 875 feet to an existing building (Building 251). Risk to workers inside Building 251 is therefore estimated at less than one in one million (1×10^{-6}), even assuming that the building affords no protection to the workers inside.

A small-scale turbine is currently located at Building 101, approximately 130 feet from Hwy 128. For a smaller turbine (up to one MW), the risk to an individual permanently located at the highway adjacent to Building 101 (not accounting for motion of a vehicle) is estimated at less than 1 in 100,000 (1×10^{-5}) per year (Kammen 2003). The risk to motorists passing that location would be much lower because very limited time would be spent at or within the maximum throw radius, and most vehicles would provide some protection from impacts.

Workers performing tasks on the ground in the immediate vicinity of wind turbines could be exposed to individual risk somewhat higher than one in one million (1×10^{-6}) per year. The risk is minor and hazard zone access is carefully controlled to minimize the risk to human health.

3.13.2 WIND TURBINE BLADE ICE THROW AND ICE SHEDDING

Ice buildup on wind turbines and blades is highly dependent on local weather conditions (such as freezing temperatures combined with high relative humidity, freezing rain, or sleet) and the turbine's operational state (GE Energy 2006). Subsequently, weather conditions can then cause this ice to be shed from the turbine as a result of either gravity or the mechanical forces of the rotating blades. Ice can also build up on meteorological tower guy wires, and fall to the ground as a result of gravity. Most ice shedding occurs as air temperatures rise and ice on the rotor blades begins to thaw. While limited information is available, evidence suggests that ice fragments tend to drop off the rotor and land near the base of the turbine, rather than being thrown off. However ice can potentially be "thrown" when ice begins to melt and stationary turbine blades begin to rotate again. In addition, ice fragments tend to shed more from the blade tip, with larger pieces of ice debris tending to fragment in flight (AWEA 2008). While more than 90,000 wind turbines have been installed worldwide, there has been no reported injury caused by ice thrown from a turbine (Tetra Tech 2007). However, ice shedding remains a potential safety concern.

Turbine operators aware of ice-forming weather may manually cease turbine operation. There are several scenarios that could lead to automatic turbine shutdown during icing conditions, including detection of ice by a nacelle-mounted ice sensor on some turbines, detection of rotor imbalance caused by blade ice formation that is detected by a shaft vibration sensor, and anemometer icing that leads to a measured wind speed below the minimum speed for turbine operation.

The NWTC General Activities Standard Operating Procedure 0141 includes a TOSS that has been developed and implemented to minimize exposure to turbine operational hazards, including blade failure and ice throw. The TOSS delineates a hazard zone encompassing at least a 100-foot (30.5 meter) radius or one rotor diameter from the turbine base, whichever is greater. Hazard zone access is carefully controlled to minimize the risk to human health.

3.13.3 UTILITY-SCALE ENERGY STORAGE

Battery Banks. Large energy storage devices currently consist of metal containers with battery banks and controls. A typical container is 8 feet (2.4 meter) wide by 40 feet (12 meter) long and weighs 100,000 to 500,000 pounds. Several types of batteries are commonly deployed as grid-scale energy storage systems, either in research settings or utility installations, including but not limited to sodium sulfur, lithium-ion, and lead-acid (NETL 2009; Innovation Toronto 2012). Most or all of these battery types present the possibility of fire or other hazards associated with thermal runaway.

All battery bank energy storage containers are and would be located remotely from other NWTC facilities. All such systems would include electrical controls and thermal management systems to minimize the risk of accidents.

The most likely accident scenario involves a fire within a battery container caused by overheating of one or more batteries. The annual probability of fire or other hazards caused by battery overheating is not known. Media reports of such events are not uncommon, but the frequency is generally low for grid-scale installations, and is likely very low over the period considered for this EA (five years). At the NWTC, battery containers would be located outdoors in the grid storage test pad areas, which are not in close proximity to other facilities. Under most conditions, involved workers would not be performing activities in close proximity to batteries, and the probability of thermal runaway events occurring while involved workers were nearby is very low on an annual basis. The relatively remote location of battery containers would make the likelihood of accidents affecting involved or noninvolved workers or the public very low.

Flywheels. FES systems may be installed at the NWTC for testing purposes. Typical installations of FES systems include large cylindrical carbon-fiber flywheels approximately seven feet (2.1 meter) tall and weighing several thousand pounds each. These flywheels are typically suspended vertically in evacuated (air-free) underground chambers and spin at over 15,000 rotations per minute.

A potential failure scenario for such FES systems is illustrated by the independent failure on separate occasions in 2011 of two flywheels at the Beacon Power Flywheel Energy Storage Plant in Stephentown, NY (Times Union 2011). The flywheels failed when they spun out of balance, tilting and touching the sides of the underground chambers, resulting in excess heat generation and damage to the flywheels. Sensors detected the resulting elevated temperatures and activated a water cooling system, which created steam and increased pressure within the chambers. The top covers of the chambers were blown off in an explosive manner, but were not propelled beyond the flywheel chambers. There were no injuries and no other damage to the facility, although carbon fiber dust was expelled from the chambers and deposited on the ground in the immediate area.

At the NWTC, flywheels would be installed below ground in an area remote from other NWTC facilities, and would be designed and installed with appropriate physical constraints and administrative controls to minimize the risk to workers. NREL SOP-0141 applies to routine operation and maintenance of FES systems, including Sections 2.1c, Rotating Machinery and Equipment Hazards, and 2.1d, Electrical Hazards (NREL 2012k). The nature of FES systems would require development of procedures specifically for the safe routine operation, monitoring, and maintenance of flywheel equipment. Because FES systems typically are operated and monitored remotely, worker time in close proximity to the flywheels is likely to be minimal. Therefore, the likelihood of accidents resulting in injury to workers or the public is judged to be very low.

3.13.4 HYDROGEN GENERATION AND STORAGE

Operation of the Wind2H2 facility involves the use of electrical energy (from the electrical grid, wind turbines, or photovoltaic arrays) to split water into oxygen and hydrogen via electrolysis. The facility includes equipment for generation, storage, and use of hydrogen. The test facility currently (and under the No Action Alternative) includes two banks of hydrogen storage tanks with maximum operating pressures of 3,500 and 6,000 pounds per square inch (psi). The total current volume of hydrogen storage capacity is 230.5 cubic feet. At 3,500 psi and 86°F (30°C), the total holding capacity of hydrogen is 255 pounds, which is equal to 51 pounds in each of five 3,500 psi tanks (NREL 2009b).

