SUPPLEMENTAL FINAL ENVIRONMENTAL IMPACT STATEMENT

NA PUA MAKANI WIND PROJECT AND HABITAT CONSERVATION PLAN

Lead Agency:

U.S. Fish and Wildlife Service
Pacific Region
911 NE 11th Ave
Portland, OR 97232

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NA PUA MAKANI WIND PROJECT AND HABITAT CONSERVATION PLAN

SUPPLEMENTAL FINAL ENVIRONMENTAL IMPACT STATEMENT

Prepared for

U.S. Fish and Wildlife Service

Prepared by

Tetra Tech, Inc.

On behalf of

Na Pua Makani Power Partners, LLC

SUPPLEMENTAL FINAL ENVIRONMENTAL IMPACT STATEMENT COVER SHEET

Title of Environmental Review:	Supplemental Final Environmental Impact Statement Na Pua Makani Wind Project and Habitat Conservation Plan
Activity Considered:	USFWS' action of issuing Incidental Take Permit to Na Pua Makani Power Partners, LLC and implementation of the Na Pua Makani Wind Farm Habitat Conservation Plan
Responsible Agencies and Officials:	Ms. Robyn Thorson Regional Director U.S. Fish and Wildlife Service Pacific Region 911 NE 11th Avenue Portland, OR 97232-4181
Contacts:	Ms. Jodi Charrier, Alternative Energy Coordinator Pacific Islands Fish and Wildlife Office U.S. Fish and Wildlife Service 300 Ala Moana Blvd Box 50088, Suite 3-122 Honolulu, HI 96850 (808) 792-9400
Legal Mandate:	Endangered Species Act of 1973, as amended, section 10(a), as implemented by 50 CFR 17.22(b) and 17.32(b)
Location of Proposed Action:	Kahuku; Koolauloa District; Oahu, HI
Land Ownership:	Private (Malaekahana Hui West, LLC) State of Hawaii
Tax Map Keys (TMKs):	(1)5-6-008:006 (portion); (1)5-6-006:018, 47, 51, 55 (portions); and (1)5-6-005:018 (portion)
Project Size:	Wind Farm Site - approximately 707 acres (286 hectares) Project Footprint – approximately 46 ac (19 ha)
Applicant:	Na Pua Makani Power Partners, LLC 2020 Alameda Padre Serra, Suite 105 Santa Barbara, CA 93103
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Acronyms and Abbreviations

AIS	Archaeological Inventory Survey
ALISH	Agricultural Lands of Importance to the State of Hawaii
amsl	above mean sea level
ANSI	American National Standards Institute
APE	Area of Potential Effect
Army	U.S. Department of the Army (U.S. Army)
AST	aboveground storage tank
BMP	Best Management Practice
BO	Biological Opinion
BYU	Brigham Young University
CAA	Clean Air Act
CCD	Census County Division
CDP	Census Designated Places
CEQ	Council on Environmental Quality
Champlin	Champlin/Oahu Wind Holdings, LLC
CFR	Code of Federal Regulations
CIA	Cultural Impact Assessment
CIAA	cumulative impact analysis area
CO_2	carbon dioxide
CWRM	Commission on Water Resource Management
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
dB	decibels
dBA	A-weighted decibels
DEFRA	(United Kingdom) Department of Environment, Food & Rural Affairs
DLNR	Hawaii Department of Land and Natural Resources
DOE	U.S. Department of Energy
DOFAW	Division of Forestry and Wildlife
DPP	Department of Planning and Permitting

EA	Environmental Assessment
EIS	Environmental Impact Statement
EISPN	EIS Preparation Notice
EMF	electric and magnetic fields
EMR	electromagnetic radiation
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESRC	Endangered Species Recovery Committee
FAA	Federal Aviation Administration
FMP	Fire Management Plan
ft/s	feet per second
GET	general excise tax
GHG	greenhouse gas
HAAQS	Hawaii ambient air quality standards
HAR	Hawaii Administrative Rules
HBWS	Honolulu Board of Water Supply
HCP	Habitat Conservation Plan
HDOT	Hawaii Department of Transportation
HECO	Hawaii Electric Company
HEPA	Hawaii Environmental Policy Act
HAR	Hawaii Administrative Rules
HDOH	Hawaii Department of Health
HMWMP	Hazardous Materials and Wastes Management Plan
HRHP	Hawai'i Register of Historic Places
HRS	Hawaii Revised Statutes
IAL	Important Agricultural Lands
IS	infrasound
ITL	Incidental Take License
ITP	Incidental Take Permit
IUCN	International Union for Conservation of Nature and Natural Resources

JEDI	Jobs and Economic Development Impacts
KLOA	Kawailoa Training Area
KMPW	Koolauloa Mountains Watershed Partnership
kph	kilometers per hour
KTA	Kahuku Training Area
kV	kilovolt
LFN	low frequency noise
LSB	Land Study Bureau
m/s	meters per second
MBTA	Migratory Bird Treaty Act
met	meteorological
mgd	million gallons per day
MOVES	Motor Vehicle Emission Simulator
mph	miles per hour
MW	megawatts
MWh	megawatt hours
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NFWF	National Fish and Wildlife Foundation
NHPA	National Historic Preservation Act
NOI	Notice of Intent
NONROAD	Non-road Engines Equipment and Vehicles
NO_x	nitrogen oxide
NPMPP	Na Pua Makani Power Partners, LLC
NRCS	Natural Resources Conservation Service
NRHP	National Historic Preservation Act
NSA	noise-sensitive area
NWI	National Wetland Inventory
NWR	National Wildlife Refuge
OEQC	Office of Environmental Quality Control

OHWM	ordinary high water mark
O&M	operation and maintenance
ROW	right-of-way
PCMM	post-construction mortality monitoring
PCMP	Post Construction Monitoring Plan
PM_{10}	inhalable particulate matter
$PM_{2.5}$	fine particulate matter
PPA	power purchase agreement
Project	Na Pua Makani Wind Farm Project
PV	photovoltaic
ROD	Record of Decision
RPS	Renewable Portfolio Standard
SBER	Schofield Barracks East Range
SCADA	supervisory control and data acquisition
SHPD	Hawaii State Historic Preservation Division
SHPO	State Historic Preservation Officer
SMA	Special Management Area
SO_2	sulfur dioxide
SPCC	Spill Prevention, Containment, and Countermeasures
SWPPP	Storm Water Pollution Prevention Plan
TESC	Temporary Erosion and Sediment Control
TMK	Tax Map Key
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WoUS	Waters of the United States
WTG	wind turbine generator
WTS	Wind Turbine Syndrome

EXECUTIVE SUMMARY

This Supplemental Final Environmental Impact Statement (EIS) for the Na Pua Makani Wind Project (Project) and Habitat Conservation Plan has been prepared pursuant to the Federal National Environmental Policy Act (NEPA). Na Pua Makani Power Partners, LLC (NPMPP) is preparing a joint Federal/State Habitat Conservation Plan (HCP) to accompany its application for an Incidental Take Permit (ITP) from the U.S. Fish and Wildlife Service (USFWS). The HCP addresses potential impacts to wildlife species listed under the Federal Endangered Species Act (ESA). Approval of the proposed HCP and issuance of the ITP by the USFWS is a discretionary federal action triggering review under NEPA. Therefore, the USFWS serves as the lead agency for this EIS.

NPMPP proposes to construct and operate a new wind farm on state and private lands near the town of Kahuku, adjacent to the existing Kahuku Wind Farm with a net generating capacity of up to approximately 25 megawatts (MW). The Draft EIS considered a Proposed Action of up to 10 wind turbines. In response to public comments on the Draft EIS, a Modified Proposed Action Option (consisting of only nine turbines with larger generating capacities and dimensions) was added to the Final EIS analysis. The Project would also include an underground electrical collection system, an onsite substation, an operations and maintenance (O&M) facility and related infrastructure, access roads, an approximately 0.8-mile (1.2 kilometer) 34.5-kilovolt HECO-owned transmission line, and a permanent meteorological tower.

The purpose of this document is to provide the public with an opportunity to review and comment on a Modified Proposed Action Option, furthering the purposes of the ESA and NEPA. This document carries forward discussion of the potential adverse and beneficial environmental impacts of the construction and operation of the proposed Project and implementation of the proposed HCP, including mitigation measures that were designed avoid or reduce significant adverse impacts, presented in the Final EIS.

Thus, this Supplemental Final EIS addresses alternatives to the Proposed Action (and Modified Proposed Action Option), including the No Action Alternative and a larger generation facility of up to approximately 42 MW (Alternative 3). Under the No Action Alternative, the USFWS would not approve the HCP or issue the ITP and the Project would not be constructed. This alternative establishes a baseline against which the action alternatives can be compared. Alternative 3 (larger generation facility) would involve issuance of the ITP by the USFWS and the construction and operation of up to 12 turbines and associated infrastructure, constructed in two phases. Alternatives that were eliminated from further consideration include smaller (less than 25 MW) and larger (more than 42 MW) facilities, greater wind turbine setback distances, alternative Project locations on Oahu, a reduced ITP permit term, and different types of renewable energy generation.

BENEFICIAL AND ADVERSE IMPACTS

Desktop and field-based analyses were completed for biological, cultural, visual, air, noise, traffic, and shadow flicker to assess the potential effects of the Project. Table ES-1 summarizes the types of impacts that could result from the proposed Project (Proposed Action), Modified Proposed Action

Option, the No Action Alternative, and Alternative 3 which are discussed in further detail in Chapter 4. Where significant impacts were identified as likely or possible, appropriate measures were developed to avoid, minimize, and mitigate impacts. In all resource areas evaluated, neither significant cumulative impacts nor secondary impacts would result from construction or operations of the Project.

PROPOSED AVOIDANCE, MINIMIZATION, AND MITIGATION MEASURES

Measures proposed to avoid, minimize, and mitigate for adverse environmental impacts include Project design features such as BMPs to control stormwater runoff and erosion, fugitive dust, and noxious vegetation; development of a Habitat Conservation Plan for protected wildlife species; and development of specific Project-related plans, such as a Fire Management Plan and a Traffic Control Plan. Proposed mitigation measures are described in detail for each resource listed discussed in Chapters 3 and 4 (existing conditions and impacts, respectively) of this EIS.

CONSISTENCY WITH LAND USE POLICIES AND PLANS

This EIS takes into account the state and local land use policies and plans that apply to the analysis area. The State Land Use Law (HRS § 205-2) allows for wind-generated energy production for public, private, and commercial use. The Project is on the inland side of Kamehameha Highway and would not include any development within the SMA or in the Shoreline Setback Area.

The City and County of Honolulu General Plan is the guiding document for long-range development of the Island of Oahu. The General Plan, currently being updated, describes general conditions to be sought over the 20-year planning horizon and outlines policies to help direct attainment of the plan's objectives. Themes of the General Plan include supporting programs and projects that contribute to the attainment of energy self-efficiency on Oahu and developing and applying new, locally available energy resources. The Project is consistent with the General Plan goals, policies, and objectives.

The City and County of Honolulu is divided into eight regional areas, each guided by a Sustainable Communities Plan (SCP). The Project is located within the boundaries of the Koolau Loa SCP, which designates the Project Area for agricultural, military, and rural residential use. The Project components are predominantly designated agricultural where wind energy facilities are permitted uses. Chapter 5 of this EIS evaluates the land use policies and plans that would be affected by the Project.

OTHER NEPA TOPICS

Wind energy is an abundant, infinitely renewable resource. Generation and integration of wind energy into the electric grid decreases fossil fuel consumption, thereby reducing GHG emissions, particulate-related health effects, and other forms of pollution associated with coal or diesel fuel electric generation. Power generated from the Project would provide greater security in maintaining an energy supply and reduce State expenditures on imported fossil fuels, and provide long-term price stability for HECO consumers. Furthermore, the proposed Project would provide economic benefits by contributing to the local economy, generating new jobs, and providing a stable, long-term source of tax revenue for the state and county.

The Project is compatible with existing agricultural uses, and as such, does not preclude the present and future agricultural productivity of the Wind Farm site or the Kahuku area. At the end of the approximately 20-year life of the Project, the Power Purchase Agreement could be renegotiated or the Project could be decommissioned, returning the land to its original condition to the extent possible.

Construction and operations of the Project would require the use of non-renewable resources for the manufacturing of the Project components, construction materials, and fuel consumed during the construction and operations of the Project. However, to the extent feasible, wastes generated during construction and operation would be recycled.

Relatively minor impacts would occur to non-native vegetation, wildlife habitat, soils, hydrology, agricultural lands, and public services, in association with construction (e.g., ground disturbance) and operation of the project. The Project would not pose a long-term risk to health and safety of workers or residents in the vicinity. Once in operation, the Project would not cause any emissions of air, water, or soil pollutants, and the potential for release of hazardous materials during construction would be limited by the implementation of appropriate construction best management systems and practices.

There is a potential for adverse impacts to threatened and endangered wildlife species. Approval of the HCP and issuance of the ITP would authorize incidental take of the Covered Species. Avoidance, minimization, and mitigation measures outlined in the HCP would reduce these biological resources impacts to below a level of significance. However, the incidental take of Covered Species would comprise a small, but irreversible, environmental change associated with implementation of any action alternative.

In accordance with NEPA (40 CFR §1502.14(e)), the USFWS has selected the Proposed Action (Alternative 2), including the Modified Proposed Action Option, as the preferred alternative. Of the alternatives evaluated in this EIS, this alternative best fulfills the agency's statutory mission and responsibilities while meeting the agency purpose and need to conserve listed species. The selection of the Proposed Action as the preferred alternative is based on the following:

- The issuance of the ITP by the USFWS under the Proposed Action would result in protections (via mitigation and conservation measures) to the Covered Species due to implementation of the HCP. The HCP that would be implemented under this alternative would also minimize impacts to birds protected under the Migratory Bird Treaty Act.
- The renewable energy generated by the Project would provide a dependable source of electrical energy and eliminate the need for an equivalent amount of fossil-fueled derived energy and capacity, which reduces use of nonrenewable resources and limits atmospheric pollution.

Table ES-1. Summary of Impacts by Alternative

Resource	Alternative 1: No Action	Alternative 2: Proposed Action (8 to 10 Turbine Wind Project)	Alternative 2a: Modified Proposed Action Option (Up to 9 Turbines with Greater Generating Capacity and Larger Dimensions)	Alternative 3: Larger Generation Wind Project (Up to 12 Turbine Wind Project)
Geology and Soils	No effect	ITP/HCP Implementation: Minor short-term soil disturbance during implementation of mitigation measures; minimized through implementation of standard BMPs. Na Pua Makani Wind Project: Minor short-term ground disturbance during construction (89.0 acres [36.0 hectares]), minor long-term ground disturbance during operation (59.9 acres [24.2 hectares]). Up to 26.1 acres (10.6 hectares) Prime Agricultural Lands impacted during construction; 12.6 acres (5.1 hectares) impacted over the long-term (approximately 5 percent of Prime Agricultural Lands in wind farm site). Potential for increased erosion and stormwater runoff/drainage impacts. Impacts minimized through implementation of standard Best Management Practices (BMPs) (Temporary Erosion and Sediment Control (TESC) and Stormwater Pollution Prevention (SWPP) plans), Project site design features, revegetation and regrading of temporarily disturbed areas, and Project facility maintenance.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Minor short-term ground disturbance during construction (84.5 acres [34.2 hectares]), minor long-term ground disturbance during operation (56.7 acres [22.9 hectares]). Up to 21.7 acres (8.8 hectares) Prime Agricultural Lands impacted during construction; 9.4 acres (3.8 hectares) impacted over the long-term (approximately 4 percent of Prime Agricultural Lands in wind farm site). Potential for increased erosion and stormwater runoff/drainage impacts. Measures for avoiding and minimizing impacts same as Alternative 2.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Minor short-term ground disturbance during construction (98.6 acres [39.9 hectares]); minor long-term ground disturbance during operation (69.8 acres [28.2 hectares]). Up to 35.7 acres (14.5 hectares) of Prime Agricultural Lands impacted by construction; 22.4 acres (9.0 hectares) impacted over the long-term (approximately 9 percent of the Prime Agricultural Lands in wind farm site). Potential for increased erosion and stormwater runoff/drainage impacts. Measures for avoiding and minimizing impacts same as Alternative 2.

Table ES-1. Summary of Impacts by Alternative (continued)

Resource	Alternative 1: No Action	Alternative 2: Proposed Action (8 to 10 Turbine Wind Project)	Alternative 2a: Modified Proposed Action (Up to 9 Turbines with Greater Generating Capacity and Larger Dimensions)	Alternative 3: Larger Generation Wind Project (Up to 12 Turbine Wind Project)
Hydrology and Water Resources	No effect.	ITP/HCP Implementation: Negligible impacts to surface and groundwater during implementation of mitigation measures; impacts minimized through implementation of standard BMPs. Na Pua Makani Wind Project: Final Project design will avoid impacts to surface water features to extent possible. Minor, localized, temporary adverse surface water quality impacts due to ground disturbance, use of hazardous materials, and creation of impervious surfaces (approx. 10.1 acres [4.1 hectares]). Net increase in stormwater runoff of approx. 11.9 cubic feet per second (cfs). Impacts minimized through implementation of standard BMPs (TESC, SWPP, and Spill Prevention, Containment, and Countermeasures [SPCC] plans) and Project design. No measurable reduction in quantity or quality of ground water.	ITP/HCP Implementation: Same as Alternative 2 Na Pua Makani Wind Project: Final Project design will avoid impacts to surface water features to extent possible. Minor, localized, temporary adverse surface water quality impacts, similar to Alternative 2. Approximately 9.1 acres (3.7 hectares) of impervious or semi-pervious surfaces created. Estimated net increase in stormwater runoff of 10.9 cfs. No measurable reduction in quantity or quality of ground water. Measures for avoiding and minimizing impacts same as Alternative 2.	ITP/HCP Implementation: Same as Alternative 2 Na Pua Makani Wind Project: Minor, localized, temporary adverse surface water impacts, similar to Alternative 2. Approximately 11.1 acres (4.5 hectares) of impervious or semi-pervious surfaces created. Estimated net increase in stormwater runoff of 13.0 cfs. No measurable reduction in quantity or quality of ground water. Measures for avoiding and minimizing impacts same as Alternative 2.

Table ES-1. Summary of Impacts by Alternative (continued)

Resource	Alternative 1: No Action	Alternative 2: Proposed Action (8 to 10 Turbine Wind Project)	Alternative 2a: Modified Proposed Action (Up to 9 Turbines with Greater Generating Capacity and Larger Dimensions)	Alternative 3: Larger Generation Wind Project (Up to 12 Turbine Wind Project)
Air Quality and Climate	No adverse or beneficial effects.	ITP/HCP Implementation: Negligible impacts to air quality and climate. Na Pua Makani Wind Project: Minor, temporary adverse air quality impacts due to greenhouse gas emissions, air pollutants, and generation of fugitive dust during construction; minimized through standard BMPs; negligible construction-related effects to climate change. Long-term beneficial effect on air quality and climate during operation due to reduction in fossil fuel consumption; reduction of carbon dioxide (CO_2) emissions by 54,780 metric tons a year as compared to oil burning facility of comparable power.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Impacts similar to Alternative 2, with slightly reduced amount of air pollutant emissions and fugitive dust levels associated with construction due to the decrease in the number of turbines. Negligible construction-related effects to climate change. Long-term beneficial effect on air quality and climate during operation due to reduction in fossil fuel consumption. Reduction of 54,780 metric tons of CO_2 emissions per year as compared to oil burning facility of comparable power.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Impacts similar to Alternative 2, with additional minor, temporary adverse air quality impacts due to greenhouse gas emissions, air pollutants, and fugitive dust during construction of additional turbines; negligible construction-related effects to climate change. Long-term beneficial effect on air quality and climate during operation due to reduction in fossil fuel consumption. Reduction of 92,076 metric tons of CO_2 emissions per year as compared to oil burning facility of comparable power.
Noise	No effect.	ITP/HCP Implementation: Negligible noise impacts. Na Pua Makani Wind Project: Minor, localized, temporary noise impacts during construction; Project would comply with Hawaii Department of Health (DOH) permit. Minor, localized, long-term increase in noise during operation; would comply with HAR 11-46 sound level limits. Negligible low frequency noise/infrasound impacts.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Noise similar to Alternative 2. Minor, localized, temporary noise impacts during construction (impacts would occur again during construction of additional turbines). Minor, localized, long-term increase in noise during operation; would comply with HAR 11-46 sound level limits. Negligible low frequency noise/infrasound impacts.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Noise similar to Alternative 2. Minor, localized, temporary noise impacts during construction (impacts would occur again during construction of additional turbines). Minor, localized, long-term increase in noise during operation; would comply with HAR 11-46 sound level limits. Negligible low frequency noise/ infrasound impacts.

Table ES-1. Summary of Impacts by Alternative (continued)

Resource	Alternative 1: No Action	Alternative 2: Proposed Action (8 to 10 Turbine Wind Project)	Alternative 2a: Modified Proposed Action (Up to 9 Turbines with Greater Generating Capacity and Larger Dimensions)	Alternative 3: Larger Generation Wind Project (Up to 12 Turbine Wind Project)
Hazardous and Regulated Materials and Wastes	No effect.	ITP/HCP Implementation: Negligible impacts with implementation of BMPs. Na Pua Makani Wind Project: Minor, localized, temporary risk of impacts from routine transport, use, storage, and disposal of hazardous materials; accidental spills and release of hazardous materials; exposure of workers to chemicals in excess of Occupational Safety and Health Administration (OSHA) limits and disturbance to existing contamination. Impacts minimized through BMPs (SPCC plan, Hazardous Materials and Wastes Management Plan (HMWMP), and Site Safety Handbook). Very low risk of vandalism at site due to site security.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Impacts similar to Alternative 2. Measures to minimize impacts same as under Alternative 2.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Impacts similar to Alternative 2. Additional construction phase would result in potential for additional minor, localized, temporary adverse impacts from transport of hazardous materials, accidental releases or spills, worker exposure, and would increase the amount of solid waste generated. Measures to minimize impacts same as under Alternative 2.
Natural Hazards	No effect.	ITP/HCP Implementation: Negligible impacts due to implementation of project Fire Management Plan. Na Pua Makani Wind Project: Negligible to minor impacts to construction and operation. Impacts from natural hazards minimized through project design features and implementation of FMP and Site Safety Handbook.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Impacts from natural hazards same as described for Alternative 2.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Impacts from natural hazards same as described for Alternative 2.

Table ES-1. Summary of Impacts by Alternative (continued)

Resource	Alternative 1: No Action	Alternative 2: Proposed Action (8 to 10 Turbine Wind Project)	Alternative 2a: Modified Proposed Action (Up to 9 Turbines with Greater Generating Capacity and Larger Dimensions)	Alternative 3: Larger Generation Wind Project (Up to 12 Turbine Wind Project)
Vegetation	No effect.	ITP/HCP Implementation: Negligible impacts to vegetation from implementation of mitigation activities; long-term beneficial effects to vegetation associated with forest restoration. Na Pua Makani Wind Project: Minor, localized, temporary and long-term effects associated with vegetation removal (primarily non-native species). Approximately 89.0 acres (36.0 hectares) affected during construction, of which 59.9 acres (24.2 hectares) affected over the long-term in association with Project facilities. Potential for indirect impacts (fire, invasive plants) minimized through implementation of BMPs (TESC plan, FMP); revegetation of temporarily disturbed areas; and invasive species prevention measures.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Impacts to vegetation similar to Alternative 2. Approximately 84.5 acres (34.2 hectares) of vegetation removal during construction, including 56.7 acres (22.9 hectares) impacted over the long term. Measures to minimize impacts same as under Alternative 2.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Impacts to vegetation similar to Alternative 2. Approximately 98.6 acres (39.9 hectares) of vegetation removal during construction, including 69.6 acres (28.2 hectares) impacted over the long-term. Measures to minimize impacts same as under Alternative 2.

Table ES-1. Summary of Impacts by Alternative (continued)

Resource	Alternative 1: No Action	Alternative 2: Proposed Action (8 to 10 Turbine Wind Project)	Alternative 2a: Modified Proposed Action (Up to 9 Turbines with Greater Generating Capacity and Larger Dimensions)	Alternative 3: Larger Generation Wind Project (Up to 12 Turbine Wind Project)
Wildlife	No beneficial effects from habitat restoration and management efforts in the mitigation areas. No adverse effects associated with the wind farm.	ITP/HCP Implementation: Negligible adverse effects; long-term beneficial effects due to habitat restoration and management activities. Na Pua Makani Wind Project: Minor, localized habitat removal (no high quality or unique habitats); collision potential; and temporary noise and disturbance associated with construction and operation activities. Common, non-native species most likely impacted, although collision potential exists for MBTA-protected and other avian species of concern. Impacts would be avoided or minimized through implementation of the HCP.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Impacts during construction similar to Alternative 2. Minor, localized habitat removal (fewer acres than Alternative 2). Potential increased risk of collision for MBTA-protected and other avian species associated with taller turbines with greater rotor-swept area, but effect may be counteracted by operation of fewer turbines. Measures to minimize impacts same as under Alternative 2.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Impacts similar to Alternative 2, but additional impacts associated with construction and operation of additional turbines. Measures to minimize impacts same as under Alternative 2.

Table ES-1. Summary of Impacts by Alternative (continued)

Resource	Alternative 1: No Action	Alternative 2: Proposed Action (8 to 10 Turbine Wind Project)	Alternative 2a: Modified Proposed Action (Up to 9 Turbines with Greater Generating Capacity and Larger Dimensions)	Alternative 3: Larger Generation Wind Project (Up to 12 Turbine Wind Project)
Threatened and Endangered Species	No adverse effect. No beneficial effect associated with implementation of Project HCP mitigation measures.	ITP/HCP Implementation: Negligible adverse effects associated with HCP implementation. Long-term beneficial effects associated with the protection (fence installation or maintenance) and/or enhancement (invasive plant species control and feral pig removal) of native ecosystems, reduction in predation pressure (predator control), and/or through research and management. Overall net benefit to Covered Species from implementation of the HCP. Na Pua Makani Wind Project: Potential for collision with turbines; impacts considered negligible due to the net benefit of HCP mitigation activities (i.e., no population level effects anticipated). Requested take of Covered Species: Hawaiian hoary bat: Tier 1: 34 bats; Tier 2: 51 bats (tiers not additive; total take requested is 51 bats); mitigation consists of funding of bat research study and habitat restoration at Poamoho Ridge Mitigation Area. Newell's shearwater: 4 adults/fledged young, 2 chicks/eggs: mitigation consists of funding to support research and management of Newell's shearwaters. Hawaiian Goose: 6 adults; mitigation consists of constructing protective fencing at James Campbell NWR.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Requested take authorizations are the same under the Proposed Action and Modified Proposed Action Option; the final HCP incorporates a wind project of nine larger turbines with greater generating capacities.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Impacts similar to Alternative 2. Increased risk of injury or mortality from construction and operation of additional turbines and associated facilities. Prior to the construction of the additional turbines proposed under Alternative 3, NPMPP would reopen consultation with the USFWS and DOFAW to assess the potential impacts of the additional turbines to listed species and develop appropriate mitigation measures.

Table ES-1. Summary of Impacts by Alternative (continued)

Resource	Alternative 1: No Action	Alternative 2: Proposed Action (8 to 10 Turbine Wind Project)	Alternative 2a: Modified Proposed Action (Up to 9 Turbines with Greater Generating Capacity and Larger Dimensions)	Alternative 3: Larger Generation Wind Project (Up to 12 Turbine Wind Project)
		Waterbirds: 4 Hawaiian duck adults, 4 Hawaiian stilt adults, 8 Hawaiian coot adults, 8 Hawaiian moorhen adults; mitigation consists of installation of fence and public information signs and funding of part-time biologist at Hamakua Marsh Mitigation Area. Hawaiian short-eared owl: 4 adults/fledged young, 4 chicks/eggs; mitigation consists of funding to support research and management of Hawaiian short-eared owls.		
Socioeconomic Resources	No adverse effects. No beneficial socioeconomic impacts associated with employment or tax revenues that would occur during construction and operation.	ITP/HCP Implementation: Minor beneficial effects associated with short-term and long-term employment associated with implementing mitigation. Na Pua Makani Wind Project: Minor short-term and long-term beneficial socioeconomic impacts through construction expenditures, job creation (approximately 43 short-term construction jobs and 3 to 6 full-time jobs during operation), and tax revenues. Negligible to minor, localized, temporary adverse effects associated demand for housing and community services associated with construction workforce. Adverse effects to property values or ability of homeowners to install rooftop photovoltaic systems on their homes not anticipated. Project would provide source of renewable energy helping Hawaii Electric Company (HECO) meet its Renewable Portfolio Standard (RPS) requirements. Includes long-term Community Benefits Package.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Impacts similar to Alternative 2.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Impacts similar to Alternative 2. Similar, but proportionally smaller beneficial socioeconomic effects from construction of additional turbines. Approximately 34 additional short-term construction jobs and 1 to 2 additional full-time jobs during operation. Additional negligible to minor, localized, temporary adverse effects associated demand for housing and community services associated with construction workforce. Project would provide additional source of renewable energy helping Hawaii Electric Company (HECO) meet its Renewable Portfolio Standard (RPS) requirements.

Table ES-1. Summary of Impacts by Alternative (continued)

Resource	Alternative 1: No Action	Alternative 2: Proposed Action (8 to 10 Turbine Wind Project)	Alternative 2a: Modified Proposed Action (Up to 9 Turbines with Greater Generating Capacity and Larger Dimensions)	Alternative 3: Larger Generation Wind Project (Up to 12 Turbine Wind Project)
Historic, Archaeological, and Cultural Resources	No effect.	ITP/HCP Implementation: Negligible adverse effects; all cultural resources would be avoided. Minor beneficial effect in Hamakua Marsh Mitigation Area due to presence of fence which would reduce trespassing into and littering near archaeological sites. Na Pua Makani Wind Project: Minor, localized, adverse effects to historic and archaeological resources meeting National Historic Preservation Act Criterion D (sites with information potential). Five sites have yielded information (through archaeological survey work) and are no longer eligible for National Register of Historic Places (NRHP) or Hawaii Register of Historic Places (HRHP) listing; no further work recommended for these sites. Three sites recommended as eligible for HRHP listing due to information potential; impacts mitigated through archaeological resources data recovery from these sites. Six sites are recommended for preservation and are potentially eligible for listing on the HRHP or NRHP.. All other archaeological sites within APE will be avoided. Access to the wind farm site would be controlled to avoid any indirect impacts to known archaeological resources associated with vandalism or theft. Negligible effects to traditional cultural uses and practices as none are known in the wind farm site, and there would be no change in mauka/makai (mountain to shoreline) access.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Same as Alternative 2.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Same as Alternative 2.

Table ES-1. Summary of Impacts by Alternative (continued)

Resource	Alternative 1: No Action	Alternative 2: Proposed Action (8 to 10 Turbine Wind Project)	Alternative 2a: Modified Proposed Action (Up to 9 Turbines with Greater Generating Capacity and Larger Dimensions)	Alternative 3: Larger Generation Wind Project (Up to 12 Turbine Wind Project)
Land Use	No effect.	ITP/HCP Implementation: Negligible adverse effects and minor beneficial effects to land use within the mitigation areas. Na Pua Makani Wind Project: Wind energy development is a compatible use on proposed wind farm site lands. Minor, localized short-term and long-term adverse effects to farming activities (approximately 8.2 acres (3.3 hectares) active agriculture affected during construction, of which 4.6 acres (1.8 hectares) would be affected during operation. However, no net loss of active agriculture because NPMPP would work with Malaekahana Hui West, LLC to prepare non-farmed lands within individual farmers lease areas for agricultural production. Minor and intermittent delays of access to nearby land uses may occur due to construction traffic and due to routine maintenance activities during operation. Project in compliance with existing land use plans and policies.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Impacts similar to Alternative 2. Approximately 6.0 acres (2.4 hectares) of active farm land affected during construction, including approximately 2.7 acres (1.1 hectares) affected during operation. However, no net loss of active agriculture because NPMPP and Malaekahana Hui West, LLC would prepare non-farmed lands within individual farmers lease areas for agricultural production.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Impacts similar to Alternative 2. Approximately 13.3 acres (5.4 hectares) of active agriculture affected during construction, including approximately 9.3 acres (3.7 hectares) affected during operation. However, no net loss of active agriculture because NPMPP would work with Malaekahana Hui West, LLC to prepare non-farmed lands within individual farmers lease areas for agricultural production.

Table ES-1. Summary of Impacts by Alternative (continued)

Resource	Alternative 1: No Action	Alternative 2: Proposed Action (8 to 10 Turbine Wind Project)	Alternative 2a: Modified Proposed Action (Up to 9 Turbines with Greater Generating Capacity and Larger Dimensions)	Alternative 3: Larger Generation Wind Project (Up to 12 Turbine Wind Project)
Recreation and Tourism	No effect.	ITP/HCP Implementation: Negligible effects to recreation and tourism. Na Pua Makani Wind Project: No loss of recreation opportunities; negligible effects to recreation opportunities associated with Project noise, traffic, and visual effects and changes in recreation and tourism use rates.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Similar to Alternative 2. No loss of recreation opportunities and no anticipated change in recreation or tourism rates due to noise, traffic, or visual effects. Although the larger turbines would create slightly more visual contrast on an individual basis, the degree of increased contrast would not be sufficient to result in a change to the overall visual impact of the wind farm at any site. At some sites, fewer turbines would be visible resulting in a slight reduction in the incremental visual change created by the Project.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Similar to Alternative 2. Negligible effects associated with noise and traffic during second construction period.
Visual Resources	No effect.	ITP/HCP Implementation: Minor, short-term and long-term adverse visual impacts due mitigation activities at Hamakua Marsh and Poamoho Ridge mitigation areas and presence of mitigation fence at Hamakua Marsh, respectively. Na Pua Makani Wind Project: Minor, temporary adverse impacts during construction due to presence of vehicles and equipment and dust. Moderate, long-term adverse impacts due to Project visibility mitigated through design and lighting measures. Project most visible from locations within 1 mile (1.6 kilometers from wind farm site).	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Visual impacts similar to Alternative 2; however, Modified Proposed Action Option would include nine larger turbines. Although the larger turbines would create slightly more contrast at each viewpoint, the degree of increased contrast would not be sufficient to result in a change to the contrast rating at any of the viewpoints as compared to Alternative 2. Measures to minimize impacts same as under Alternative 2.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Visual impacts similar to Alternative 2. Two construction periods under Alternative 3, each resulting in similar visual impacts. Measures to minimize impacts same as under Alternative 2.

Table ES-1. Summary of Impacts by Alternative (continued)

Resource	Alternative 1: No Action	Alternative 2: Proposed Action (8 to 10 Turbine Wind Project)	Alternative 2a: Modified Proposed Action (Up to 9 Turbines with Greater Generating Capacity and Larger Dimensions)	Alternative 3: Larger Generation Wind Project (Up to 12 Turbine Wind Project)
Transportation	No effect.	ITP/HCP Implementation: Negligible effects to transportation. Na Pua Makani Wind Project: Up to 100 nighttime roundtrips of oversized loads needed during 20 construction days. Average of 144 daytime and 154 nighttime construction-related trips per day. Minor, temporary adverse impact on transportation, minimized through implementation of traffic management plan and permit requirements for oversize and overweight loads. Temporary modifications of overhead utility lines, relocation of traffic lights and guardrails, tree trimming, and asphalt curb removal necessary along construction access routes. Negligible long-term Project-related transportation effects.	ITP/HCP Implementation: Same as Alternative 2 Na Pua Makani Wind Project: Same as Alternative 2. Fewer, taller wind turbines would result would result in the same number of nighttime roundtrips, average number of truck trips per day and maximum number of truck trips per day. Measures to minimize traffic impacts same as Alternative 2.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Impacts similar to Alternative 2. Additional 40 nighttime roundtrips of oversized loads during approximately 8 days of construction for the additional turbines, above roundtrip requirements for first 8 to 10 turbines. Negligible long-term Project-related transportation effects. Measures to minimize impacts same as Alternative 2.
Public Health and Safety	No effect.	ITP/HCP Implementation: Negligible effects on public health and safety. Na Pua Makani Wind Project: Negligible impacts associated turbine collapse and blade throw, EMF, and stray voltage and minor, long-term impacts associated with fire and fuels; impacts minimized by implementation of mitigation measures, including adherence to industry design standards and implementation of the Site Safety Handbook and other Project plans. Moderate, long-term shadow flicker impacts; 98 percent of receptors predicted to experience below 30 hours of shadow flicker per year (industry standard).	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Impacts same as Alternative 2 with the exception of slightly greater shadow flicker at some receptors (97 percent of receptors predicted to experience below 30 hours of shadow per year). Measures to minimize impacts same as Alternative 2.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Impacts similar to Alternative 2. Additional safety issues associated with second construction period under Alternative 3; impacts to public health and safety from additional turbines comparable to Alternative 2. Measures to minimize impacts same as Alternative 2.

Table ES-1. Summary of Impacts by Alternative (continued)

Resource	Alternative 1: No Action	Alternative 2: Proposed Action (8 to 10 Turbine Wind Project)	Alternative 2a: Modified Proposed Action (Up to 9 Turbines with Greater Generating Capacity and Larger Dimensions)	Alternative 3: Larger Generation Wind Project (Up to 12 Turbine Wind Project)
Environmental Justice	No effect.	ITP/HCP Implementation: No effect. Na Pua Makani Wind Project: No high and adverse human health or environmental effects anticipated with construction or operation of the Project; all other effects (e.g., visual, noise, public health and safety, socioeconomic) less than significant. Because there are no high or adverse effects to any population, there would be no high or adverse effects to any minority or low income population and, therefore, no environmental justice issues resulting from this Project	ITP/HCP Implementation: No effect. Na Pua Makani Wind Project: Same as Alternative 2.	ITP/HCP Implementation: No effect. Na Pua Makani Wind Project: Same as Alternative 2.
Public Infrastructure and Services	No effect.	ITP/HCP Implementation: No effect. Na Pua Makani Wind Project: Minor short- and long-term adverse effects on public infrastructure and the provision of public services. Minor additional demands for electricity, water, wastewater services, stormwater management, solid waste services, and emergency and health services during construction and operation. Project would provide source of renewable energy helping HECO meet its RPS requirements.	ITP/HCP Implementation: No effect. Na Pua Makani Wind Project: Impacts similar to Alternative 2.	ITP/HCP Implementation: No effect. Na Pua Makani Wind Project: Impacts similar to Alternative 2. Additional, minor demands for electricity, water, wastewater services, stormwater management, solid waste services, and emergency and health services during construction and operation of additional turbines.
Military Interests	No effect.	ITP/HCP Implementation: Negligible impact on military interests. Na Pua Makani Wind Project: No effect from construction. Negligible effects to military interests or the ability of the military to conduct training operations during operation.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Same as Alternative 2.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Same as Alternative 2.

Table ES-1. Summary of Impacts by Alternative (continued)

Resource	Alternative 1: No Action	Alternative 2: Proposed Action (8 to 10 Turbine Wind Project)	Alternative 2a: Modified Proposed Action (Up to 9 Turbines with Greater Generating Capacity and Larger Dimensions)	Alternative 3: Larger Generation Wind Project (Up to 12 Turbine Wind Project)
Agriculture	No effect.	ITP/HCP Implementation: Minor effects on agricultural resources due to post-construction monitoring activities (planting of low growing crops to improve visibility of downed birds and bats). Na Pua Makani Wind Project: Potential for short-term reductions in road access and/or access to irrigation water during construction. Approximately 21.6 acres (8.7 hectares) of land with LSB ratings of A and B (most productive soils); 12.6 acres (5.1 hectares) of Prime Agricultural Land; and 2.9 acres (1.2 hectares) of soils with an NRCS Class II (conducive to agricultural production) rating would be impacted over the long term. No net loss in active agriculture; NPMPP would work with Malaekahana Hui West, LLC to assist farmers in preparing this non-farmed lands for agricultural production	ITP/HCP Implementation: Similar as Alternative 2 with slightly less impacts from post construction monitoring due to fewer wind turbines. Na Pua Makani Wind Project: Impacts similar to Alternative 2. Approximately 18.8 acres (7.6 hectares) of land with LSB ratings of A and B (most productive soils); 9.4 acres (3.4 hectares) of Prime Agricultural Land; and 1.2 acres (0.5 hectares) of soils with an NRCS Class II (conducive to agricultural production) rating would be impacted over the long term. No net loss in active agriculture; mitigation same as Alternative 2.	ITP/HCP Implementation: Same as Alternative 2. Na Pua Makani Wind Project: Impacts similar to Alternative 2. Approximately 30.7 acres (12.4 hectares) of land with LSB ratings of A and B (most productive soils); 22.4 acres (9.0 hectares) of Prime Agricultural Land; and 3.0 acres (1.2 hectares) of soils with an NRCS Class II (conducive to agricultural production) rating would be impacted over the long term. No net loss in active agriculture; mitigation same as Alternative 2.

1.0 INTRODUCTION AND PURPOSE AND NEED

1.1 INTRODUCTION

This Supplemental Final Environmental Impact Statement (EIS) for the Na Pua Makani Wind Project (Project) and Habitat Conservation Plan has been prepared by the U.S. Fish and Wildlife Service (USFWS) pursuant to the National Environmental Policy Act (NEPA), as amended (42 U.S.C. §4321 et seq.), and Council on Environmental Quality (CEQ) regulations (40 CFR Part 1502.9). This chapter provides an overview of the proposed Project and summary of the NEPA environmental review; describes the purpose of this Supplemental Final EIS; describes the Project location including HCP mitigation areas; and presents the purpose and need for the Federal action.