NREL has evaluated hazards associated with hydrogen storage in the Final Site-Wide EA for the South Table Mountain Site, Final Supplement-II (DOE 2009). In that evaluation, several event scenarios were identified and evaluated for their potential risk both with and without safety features installed. Available knowledge of hydrogen hazards includes the extensive National Aeronautics and Space Administration (NASA) experience handling large quantities of gaseous hydrogen at high pressures. Metals fabrication facilities also use large quantities of hydrogen, as does the petroleum refining industry. Overall, there

have been many years of safe operation, as well as some spectacular failures. The Wind2H2 facility at the NWTC is currently operating under an approved SOP (NREL 2012l). Before operations began, the facility was subject to an extensive Readiness Verification to verify that all system components were installed according to the design, met the required pressure ratings, and were approved for hydrogen service, and to verify that all safety systems were functional.

The hazards of handling hydrogen stem from its large flammability range—4 percent to 75 percent (Lees 2006)—and its very low spark ignition energy—0.019 millijoules (Lees 2006). The Fire Protection Handbook (Cote 1986) states: "Although its wide flammability range and high burning rate accentuate these hazards, its low ignition energy, low heat of combustion on a volume basis and its nonluminous (low thermal radiation level) flame exert counteracting influences in many instances." The handbook further states:

> Because of its low ignition energy, when gaseous hydrogen is released at high pressure, normally small heat producing sources, such as friction and static generation, often result in prompt ignitions. Accordingly, hydrogen is often thought of as self-igniting under these circumstances. A record of releases at high pressure reveals that fires rather than combustion explosions occur. When hydrogen is released at low pressure, self-ignition is unlikely and combustion explosions occur which are often characterized by very rapid pressure rises which are extremely difficult to vent effectively. Open air or space explosions or deflagrations have occurred from large releases of gaseous hydrogen.

Because of its broad flammable range, if there is a leak of hydrogen in any area where hydrogen can accumulate, from a safety perspective, it should be assumed that there would be a location where the hydrogen concentration is within the flammability range and that a spark source of sufficient energy to ignite the hydrogen would also be present. Safe design standards would take into account the rapid dissipation of released hydrogen. Specifically, the design must ensure that (1) released hydrogen cannot rise into an enclosed area, and (2) vent pipes designed to remove any hydrogen are not venting a flammable mixture of hydrogen and air. For the Wind2H2 process at the DERTF, all high pressure hydrogen storage is located outdoors where a release cannot accumulate in a confined space. Within the Hydrogen Production Building, an in-depth defensive approach has been employed, as follows:

- If all available hydrogen present inside the building was suddenly released in its entirety, the accumulated hydrogen would not surpass the lower flammable limit.

- Electrical wiring within the facility is appropriate for Class I Division 2 locations, meaning it should not pose an ignition source in this location where flammable gases are present.

- There is an exhaust fan that operates continuously and is equipped with a differential pressure switch that is interlocked with the production system. If the fan would not operate or fails, the system will not start or continue to operate.

- There is combustible gas detection equipment in the room that is set to trigger at 10% of the lower flammability limit. If this occurs, the system shuts down automatically.

- There are ultraviolet/infrared cameras that have been installed that will detect the presence of a hydrogen flame and are programmed to automatically shut down the system if a flame is detected.

It has been shown experimentally and theoretically that the flame front produced in an unconfined three-dimensional flammable gas cloud would not accelerate and produce a much more damaging explosive shock wave. That is not the case if the plume is confined in one or two of the three dimensions. Numerous detailed accident investigations have concluded that the damage resulting from partially confined plumes

is much greater than would be expected for an unconfined vapor cloud deflagration. Similarly, if the flammable mixture is in a pipe of sufficient diameter (typically one inch or greater) and ignition occurs, the flame front rapidly accelerates; after about 10 pipe diameters, the flame front would reach sonic velocity and the resultant shock wave would split the pipe open.

Regarding the storage of hydrogen at high pressures, the failure of a vessel is judged to be in the impossible range using the NREL risk matrix. A NASA-authored report discussing catastrophic storage vessel failure states: "Although there is a very low probability for catastrophic occurrence, selecting a site that would minimize the effects of such an event is prudent" (NASA 2004). The analysis then assumes a catastrophic failure of the pressure vessel and establishes a safe distance to the nearest building from the storage location. The basis for the distance comes from a modeling of the release plume. The objective is to place the storage location far enough away from any adjacent structure such that the release plume would be unconfined should it be ignited. National Fire Protection Association standards for hydrogen handling incorporate these distances.

High-pressure hydrogen is stored at Wind2H2 in outdoor tube racks consisting of a number of cylinders (currently five), each about 20 feet (6 meter) long and 2 feet (0.6 meter) in diameter. Each cylinder is protected by a pressure relief valve, and each bank of cylinders is protected by a fail-safe isolation valve. Failure of a hydrogen storage cylinder is not anticipated. If a cylinder did fail, it would not be expected to cause an adjacent pressure cylinder to fail because such vessels are often made of ductile metals.

Under the failure scenario, one of the pressure cylinders fails and generates a large gas cloud. While such failures are rare, those that have occurred are often the result of hydrogen embrittlement in an area sensitized following welding. Accumulation of combustibles, trash, or a fuel spill around the pressure cylinders could also result in cylinder failures if a fire occurred. The 20 foot-long storage vessels are long enough to make it possible for a fire to overheat one end of a vessel; if the rupture disk is at the other end, the vessel could fail catastrophically before it vented to the atmosphere. Even in this case, although several vessels might be close to failing, it is not expected that they would fail simultaneously. The maximum quantity in one vessel, about 50 pounds, limits the energy that would be released should one or more of the storage vessels fail.

Another hydrogen hazard that must be considered is the quantity of hydrogen that could be released should a high-pressure hydrogen pipe be damaged and fail. The system would be provided with a quick-acting isolation valve that would isolate the hydrogen in the line from the storage vessels when the pressure in the piping drops rapidly. Often, the volume of hydrogen that exits the system before shutdown is initiated and the volume that exits after shutdown is great enough to cause all or a large portion of the atmosphere in a laboratory room to exceed the lower flammability limit for hydrogen in just a few seconds. An ignition source, if present, would ignite the gas cloud, and because the cloud is confined, the pressure in the room would rapidly rise. If the whole room were in the flammable range at the time of ignition, the pressure would breach the walls and potentially damage adjacent laboratories. As previously discussed, if the vented hydrogen accumulates in a pipe and the flammable mixture ignites, an even more damaging detonation could occur.