1.2 PROJECT OVERVIEW AND NEPA ENVIRONMENTAL REVIEW SUMMARY

Na Pua Makani Power Partners, LLC (NPMPP), a wholly owned subsidiary of Champlin Oahu Wind Holdings, LLC, proposes to construct and operate the proposed Project near the town of Kahuku on the island of Oahu, Hawaii (Figure 1-1). The proposed Project would consist of wind turbine generators and associated infrastructures, with a nameplate generating capacity of up to approximately 25 megawatts (MW). Because the proposed Project could potentially impact species listed under the Federal Endangered Species Act (ESA), NPMPP is preparing a joint Federal and State Habitat Conservation Plan (HCP) to accompany its application for an Incidental Take Permit (ITP) from the USFWS, and an Incidental Take License (ITL) from the Hawaii Department of Land and Natural Resources (DLNR) Division of Forestry and Wildlife (DOFAW) under Hawaii Revised Statute (HRS) Section 195D. The purpose of the HCP is to ensure that measures to minimize and mitigate the adverse effects of the applicant's proposed action on the Covered Species are adequate. The USFWS will use the environmental review process to determine whether or not to issue an ITP to NPMPP.

The environmental review process for the Project began as a joint State and Federal effort with public scoping and preparation of the Draft EIS satisfying both NEPA and State Chapter 343 Hawaii Environmental Policy Act (HEPA) requirements. The HEPA environmental review process was triggered because the proposed Project is located on State of Hawaii lands, requiring a commercial lease from the State of Hawaii Department of Land and Natural Resources (DLNR). DLNR Land Division was the co-lead agency for the Draft EIS.

A Notice of Availability for the joint NEPA/HEPA Draft EIS and Draft HCP was published in the Federal Register on June 12, 2015 (80 FR 33535-33537). Subsequently, in response to public comments, NPMPP made a design change to reduce the maximum number of wind turbines needed to meet the required energy generating capacity for the project from 10 wind turbines under the original Proposed Action to 9 wind turbines (potentially as few as 8) with greater generating capacities and larger dimensions. The larger wind turbines were incorporated into the analysis as the Modified Proposed Action Option.

A technical analysis, comparing the original Proposed Action and the Modified Proposed Action Option, was conducted to confirm that the modified Project did not result in any significant new or more adverse environmental impacts than the original Proposed Action. This analysis was included in Appendix L to the Final EIS and is carried forward into Appendix A of this Supplemental Final EIS for reference. The Final HCP was also updated to incorporate the Modified Proposed Action Option. At this point, the Federal and State environmental review processes diverged. A Notice of Availability for a NEPA-only Final EIS and Final HCP was published in the Federal Register on June 12, 2016 (81 FR 45174-45176).

Where information supports the analysis or provides additional context, reference to the HEPA process has been retained in this Supplemental Final EIS. This is because the Federal and State environmental review processes consider the same Project, resource topics, and analyses and involved the same stakeholder groups (i.e., organizations, elected officials, and community members). Public comments received during the scoping period and Draft EIS public comment period were included in Appendix M to the Final EIS, and are incorporated by reference here.

1.3 PURPOSE OF SUPPLEMENTAL FINAL EIS

CEQ regulations require agencies to prepare supplements to either draft or final EISs if there are substantial changes in the proposed action that are relevant to environmental concerns or there are significant new circumstances or information relevant to environmental concerns that bear on the proposed action or its impacts; supplemental EISs may also be prepared if the lead agency determines that the purpose of NEPA will be furthered by doing so. Based on input from the community, the USFWS has concluded that publishing a Supplemental Final EIS and providing an additional opportunity for public review would further the purposes of NEPA and the ESA. This Supplemental Final EIS provides the public with an opportunity to review and comment on the Modified Proposed Action Option (the refined Project design with fewer but larger wind turbines).

Therefore, the format of this Supplemental Final EIS mirrors the July 2016 Final EIS in that, with the exception of the items noted below, Chapters 2 through 9 in this document are the same as those included in the July 2016 Final EIS. The effects analysis for each resource in Chapter 4 includes a separate subsection describing impacts specific to the Modified Proposed Action Option and notes where effects are consistent with, or differ from, the original Proposed Action. Between the Draft and Final EIS all technical analyses were updated to incorporate the Modified Proposed Action Option including visual simulations (discussed in Section 4.12 – Visual Resources with visual simulations in Appendix A), traffic analysis (Appendix B), noise modeling (Appendix C), and shadow flicker analysis (Appendix D). Results of all other updated technical reports are included in Chapter 4 of this EIS.

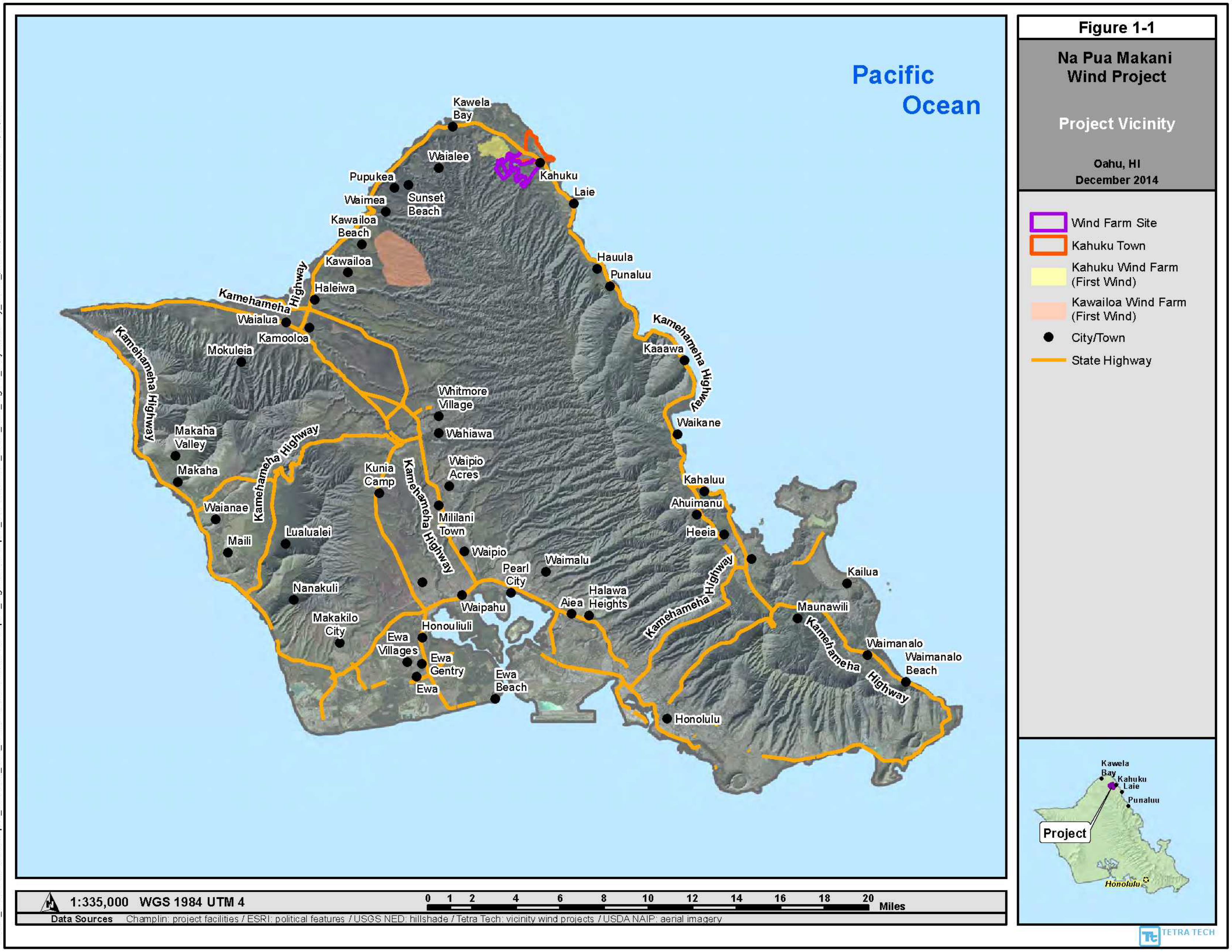
Figure 1-1
Na Pua Makani Wind Project
Project Vicinity
Oahu, HI
December 2014
Wind Farm Site
Kahuku Town
Kahuku Wind Farm (First Wind)
Kawailoa Wind Farm (First Wind)
City/Town
State Highway
Pacific Ocean
Kawela Bay
Waialee
Kahuku
Laie
Pupukea
Sunset Beach
Waimea
Kawailoa Beach
Kawailoa
Haleiwa
Hauula
Punaluu
Kamehameha Highway
Waialua
Kamooloa
Mokuleia
Kaaawa
Whitmore Village
Wahiawa
Waikane
Makaha Valley
Makaha
Waipio Acres
Kunia Camp
Kahaluu
Ahuimanu
Waianae
Mililani Town
Heeia
Maili
Lualualei
Waipio
Waimalu
Pearl City
Kailua
Nanakuli
Halawa Heights
Aiea
Waipahu
Maunawili
Makakilo City
Honouliuli
Ewa Villages
Ewa Gentry
Ewa
Ewa Beach
Waimanalo
Waimanalo Beach
Honolulu
Project
1:335,000 WGS 1984 UTM 4
0 1 2 4 6 8 10 12 14 16 18 20 Miles
Data Sources Champlin: project facilities / ESRI: political features / USGS NED: hillshade / Tetra Tech: vicinity wind projects / USDA NAIP: aerial imagery
TETRA TECH

Based on public input provided during the State environmental review process after the HEPA and NEPA processes diverged, clarification on the following topics has been added to this Supplemental Final EIS:

- The effect of the Modified Proposed Action Option on threatened and endangered species incidental take estimates (see Section 4.11 – Threatened and Endangered Species);
- Traffic and associated impacts along the Kahuku Agricultural Park Interior Roadway, accessing the DLNR-portion of the wind farm site (see Section 4.17 – Traffic); and
- Best available science regarding wind turbines and public health (see Section 4.18 – Public Health and Safety).

Following issuance of this Supplemental Final EIS, the USFWS will publish a Record of Decision (ROD) documenting its decision on whether or not to issue the ITP.

1.4 Project Description and Location

The proposed Project is located in the Koolauloa District, west of the town of Kahuku in the City and County of Honolulu. It includes portions of two parcels (Tax Map Key [TMK] 5-6-008:006 and 5-6-006:018) which would be leased from the DLNR (approximately 234 acres [95 hectares]) and from the Malaekahana Hui West, LLC (approximately 452 acres [183 hectares], of which approximately 10 acres will be leased over the long term by NPMPP), respectively. Additional parcels would be used to access the Project (TMK 5-6-006: 047, 051, 055, and 5-6-005:018) for which NPMPP has a long-term easement from the Department of Agriculture.

The leased area plus the State-owned access is hereafter referred to as the "wind farm site," consisting of approximately 707 acres (286 hectares). Within the wind farm site, all proposed Project activities would occur within a smaller approximately 464-acre (188-hectare) project area, defined for the purposes of archaeological impact assessment (see Section 3.11 of this EIS for further discussion). This area constitutes the maximum footprint of the Project within which all ground-disturbing activities would occur and which would be occupied by permanent Project facilities. The Project is located adjacent to Kamehameha Highway at its closest point, southwest of the Town of Kahuku (Figure 1-2). It is accessible via local roads off of Kamehameha Highway, and is located east of the existing Kahuku Wind Farm.

The proposed Project is located almost entirely within the State agricultural land use district with only a small portion of the wind farm site (2 acres [1 hectare]) near Kamehameha Highway falling within the State urban land use district. All of the proposed Project facilities are located within the State agricultural land use district. The proposed Project is located within Honolulu County agricultural zoning districts: General Agricultural and Restricted Agricultural. Higher elevations of the wind farm site occur on vegetated ridges not actively used for agriculture; lower elevations occur on cultivated lands. The area as a whole is highly fragmented habitat used for agriculture, with a wide array of crops being cultivated by lessees and private landowners. Some of the area is also fallow agricultural lands.

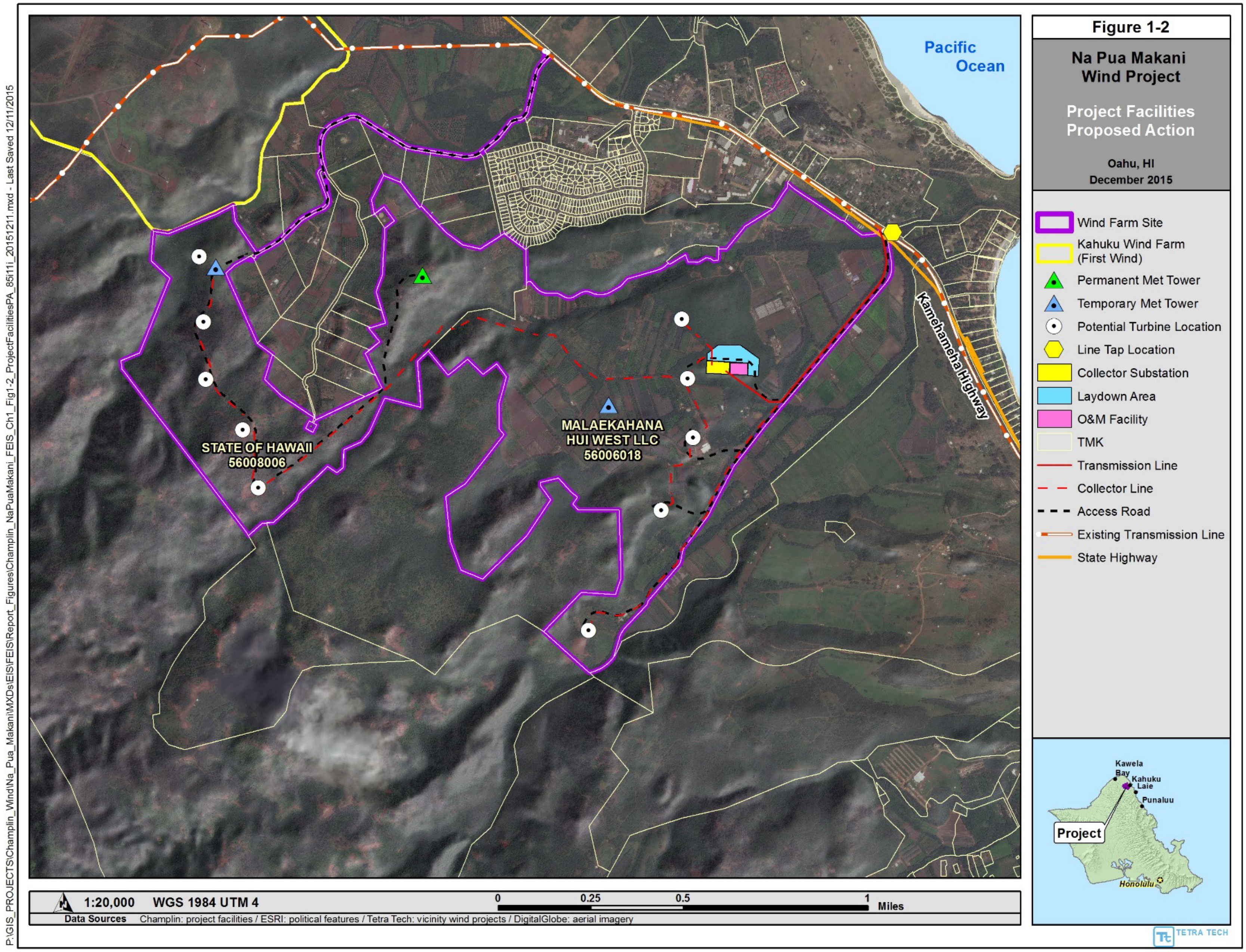
Figure 1-2
Na Pua Makani
Wind Project
Project Facilities
Proposed Action
Oahu, HI
December 2015
Wind Farm Site
Kahuku Wind Farm
(First Wind)
Permanent Met Tower
Temporary Met Tower
Potential Turbine Location
Line Tap Location
Collector Substation
Laydown Area
O&M Facility
TMK
Transmission Line
Collector Line
Access Road
Existing Transmission Line
State Highway
Pacific
Ocean
Kamehameha Highway
STATE OF HAWAII
56008006
MALAEKAHANA
HUI WEST LLC
56006018
Kawela
Bay
Kahuku
Laie
Punaluu
Project
Honolulu
1:20,000
WGS 1984 UTM 4
0
0.25
0.5
1
Miles
Data Sources
Champlin: project facilities / ESRI: political features / Tetra Tech: vicinity wind projects / DigitalGlobe: aerial imagery
TETRA TECH

The proposed Project, as considered in the Draft EIS, would consist of up to 10 turbines, each with a generating capacity of up to 3.3 MW. NPMPP is currently considering turbine models from leading turbine manufacturers including Siemens, Vestas, and GE. The turbine array could include a combination of models from a single manufacturer ranging in generating capacity and dimensions. NPMPP would select the most appropriate turbines for the site-specific conditions of the wind farm site prior to construction. The proposed Project would also include permanent facilities including access roads, overhead and underground transmission and collector lines, an onsite substation, and an operation and maintenance (O&M) building and associated storage yard and parking area. Temporary wind turbine assembly lay-down areas would also be used during construction. Chapter 2 provides a more detailed description of the Project components.

In response to public comments on the Draft EIS related to visual impacts and a request to consider fewer turbines with larger generating capacities, NPMPP reevaluated the proposed turbine locations and turbine models considered under the Draft EIS Proposed Action with the goal of reducing the number of turbines. Through this effort, NPMPP was able to reduce the maximum number of turbines needed to meet the target generating capacity for the Project from 10 turbines to 9 turbines. Depending on the selection of the final turbine model, the number of turbines may be as few as 8. This modification takes advantage of recent technological advancements that have resulted in the availability of uprated versions of turbine models that are larger, more efficient, have increased generating capacity, and are better suited for the moderate to low wind conditions of the wind farm site than previous models. These modifications are evaluated in this document as the Modified Proposed Action Option (Alternative 2a; Figure 1-3). Although a nine-turbine Project could ultimately be developed under the Proposed Action, the choice to separately evaluate the Modified Proposed Action Option within this document was made to fully disclose the impact tradeoffs potentially resulting from a project consisting of fewer, larger generating capacity turbines.

The Project is expected to produce, on average, approximately 88,000 megawatt hours (MWh) of electricity generation per year (assuming an installed capacity of up to approximately 25 MW). The energy generated by the Project would connect to an onsite substation and feed into HECO's grid (Figure 1-2).

1.4.1 HCP Mitigation Sites

As stated in Section 1.2, the proposed Federal action which triggers public review under NEPA is approval of the proposed HCP and the issuance of an ITP by USFWS. The ITP is required because construction and operation of the Project have the potential to result in the incidental take of eight species listed under the Federal ESA that may inhabit or may transit through the wind farm site. The HCP provides mitigation for protecting the covered species in the wind farm site in addition to adding protection and habitat for the covered species in offsite areas.

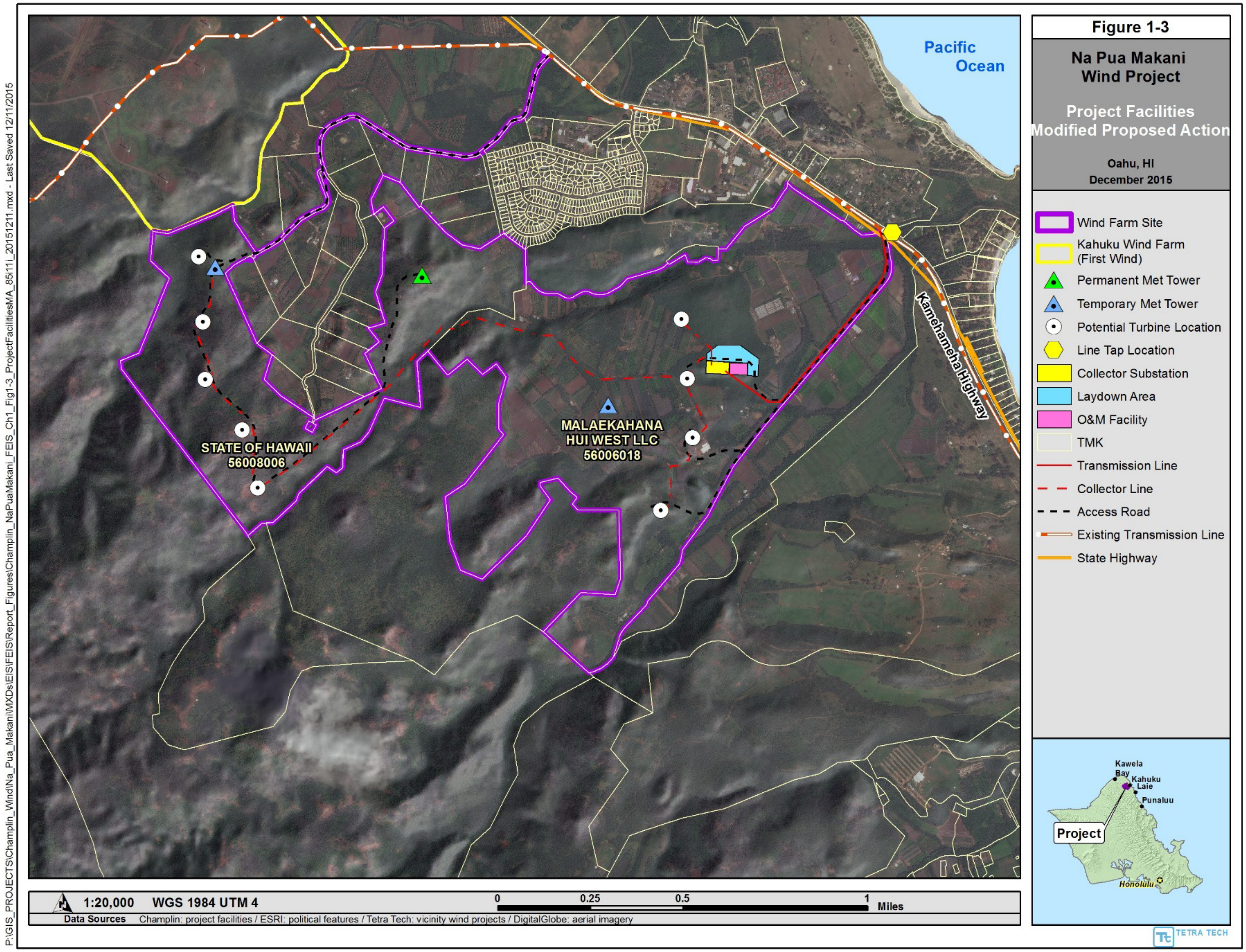
Figure 1-3
Na Pua Makani Wind Project
Project Facilities Modified Proposed Action
Oahu, HI
December 2015
Wind Farm Site
Kahuku Wind Farm (First Wind)
Permanent Met Tower
Temporary Met Tower
Potential Turbine Location
Line Tap Location
Collector Substation
Laydown Area
O&M Facility
TMK
Transmission Line
Collector Line
Access Road
Existing Transmission Line
State Highway
Pacific Ocean
Kamehameha Highway
STATE OF HAWAII 56008006
MALAEKAHANA HUI WEST LLC 56006018
Kawela Bay
Kahuku
Laie
Punaluu
Project
Honolulu
1:20,000 WGS 1984 UTM 4
0 0.25 0.5 1 Miles
Data Sources Champlin: project facilities / ESRI: political features / Tetra Tech: vicinity wind projects / DigitalGlobe: aerial imagery
TETRA TECH
P:\GIS_PROJECTS\Champlin_Wind\Na_Pua_Makani\MXDs\EIS\FEIS\Report_Figures\Champlin_NaPuaMakani_FEIS_Ch1_Fig1-3_ProjectFacilitiesMA_85i11i_20151211.mxd - Last Saved 12/11/2015

These eight species requiring additional protection include:

- the ‘a’o or Newell’s shearwater (*Puffinus newelli*),
- the koloa maoli or Hawaiian duck (*Anas wyvilliana*),
- the ae’o or Hawaiian black-necked stilt (*Himantopus mexicanus knudseni*),
- the ‘alae ke’oke’o or Hawaiian coot (*Fulica alai*),
- the ‘alae ‘ula or Hawaiian common moorhen (*Gallinula chloropus sandvicensis*),
- the pueo or Hawaiian short-eared owl (*Asio flammeus sandwichensis*),
- the ope‘ape‘a or Hawaiian hoary bat (*Lasiurus cinereus semotus*), and
- the nene or Hawaiian goose (*Branta sandvicensis*)

These species are also listed under the Hawaii Endangered Species Act (HRS Section 195D-1-32). The ITP/ITL would authorize the incidental take of these species (referred to hereafter as the “Covered Species”) as a result of otherwise lawful activities of the Project.

The HCP includes conservation measures intended to avoid, minimize, and mitigate for potential incidental take of the Covered Species. Mitigation measures described in the HCP would be implemented off-site (i.e., outside of the wind farm) and are intended to offset or compensate for the effects of incidental take of the Covered Species through beneficial effects associated with management and monitoring or through enhancement and improvement of their habitats at the mitigation sites. The implementation of the conservation measures described in detail within the HCP will be discussed and analyzed as appropriate in Chapters 3 and 4. The geographic areas that are the focus of the HCP mitigation measures that involve habitat restoration are:

- **Hamakua Marsh,** a DLNR-owned waterbird sanctuary located on the edge of the town of Kailua adjacent to Kawainui Marsh, a DLNR-owned and managed waterbird management area. The combined area forms 714 acres (289 hectares) of State-managed wetlands, with 34 acres (14 hectares) within Hamakua Marsh and 680 acres (275 hectares) within Kawainui Marsh (Figure 1-4).
- **Poamoho Ridge,** a DLNR-owned forested habitat occurring along the leeward summit of the central Koolau Mountains. It is located above Wahiawa in the Ewa Forest Reserve, and is part of the State Natural Area Reserve System (Figure 1-5). It contains suitable, but degraded, bat habitat within two units that are 655 acres (265 hectares) and 618 acres (250 hectares), respectively, which DLNR has already identified for native forest restoration.
- **James Campbell National Wildlife Refuge (James Campbell NWR),** part of the Oahu National Wildlife Refuge complex located approximately 0.75 mile (mi; 1.2 kilometers [km]) to the north of the Project (Figure 1-6). It includes one of the few scattered remnants of natural wetlands that still exist on Oahu. The James Campbell NWR Comprehensive Conservation Plan (USFWS 2011a) identifies several management units for which activities such as fencing, predator control, and invasive plant species control are prescribed as measures to protect endangered waterbirds, migratory shorebirds, waterfowl, and seabirds and their habitats.

Other HCP mitigation measures which are not location-specific are described in detail in Chapter 2.

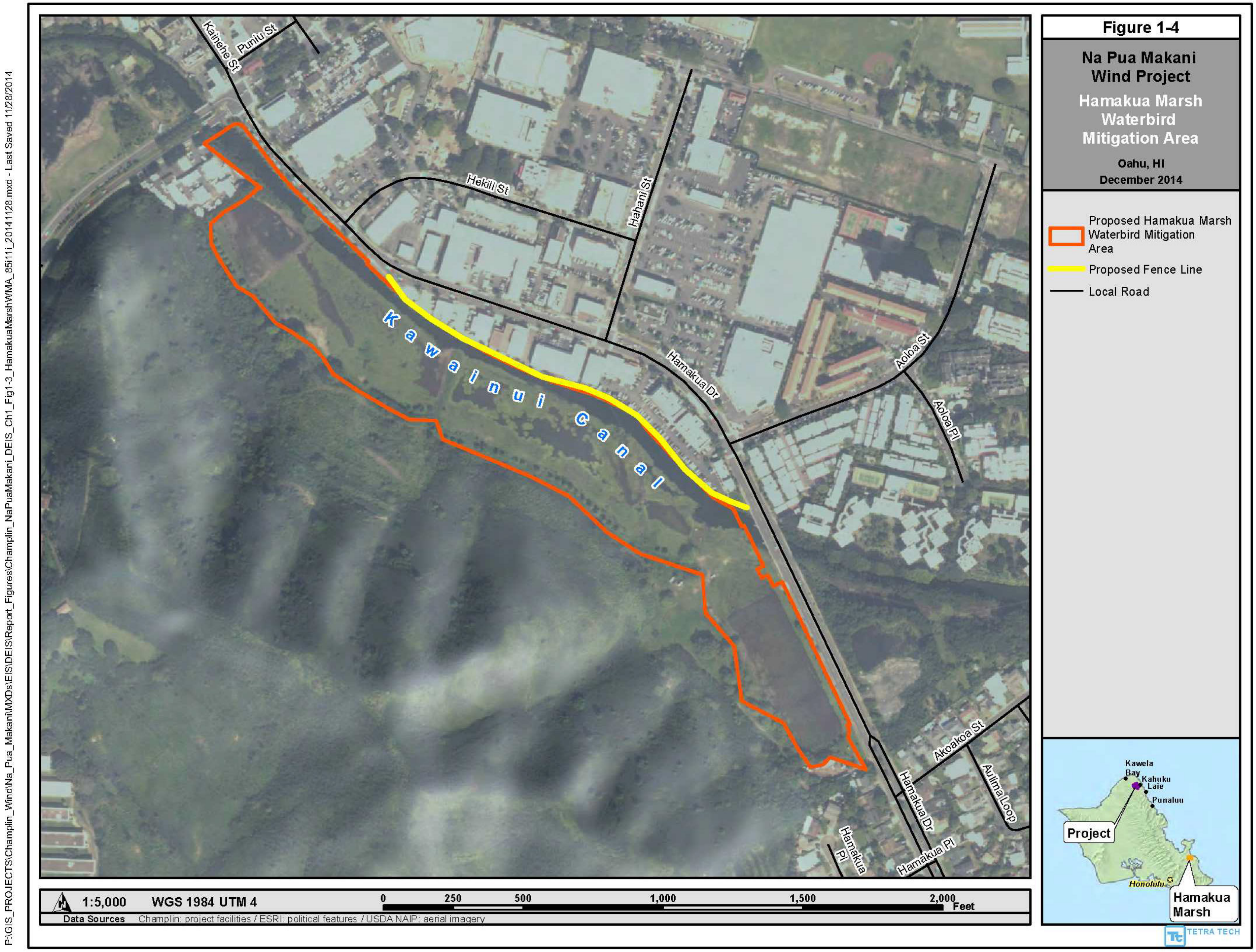
Figure 1-4
Na Pua Makani Wind Project
Hamakua Marsh Waterbird Mitigation Area
Oahu, HI
December 2014
Proposed Hamakua Marsh Waterbird Mitigation Area
Proposed Fence Line
Local Road
Kaineho St
Puniu St
Hekili St
Hahani St
Hamakua Dr
Aoloa St
Aoloa Pl
Kawainui Canal
Akoakoa St
Aulima Loop
Hamakua Pl
Kawela Bay
Kahuku
Laie
Punaluu
Project
Honolulu
Hamakua Marsh
1:5,000
WGS 1984 UTM 4
0
250
500
1,000
1,500
2,000
Feet
Data Sources Champlin: project facilities / ESRI: political features / USDA NAIP: aerial imagery
TETRA TECH
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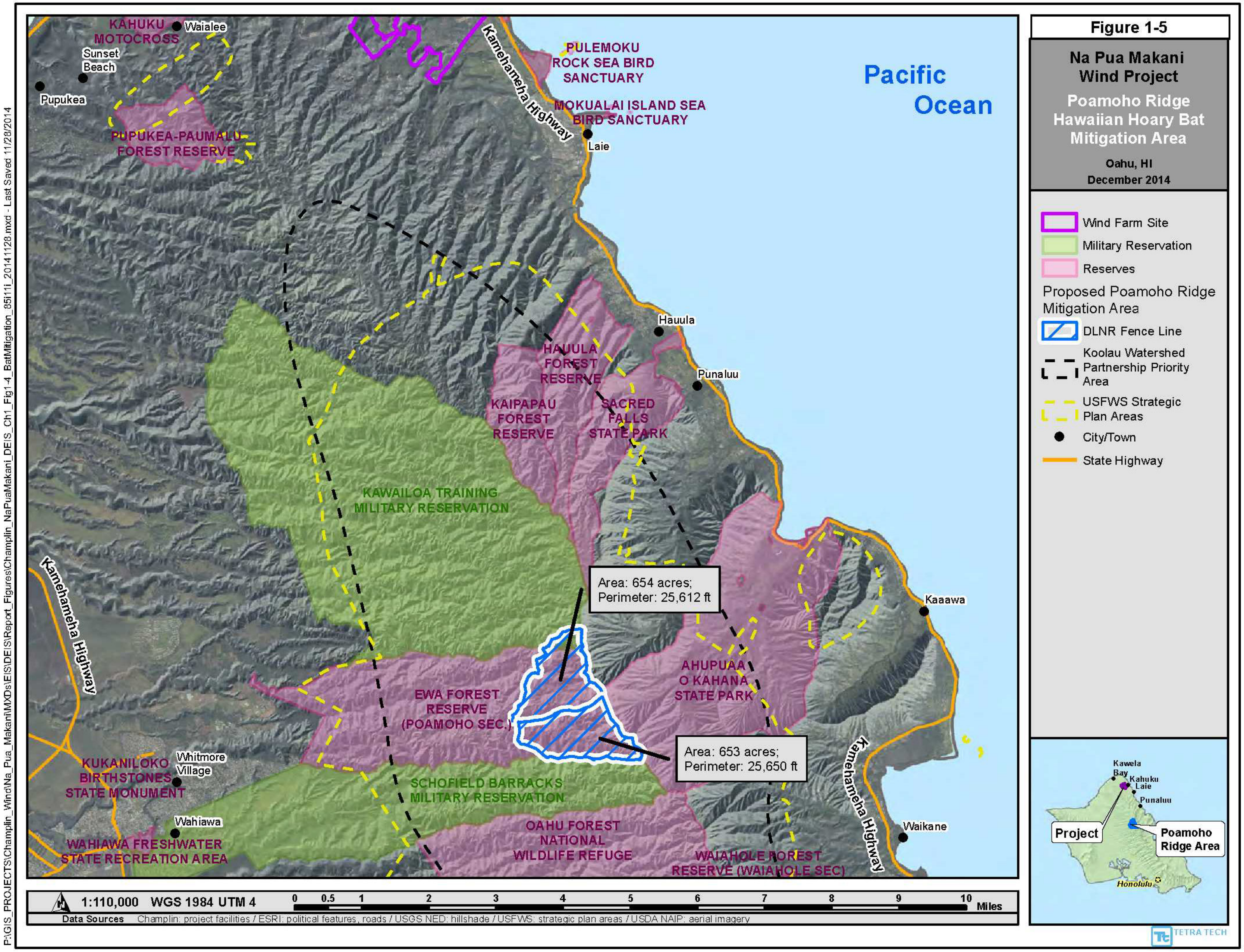
Figure 1-5
Na Pua Makani Wind Project
Poamoho Ridge Hawaiian Hoary Bat Mitigation Area
Oahu, HI
December 2014
Wind Farm Site
Military Reservation
Reserves
Proposed Poamoho Ridge Mitigation Area
DLNR Fence Line
Koolau Watershed Partnership Priority Area
USFWS Strategic Plan Areas
City/Town
State Highway
Pacific Ocean
KAHUKU MOTOCROSS
Waialee
Sunset Beach
Pupukea
PUPUKEA-PAUMALU FOREST RESERVE
PULEMOKU ROCK SEA BIRD SANCTUARY
MOKUALAI ISLAND SEA BIRD SANCTUARY
Laie
Kamehameha Highway
Hauula
Punaluu
HAUULA FOREST RESERVE
KAIPAPAU FOREST RESERVE
SACRED FALLS STATE PARK
KAWAILOA TRAINING MILITARY RESERVATION
Area: 654 acres; Perimeter: 25,612 ft
Area: 653 acres; Perimeter: 25,650 ft
Kaaawa
AHUPUAA O KAHANA STATE PARK
EWA FOREST RESERVE (POAMOHO SEC.)
KUKANILOKO BIRTHSTONES STATE MONUMENT
Whitmore Village
Wahiawa
SCHOFIELD BARRACKS MILITARY RESERVATION
OAHU FOREST NATIONAL WILDLIFE REFUGE
WAHIAWA FRESHWATER STATE RECREATION AREA
WAIAHOLE FOREST RESERVE (WAIAHOLE SEC)
Waikane
Kawela Bay
Kahuku
Laie
Punaluu
Project
Poamoho Ridge Area
Honolulu
1:110,000 WGS 1984 UTM 4
0 0.5 1 2 3 4 5 6 7 8 9 10 Miles
Data Sources Champlin: project facilities / ESRI: political features, roads / USGS NED: hillshade / USFWS: strategic plan areas / USDA NAIP: aerial imagery
TETRA TECH
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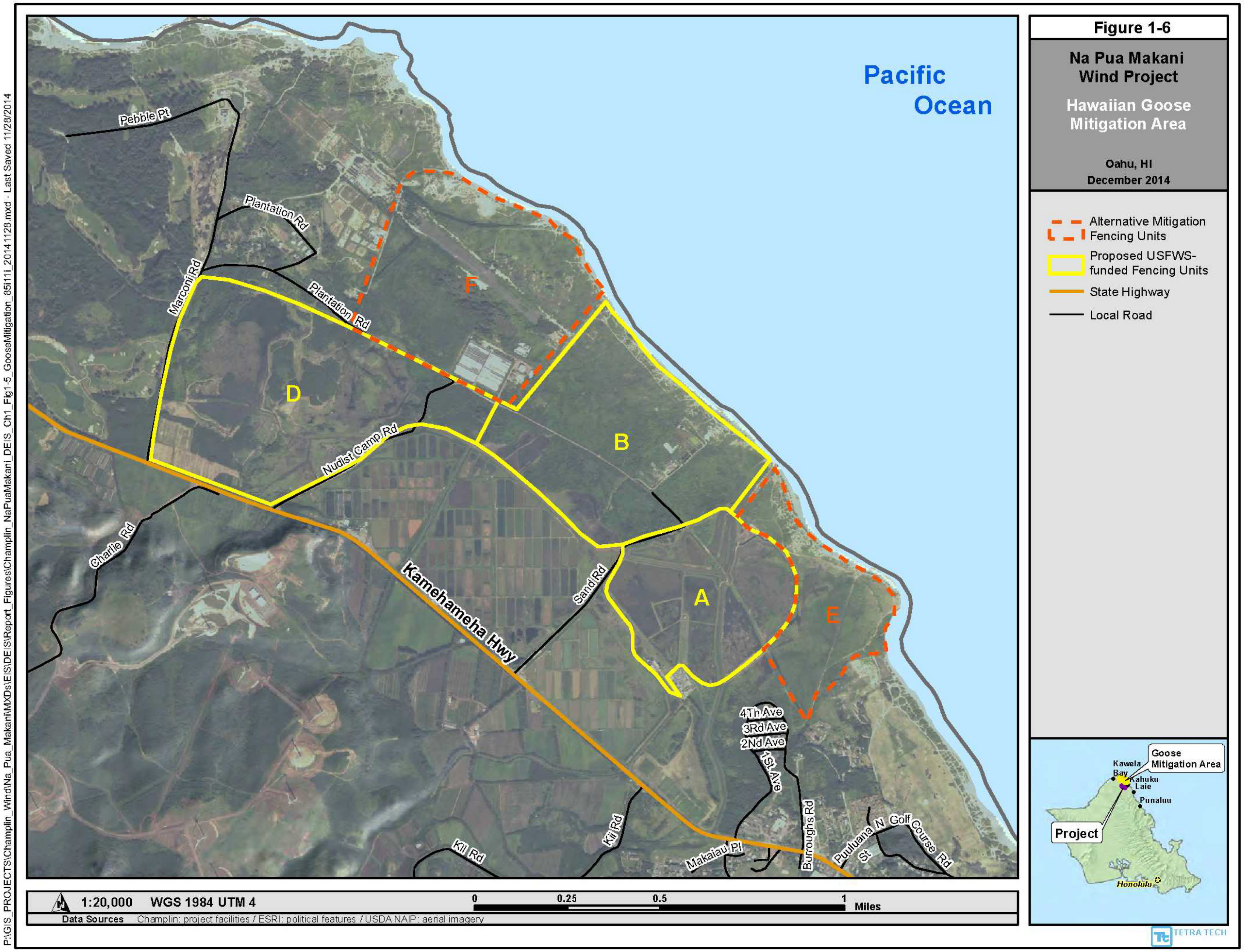
Figure 1-6
Na Pua Makani Wind Project
Hawaiian Goose Mitigation Area
Oahu, HI
December 2014
Alternative Mitigation Fencing Units
Proposed USFWS-funded Fencing Units
State Highway
Local Road
Pacific Ocean
Pebble Pt
Plantation Rd
Marconi Rd
Nudist Camp Rd
Charlie Rd
Kamehameha Hwy
Sand Rd
Kii Rd
Makaiau Pl
Burroughs Rd
Puuluana St
N Golf Course Rd
4Th Ave
3Rd Ave
2Nd Ave
1St Ave
A
B
D
E
F
Goose Mitigation Area
Project
Kawela Bay
Kahuku
Laie
Punaluu
Honolulu
1:20,000 WGS 1984 UTM 4
0 0.25 0.5 1 Miles
Data Sources Champlin: project facilities / ESRI: political features / USDA NAIP: aerial imagery
TETRA TECH
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1.5 Purpose and Need for the Proposed Action

Under NEPA, the purpose and need for a proposed action help define the range of alternatives considered. Only reasonable alternatives need be considered (40 CFR 1502.14(A)), which are those that are technically and economically feasible and that show evidence of common sense, and that also meet project objectives, resolve need, and alleviate potentially significant impacts to important resources (CEQ 46 FR 18026).