There are other properties of hydrogen that present some hazards. Explosions have occurred within a pressure cylinder if air is not purged from the cylinder before hydrogen is added. Static electricity could ignite the hydrogen concentration if within the flammability range. The flame front formed would accelerate down the cylinder and detonate. Such a detonation could be violent enough to cause the remaining cylinders to fail.

Another hazard of hydrogen is associated with its interaction with the pressure cylinder. If the hydrogen is extremely pure, which might be the case with hydrogen generated onsite, the pressure vessel would be more susceptible to hydrogen embrittlement.

General Controls used for Hydrogen. The following industry-recognized safety controls and design considerations have been employed by NREL in designing, building, and operating the current Wind2H2 facility:

- Providing adequate ventilation, as well as designing and operating hydrogen systems to prevent leakage, and eliminating potential ignition sources
- Installing barriers or safeguards to minimize risks and control failures
- Installing safety systems to detect and counteract or control the possible effects of such hazards as vessel failures, leaks and spills, embrittlement, collisions during transportation, ignitions, fires and explosions, cloud dispersions, and the exposure of personnel to flame temperatures
- Maintaining a safe interface under normal and emergency conditions so at least two failures occur before hazardous events could lead to personal injury, loss of life, or equipment or property damage
- Installing warning systems to detect abnormal conditions, measure malfunctions, and indicate incipient failures.
- Providing warning system data transmissions with visible and audible signals that have sufficient redundancy to prevent any single-point failure from disabling the warning system
- Installing safety valves and flow regulation that would adequately respond to and protect personnel and equipment during hydrogen storage, handling, and use
- Using automated control systems with caution and warning feedback inputs. Also, constraining manual controls within the systems by using automatic limiting devices to prevent over-ranging
- Applying a system of verifications of equipment, power, and other system services for safe performance in the design and normal operational regimes
- Applying “fail-safe” system design, meaning that any single point failure from which potentially hazardous conditions are a risk must cause the system to revert to conditions that would be safest for personnel and with the lowest property damage potential
- Applying redundant safety features to prevent a hazardous condition when a component fails
- Subjecting all plans, designs, and operations associated with hydrogen use to an independent safety review. Safety reviews should be conducted on effects of fluid properties, training, escape and rescue, fire detection, and firefighting
- Establishing operating procedures for normal and emergency conditions and reviewing these procedures as appropriate
- Performing hazards analyses to identify conditions that may cause injury, death, or property damage
- Assuring continuous improvement of systems through reporting, investigating, and documenting the occurrences, causes, and corrective actions required for mishaps, incidents, test failures, and mission failures in accordance with standardized procedures

All of these safety controls and precepts are currently used at NREL, and NREL's Integrated Safety Management System provides a rigorous administrative structure and requires resources to ensure that these safety precepts are successfully applied to the NWTC.

NREL uses SOPs in conjunction with other administrative and engineering controls to protect workers from these hazards. Potential hazards associated with activities at the Wind2H2 facility are described in NREL SOP-0766, "Safe Operating Procedure for Xcel/NREL Wind to Hydrogen Test Facility" (NREL 2012l).

The Wind2H2 system was designed, built, and verified to meet the National Electric Code, Articles 500 and 501 (NREL 2009b). The safety features incorporated into the system include emergency stops, hydrogen and fire detection, and alarm systems. Specific design safety features include (NREL 2012l):

- All bulk hydrogen storage is located outdoors so that any release from the tanks would not accumulate.
- Within the Hydrogen Production Building, the sudden release of all available hydrogen within the building would not result in reaching the lower flammability limit of hydrogen in the building.
- Electrical wiring within the facility is rated (Class I, Division 2) for potential flammable environments.
- An exhaust fan operates continuously, and is interlocked such that if the fan fails the production system will not operate.
- Combustible gas detectors will initiate automatic shutdown of the system and activate alarms if they detect 10 percent of the lower flammability limit of hydrogen in air.
- Ultraviolet/infrared cameras inside the facility will detect the presence of a hydrogen flame and automatically shut down the production system.

The facility is designed and installed with redundant safety components, blast panels, and fail-safe isolation valves at hydrogen storage tanks (NREL 2012l)

The bounding accident scenario at the Wind2H2 facility would be a release of a substantial volume of hydrogen gas from the storage tanks or piping and subsequent fire or explosion. This accident could occur as a result of failure of a pressure vessel (hydrogen storage tank) or piping under either the Proposed Action or the No Action Alternative. A number of event scenarios involving hydrogen releases were evaluated for the South Table Mountain site (DOE 2009). The scenarios evaluated there are similar to those that may be reasonably expected at the Wind2H2 facility. When evaluated without safety features, it was estimated that the likelihood of occurrence for these scenarios ranged from remote to frequent, and the severity of consequences were generally catastrophic or critical. The application of safety features as preventive, protective, or mitigation measures reduced the likelihood of occurrence to a range from impossible to occasional, and reduced the severity of consequences to a range from negligible to marginal in most cases.

Preventive, protective, and mitigative safety features effectively lower the risk profile for the hydrogen generation and storage at the NWTC. In the absence of safety features, many event scenarios are high-risk (high frequencies with severe consequences). With safety features in place, none of the scenarios are high-risk.

3.14 Socioeconomics and Environmental Justice

3.14.1 DEFINITION OF THE RESOURCE

3.14.1.1 Socioeconomics

Socioeconomics is the relationship between economics and social elements such as population levels and economic activity. There are several factors that can be used as indicators of economic conditions for a geographic area, such as demographics, median household income, unemployment rates, percentage of families living below the poverty level, employment, and housing data. Data on unemployment identify gross numbers of employees, employment by industry or trade, and unemployment trends. Data on industrial, commercial, and other sectors of the economy provide baseline information about the economic health of a region.