1.5.1 Purpose and Need

In accordance with NEPA, the USFWS must review the environmental impacts associated with implementation of the proposed HCP and issuance of the ITP to NPMPP. The ITP is required because construction and operation of the proposed Project have the potential to result in the incidental take[1] of eight Covered Species listed under the Federal ESA and Hawaii ESA (HRS Section 195D-1-32) that may inhabit or may transit the wind farm site.

Based on potential impacts, NPMPP is preparing a joint Federal and State HCP to accompany its application for an ITP from USFWS under ESA Section 10(a)(1)(B), and an ITL from the DLNR DOFAW under HRS Section 195D. The ITP/ITL would authorize the incidental take of the Covered Species as a result of otherwise lawful activities of the Project[2]. The purpose of the ITP/ITL is to ensure that any incidental taking that might occur would be minimized and mitigated to the maximum extent practicable and would not appreciably reduce the likelihood of the survival and recovery of the Covered Species in the wild. The proposed permit term is 21 years. The ITP/ITL would also provide a stable and predictable operating and regulatory environment and preserves the Applicant's ability to pursue their development objectives with assurances from the USFWS and DLNR DOFAW that incidental take of Covered Species is authorized. Additional background information on each Covered Species, including its status and ecology; distribution, abundance, and population trends; threats; presence on Oahu; and potential for occurrence in the wind farm site is provided in Section 3.9.

In support of an application for both the ITP and the ITL, NPMPP must prepare an HCP. This document establishes avoidance, minimization, and mitigation measures for potential impacts to the Covered Species. The purpose of the HCP is to:

1. Quantify the potential impacts that the Project may have on the listed species or species under consideration for listing;

[1] Section 9 of the ESA defines "take" as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect such species or to attempt to engage in any such conduct." Section 10(a)(1)(B) of the ESA defines incidental take as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity.

[2] Although the issuance of an ITP triggers the need for Federal environmental review, issuance of the ITL is not a trigger for environmental review under HEPA.

2. Address the potential take of the listed species by setting forth measures that are intended to ensure that any such take caused by the Project will be incidental (i.e., avoided and minimized to the extent practicable);
3. Ensure that the impacts of the take will, to the maximum extent practicable, be minimized and mitigated, and identify procedures to deal with changed and unforeseen circumstances;
4. Ensure that mitigation for impacts to listed species that cannot be avoided, will result in a net benefit to the Covered Species;
5. Ensure that adequate funding for implementation of the HCP will be provided; and
6. Ensure that the take of the listed species will not appreciably reduce the likelihood of the survival and recovery of these species in the wild.

The USFWS is the lead Federal agency for implementing the regulatory requirements of the ESA as it relates to the Project. This EIS will identify the impacts and risks associated with alternatives related to the decision on whether to issue the ITP and approve the HCP, or deny the permit if the HCP does not meet the criteria of section 10(a)(1)(B) of the ESA. As the issuance of the requested ITP constitutes a Federal action that may affect the human environment, the USFWS will evaluate the impacts that the Proposed Action and identified alternatives would have on the human environment.

The purpose and need for the Federal action is to evaluate the authorization of incidental take of the Covered Species associated with otherwise lawful construction and operation of the Project, as described in the HCP and make a decision on the application by NPMPP for an ITP for the proposed Covered Species related to activities that have the potential to result in take, pursuant to the requirements of ESA Section 10(a)(1)(B) and its implementing regulations and policies;. The USFWS may decide to:

- Issue the ITP conditioned on implementation of the Applicant's HCP;
- Issue an ITP conditioned on implementation of the Applicant's HCP together with other specified measures; or
- Deny the ITP application.

Any permit approved by the USFWS must meet all applicable issuance criteria and implementation by NPMPP should be practical and feasible. Issuance criteria include:

- The taking will be incidental;
- The Applicant will, to the maximum extent practicable, minimize and mitigate the impacts of such taking;
- The Applicant will ensure that adequate funding will be provided for the HCP;
- The taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild;
- The HCP addresses the five concepts outlined in the Five Point Policy: permit duration, public participation, adaptive management, monitoring provisions, and biological goals;
- The HCP will be implemented; and
- Such other measures that the Secretary may require as being necessary or appropriate for purposes of the HCP will be implemented. This includes provisions for addressing

Upon the completion of the EIS process, the USFWS will provide a concise record of its consideration of the environmental analysis in a Record of Decision (ROD). The ROD will discuss the agency's assessment of the alternatives considered in the EIS and its determination on whether to issue an ITP for the Project.

Section 7 of the ESA requires intra-Service consultation to address the action of issuing the ITP. In the intra-Service consultation, the USFWS evaluates the potential effects relative to baseline conditions to determine whether the Proposed Action is likely to jeopardize the continued existence of the Covered Species or result in destruction or adverse modification of the Covered Species designated critical habitat. The Service then prepares its Biological Opinion (BO), which contains an effects assessment of issuing the ITP under the implementation of the HCP on listed species and their habitats. The BO includes an incidental take statement with take limits, reasonable and prudent measures, and other terms and conditions. The internal Section 7 consultation on the Service's action of ITP issuance will be completed before the ROD finding is reached under NEPA.

2.0 PROPOSED ACTION AND ALTERNATIVES

This chapter describes and compares the alternatives considered in detail for the Project and the alternatives considered but dismissed from further analysis; it also discusses how these alternatives respond to the purpose of and need for action and address the significant issues identified during scoping (these the Scoping Report in Appendix A of the Final EIS). The alternatives considered in detail represent a range of possible actions that respond to the significant issues, purpose and need, and Federal and State laws and regulations. This chapter describes the siting and design criteria considerations for developing alternatives, the Proposed Action project description, and a description of the HCP which will be a part of the Proposed Action. The alternative development process complies with the requirements as stated in the CEQ's *Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act (NEPA).* The USFWS's Preferred alternative and the Environmentally Preferable alternative are identified and described in Chapter 6.

2.1 Alternative Development and Screening Criteria

The first step in the alternative development process was to develop and assess action alternatives that would meet the Project purpose and needs as described in Chapter 1. NEPA requires the analysis of a No Action alternative, the proposed action, and a reasonable range of alternatives to address the purpose and need for the proposed action. NPMPP developed screening criteria (listed below), with input from the public and Federal and State agencies, to assist in determining whether alternatives would be technically and economically practical and feasible

Wind Resource. For a project site to be viable and economically competitive, it must have a very good wind resource. It is well documented that the North Shore area of Oahu has the best wind resource on the island. Beginning in 2009, temporary met towers were installed within the Na Pua Makani wind farm site to obtain in-depth information about the onsite wind resources. The results of 4 years of data collection indicate that the wind regime (in terms of strength, direction, duration, turbulence, and temporal and spatial variations) throughout the wind farm site is strong due to its location and exposure to the trade winds, which accelerate as they ascend from ocean through the Wind farm site into the mountains. The data determined that there is sufficient wind resource within the wind farm site for a viable project. Ongoing wind monitoring would be used to further microsite turbine locations to maximize energy production.

Utility Interconnection and Transmission Capacity. Additionally, for a project site to be viable it must have access to adequate and available transmission capacity without the requirement for substantial upgrades required on the HECO system and be located in proximity to existing transmission lines. These factors help determine the viability and economic feasibility of a project; projects located in areas where there is no transmission capacity are not viable. Projects in locations that are not adjacent to transmission lines incur greater construction costs due to the need for longer connector lines, and may also result in greater environmental impacts than projects located closer to an existing transmission line. The Na Pua Makani wind farm site is located within approximately 1 mile (1.6 kilometers) of HECO's existing transmission system, which was determined by HECO to have an adequate capacity to support a wind project of up to approximately 25 MW without substantial transmission upgrades, or wind project of up to 42 MW with substantial transmission upgrades that would be paid for by NPMPP.

Land Availability. Wind projects require available contiguous land that is designated to allow wind energy development. The wind farm site is located on two parcels of land: one that will be leased from DLNR, and the other under private ownership that will be leased from the Malaekahana Hui West, LLC. Both parcels are classified as Agricultural District by the State Land Use District, and AG-1 and AG-2 Agricultural zoned by the City and County of Honolulu. Wind energy facilities are a permitted use on State Agricultural District and Agricultural zoned lands.

Site Conditions. Topography within the wind farm site was assessed to identify areas that would be too steep for construction or that would be inaccessible by construction vehicles. The presence of several steep ridges and deep southwest–northeast trending gullies eliminated some portions of the wind farm site from consideration because construction in these areas would be logistically infeasible and/or terrain ruggedness would inflate construction costs. After portions of the wind farm site were eliminated due to topography, the remaining land area was determined to have a sufficient area for a viable project.

Potential Impacts. The initial Project design was further refined based on input from the surrounding communities regarding visual impacts and concerns about City and County of Honolulu setback distances which are the distance equal to the maximum turbine tip height above ground. The Project design eliminated locations that were the closest and most visible from the Kamehameha highway and from the town of Kahuku. Proposed turbine locations are located at a distance several times the County-required setbacks from key points in the community including the Kahuku Medical Center, Kahuku High School, and Kahuku Elementary School. Additionally, turbine locations have been sited to avoid known biological, cultural, and archaeological resources and areas of active agriculture.

2.2 Alternatives Considered

Three alternatives are considered and analyzed in this EIS. They include:

- Alternative 1 – No Action
- Alternative 2 (Proposed Action) – Wind Project of up to 10 Turbines
- Alternative 3 – Larger Generation Wind Project (up to 12 Turbines)

In response to public comments on the Draft EIS, NPMPP reevaluated the proposed turbine locations and turbine models considered under the Proposed Action. Through this effort, NPMPP was able to reduce the maximum number of turbines needed to meet the target generating capacity for the Project from 10 to 9 using a larger generating capacity turbine model. These modifications are evaluated in this EIS as the Modified Proposed Action Option (Alternative 2a), described below. All other components of the Modified Proposed Action Option are the same as the Proposed Action.

2.2.1 Alternative 1 – No Action

CEQ regulations (1502.14(d)) require an EIS to include an alternative of No Action. The No Action alternative is analyzed as a baseline for comparative purposes with the action alternatives. This alternative would not meet the purpose and need for the Project identified in Chapter 1.

Under Alternative 1, USFWS would not issue an ITP, and the Project would not be constructed. Alternative 1 would avoid the potential take of Covered Species, but would not provide a clean source of electricity, offset carbon emissions, or contribute to the achievement of the State's renewable energy goals and achievement of the State's RPS law. Under Alternative 1, the HCP would not be implemented and beneficial activities resulting from the HCP would not occur, including protection, restoration, research, and monitoring of Covered Species.

2.2.2 Alternative 2 – Wind Project of Up to 10 Turbines (Proposed Action)

Alternative 2 is an up to approximately 25-MW project consisting of between 8 and 10 wind turbines each with a nameplate generating capacity of up to 3.3 MW (see Figure 1-2 and Section 2.4). The Project would also include permanent facilities including up to 5.0 miles (8.0 kilometers) of internal access roads, overhead and underground transmission and collector lines, an onsite substation, and an O&M building and associated storage yard and parking area. Temporary wind turbine assembly lay down areas would also be used during construction.

A more detailed description of the Project components can be found in Section 2.4. Project components and disturbance acreages for Alternative 2 are listed in Table 2-1. Best Management Practices, design features, and project plans included under the Proposed Action are described in Section 2.4.7. – Construction of this alternative would begin as soon as the fourth quarter of 2016, with commercial operation planned in 2017.

Alternative 2 includes the approval of the proposed HCP and the issuance of an ITP/ITL to authorize incidental take of the Covered Species (see Section 2.5) in association with construction and operation of the Project. The avoidance, minimization, and mitigation measures that would be implemented for the Covered Species associated with the Project HCP are discussed in detail in Section 2.5.1.

Alternative 2 meets the Applicant's goals for the Project by providing a clean source of renewable energy to the Island of Oahu, and in doing so, helps to achieve the State's new law requiring 100 percent of electricity from renewables by 2045 and also assists HECO in meeting its RPS requirements. Alternative 2 also meets the Project objectives of being located in an area with compatible land uses, being compatible with HECO's overall system requirements, and maintaining overall environmental quality and contributing to stabilizing future energy prices. It would also meet the objective of increasing the portion of Oahu's energy derived from renewable energy sources and reducing dependencies on fossil fuels.

2.2.3 Alternative 2a – Modified Proposed Action Option (up to 9 turbines)

In response to public comments on the Draft EIS related to visual impacts and consideration of fewer turbines with larger generating capacities (to reduce the total number of turbines), NPMPP reevaluated the proposed turbine locations and turbine models considered in the Draft EIS. Through this effort, NPMPP was able to reduce the maximum number of turbines needed to meet the target generating capacity for the Project. This modification takes advantage of recent technological advancements that have resulted in the availability of uprated versions of turbine models that are have increased generating capacity, more efficient, and taller and are better suited for the existing wind conditions of the wind farm site than previous models.

Accordingly, this Supplemental Final EIS analyzes a Modified Proposed Action Option (Alternative 2a) with a reduced maximum number of turbines (reduced from 10 turbine to 9 turbines) with taller dimensions than were analyzed in the Draft EIS (Figure 1-3). If the largest generating capacity turbine model under consideration was selected, a total of 8 turbines would be constructed, eliminating one turbine on each Project parcel. All other Project components would be the same as under the Proposed Action. All Best Management Practices, design features, and project plans included under the Proposed Action and described in Section 2.4.7 would also apply to the Modified Proposed Action Option. Likewise, the Modified Proposed Action Option includes the approval of the Project HCP and issuance of an ITP. Alternative 2a would continue to meet the Project's purpose and need and objectives as described above for the Proposed Action. See Section 2.2.2 for additional discussion. A supplemental analysis comparing the Draft EIS Proposed Action (modified to reflect the refined Project design; see Section 2.4 for a description of Project design changes between the Draft and Final EIS) and the Modified Proposed Action Option is included in Appendix A.

2.2.4 Alternative 3 – Larger Generation Wind Project (up to 12 turbines)

Alternative 3 would involve the construction and operation of a larger generation facility of up to approximately 42 MW. Alternative 3 would consist of up to 12 turbines total (2 to 4 additional turbines compared to the Proposed Action), each with a generating capacity of up to 3.3 MW (see Figure 2-1 and Section 2.4). Alternative 3 would include the construction of approximately 5.9 miles (9.5 kilometers) of associated internal access roads. Other Project components (substation, met towers, transmission line, etc.) would be the same as discussed under Alternative 2. Project components and disturbance acreages for Alternative 3 are listed in Table 2-1. Best Management Practices, design features, and project plans described for Alternative 2 would also apply to Alternative 3 (Section 2.4.7). As under Alternative 2, construction of the first up to 8 to 10 turbines is proposed to begin as soon as the fourth quarter of 2016, with commercial operation planned in 2017. Due to HECO transmission line upgrades required for additional turbines and associated generating capacity beyond those identified in Alternative 2, there would be a lag of at least 3 years before the construction of the additional 2 to 4 turbines. At this time, there is no specific engineering information from HECO indicating the extent or specific location of the transmission line upgrade that would be needed.

Similar to Alternative 2, Alternative 3 includes the issuance of an ITP/ITL to authorize incidental take of the Covered Species (see Section 2.5) in association with construction and operation of the up to approximately 25 MW Project and implementation of the Project HCP. Thus, avoidance, minimization, and mitigation measures identified for Covered Species would occur at levels described above for Alternative 2 (see Section 2.6). However it can be assumed that the larger project would result in additional amounts of incidental take of the Covered Species, requiring additional mitigation. Due to the uncertainty related to the timing of construction of the addition turbines under this alternative, NPMPP would re-initiate consultation with the USFWS and DOFAW prior to their construction to address potential impacts of the larger generation facility to the Covered Species. The mitigation and monitoring associated with the additional turbines would be covered in an amendment to the HCP, and would be similar in amounts and types as described in Section 2.5 for the Proposed Action.

Alternative 3 would also meet the Applicant's goals and objectives by providing a clean source of renewable energy, helping to achieve the State's new law requiring 100 percent of electricity from renewables by 2045 and also assisting HECO in meeting its RPS requirements. See Section 2.2.2 for additional discussion.

2.3 Alternatives Considered but Eliminated from Detailed Study

The following sections describe alternatives that were considered but eliminated from detailed study in this EIS. Alternatives discussed in this section were either identified by NPMPP during preparation of this EIS, or derived from comments received during the Federal and State scoping processes. Alternatives were eliminated based primarily on their failure to comply with the criteria listed in Section 2.1 which define the minimum requirements for a feasible project.

2.3.1 Larger Project Size (greater than approximately 42 MW)

The generating capacity of a wind farm is limited by the amount contiguous land at the site as well as the amount of wind-generated energy that the existing high voltage electrical grid can accept. On Oahu, HECO has determined that the grid in the Kahuku area can accept no more than approximately 25 MW of additional energy, as is currently proposed by NPMPP, without significant and costly upgrades to the transmission system. Therefore, an increase in Project generating capacity past that amount is not feasible without major upgrades to the existing transmission system.

Additionally, the number of additional turbines that are feasible to construct is limited by the land area available and topography of the wind farm site and surrounding land ownership and uses. Although the locations identified within the wind farm site are conducive to locating wind turbines, they also provide some limitation as to where those turbines could be placed due to manufacturer spacing requirements, setback, and other requirements. In general, placement of turbines in gullies would not be viable to effectively make use of the wind resource within the wind farm site and also as a result of cost of trying to construct the turbines in gullies, thereby compromising the economic feasibility of the Project. Moreover, expansion of the Project beyond that proposed under

Alternative 3 would require placement of turbines and access roads in areas that are currently being avoided because of the manufacturer and County setback requirements, and the potential for greater impacts to biological, visual, and other resources such as active agriculture. Likewise, the Project is bordered by the existing Kahuku wind farm, the Kamehameha Highway, and private land associated with the town of Kahuku to the north; the U.S. Department of the Army's (Army's) 8,216-acre (3,325-hectare) Kahuku Training Area to the south and west; and privately-owned agricultural lands to the east which precludes expansion of the Project. Thus, this alternative would meet the objective of increasing the portion of Oahu's energy derived from renewable sources, but would not be compatible with HECO's system requirements or existing land uses, and may not maintain overall environmental quality while contributing to stabilization of future energy prices, and therefore was not carried forward for analysis.

2.3.2 Smaller Project Size (less than approximately 25 MW)

A reduction in Project size and generating capacity (i.e., a project smaller than the Proposed Action) would reduce resource impacts and potential incidental take levels of covered species, but would not have economies of scale and would not be economically feasible for NPMPP to develop. That is, a smaller wind farm would be unlikely to offset Project infrastructure and development costs. The Project is proposed as a single, integrated power plant, not individual pieces where some turbines may be eliminated and others kept. The Project, through its Power Purchase Agreement, has a defined power output, based on site and design characteristics, market demand, and Applicant objectives. These objectives include providing a minimum level of generation at a competitive price to be attractive to HECO, which is seeking to fulfill their RPS requirements, as well as providing a return on investment to the Applicant. In order to provide this return, NPMPP has determined that the Project must be capable of producing a minimum of approximately 25 MW. The number of wind turbines in the wind farm site has already been minimized to the extent practicable in light of the Project's purpose and need and criteria considerations. Accordingly, if any turbines are removed from the Project design, other locations must be found to replace those turbines to maintain the minimum necessary capacity. Reducing the generating capacity for the Project would also decrease the Project's contribution to HECO's RPS requirements and consequently reduce the benefits to the State. For these reasons, the size and generating capacity of the Project was determined to be appropriate, and a smaller project size was eliminated from further evaluation.

2.3.3 Greater Setback Distances

A number of comments were received during scoping regarding project setbacks. Although the setbacks utilized in the Project design are several times the County-required setbacks of one length of the total turbine height from zoned residential areas, a number of commenters asked that the Project be sited farther from the town of Kahuku due to concerns over potential visual and noise impacts. The wind farm site is bordered by the existing Kahuku wind farm, the Kamehameha Highway, and private land associated with the town of Kahuku to the north; the U.S. Department of Army's 8,216-acre (3,325-hectare) Kahuku Training Area to the south and west; and privately-owned agricultural lands to the east. Lands farther inland were not considered further because they are Federally-owned by the Army and construction and operation of turbines is not a use consistent with the military training these lands are used for. Additionally, much of the Federal land adjacent to the current wind farm site boundary is characterized by steep topography that is not feasible to locate wind turbines on. The original site plan for the Project has gone through a number of revisions since the start of community outreach in the spring of 2013, including the relocation and/or elimination of five turbines to increase the distance between the wind farm site and the community and key points of community interest. Therefore, greater setbacks for the turbines from what are currently proposed under Alternatives 2/2a and 3 are no longer a practicable option, and therefore, such an alternative is not carried forward as a viable alternative for further analysis.