3.14.1.2 Environmental Justice

EO 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," pertains to environmental justice issues and relates to various socioeconomic groups and the disproportionate impacts that could be imposed on them. This executive order requires that federal agencies' actions substantially affecting human health or the environment do not exclude persons, deny persons benefits, or subject persons to discrimination because of their race, color, or national origin. The executive order was issued to ensure fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Environmental justice concerns include race, ethnicity, and the poverty status of populations in the vicinity of the Proposed Action.

3.14.1.3 Children's Environmental Health and Safety Risks

EO 13045, "Protection of Children from Environmental Health Risks and Safety Risks," states that each federal agency "(a) shall make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children; and (b) shall ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks."

3.14.2 EXISTING CONDITIONS

To provide a baseline measurement for socioeconomics and environmental justice, an area around the site of a Proposed Action must be established to examine the impacts on human environment, including minority and low-income populations. For the purpose of this analysis, the region of influence for activities occurring at the NWTC site in Golden, Colorado, consists of the Denver-Aurora-Boulder Combined Statistical Area (CSA) in Jefferson County, Colorado, because this is where most of the impacts are likely to occur. The State of Colorado and the United States serve as the respective baseline.

3.14.2.1 Demographics

The Denver-Aurora-Boulder CSA is defined by the U.S. Census Bureau as a CSA composed of three Metropolitan Statistical Areas (MSAs): the Denver-Aurora-Lakewood MSA, the Boulder MSA, and the Greeley MSA. The population of the Denver-Aurora-Boulder CSA was estimated to be 3,090,874 in the 2010 Census (USCB 2010a). The data from the 2000 Census for the MSAs that comprise the recently formed Denver-Aurora-Boulder CSA were combined in order to conduct this analysis.

The State of Colorado's population totaled 5,029,196 in 2010. The population of the Denver-Aurora-Boulder CSA was 3,090,874 in 2010, representing 61 percent of the total population for the State of Colorado. Based on 2000 and 2010 U.S. Census data, the population growth rate in the Denver-Aurora-Boulder CSA from 2000 to 2010 (15.8 percent) was slightly less than the growth rate of the State of Colorado (16.9 percent) but much greater than the growth rate of the United States (9.7 percent) over the same time period. See **Table 3-28** for 2000 and 2010 population data (USCB 2001, 2010a).

Table 3-28. 2000 and 2010 Population

Location	2000	2010	Percentage Change
United States	281,421,906	308,745,538	9.7%
Colorado	4,301,261	5,029,196	16.9%
Denver-Aurora-Boulder CSA	2,668,252	3,090,874	15.8%

Sources: USCB 2001, 2010a

3.14.2.2 Employment Characteristics

The three largest industries in the Denver-Aurora-Boulder CSA in terms of percentage of the workforce employed within the industry are the educational services, and health care and social assistance industry (19 percent); the professional, scientific, management, and administrative and waste management services industry (15 percent); and the retail trade industry (11 percent). The construction industry represents seven percent of the workforce (USCB 2010b). Unemployment in the Denver-Aurora-Broomfield MSA (the MSA closest to the NWTC) from 2003 to 2012 ranged from 6.4 to 7.9 percent annually. In March 2013, the unemployment rate dropped to 7.2 percent (BLS 2013).

3.14.2.3 Environmental Justice and Protection of Children

To provide a baseline measurement for environmental justice, an area around the NWTC was established to examine the impacts on minority and low-income populations. For the purpose of this analysis, this area corresponds to the Denver-Aurora-Boulder CSA. This area includes numerous towns, villages, census-designated places, and cities. In the Denver-Aurora-Boulder CSA, 22.1 percent of the population is Hispanic, 4.8 percent is Black or African American, and 1.0 percent is Native American (see **Table 3-29**) (USCB 2001).

Table 3-29. Minority and Low-Income Characteristics (2010)

Race and Origin	Denver-Aurora-Boulder CSA	Colorado	United States
Total population	3,090,874	5,029,196	308,745,538
Percent under 5 years of age	7.0	6.8	6.5
Percent over 65 years of age	10.0	10.9	13.0
Percent white	79.2	68.4	72.4
Percent Black or African American	4.8	2.1	12.6
Percent American Indian and Alaska Native	1.0	9.4	0.9
Percent Asian	3.5	1.4	4.8
Percent Native Hawaiian and Other Pacific Islander	0.01	0.1	0.2
Percent other race	7.9	15.0	6.2

Percent two or more races	3.4	3.7	2.9
Percent Hispanic or Latino	22.1	46.3	16.3
Estimated median household income	$58,523	$54,046	$50,046
Estimated percent of families living below poverty level	9.1	9.4	11.3

Source: USCB 2001

The percentage of individuals under the age of five is very similar in the Denver-Aurora-Boulder CSA when compared to the State of Colorado and the United States. The average median household income for the Denver-Aurora-Boulder CSA is estimated at $58,523, which is greater than the United States estimated average of $50,046. The percentage of families living below the poverty level is very similar in the Denver-Aurora-Boulder CSA when compared to the State of Colorado, but less than the United States (USCB 2001) (see **Table 3-29**).

3.14.3 ENVIRONMENTAL CONSEQUENCES

3.14.3.1 Evaluation Criteria

Socioeconomics. This section addresses the potential for direct and indirect impacts that the Proposed Action could have on local or regional socioeconomics. Impacts on local or regional socioeconomics are evaluated according to their potential to stimulate the economy through the purchase of goods or services and increase in employment and population.

Environmental Justice and Protection of Children. Ethnicity and poverty data are examined for the Denver-Aurora-Boulder CSA and compared to the State of Colorado and the United States to determine if a low-income or minority population could be disproportionately affected by the Proposed Action.

3.14.3.2 Proposed Action

Increasing and Enhancing Research and Support Capabilities (Zone 1 and Zone 2)

Demographics. The construction workers hired to construct new facilities, modify existing facilities, and upgrade infrastructure would most likely come from the existing workforce within the Denver-Aurora-Boulder CSA. The scope of the proposed construction activities should not necessitate out-of-town workers to permanently relocate. Therefore, the Proposed Action would not be expected to result in impacts on demographics.

Employment Characteristics. The number of construction workers necessary for the Proposed Action would not be large enough to outstrip the supply of the local industry within the Denver-Aurora-Boulder CSA. Short-term, direct beneficial impacts on employment would be expected from the Proposed Action during proposed construction activities. Indirect beneficial impacts would result from the increase in payroll tax revenues, purchase of materials, and purchase of goods and services in the area, resulting in minor beneficial impacts on the socioeconomic climate of the Denver-Aurora-Boulder CSA.