2.3.4 Alternate Project Location on Oahu

As noted in Section 2.1, a suitable site for development of a wind farm on Oahu must have a very good wind resource, must be located near HECO's transmission lines that have transmission capacity available, and must be able to sell electricity at a price that is competitive and attractive to HECO. It must also have land uses that are compatible with wind farm development and must be built in such as way so as to minimize environmental impacts. There may be other areas of Oahu with a wind regime that could support a wind energy project (e.g., some areas along the leeward and windward coasts); however, unless the wind resource was at least as good as the wind farm site, without regards to other factors, the Project could not offer HECO the same price and would therefore not be acceptable to HECO. It has been well documented that the North Shore area of Oahu has the best wind resource on Oahu. Additionally, there is currently no transmission capacity available on other high voltage circuits on the North Shore without costly transmission upgrades.

Prior to NPMPP's acquisition of this Project, other locations on Oahu and the North Shore with sufficient wind and potential for interconnection with the HECO grid were considered but eliminated because:

- there was no available transmission capacity;
- the wind resource was not sufficient to generate electricity at a competitive and attractive rate;
- there was a lack of contiguous suitable land and/or available land was of insufficient size to support a viable wind farm;
- land use restrictions, environmental concerns and potential environmental impacts (e.g., proximity to wildlife refuges or other natural areas) made the location not feasible; and/or
- due to the difficulty and expense of construction due to steep, remote topography.

For these reasons, alternative locations on Oahu and the North Shore were eliminated from further consideration.

2.3.5 Reduced ITP/ITL Permit Term

This alternative would involve an ITP/ITL of shorter duration than the proposed term of 21 years. This alternative was considered because it would reduce the level of incidental take authorized by accounting for fewer years of Project operation. However, in doing so, this alternative would not be consistent with the USFWS 5-Point Policy, which requires that the USFWS consider the expected duration of the covered activities. As described below, the anticipated operating life of the Project is 20 years.

Additionally, a reduced permit term has the potential to create a legal liability for NPMPP associated with non-compliance with the ESA and Chapter 195D if additional incidental take were to occur outside of the permit term during the remaining years of Project operation. Even if the ITP/ITL were to be amended to cover the remaining years of Project operation, there would be financial and potentially operational implications associated with reopening consultation with the USFWS and DOFAW and with the interim period between expiration of the ITP/ITL and when the period of coverage could be extended. For these reasons, this alternative was not carried forward for consideration.

2.3.6 Different Type of Renewable Energy Generation

Some comments received during scoping and during the public comment period for the Draft EIS felt that other types of renewable energy, rather than wind energy development, should be explored as an option for the Project. Wind power is not the only type of renewable energy which could contribute to meeting the State's RPS goals. However, NPMPP is a wind energy development company and the purpose of this Project is to contribute to the amount of renewable wind energy on Oahu to help achieve the State's goals and State RPS law and HECO requirements under the RPS. There are a number of other renewable energy sources such as geothermal (on islands other than Oahu), tidal, biofuels, or solar which are complementary to wind energy, and the Na Pua Makani Project would not preclude other developers from pursuing these energy sources.

Additionally, comments on the Draft EIS suggested the use of bladeless wind turbine technologies (e.g., Vortex). Bladeless technologies were not considered for the Project in part because they are still in the research and development stage and are not yet commercially viable or available. The wind turbine models being considered for the Project are those most appropriate for site-specific wind conditions and terrain as well as economic and energy production considerations.

2.4 Project Components

Alternative 2 is the Proposed Action and would include up to 10 turbines (8 to 10 depending on the turbine models selected) and associated foundations and transformers, an underground electrical collection system, up to three met towers, access roads, construction staging areas, an operations and maintenance building and associated storage yard, a transmission line, and an onsite substation (Figure 1-2). Alternative 2a, the Modified Proposed Action Option, would include up to 9 larger generating capacity turbines (Figure 1-3). Alternative 3 would include up to 12 turbines total (additional 2 to 4 turbines beyond what is described under the Proposed Action) and associated facilities (Figure 2-1). Each of these major Project components are described in detail below and summarized in Table 2-1. Differences between the action alternatives are called out where they exist. The construction access route between Kalaeloa Harbor and the Project is also described below.

The Project design presented in the Draft EIS represents locations of Project components within the wind farm site based on information available at the time. Subsequent to the publication of the Draft EIS, additional micrositing was conducted to reflect ongoing site evaluations. This included additional wind monitoring, and input from Malaekahana Hui West, LLC, to ensure that the proposed locations of Project components found the best balance between optimizing the wind resource, topography and other constraints, and ongoing agricultural operations (including farming and operation of an agribusiness zip line facility) and other uses on the property. This resulted in micrositing of some Project components, including:

- Shifting wind turbine locations on both the DLNR and Malaekahana Hui West, LLC properties (the furthest shift occurred to the two northernmost wind turbines on the Malaekahana Hui West, LLC side by up to 300 feet [91 meters] to the northwest).
- Adjusting the electrical collection line alignment to follow a more direct route to the proposed substation and minimizing its crossing of actively farmed land.
- Shifting the laydown area, O&M building, and substation approximately 250 feet (76 meters) to the south.
- Adjusting wind farm access roads to match the refined wind turbine locations.

The refined Project design was incorporated into the Proposed Action and Alternative 3 in the Final EIS (i.e., all analyses were updated to reflect the current Project design), and is carried forward here.

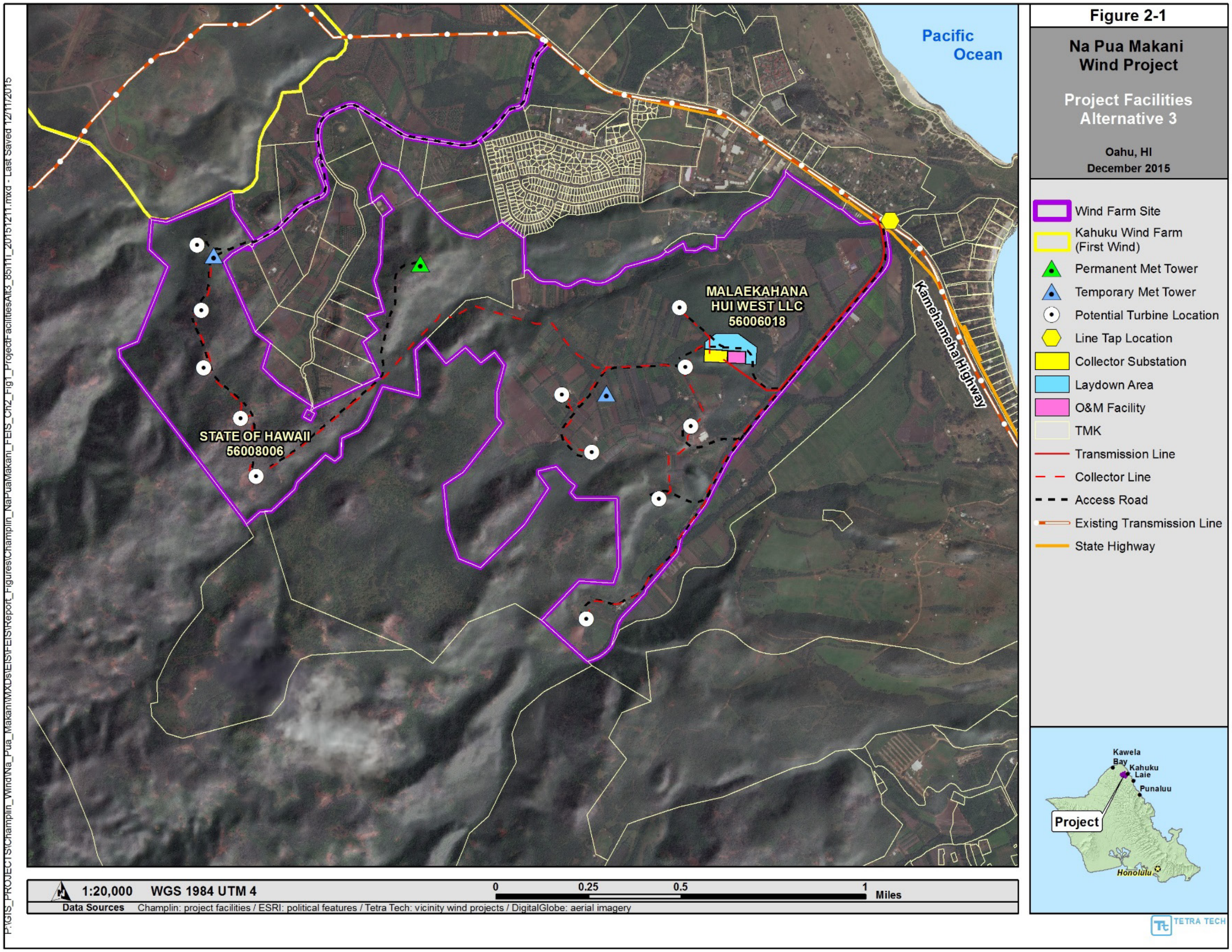


Figure 2-1
Na Pua Makani Wind Project
Project Facilities Alternative 3
Oahu, HI
December 2015
Wind Farm Site
Kahuku Wind Farm (First Wind)
Permanent Met Tower
Temporary Met Tower
Potential Turbine Location
Line Tap Location
Collector Substation
Laydown Area
O&M Facility
TMK
Transmission Line
Collector Line
Access Road
Existing Transmission Line
State Highway
Pacific Ocean
MALAEKAHANA HUI WEST LLC 56006018
STATE OF HAWAII 56008006
Kamehameha Highway
Kawela Bay
Kahuku
Laie
Punaluu
Project
Honolulu
1:20,000
WGS 1984 UTM 4
0
0.25
0.5
1
Miles
Data Sources
Champlin: project facilities / ESRI: political features / Tetra Tech: vicinity wind projects / DigitalGlobe: aerial imagery
TETRA TECH

Table 2-1. Comparison of Alternatives: Project Components and Disturbance Areas

Project Component	Area of Soil Disturbance (Total)	Area of Permanent Disturbance (Fill/Structures/Grading)1/	Alternative 2 – Proposed Action	Alternative 2a – Modified Proposed Action Option	Alternative 3 – Larger Generation Facility
Wind turbines and pads (incl. construction laydown areas)	4.0 ac (1.6 ha) per turbine	2.0 ac (0.8 ha) per turbine	8 to 10 (up to 10 total)	Up to 9 total	Up to 12 total
Internal Access Roads	50.0 ft (15.2 m) wide per linear foot	16 ft (4.9 m) wide per linear foot	Up to 5.3 mi (8.6 km)	Up to 4.8 mi (7.8 km)	Up to 6.0 mi (9.6 km)
DLNR Access to Project	0.3 ac (0.1 ha)	0.3 ac (0.1 ha)	1	1	1
Met towers2/	1.0 ac (0.4 ha) per structure	0.1 ac (0.04 ha)	Up to 3	Up to 3	Up to 3
Underground electrical collection system3/	40.0 ft (12.2 m) wide per linear foot	0.0	3.8 mi (6.1 km)	2.9 mi (4.7 km)	4.2 mi (6.7 km)
Construction staging and equipment laydown area, parking and storage, substation, and O&M building	8.9 ac (3.6 ha)	8.3 ac (3.3 ha)	1	1	1
Transmission line (above ground)4/	30.0-ft (9.1-m)-wide right-of-way per linear foot	10 x 10 ft (3 x 3 m) space per pole plus pull sites4	0. 8 mi (1.2 km)	0.8 mi (1.2 km)	0. 8 mi (1.2 km)
Point of interconnect	0.0	0.0	1	1	1
Disturbance Acreage By Alternative					
	Total/Construction		89.0 ac (36.0 ha)	84.5 ac (34.2 ha)	98.6 ac (39.9 ha)
	Permanent		59.9 ac (24.2 ha)	56.7 ac (22.9 ha)	69.8 ac (28.2 ha)
Acreage by Landownership					
State Land	Total/Construction		47.2 ac (19.1 ha)	47.2 ac (19.1 ha)	47.2 ac (19.1 ha)
	Permanent		34.2 ac (13.8 ha)	34.2 ac (13.8 ha)	34.2 ac (13.8 ha)
Private Land	Total/Construction		41.7 ac (16.9 ha)	37.2 ac (15.1 ha)	51.4 ac (21.8 ha)
	Permanent		25.7 ac (10.4 ha)	22.5 ac (9.1 ha)	35.6 ac (14.4 ha)

1/ Permanent impact acreages are a subset of total impacts.
2/ Note that of the three met tower locations, one will be permanent and two will be temporary.
3/ Portions of the electrical collection system would be within the access road construction buffer; no additional permanent impacts would occur in these areas.
4 /For impact calculations assumed a 7-ft-wide (2-m-wide) corridor centered on the transmission line; actual impacts would be less and limited to pole and pull site locations.

Civil and electrical infrastructure necessary to support the Project includes the underground components of the Project, such as turbine and met tower foundations, the transmission line, and the electrical collection system. Installation of these components would require excavation with standard excavators, bulldozers, and/or hydraulic hammers. Blasting is not anticipated, although if rock is encountered it would either be blasted using drill and shot methods, or removed with the use of hydraulic hammers.

2.4.1 Turbines

NPMPP is currently considering turbine models from leading turbine manufacturers including Siemens, Vestas, and GE, among others. The turbine array could include a combination of models from a single manufacturer ranging in generating capacity and dimensions. Table 2-2 describes the range of turbine dimensions considered for the purposes of impact analysis. NPMPP will select the most appropriate turbines for the site-specific conditions of the wind farm site prior to construction.

Table 2-2. Key Dimensions and Specifications of the Turbines

Description	Measurement	
	Alternatives 2 and 3	Modified Proposed Action Option
Power generation	Up to 3.3 MW[1/]	Up to 3.45 MW[1/]
Tower height	Up to 302 feet (92 meters)	Up to 443 feet (135 meters)[2/]
Rotor type	3-bladed, horizontal axis	3-bladed, horizontal axis
Rotor diameter	Up to 384 feet (117 meters)	Up to 427 feet (130 meters)
Blade length	Up to 187 feet (57 meters)	Up to 208 feet (63 meters)
Number of blades	3	3
Total height above ground	Up to 512 feet (156 meters)	Up to 656 feet (200 meters)
Rotor swept area	Up to 115,723 feet^2 (10,751 meters^2)	Up to 143,160 feet^2 (13,300 meters^2)
Rotor speed	6-16 rotations per minute[3/]	6-16 rotations per minute[3/]
Cut -in wind speed	10 ft/s (3 m/s)	10 ft/s (3 m/s)
Cut-out wind speed	Up to 82 ft/s (25 m/s)	Up to 82 ft/s (25 m/s)

ft/s = feet per second; m/s = meters per second

1/ Should the turbine manufacturers make available up-rated versions of existing turbine models prior to construction, they will be considered for use in this project.

2/ To meet City and County of Honolulu setback requirements (a distance equivalent to the maximum turbine blade tip height), if the largest turbine model under consideration were selected, hub heights of individual turbines would range from 85 to 135 meters (blade lengths would be the same).

3/ Note that the tallest turbine models considered under the Modified Proposed Action Option actually have the slowest rotor speed of 12 rotations per minute; maximum blade tip speed would be approximately 243 miles per hour under Alternatives 2 and 3, and 192 miles per hour under the Modified Proposed Action Option.

Turbine models being considered (all manufacturers) range in hub height from approximately 262 feet (80 meters) to 443 feet (135 meters) with rotor diameters ranging from 328 feet (100 meters) to 427 feet (130 meters), resulting in a maximum height at the top of the blade of up to 656 feet (200 meters) above ground level (Table 2-2). Smaller turbine models (i.e., those with shorter hub heights) would be considered for turbine locations nearest the TMK boundaries to ensure compliance with City and County of Honolulu setback requirements, and larger turbines (i.e., those with taller hub heights) may be considered for the remaining turbine locations. The combination of turbine models and specific number of turbines under each alternative will be selected to ensure consistency with HECO grid requirements, onsite wind resources, and other Project-specific factors. Since the publication of the Draft EIS the proposed turbine alignment has been refined as the Project design continues to develop. These updates have been incorporated into the Project's impact calculations and figures in this EIS.

A Federal Aviation Administration (FAA)-approved lighting plan will be developed for the Project. This plan will specify the installation of flashing red lights on wind turbines and met towers to improve nighttime visibility for aviation.

2.4.1.1 Construction

Each turbine would be transported from Kalaeloa Harbor via highways (see Construction Access Route below) and assembled on a constructed foundation at the Project site. Each turbine would require multiple deliveries (at least 12 separate loads, including 8 superloads) of equipment and materials to its pad. Towers are generally delivered in three or four sections. Each blade would be delivered separately, as would the nacelles, rotors, and down-tower components (e.g., controllers, ladders and platforms, pad-mount transformers, and pad-mounted transformer vaults). Deliveries would be made using transport vehicles that conform to road weight limits; any variances would be incorporated into permits submitted to the Hawaii Department of Transportation (HDOT). Transportation of turbine components would primarily occur between the hours of 11 p.m. and 6 a.m. A Traffic Assessment Report is included in Appendix B.

A work area would be cleared and graded at each turbine location to provide space for delivery and laydown of turbine components, crane access, and foundations, as well as turbine construction. An area of approximately 4 acres (2 hectares; Table 2-1) would be required at each turbine for the crane pad and construction laydown area.

Foundations would be spread footing or tensionless pier, depending on site-specific soil conditions. Spread footing foundations would be approximately 10 feet (3 meters) deep and up to 60 feet (18 meters) wide. Tensionless foundations would be up to 40 feet (12 meters) deep and up to 15 feet (5 meters) wide. Actual foundation depth would depend upon the results of geotechnical tests conducted at each final tower location and final structural engineering. Each turbine foundation will consist of up to approximately 500 cubic yards (382 cubic meters) of concrete, reinforcing bars, and anchor bolts. Up to approximately 50 trucks of concrete will be required per foundation. NPMPP anticipates that for each turbine pad, concrete deliveries and pouring would occur over a 2-day period.

In total, the Project would require up to approximately 5,170 cubic yards (3,949 cubic meters) of concrete for construction of foundations for the turbines, met towers, the O&M building, onsite substation, and other equipment pads under Alternative 2, or up to approximately 6,670 cubic yards (5,095 cubic meters) under Alternative 3. Concrete typically needs to be poured within 90 minutes of being mixed with water. Concrete will either be supplied from an existing batch plant on

Oahu, or may be mixed at an onsite batch plant which would be located in the construction staging area. Water for a batch plant would be delivered to the site and stored in an onsite water tank, come from existing irrigation lines, or come from a similar source. Aggregate would be sourced from an existing supply or quarry on Oahu.

General fill would be needed for grading of turbine pads (concrete foundations plus surrounding cleared areas), access roads, and laydown areas. Fill material would be utilized from onsite excavations and earthwork. Additional sources of this fill, if needed, include nearby pits or excess material taken from within the property.

Construction would be completed during daylight hours, typically from 7 a.m. to 5 p.m. There may be instances where those hours need to be extended earlier or later and nighttime construction may occur to avoid traffic and to facilitate schedule. All proper communication channels would be followed and compliance with applicable permits will be maintained.

Once the foundations are constructed, the turbines would be assembled and erected using a combination of forklifts, medium-size cranes with a lift capacity of 99 to 143 tons (90 to 130 metric tons), and a main erection crane with a lift capacity of 660 tons (600 metric tons), located on a compacted earthen or gravel crane pad. Construction equipment requiring access to these areas would include both wheeled and tracked vehicles. Cranes used to assemble the turbine components would be delivered to the wind farm site in multiple legal-weight loads.

2.4.1.2 Operation and Maintenance

After construction, a portion of the turbine pad area would be revegetated through replanting with non-aggressive resident species that are compatible with Project operations in order to minimize erosion. Permanent low-growing vegetation or gravel pads up to 2 acres (1 hectare) around each turbine would be maintained to allow for O&M requirements. An additional area up to 4 acres (2 hectares) per pad would be maintained to facilitate post-construction mortality monitoring efforts, as practicable (see Appendix A of the HCP).

During Project operation, technicians would perform routine preventative maintenance on each turbine and troubleshoot problems as needed. Routine maintenance and repairs require service vehicle access. Should there be a need for major component replacement (e.g., blades, generator, supporting tower), heavy equipment similar to that used during construction would be required. In that case, the access road, crane pad, and staging area would be used in a manner similar to their use during the original tower assembly and construction process.

2.4.2 Electrical System (Electrical Collection System, Substation, Transmission Line, and Point of Interconnect)

Power from the turbines would be stepped up to 34.5 kV at pad-mounted transformers and then collected through an electrical collection system, most of which would be installed underground (Figures 1-2 and 2-1). This system would feed into an onsite electrical substation, which would step up the voltage and transmit the power to the point of interconnect with the Oahu's general transmission system via a new HECO-owned and operated transmission line. Subsequent to the publication of the Draft EIS, the proposed alignment of the electrical collection line was modified on the Malaekahana Hui West, LLC portion of the wind farm site to more directly connect with the proposed substation site at the request of the landowner (Figures 1-2 and 2-1).

2.4.2.1 Construction

The electrical collection system would be installed within the onsite access road bed where possible and would run from turbine to turbine. The electrical collection system would consist of up to two separate 34.5-kV feeder circuits (see Figure 2-1; Table 2-1). To the extent practicable the collection system would be installed underground; however, it may be necessary to install portions of the collection system above ground to respond to construction challenges or to avoid impacts to streams and other resources in the wind farm site. For the underground portions of the collection system, cables would be directly buried in trenches and would terminate at the onsite substation. Depending on the subsurface conditions, blasting is not expected but may be required to install the trenches. Each trench would contain three sets of power cables, plus a ground wire and a fiber optic communication cable for the supervisory control and data acquisition (SCADA) system (to transmit data from the turbine controllers to the onsite substation and O&M building). The cable trench would be backfilled with select fill material to protect the cables from damage or possible contact and to provide appropriate media for heat dissipation from the cables. It is estimated that approximately 3.8 miles (6.1 kilometers) of collection cable would be required under Alternative 2 (approximately 2.9 miles [4.7 kilometers] under the Modified Proposed Action Option); approximately 4.2 miles (6.7 kilometers) would be required under Alternative 3. Trenches would be approximately 24 inches (61 centimeters) wide excavated by rubber tire or tracked equipment and, where the collection system parallels Project access roads, the cable would be buried directly alongside access roads. In these areas, no additional ground disturbance would occur in association with construction of the underground electrical collection system (i.e., disturbance is accounted for in association with the access roads). Above ground portions would have a maximum pole height of 75 feet (23 meters) and wire heights ranging from 35 to 50 feet (11 to 15 meters) above the ground.

The onsite substation would be approximately 400 by 200 feet (122 by 61 meters) within a fenced area of approximately 2 acres (1 hectare) (Figures 1-2 and 2-1; Table 2-1). A portion of the substation would be HECO's switching station that would be a separately fenced area approximately 160 by 130 feet (48 by 40 meters). The substation would include the substation pad and above- and below-grade electrical infrastructure which, subject to the final design, may include:

- A main power transformer;
- Two 34.5 kV breakers;
- A 46-kV breaker;
- A 34.5-kV main bus structure;
- Two 34.5-kV electrical feeder termination structures;
- A 34.5-kV station power transformer;

- A 46-kV metering structure;
- A dead end structure;
- An electrical control enclosure for electrical relays and metering equipment;
- A 200-foot (70-meter)-tall microwave tower; and
- An 85-foot (26-meter)-tall wood pole with yard light pole for shield wire attachment.

During construction, the onsite substation area would be cleared and graded, and the substation pad would be compacted with well-graded material. Foundations would be installed for the components as required.

The new 0.8-mile- (1.2-kilometer)-long HECO-owned transmission line would allow the Project to be interconnected to an existing HECO 46-kV line, extending from the point of interconnect at the onsite substation to the line tap location near Kamehameha Highway (Figures 1-2 and 2-1). The transmission line would consist of a 46-kV power line installed above ground. The transmission line poles would have heights of approximately 75 feet (23 meters) and wire heights would range from approximately 35 to 50 feet (11 to 15 meters) above the ground. All construction activities for the transmission line would occur within an approximately 30-foot-wide (9-meter-wide) temporary right-of-way (ROW). This includes an area of approximately 10 by 10 feet (3 by 3 meters) of ground disturbance for each pole and also includes pull sites (Table 2-1). Permanent disturbance acreages were assumed to occur within a 7-foot-wide (2-meter-wide) corridor centered on the transmission line, although actual impacts would be considerably less, limited to individual pole and pull site locations. Access to the transmission line would be by vehicle or ATV from existing roads. The line tap location may require new or replacement utility poles resulting in minor ground disturbance. (Table 2-1).

Construction of the electrical collection system and transmission line would utilize standard industry procedures including surveying, corridor preparation, materials hauling, pull sites, staging areas, structure assembly and erection, ground wire, conductor stringing, cleanup, and replanting with non-aggressive resident species that are compatible with Project operations.

2.4.2.2 Operation and Maintenance

Qualified personnel would routinely monitor, inspect, and maintain the communication and electrical collector cables and transmission line facilities during Project operation. Typically, small trucks would be used to inspect the system. Heavy equipment would only be necessary if underground cables were determined to have failed or if overhead conductor or supporting structures need to be repaired or replaced.

Qualified personnel would operate and maintain the interconnection substation; maintenance activities would include routine inspections of each component and monitoring of equipment and electronics according to the manufacturer's recommendations and owner's and regulatory requirements. Routine maintenance of the interconnection substation would not typically require heavy construction equipment. However, if a major component (e.g., a main transformer) fails, then appropriate construction equipment would be required to replace the component.

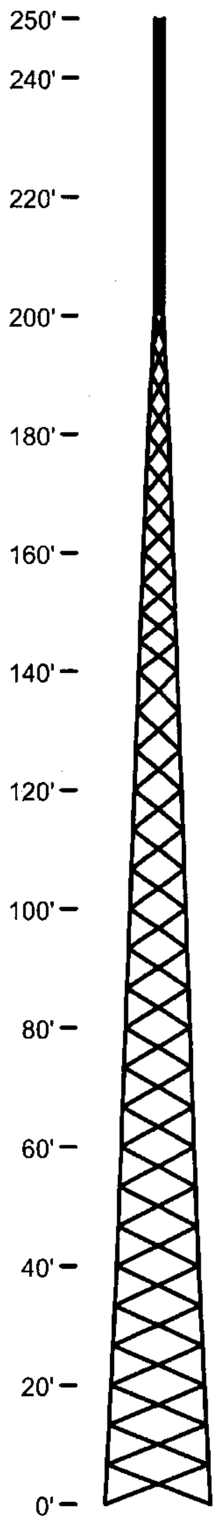


Figure 2-2.
Met Tower Diagram

2.4.3 Met Towers

The Project would include one permanent un-guyed lattice-frame met tower and two temporary guyed towers (Figure 2-2 shows an example of the permanent met tower). These towers would support weather instruments that measure and record weather data to measure performance and guide Project operation. The met towers would be approximately 262 feet (80 meters) tall with base dimensions approximately 22 by 22 feet (7 by 7 meters) and reducing down to approximately 2 by 2 feet (1 by 1 meter) for the top 42 feet (13 meters). The temporary met towers would be removed during Project construction.

2.4.3.1 Construction

Construction of the met towers would require onsite tower assembly on a constructed footing using a large crane approximately 315 feet (96 meters) tall. Approximately 1 acre (0.4 hectare) per met tower would be disturbed during construction (Table 2-1). Following construction, the temporary construction areas would be re-vegetated using non-aggressive resident species that are compatible with Project operations. The central met tower would be accessed from existing State-owned and/or internal access roads. A 40-foot-wide (12-meter-wide) met tower access road may be constructed for the central met tower, extending from the internal access road (Figures 1-2 and 2-1; Table 2-1). The western- and eastern-most met towers are close enough to the access roads that they would not require their own separate roads (Figures 1-2 and 2-1).

2.4.3.2 Operation and Maintenance

The area of permanent impact would consist of an approximately 0.1 acre (0.04 hectare; Table 2-1) gravel pad, which would be maintained around the base of the permanent met tower to allow for O&M requirements. The permanent met tower would require routine monitoring and maintenance during the period of operation. Routine monitoring and maintenance activities would require vehicle access, but met towers do not typically require heavy equipment for servicing.

2.4.4 Access Roads

Roads used for the Project will include portions of an existing road network plus the addition of new roads (Figures 1-2 and 2-1). For the purpose of estimating maximum potential impacts, this discussion assumes the same level of disturbance for all Project access roads.

2.4.4.1 Construction

The extent of new and improved roads to be developed during Project construction is described in Table 2-1. Existing roads would be improved, as needed, and widened to meet construction and maintenance activity requirements. Approximately 5.3 miles (8.6 kilometers) of internal access roads would be required for the Proposed Action (approximately 4.8 miles [7.7 kilometers] of access roads would be required for the Modified Proposed Action Option); for Alternative 3, approximately 6.0 miles (9.6 kilometers) of access road would be required. Existing roads within the wind farm site would be widened to, and new access roads would be constructed to, approximately 16 feet (5 meters; Table 2-1). Disturbance during construction would occur within a larger area of approximately 50 feet (15 meters) wide along the access roads to allow adequate passage for the crawler crane and transport trucks, as well as turn-around locations. The total temporary disturbance required during construction of the roads will depend on the amount of cut-fill in any one area and could expand to 100 feet (30 meters) wide in certain defined areas. All access roads would have a gravel surface, storm water erosion and control features.

2.4.4.2 Operation and Maintenance

Permanent impacts associated with internal access roads are quantified in Table 2-1. During operation, service vehicles and equipment would continue to use these roads for routine maintenance of the turbines and associated Project infrastructure. Permanent roadway surfaces would be maintained in good working order by NPMPP through periodic grading and compacting to minimize naturally occurring erosion.

2.4.5 Construction Staging and Equipment Laydown Area, Operations and Maintenance Building and Associated Storage Yard

The construction staging area and equipment laydown area will serve a variety of storage and support functions over the life of the Project (Figures 1-2 and 2-1). During construction, the area would be used as temporary storage and laydown area, refueling location, and waste collection area. It would also serve to provide temporary parking, office space, and sanitary facilities. Refueling of construction vehicles would be accomplished by a vendor supplied fuel truck making deliveries daily. Crew trucks and water trucks would be fueled at an off-site gas station.

The O&M building, storage, and parking area would be constructed close to the larger construction staging and equipment laydown area and onsite substation. The O&M building, storage, and parking area are permanent facilities that would be used throughout the life of the Project (Figures 1-2 and 2-1).

2.4.5.1 Construction

The construction staging and equipment laydown area would consist of an approximately 8.9-acre (3.6-hectare; Table 2-1) compacted gravel pad on a cleared and graded footprint. During construction, large equipment such as cranes could be stored in the staging area. Following construction, portions of the construction staging and equipment laydown area would be restored to pre-construction conditions through the removal of gravel and replanted with non-aggressive resident species that are compatible with Project operations.

2.4.5.2 Operation and Maintenance

A permanent 8.3-acre (3.3-hectare) area would be maintained during Project operations which would include the permanent O&M building and vehicle parking for wind farm operations (approximately 1 acre [0.4 hectare]; Figure 2-3), as well as the onsite substation (Figure 2-1). The O&M building and surrounding storage yard and parking areas would undergo routine maintenance and upkeep to minimize erosion, control stormwater runoff and drainage, and maintain the building and its permanent water, septic, electrical, and communications infrastructure. During operations, large equipment required for maintenance could be staged in the O&M storage yard.

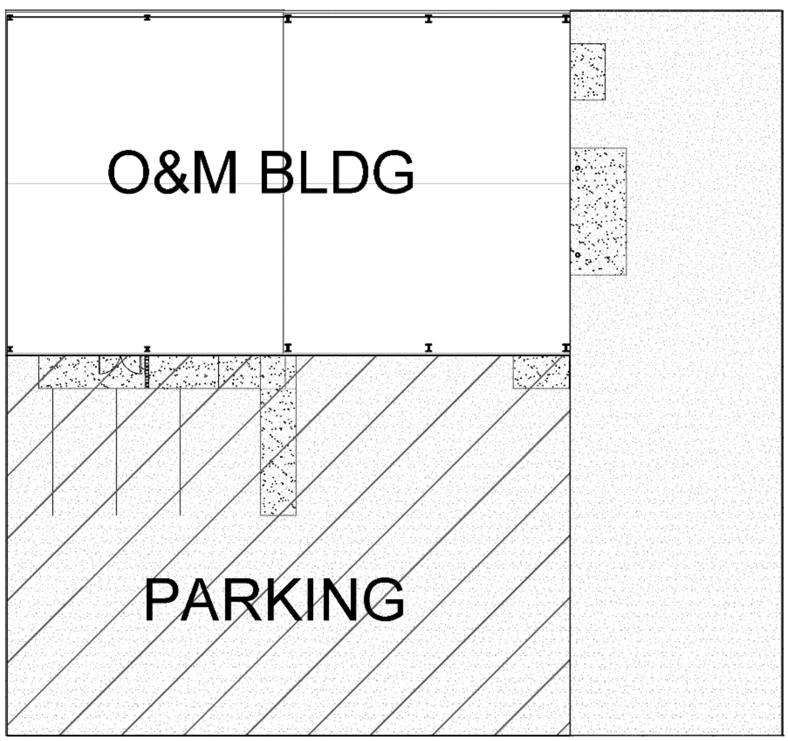


Figure 2-3. O&M Building Plan

2.4.6 Construction Access Route

Construction related traffic for the Project would include the transporting of the major turbine components, hauling in materials for the turbine foundations, other miscellaneous deliveries, and employee-related traffic. The major turbine components would be transported by sea and offloaded at Kalaeloa Harbor located in the west side of Oahu. Due to the size and weight of these turbine components, Hawaii State Department of Transportation and City and County of Honolulu permits to transport these oversized and overweight loads would need to be obtained.

The Traffic Assessment Report (Appendix B) identified three proposed routes from Kalaeloa Harbor to the wind farm site to transport the turbine components as follows and seen in Figure 2-4 and Tables 2-3, 2-4, and 2-5.

The transport of the oversized components would require trees along the entire identified routes to be trimmed to a clearance height of 17 feet (5.2 meters), and temporary removal of street signs, poles, utility poles, and traffic signals for clearance of the oversized loads. In addition, the left turn on Wilikina Drive and the right turn from Kamehameha Highway to Ka Uka Boulevard would require police escorts to shut down traffic in order for the trucks to make the turns. Also, minor temporary improvements would need to be implemented such as curb removal or additional of fill in order for the oversize load to safely navigate through curbs.

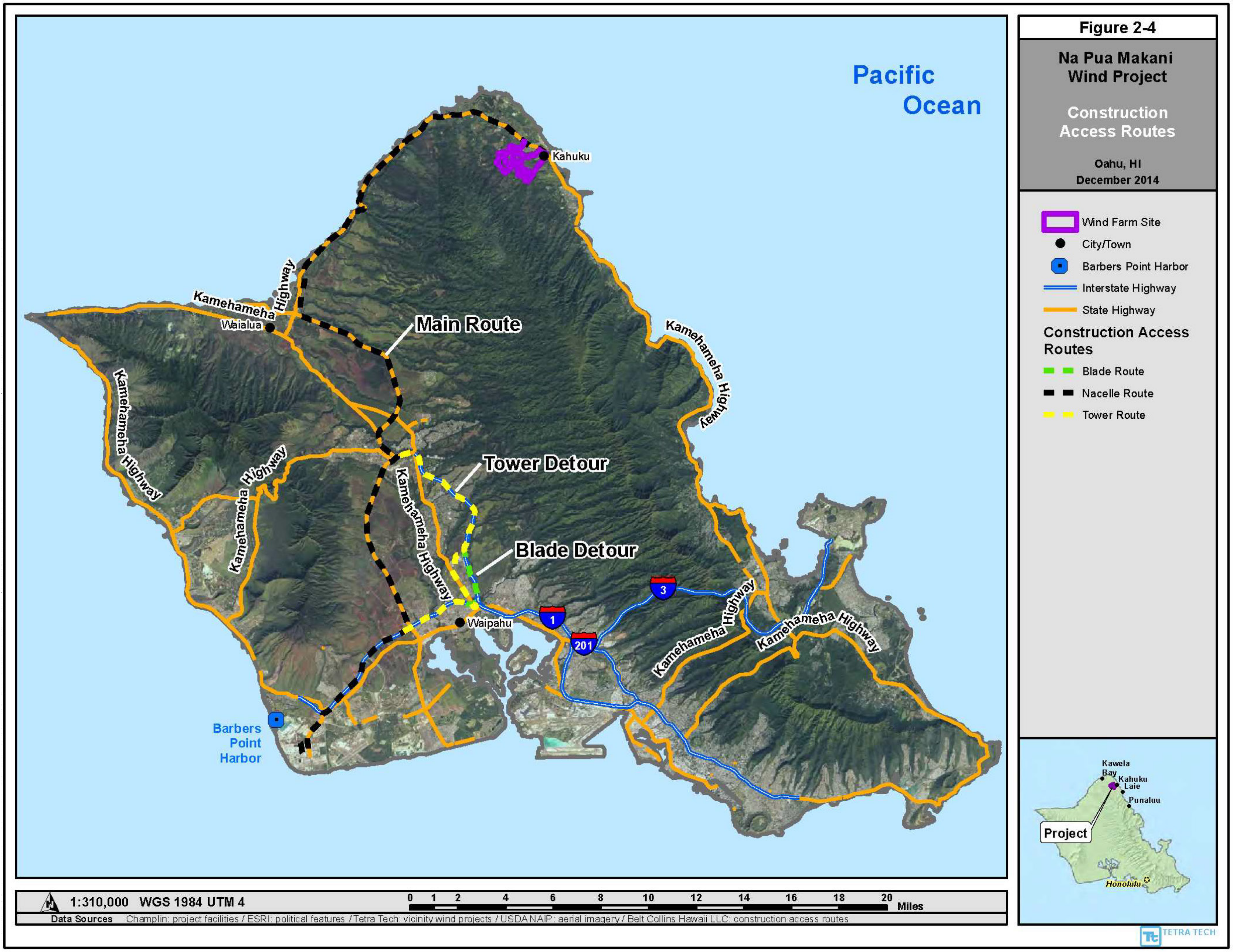


Figure 2-4
Na Pua Makani Wind Project
Construction Access Routes
Oahu, HI
December 2014
Wind Farm Site
City/Town
Barbers Point Harbor
Interstate Highway
State Highway
Construction Access Routes
Blade Route
Nacelle Route
Tower Route
Pacific Ocean
Kahuku
Waialua
Waipahu
Main Route
Tower Detour
Blade Detour
Kamehameha Highway
Barbers Point Harbor
1
201
3
1:310,000 WGS 1984 UTM 4
0 1 2 4 6 8 10 12 14 16 18 20 Miles
Data Sources Champlin: project facilities / ESRI: political features / Tetra Tech: vicinity wind projects / USDA NAIP: aerial imagery / Belt Collins Hawaii LLC: construction access routes
Kawela Bay
Kahuku
Laie
Punaluu
Project
Honolulu
TETRA TECH

Table 2-3. Route 1 for the Longer Nacelle Components

Segment	Description	Length (miles)	Jurisdiction / Ownership
1	Continue straight out of the Grace Pacific gate onto Hanua Street	0.4	City and County
2	Turn left on Kauhi Street toward Kalaeloa Boulevard	0.3	City and County
3	Turn left at Kalaeloa Boulevard	1.8	(multiple) maintained by City and County
4	Merge onto H-1 East	6.5	State
5	Take Exit 5 to Kunia Waipahu / Ewa	0.3	State
6	Turn left onto Kunia Road	--	
7	Continue on Kunia Road to Wilikina Drive	8.1	State
8	Turn left on Wilikina Drive	1.3	State
9	Turn right on Kamananui Road	1.2	State
10	Continue north on Kamehameha Highway	--	
11	Continue on Kamehameha Highway to Joseph P. Leong Highway (Highway 99)	6.6	(multiple) maintained by City and County
12	Continue on Highway 99 to Kamehameha Highway East (Highway 83)	1.9	State
13	Continue on Highway 83 to the access roadway to the Project	14.3	State
	Total	42.7	

Table 2-4. Route 2 for the Taller Tower Sections and Nacelle Components

Segment	Description	Length (miles)	Jurisdiction / Ownership
1	Continue straight out of the Grace Pacific gate onto Hanua Street	0.4	City and County
2	Turn left on Kauhi Street toward Kalaeloa Boulevard	0.3	City and County
3	Turn left on Kalaeloa Boulevard	1.8	State
4	Merge onto H-1 East	--	
5	Continue of H-1 East and stay in the right lane	7.9	State
6	Take Exit 8C for Kamehameha Highway North	2.2	State
7	Turn right on Ka Uka Boulevard	1.1	City and County
8	Turn left onto H-2 North	--	
9	Continue on H-2 North to Wilikina Drive	5.8	State
10	Continue on Wilikina Drive to Kamananui Road	1.8	State
11	Turn right on Kamananui Road	1.2	State
12	Continue north on Kamehameha Highway	--	
13	Continue on Kamehameha Highway to Joseph P. Leong Highway (Highway 99)	6.6	(multiple) maintained by City and County
14	Continue Highway 99 to Kamehameha Highway East (Highway 83)	1.9	State
15	Continue on Highway 83 to the access roadway to the Project	14.3	State
	Total	45.3	

Table 2-5. Route 3 for the Blades

Segment	Description	Length (miles)	Jurisdiction / Ownership
1	Continue straight out of the Grace Pacific gate onto Hanua Street	0.4	City and County
2	Turn left on Kauhi Street toward Kalaeloa Boulevard	0.3	City and County
3	Turn left on Kalaeloa Boulevard	1.8	(multiple) maintained by City and County
4	Merge onto H-1 East	--	
5	Continue on H-1East and stay in the left lane to merge onto the H-2 North	7.8	State
6	Take Exit 8B for H-2 North to Mililani and Wahiawa	0.7	State
7	Continue on H-2 North to Wilikina Drive	7.6	State
8	Continue on Wilikina Drive to Kamananui Road	1.8	State
9	Turn right on Kamananui Road	1.2	State
10	Continue north on Kamehameha Highway	--	
11	Continue north on Kamehameha Highway to Joseph P. Leong Highway (Highway 99)	6.6	(multiple) maintained by City and County
12	Continue on Highway 99 to Kamehameha Highway East (Highway 83)	1.9	State
13	Continue on Highway 83 to the access roadway to the Project	14.3	State
	Total	44.4	

2.4.7 Best Management Practices, Design Features, and Project Plans

Table 2-6 lists industry standard BMPs, Project-specific design features, and Project plans that NPMPP has committed to incorporating into the Project to reduce potential impacts. Additional avoidance and minimization measures specific to each resource area are discussed under their respective subsections below.