Environmental Justice and Protection of Children. No adverse impacts would disproportionately affect low-income or minority populations during construction activities. The Denver-Aurora-Boulder CSA contains lower minority and low-income populations in comparison to the United States, but is similar to the State of Colorado (see **Section 3.14.1**). Construction activities would occur in industrial areas of the NWTC site; therefore, no offsite minority or youth populations would be disproportionately impacted by the Proposed Action.

Increasing Site Use and Density (Zone 2)

Demographics. The Proposed Action would not be expected to result in impacts on demographics, as the construction workforce would most likely come from the existing workforce within the Denver-Aurora-Boulder CSA and would not require relocation of out-of-town construction workers.

Employment Characteristics. Short-term, direct beneficial impacts on employment would be expected from the Proposed Action during proposed construction activities. Indirect beneficial impacts would result from the increase in payroll tax revenues, purchase of materials, and purchase of goods and services in the area resulting in minor beneficial impacts on the socioeconomic climate of the Denver-Aurora-Boulder CSA.

Environmental Justice and Protection of Children. No adverse impacts would disproportionately affect low-income or minority populations during construction activities.

Expanding Power Capacity

Demographics. Construction workers required for building the substation and transmission line interconnect would most likely come from the existing workforce within the Denver-Aurora-Boulder CSA. Thus, the proposed Action would not be expected to result in impacts on demographics.

Employment Characteristics. Similar to the other activities in the Proposed Action, short-term, direct beneficial impacts on employment would be expected from utilizing the workforce within the Denver-Aurora-Boulder CSA. Indirect beneficial impacts from the increase in payroll tax revenues would also be realized.

Environmental Justice and Protection of Children. No adverse impacts would disproportionately affect low-income or minority populations during construction activities.

3.14.3.3 No Action Alternative

Under the No Action Alternative, current operations and activities would continue at the NWTC. No impacts on socioeconomics would be expected, as no additional jobs would be created, expenditures for goods and services for construction activities and maintenance of existing facilities would be minimal, and there would be no increase in tax revenues as a result of employee wages and sales receipts. Impacts on environmental justice and protection of children would not occur as a part of the No Action Alternative as the NWTC would continue to operate under current conditions.

3.15 Intentional Destructive Acts

DOE considers intentional destructive acts (that is, acts of sabotage or terrorism) in all its EAs and EISs. Each EA or EIS should explicitly consider whether the accident scenarios adequately bound intentional destructive acts. DOE applies a sliding scale in considering the potential impacts of intentional destructive acts such that a more detailed threat analysis would be appropriate for a nuclear facility or a non-nuclear facility with large amounts of hazardous or explosive material onsite (DOE 2006b).

NREL is a non-nuclear facility. No work activities at the NWTC involve nuclear material and there are no legacy radiological contamination issues. None of the proposed site improvement projects that are the subject of this EA would involve the transportation, storage, or use of radioactive or explosive materials. The Proposed Action includes continued operation or enhancement of research at the DERTF facility, which houses the Wind-2H2 demonstration project. This project generates hydrogen gas that is currently

stored outside in five 3,500 psig storage tanks and seven 6,000 psig storage tanks. NREL also maintains seven above-ground petroleum fuel storage tanks at the NWTC facility with a total capacity of 1,565 gallons (NREL 2011c). **Section 3.10**, Hazardous Materials and Waste Management, describes other hazardous materials on the site.

The Proposed Action would not offer any credible targets of opportunity for terrorists or saboteurs to inflict major adverse impacts to human life, health, or safety, nor would the Proposed Action render the NWTC site as a whole any more susceptible to such acts. Impacts resulting from intentional destructive acts would be those resulting from the acts themselves, and would not be magnified by any aspect of the Proposed Action or alternatives. However, an act of terrorism or sabotage could imitate the consequences of an operational accident involving the hazardous materials described in **Section 3.10** Hazardous Materials and Waste Management, **Section 3.12** Human Health and Safety, or **Section 3.13** Accident Risk.

It is not expected that there would be any intentional destructive acts that would impact electrical power service. However, should an intentional act occur that leads to temporary shutdown of all or part of NWTC operations, the shutdown would not substantively impact the local or regional electrical power grid. The effects of any shutdown due to an intentional act would mimic those of a temporary shutdown caused by mechanical failure.

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4. CUMULATIVE IMPACTS

The CEQ regulations for implementing NEPA define cumulative effects as "the impact on the environment which results from the incremental impact of the action 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. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7).

This Site-Wide EA considers past, present, and reasonably foreseeable short-term and long-term future actions at the NWTC. It also considers offsite factors and reasonably foreseeable offsite projects that could result in cumulative impacts. CEQ guidance on considering cumulative effects identifies the steps for assessing cumulative effects and begins with defining the scope of the other actions and their interrelationship with the Proposed Action. The scope must consider other projects that coincide with the location and timetable of a proposed action and other actions. Cumulative effects analyses must also evaluate the nature of interactions among these actions. Impacts subject to cumulative effects analysis are identified by reference to both the timeframe and geographic extent in which the proposed action would cause effects.

4.1 Actions Considered with Potential Cumulative Impacts

Proposed activities in the vicinity of the NWTC were considered in preparing a cumulative impacts scenario for analysis. No other wind turbine projects are known to be planned near the NWTC. The closest wind farm with utility-scale turbines is located in Limon, Colorado approximately 90 miles southeast of the NWTC. Proposed activities in the vicinity of the NWTC that were used for the cumulative impacts scenario include the adjacent Rocky Flats National Wildlife Refuge, transportation and infrastructure improvements, mining and reclamation activities, and transmission line upgrades. Each of these proposed nearby activities is described below.

4.1.1 ROCKY FLATS NATIONAL WILDLIFE REFUGE

The Rocky Flats National Wildlife Refuge borders the NWTC on the south and east. In July 2007, DOE completed the transfer of land to the USFWS mandated by the *Rocky Flats National Wildlife Refuge Act* of 2001. The USFWS approved the Rocky Flats National Wildlife Refuge Comprehensive Conservation Plan in April 2005. The plan describes future uses for the refuge, including visitor facilities and wildlife and habitat management. Implementation of the plan has been delayed due to lack of funding and the refuge has remained closed to public use. Assuming that in the foreseeable future funding would become available, the cumulative impacts scenario considers the following activities at the wildlife refuge described in the conservation plan (USFWS 2005):

- Removing 28 miles (45 kilometers) of unused roads and 13 stream crossings to improve wetland and riparian habitat for the Preble's meadow jumping mouse
- Managing deer and elk populations to prevent damage to sensitive habitats
- Evaluating the introduction of native species to the refuge, such as the short-tailed grouse
- Allowing the expansion of prairie dog populations to 75 acres in appropriate areas
- Constructing a visitor contact station, interpretive overlooks, and associated access roads and parking facilities

- Building 12.8 miles (20.6 kilometers) of multi-use trails and 3.8 miles (6.1 kilometers) of hiking trails

In December 2011, the USFWS completed an EA for a land exchange that would add 617 acres of contiguous land on the southwest border of the refuge that had been held in trust by the State of Colorado. The acquisition of these lands provides the USFWS additional Preble's mouse habitat and xeric tallgrass prairie, while connecting the refuge to regional open space to the west, thus protecting an important wildlife corridor. As part of the acquisition, the USFWS transferred approximately 100 acres of land to the Jefferson Parkway Public Highway Authority for the sole purpose of transportation improvements. The transferred land consists of a 300-foot (91-meter) corridor on the eastern border of the wildlife refuge along Indiana Street, from approximately 96th Avenue on the south to Hwy 128 on the north (USFWS 2011).

4.1.2 TRANSPORTATION INFRASTRUCTURE IMPROVEMENTS

The Denver Regional Council of Governments has prepared the *2035 Metro Vision Regional Transportation Plan* to guide the long-term development of transportation systems in the Denver metropolitan region. As a federal requirement, a section of the plan identified regionally significant projects that are fiscally constrained, so that they can be eligible for short-range funds for priority funding. The plan lists one fiscally constrained priority project in the vicinity of the NWTC, the Jefferson Parkway linking metropolitan Denver's beltway system between Hwy 93 and Hwy 128. The project would include 10.2 miles (16.4 kilometers) of four-lane toll road and three interchanges located at Hwy 72, at Candelas Parkway, and at Indiana Street south of Hwy 128 (DRCOG 2011). The highway would traverse the 300-foot (91-meter) transportation corridor acquired from the USFWS as part of the land exchange described above. Due to the limited availability of state and federal highway funds, the Jefferson Parkway Public Highway Authority plans to complete the project through a public-private partnership to finance, design, build, operate, and maintain the Parkway.

4.1.3 MINING AND RECLAMATION ACTIVITIES ON ADJACENT PROPERTY

A company mining the property immediately adjacent to the NWTC's southern boundary has filed a reclamation plan with the Colorado Division of Reclamation, Mining and Safety for land immediately south of the NWTC property (see unvegetated area visible in the lower left corner of **Figure 3-9**). The plan specifies removing culverts and reseeding existing roads on the mine site, including the road parallel to the southern boundary of the NWTC. Soil stockpiles varying in size from 100 to 68,000 cubic yards would be regraded and reseeded throughout the former mining area. Silt ponds and associated berms would be graded with compacted fill and reseeded. Other reclamation activities include the removal of four existing utility poles and installing sediment control structures (Tetra Tech 2012).

Existing ponds would be graded to fill the depression to a depth of two feet above groundwater, with the exception of the northernmost pond just south of the NWTC solar PV array. This particular pond was created by previous operators prior to issuance of a mining permit and was not enlarged during subsequent mining operations. The pond would remain as it currently appears (Applegate Group 2012). The mining company has completed the majority of the earth work for the reclamation. The area will also be stabilized and seeded. Final approval and acceptance of the reclamation by the State of Colorado is not expected until the end of 2014.

4.1.4 TRANSMISSION LINE UPGRADES

Public Service Company of Colorado (Xcel Energy) plans to upgrade the 115 kV transmission line between the Plainview substation south of the NWTC and the Eldorado substation. This 4-mile

(6.4-kilometer) transmission line, originally built in 1910, traverses Jefferson County open space and City of Boulder OSMP lands on the west side of Hwy 93. The project would replace the existing line rated at 17 megavolt-amperes with a new 115 kV transmission line rated at 150 megavolt-amperes for increased reliability (Public Service 2011).

The future NWTC 50 MW expansion would require installing a new higher voltage service line from one of Xcel Energy's existing substations to the new substation proposed on NWTC property (see **Section 2.1.3**). Although the alignment of the service line has not yet been selected, the offsite installation of the transmission line is reasonably foreseeable and is included in the cumulative impacts scenario.

4.2 Cumulative Impacts Analysis

The actions considered for the cumulative impacts analysis are anticipated to potentially affect five resource areas: land use, traffic and transportation, visual quality and aesthetics, biological resources, and utilities and infrastructure. A description of the potential for cumulative impacts to each resource area is provided in the following sections.

4.2.1 LAND USE

The Proposed Action would not have major adverse cumulative impacts on land use in or near the NWTC. The construction of the Jefferson Parkway would potentially require a change of the current land use designations of open space, commercial, and residential on either side of Hwy 72 to accommodate the transportation and infrastructure rights-of-way (City of Arvada 2008). This could result in the updated land use for the Parkway corridor being incompatible with adjacent land uses, but the Proposed Action is compatible with current land use designations in the region, and does not contribute to any requirements for changing them. The other reasonably foreseeable actions would not be anticipated to impact land use.

4.2.2 TRAFFIC AND TRANSPORTATION

When considered in conjunction with past actions and reasonably foreseeable future actions, the Proposed Action would not cause major cumulative impacts on traffic and transportation near the project area. Construction of the Jefferson Parkway would create an additional highway corridor through the region, which would allow for easier region-to-region transportation. None of the reasonably foreseeable future actions would be anticipated to markedly change local employment levels; therefore, traffic levels in the project area would not be affected beyond those described for the Proposed Action.

4.2.3 VISUAL QUALITY AND AESTHETICS

The Proposed Action would not cause major cumulative impacts on visual quality and aesthetics near the project area. Upgrading the 115 kV transmission line between the Plainview Station and the Eldorado Substation would not alter the visual or aesthetic quality of the viewshed, as the transmission line would be upgraded in its current location. Installing new transmission lines to support the expansion of the NWTC to 50 MW would be expected to degrade the overall visual and aesthetic quality of the area; however, the new transmission lines would be reasonably consistent with existing features, and would not be anticipated to block views following construction. The future reclamation actions at the mining property would contribute to an overall increase in the visual quality of the site, as the site would be restored to more natural conditions. Activities at the Rocky Flats National Wildlife Refuge would not be anticipated to impact visual quality or aesthetics. When taken together, the cumulative impact to aesthetics and visual quality would be similar to that described for the Proposed Action: new and larger features would be visible in the surrounding community; however, the features would be reasonably consistent with existing features and no views would be blocked.

4.2.4 BIOLOGICAL RESOURCES

Long-term, minor, cumulative adverse effects on vegetation would be expected. The Proposed Action and other reasonably foreseeable development projects would occur in both developed and undeveloped areas, so some native vegetation would be disturbed, with an increased potential for noxious weed introduction, as well as habitat loss. The temporary disturbance of vegetation on the NWTC would not have an adverse cumulative effect on the grassland habitat and wildlife. There is abundant similar habitat for displaced wildlife within the NWTC and in surrounding open space areas until the grasses are reestablished on the disturbed areas.

Short-term minor cumulative adverse effects on wildlife could be expected during construction or demolition activities, particularly when these activities are occurring at the same time and in proximity to each other. Cumulative construction and operational projects would result in direct, indirect, and temporary adverse impacts on threatened and endangered species, and migratory birds. Construction of up to three additional utility-scale wind turbines and associated meteorological towers would present additional vertical elements to the landscape, along with the existing overhead transmission lines to the south and west of the NWTC, which could increase the collision risk to birds and bats in the area. Although the new turbines would add cumulatively to this risk, the incremental increase in collisions would be very small or immeasurable. Because of compensation and preservation measures, no major adverse cumulative effects would be expected.

Long-term minor beneficial cumulative effects on vegetation would be expected from the reclamation efforts on the adjacent mining property. Long-term negligible beneficial impacts on wildlife in the region would be expected, as the proposed activities on adjacent properties (the wildlife refuge and the mining property) would improve wildlife habitat. Additionally, long-term minor beneficial cumulative effects on the threatened Preble's mouse would be expected due to the proposed activities at the wildlife refuge to remove roads and stream crossings to improve habitat.

4.2.5 UTILITIES AND INFRASTRUCTURE

The Proposed Action would not cause major adverse cumulative impacts on utilities and infrastructure near the project area. Upgrading the 115 kV transmission line between the Plainview Station and the Eldorado Substation would improve the reliability of the electricity at the NWTC. Installing new transmission lines to support the expansion of the NWTC to 50 MW would greatly increase the supply capacity of the NWTC. Both of these projects, when considered in conjunction with the infrastructure improvement projects under the Proposed Action, would result in a beneficial cumulative impact on utilities and infrastructure at the NWTC. No offsite cumulative impacts would be expected.

4.3 Irreversible/Irretrievable Commitment of Resources

An irreversible commitment of resources is defined as the loss of future options. The term applies primarily to the effects of using non-renewable resources, such as minerals or cultural resources, or to those factors such as soil productivity that are renewable only over long periods. It could also apply to the loss of an experience as an indirect effect of a "permanent" change in the nature or character of the land. An irretrievable commitment of resources is defined as the loss of production, harvest, or use of natural resources. The amount of production foregone is irretrievable, but the action is not irreversible. If the use changes, it is possible to resume production.

The Proposed Action would not have irreversible impacts because future options for using this site would remain possible. A future decommissioning process could restore the site for alternative uses, ranging from natural open space to urban development. No loss of future options would occur.

The primary irretrievable impacts of the Proposed Action would involve the use of energy, labor, materials, and funds, and the conversion of some lands from a natural condition through the construction of buildings and facilities. Irretrievable impacts would occur as a result of construction, facility operation, and maintenance activities. Nonrenewable fossil fuels would be irretrievably lost through the use of gasoline and diesel fuel used to power worker vehicles and construction equipment during construction activities. Direct losses of biological productivity would be offset by continued conservation management efforts (see **Section 4.6**). The use of natural resources from these impacts would be inconsequential, and would be offset by achieving the mission of the NWTC to improve energy efficiency and renewable energy technology and by generating renewable power by turbines, distributed energy systems, and other facilities at the NWTC and elsewhere.

4.4 The Relationship between Local Short-Term Uses of the Human Environment and the Maintenance and Enhancement of Long-Term Productivity

The Proposed Action would involve a long-term commitment of resources in the form of energy, labor, materials, and funds. The justification for these commitments at this time is described in the purpose of and need for DOE's undertaking of the Proposed Action (see **Section 1.3**). Long-term productivity associated with the site relates to its potential agricultural value for livestock grazing, biological value as habitat, and aesthetic quality and recreational values associated with open space. The Proposed Action would involve the use of lands where these values have already been compromised by facility development and operations, so any losses would be incremental and minor and off-set by the potential for the Proposed Action to improve energy efficiency and harness renewable energy resources.

Improved efficiency and increased reliance on renewable energy resources could substantially reduce reliance on coal, oil, and nuclear fuels and reduce resource productivity losses in resource extraction areas. No long-term risks to public health and safety would be created by the Proposed Action.

4.5 Unavoidable Adverse Impacts

Unavoidable adverse impacts associated with the Proposed Action are as follows:

- Long-term loss of land within the NWTC site for construction of new buildings and additions to existing buildings, upgrades to facilities and infrastructure, and installing access roads and new test sites associated with installation of wind turbines. The amount of acreage disturbed is conservatively estimated at 24 acres (less than 8 percent of the NWTC site).
- A small increase in noise and dust levels during construction
- A slight increase in surface water runoff due to increased impervious surfaces

The impacts from construction activities would be temporary. Overall, impacts of the Proposed Action on the human and natural environment would be minor.

4.6 DOE and NREL Committed Measures

NREL's Environmental Management System (EMS) is certified to the ISO 14001:2004 standard for environmental management systems. ISO 14001 is a globally recognized standard that defines the structure of an organization's EMS to improve its environmental performance. NREL's EMS provides effective environmental stewardship and its implementation minimizes the environmental impacts of

laboratory activities and operations. The EMS is a framework of policies, procedures, and programs that integrates environmental protection into daily work practices. The laboratory's EMS efforts include protecting and enhancing the vegetation, wildlife, and natural resources of the laboratory sites; preventing pollution; complying with environmental requirements; and encouraging continual improvement in environmental protection and sustainability performance.

All applicable federal and state statutes and regulations, as listed in **Tables 1.4** and **1.5**, would be followed in implementing the Proposed Action. Environmental protection and sustainable policies are in place; the procedures associated with these policies are discussed in Chapter 3 and included in the reference list. DOE and NREL have committed to the following additional measures and procedures to avoid, minimize, or mitigate environmental impacts during operation of the NWTC. Any contractors working on the NWTC would also be required to follow these committed measures.

4.6.1 GEOLOGY AND SOILS

Measures to protect natural resources and prairie grass include limited off-road driving, weed control, marking the boundary to limit foot traffic, use of regional tallgrass prairie seed mixes for revegetation, and provisions for supplemental watering during plant establishment and extended periods of drought. Any land disturbances would be planned in cooperation with the EHS Office.

4.6.2 STORMWATER CONTROLS

Erosion and sediment controls, proper chemical storage and fueling procedures and good housekeeping practices would be implemented during construction activities, as outlined in **Section 3.7** and in accordance with NREL's stormwater management procedure (NREL 2012f). Regular inspections by contractors, DOE staff, and NREL staff would be conducted to verify that the implemented controls are functioning properly.

4.6.3 NONNATIVE AND INVASIVE PLANT SPECIES

DOE and NREL routinely take action to control nonnative and invasive plant species at the NWTC. In addition, any land disturbance would be reseeded with native plant species to maintain the prairie grassland that provides wildlife habitat. Vegetation management activities are conducted on a site-wide basis with the objectives of controlling nonnative and invasive plant species, preserving species diversity, and maintaining ecosystem health to the maximum extent possible.

4.6.4 CONSERVATION MANAGEMENT AREAS

DOE and NREL have made a number of commitments to manage conservation areas, including performing annual assessments to document environmental conditions, avoiding activities in areas containing sensitive natural resources, and minimizing or avoiding development in the conservation management areas. These areas, as described in Chapter 3, include wetlands, headwater tributaries to Coal Creek and Rock Creek, the western portion of the NWTC, two areas of ancient soils, rare and diverse plant communities, and critical habitat for the Preble's mouse.

4.6.5 AIR QUALITY AND CLIMATE CHANGE

DOE minimizes temporary dust generated during construction, operation, and decommissioning activities. Emergency generators are permitted in accordance with state regulations and would not impact the regional air quality, as discussed in Chapter 3. NWTC research and outdoor activities are directly related to reducing impacts to climate change.

4.6.6 WILDLIFE

Prior to commencing onsite construction activities, biologists would conduct surveys for nesting birds and have the authority to delay construction or instruct workers to avoid sensitive areas if necessary until young birds fledge the nest. Areas with planned construction would be mowed in the weeks prior to construction to discourage birds from nesting. When snakes are encountered, they would be safely relocated away from active construction areas. The northwestern corner of the NWTC is managed as prairie dog habitat. Prairie dogs that occur in other parts of the NWTC are relocated to the designated prairie dog habitat area. In addition, DOE is committed to protecting the Preble's mouse habitat located in the southeastern corner of the site, designated as critical habitat by USFWS. No construction or disturbances would occur in this area. NREL will continue to assess and monitor wildlife site use and mortality, perform effectiveness studies for BMPs, and employ adaptive management principles, as necessary.

4.6.7 MIGRATORY BIRDS

In accordance with the "Memorandum of Understanding between DOE and the USFWS Regarding Implementation of EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds," DOE agrees to integrate migratory bird conservation principles, measures, and practices into agency activities, and avoid or minimize adverse impacts on migratory bird resources and their habitats. As required in the MOU, both parties have agreed to protect, enhance, and manage habitats of migratory birds, to the extent practicable, and DOE has agreed to engage the USFWS for coordination prior to any operations and activities with significant adverse effects on migratory birds and their habitats (DOE 2013b).

4.6.8 OTHER NATURAL RESOURCES

An MOU between the Trustee Council for Natural Resources at Rocky Flats and the DOE Office of EERE was established to promote natural resource conservation at the NWTC as the mineral rights were conveyed to the U.S. government. This agreement was made to avoid onsite mining activities, to develop and implement a site-specific Natural Resource Conservation Program, and to maintain weed control activities following site development activities (Rocky Flats Trustee Council 2009).

4.6.9 WATER RESOURCES

Sediment and erosion control BMPs would be used during construction, operation, and decommissioning activities to minimize erosion of soils and impacts to surface water and wetlands. BMPs would include, at a minimum, containing excavated material, using silt fences, protecting exposed soil, stabilizing restored material, and revegetating disturbed areas. Native seed mixes and supplemental watering would be used to stabilize areas. Surface water and wetland areas are considered "no build zones" and would be protected as conservation management areas.

4.6.10 CULTURAL AND HISTORIC RESOURCES

Archaeological studies have determined that encountering archaeological resources during ground-disturbing activities is not likely. If archaeological resources were to be encountered, activities would immediately cease, an on-call archeologist would be summoned to evaluate the object, and the SHPO would be contacted, if needed, for resolution and further instruction regarding additional studies and potential avoidance, minimization, or mitigation measures in accordance with the NHPA.

4.6.11 WASTE MANAGEMENT

The NWTC generates four major types of waste: nonhazardous municipal solid waste, industrial nonhazardous waste, hazardous waste, and universal waste. The NWTC recycles as much of these wastes as possible. If not recycled, any waste would be transported and disposed at permitted facilities.

4.6.12 HUMAN HEALTH AND SAFETY AND ACCIDENT RISK

All activities would be conducted in accordance with the DOE Worker Safety and Health Program Rule (10 CFR Part 851), which outlines requirements to ensure DOE contractors and workers operate a safe workplace. NREL's safety and health policies and procedures implement applicable Worker Safety and Health Program Rule requirements.

4.6.13 OPERATION AND MAINTENANCE

DOE and NREL maintain and operate the NWTC according to standard industry procedures and requirements in accordance with applicable federal, state, and local standards and regulations.

5. LIST OF PREPARERS

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