Table 2-6. Best Management Practices, Project-specific design features, and Project plans

BMP	Geology and Soils	Hydrology and Water Resources	Air Quality	Noise	Hazardous Materials	Natural Hazards	Vegetation	Wildlife	Threatened and Endangered Species	Socioeconomics	Cultural	Land Use	Recreation and Tourism	Visual	Transportation	Public Health and Safety	Environmental Justice	Public Infrastructure	Military	Agriculture
A Temporary Erosion and Sediment Control (TESC) Plan will be prepared that would be implemented by the construction contractor. The TESC Plan will include standard storm water BMPs such as building during the summer months when rainfall potential is low, using silt fences or hay bales to prevent eroded soil from being transported off-site, and contouring to stop drainage from entering the site and to prevent runoff from entering surface waters.	X	X					X	X	X											
To minimize the potential for erosion and impacts to site drainage patterns, Project access roads will be sited to follow natural contours and minimize side hill cuts to the extent possible.	X	X																		
At the onsite substation, a retention basin will be constructed to avoid erosion and eliminate the possibility of degrading downstream waters.	X	X				X														
Ditches and culverts and other erosion controls will be implemented to capture and convey storm water in areas of temporary disturbance.	X	X																		
If blasting is required it would be conducted such that it would minimize the creation of excessive slopes.	X					X														
During construction, wind erosion will be minimized by using common dust suppression techniques, such as regularly watering exposed soils, stockpiling soils, and stabilizing soils.	X		X																	
With the exception of areas where permanent surface recontouring is required, disturbed areas will be restored to pre-existing grades and revegetated.	X	X				X	X	X	X			X		X						
Permanent storm water control structures will be installed to prevent erosion where access roads, buildings, storage areas, and parking areas are constructed.	X	X				X														
To minimize the introduction and spread of invasive plant species, potential off-site sources of materials (gravel, fill, etc.) will be inspected, and the import of materials from sites that are known or likely to contain seeds or propagules of invasive species will be prohibited.							X													
Vehicle operators transporting materials to the Project site from off-site will be required to follow protocols for removing soils and plant material from vehicles and equipment prior to entry onto the site.							X	X	X			X								
The Hawai'i Department of Agriculture will be consulted to establish protocols and training orientation methods for screening invasive species introductions during construction.							X	X	X			X								
Noisy construction activities (including blasting, if required) will be conducted between 7a.m. and 5 p.m., unless further restricted by Hawaii Department of Health (HDOH) noise permits, to reduce the potential impact of construction noise during sensitive nighttime hours.				X																
Equipment and vehicles will be maintained in good working order and will employ adequate mufflers and engine enclosures to reduce equipment noise.				X																
Contractors and Project staff will implement proper O&M procedures as recommended by product manufacturers.			X	X								X								

Table 2-6. Best Management Practices, Project-specific design features, and Project plans (continued)

BMP	Geology and Soils	Hydrology and Water Resources	Air Quality	Noise	Hazardous Materials	Natural Hazards	Vegetation	Wildlife	Threatened and Endangered Species	Socioeconomics	Cultural	Land Use	Recreation and Tourism	Visual	Transportation	Public Health and Safety	Environmental Justice	Public Infrastructure	Military	Agriculture
A site-specific Storm Water Pollution Prevention Plan (SWPPP) will be prepared that would be implemented by the construction contractor to reduce impacts to hydrology, drainage, and surface waters. The SWPPP will contain a description of the characteristics of the site such as nearby surface water, topography, and storm water runoff patterns; identification of potential pollutants such as sediment from disturbed areas, and stored wastes or fuels; and identify BMPs that will be used to minimize or eliminate the potential for these pollutants to reach surface waters through storm water runoff.	X	X																		
To reduce the risk of earthquake damage, all structural elements of the Project will meet or exceed current building code requirements for the seismic risk on Oahu. The current design standard is defined by the 2006 Uniform Building Code.						X														
A Traffic Management Plan will be prepared and implemented reduce potential impacts to traffic during construction.															X					
A Hazardous Materials and Wastes Management Plan (HMWMP) will be prepared and implemented that details proper procedures for storing and using hazardous materials and storing and disposing of hazardous waste. The plan will contain sufficient detail to address the purpose of the plan and to readily translate into the actions necessary to comply with relevant regulations. The plan would include information about site activities, site contacts, worker training procedures, and a hazardous materials inventory in accordance with Article 80 of the Uniform Fire Code.					X											X				
A Site Safety Handbook will be prepared for construction and operations and maintenance					X	X						X				X				X

2.4.7.1 Estimated Schedule for the Proposed Action

Alternative 2 is proposed to begin construction as soon as the fourth quarter of 2016 with commercial operation planned in 2017. Table 2-7 presents the anticipated Project schedule, which is driven by time constraints required by the power purchase agreement (PPA) with HECO.

Table 2-7. Project Schedule

Project Activity	Estimated Start Date	Estimated Completion Date
Permitting Process	Spring 2013	fourth quarter 2016
Construction	fourth quarter 2016	fourth quarter 2017
Commence Commercial Operations	2017	2017

2.4.8 Project Life and Decommissioning

The anticipated life of the Project is 21 years (1 year of construction and 20 years of commercial operation). After that time, NPMPP will evaluate whether to continue operation of the Project or to decommission it. Should the period of Project operation be extended, the facility may also be upgraded and repowered with renegotiated leases (and any necessary extensions of Project permits and approvals, such as the ITP and ITL, would need to be obtained).

If the Project is decommissioned, the goal of decommissioning would be to remove the power generation equipment and return the site to a condition as close to its pre-construction state as possible within 1 year as contractually required in both the land lease with DLNR and the PPA with HECO. All decommissioning- and restoration-related waste would be properly handled and disposed of or recycled, as appropriate, in accordance with county, state, and Federal laws and permit requirements. Foundations would be removed to a depth below grade, and roads would be left for use. Major activities required for decommissioning would typically occur in reverse order to those of construction and are listed below:

- Turbine components would be disassembled.
- Turbine foundations and the permanent met tower would be removed. Foundations would be removed to a point several feet below grade and the remaining portions buried. Remaining concrete and steel would be hauled offsite. Foundations would be filled with native weed-free aggregate and soils.
- The electrical collection system would be removed for above-ground structures and decommissioned in place for below-ground cables.
- The O&M building would be sold or demolished**.** The onsite septic system would be abandoned consistent with State and local requirements, unless needed for a future use of the site.
- Transmission line would be removed. Foundation holes would be filled with native, weed-free soil.

- Road removal would occur as required by permit and/or site control agreements by landowners. Roads would be re-graded to original contours where feasible. Any roads left in place would become the responsibility of the landowner.
- Grading of disturbed areas would be done to preconstruction contours, where feasible;
- Revegetation would occur with native or pasture grass species to ensure establishment of vegetation. Where applicable, restored areas would be stabilized and returned to preconstruction conditions, to the extent feasible.
- Recycling and disposal of materials, turbine components (i.e., metal parts), and any hazardous and regulated materials and wastes would be conducted per applicable local, State, and Federal regulations.
- Electrical substation would remain in place pending the local utility long-term plans (local utility own and operates portion of onsite substation), otherwise all above and below grade materials would be removed as indicated above.

Decommissioning would restore, to the extent practical, the visual and ecological character of the landscape and also remove effects to other environmental and public resources that may have occurred as a result of Project operations. NPMPP would provide the land owners with security as may be required under the terms of the leases to ensure decommissioning obligations are met.

2.5 Habitat Conservation Plan (HCP)

The Proposed Action from the Federal perspective is the issuance of an ITP by USFWS under Section 10(a)(1)(B) of the ESA, as requested by NPMPP, and implementation of the Project HCP. The ITP issued by the USFWS would be valid for a period of 21 years. The take levels requested are listed in Table 2-8. The HCP and associated ITP cover activities associated with the proposed Project only (they do not account for take associated with the larger generation project under Alternative 3).

Subsequent to the publication of the Draft EIS, the Draft HCP was updated to reflect refinements in the Project design, address public and agency comments, and incorporate new information about the Covered Species (refining assumptions used to estimate Project-related take of the Covered Species). The Final HCP includes incidental take calculations based on the Modified Proposed Action Option, incorporating nine turbines with larger generating capacity and taller dimensions (see the Project HCP and Sections 2.2.2, and Section 4.11 of this EIS for additional detail). However, Project take estimates under the Proposed Action (i.e., included in the Draft HCP and evaluated in the Draft EIS) and Modified Proposed Action Option are comparable and do not result in different levels of requested take for any of the covered species. Although the taller turbines have larger rotor swept areas which could influence collision risk, the effect of wind turbine height, rotor swept area, and blade tip speed on bird and bat collision fatalities remains uncertain (Marques et al. 2014). Note that the maximum blade tip speed among the turbine models considered in the Draft EIS is 243 miles per hour, whereas the maximum blade tip speed of the largest turbines considered under the Modified Proposed Action Option is 192 miles per hour due to lower wind turbine rotor speed (maximum revolutions per minute). Moreover, collision risk may decrease through the use of larger turbines because fewer are required to produce the same amount of energy (AWWI 2014). Therefore, the take estimates presented in Chapter 4 have additional conservative assumptions to account for the uncertainty associated with changes in the collision risk associated with fewer but larger turbines or differences in the rotor swept area or blade tip speed (see Chapter 4 for additional discussion). Additionally, the Modified Proposed Action Option does not result in changes to HCP avoidance, minimization, and mitigation measures. Therefore, this EIS reflects components of the Final HCP (i.e., updates to the Draft HCP) which are described below.

The scope of the HCP covers the area and activities where incidental take authorization would be provided under the ITP and ITL. The covered area includes the portions of the DLNR and Malaekahana Hui West, LLC leased properties which comprise the wind farm site, the construction access route, and the mitigation areas. The covered activities include all Project activities which may occur during construction, operation, and maintenance of the Project that have the potential to result in take of the Covered Species.

Table 2-8. Requested ITP Authorization for ESA-listed Species

Species	Requested Take Over the Permit Term
Hawaiian hoary bat	Tier 1: 34 bats Tier 2 (Authorized Take Level): 51 bats Tier 1 represents estimated take; Tier 2 (authorized take request) equates to 150 percent of estimated take.
Newell's shearwater	4 adults/fledged young; 2 eggs/chicks
Hawaiian stilt	4 adults
Hawaiian coot	8 adults
Hawaiian moorhen	8 adults
Hawaiian duck	4 adults
Hawaiian short-eared owl	4 adults/fledged young; 4 eggs/chicks
Hawaiian goose	6 adults

NPMPP is requesting a 21-year ITP and ITL term that covers construction and operation of the Project. Before expiration of the ITP and ITL, and to the extent allowed by applicable laws and regulations, NPMPP reserves the right to apply to renew or amend the HCP and its associated permits and authorizations to extend its term of operation.

The Project HCP includes a detailed discussion of incidental take estimation and assumptions about direct and indirect take for each species. Mitigation areas are shown in Figures 1-4, 1-5, and 1-6 of this EIS. The following sections describe the covered activities and the conservation measures incorporated into the HCP.

2.5.1 Avoidance and Minimization Measures

NPMPP has worked collaboratively with USFWS and DOFAW to assess the potential for the Project to cause adverse effects to the Covered Species. The HCP identifies goals and objectives for each Covered Species that establish a framework for developing the HCP conservation strategy, as outlined in the

USFWS Five-point Policy guidance for the HCP process (USFWS and NMFS 2000). NPMPP has incorporated measures to avoid and minimize impacts to the Covered Species including impacts related to Project components and siting considerations as well as general project development measures. The measures described in this section to avoid and minimize impacts to the Covered Species would do the same for other bird species, including those protected under the MBTA, and culturally important birds.

Project Components and Siting Considerations

- The three Project temporary guyed met towers were fitted with bird flight diverters and/or white poly tape (1 inch [2.5 centimeter]) to increase visibility and, as a result, the likelihood of avoidance by Covered Species.
- The Project plans to install an un-guyed, free-standing permanent met tower to maximize the detectability of all features of the structure for birds and bats and minimize the risk of collision. This permanent tower would replace one temporary guyed met tower, and the remaining temporary met towers would be removed before the commercial operation date.
- The majority of the wind farm site is sited in disturbed agricultural habitat, which minimizes impacts to most native species.
- The wind farm site does not have suitable listed waterbird breeding or foraging habitat, thereby minimizing Hawaiian stilt, Hawaiian coot, and Hawaiian moorhen use of the wind farm site and minimizing potential Project impacts to these species.
- To minimize potential impacts to wildlife, onsite lighting at the O&M building and substation will be shielded and/or directed downward, triggered by a motion detector, and fitted with non-white light bulbs. Lighting is only expected to be used when workers are at the site at night. Most O&M activities are expected to occur during daylight hours. Nighttime activities during construction are addressed in the General Project Development Measures below.
- Barbed wire will not be used on perimeter fences required to secure Project infrastructure to avoid the risk of entangling bats.
- Flashing red lights on the nacelle have been shown to not be attractive to birds and will be used in accordance with FAA requirements.
- The collection line will be placed below ground to the maximum extent practicable, thereby reducing the risk of collision of the Covered Species.
- New above-ground portions of the power lines associated with the Project will use line marking devices to improve visibility to birds and follow Avian Protection Plan Guidelines (APLIC 2012).

General Project Development Measures

- Hawaiian hoary bats roost in non-native and native woody vegetation that is 15 feet (4.5 meters) or taller. To minimize potential impacts to the Hawaiian hoary bat, woody plants greater than 15 feet (4.5 meters) tall will not be removed or trimmed between June 1 and September 15 during the installation and ongoing maintenance of the Project structures.

- NPMPP will implement low wind speed curtailment to reduce potential impacts to Hawaiian hoary bats. Proposed implementation will include increasing manufacturer's recommended cut-in speeds[1] from 10 feet/ per second (ft/s; 3 meters/ per second [m/s]) to 16 ft/s (5 m/s), and feathering turbine blades[2] into the wind below 16 ft/s (5 m/s). Low wind speed curtailment will be instituted March – November between sunset and sunrise. In addition to the intended benefit of reducing bat fatalities, low wind speed curtailment will reduce the risk to Newell's shearwaters, which could transit the wind farm site at night April – November.
- NPMPP will deploy bat acoustic monitors at the Project to document bat acoustic activity for a period during operations. Results from this monitoring may potentially be used to adaptively manage implementation of low wind speed curtailment to reduce observed and unobserved bat fatalities.
- A daytime speed limit of 25 miles per hour (mph; 40 kilometers per hour [kph]) and a nighttime speed limit of 10 mph (16 kph) will be observed on wind farm site roads to minimize the potential for vehicle collisions with Covered Species.
- Should the Hawaiian goose begin to use the wind farm site for foraging or nesting, NPMPP will reduce daytime speed limits to 10 mph (16 kph) to minimize the potential for vehicle collisions.
- Stormwater management on the Project including the turbine pads and roads will be designed to avoid the potential for accumulating standing water, which could serve as an attractant to waterbird species.
- As appropriate to control erosion or other site-specific concerns, disturbed areas will be replanted with non-invasive resident species that are compatible with Project operations, such as being suitable for post-construction mortality monitoring within search areas. To the extent practicable, NPMPP will minimize the creation of suitable Hawaiian goose nesting habitat (shrubs adjacent to low-growing grass) in developing post-construction monitoring search plots.
- Trash will be collected in lidded receptacles and removed from the construction area on a weekly basis to avoid attraction of ants and other animals such as mongooses, cats, and rats that may negatively affect the Covered Species or NPMPP's ability to detect fatalities of the Covered Species.
- NPMPP will maximize the amount of construction activity that can occur in daylight during the seabird breeding season including the peak fledging period (approximately October 15-November 23).
- Should nighttime construction be required, NPMPP will use shielded lights and maximize the use of non-white lights if construction safety is not compromised, to minimize the attractiveness of construction lights to wildlife. NPMPP will also have a biological monitor in the construction area to watch for the presence of Covered Species at all times during

[1] Cut-in speed is the speed at which the turbine first starts to rotate and generate power.
[2] Feathering turbine blades refers to increasing the angle of the blade's pitch by turning the blade parallel to the air flow to reduce air resistance or wind drag.

nighttime construction. Should a Covered Species be observed, the monitor will stop construction activities and shut down construction lighting until the individual(s) move out of the area.

- When not in use, construction cranes will be lowered at night, when practicable, to minimize the risk of bird collisions.
- To address concerns about fire safety, NPMPP will establish fire safety-related construction and O&M requirements (including landscaping considerations), response protocols, and responsibilities. A Fire Management Plan is included in Appendix C of the Final EIS.
- Chromolaena (*Chromolaena odorata)*, an invasive plant species, occurs on the nearby Kahuku training area. NPMPP will coordinate with the Oahu Invasive Species Committee to identify and implement measures to minimize the risk of introducing chromolaena to the wind farm site. Approaches to minimize risk may include periodic site inspections by qualified personnel to search for the presence of plants and cleaning of equipment used in the wind farm site.

2.5.2 HCP (Off-site) Mitigation Measures

In addition to the need for avoidance and minimization measures, Section 10(a)(2)(A) of the ESA and HRS Chapter 195D require that an HCP describe the specific steps that will be taken to mitigate the effects of the take authorized by the ITP and ITL. The mitigation measures described below, and summarized in Table 2-9, would be implemented at locations outside of the wind farm site and are designed to offset or compensate for the effects of incidental take of the Covered Species which cannot be avoided or minimized through the measures described in the Section 2.5.1. The intent of the measures described here is to benefit the Covered Species through management and monitoring or through enhancement and improvement of their habitats.

Table 2-9. Proposed Mitigation for the Covered Species

Species	Tier 1 or One-time	Tier 2
Hawaiian hoary bat	Provide funding for and report results from a bat research study contributing to the knowledge of Hawaiian hoary bats on Oahu and implement bat habitat restoration measures and associated monitoring at the Poamoho Ridge mitigation area.	Provide funding for and report results from a bat research study contributing to the knowledge of Hawaiian hoary bats on Oahu and implement bat habitat restoration measures and associated monitoring at the Poamoho Ridge mitigation area.
Newell's shearwater	Provide funding to National Fish and Wildlife Foundation research fund to support research and management of Newell's shearwaters.	NA
Hawaiian stilt	Design and install fence and public information signs to reduce fatalities of waterbirds at Hamakua Marsh. Support public education and monitoring through the funding of a part-time biologist.	NA
Hawaiian coot	See Hawaiian stilt, above	NA
Hawaiian moorhen	See Hawaiian stilt, above	NA

Table 2-9. Proposed Mitigation for the Covered Species (continued)

Species	Tier 1 or One-time	Tier 2
Hawaiian duck	See Hawaiian stilt, above	NA
Hawaiian short-eared owl	Provide funding to DOFAW's Endangered Species Trust Fund to support research and management of Hawaiian short-eared owl.	NA
Hawaiian goose	Construct a protective hogwire fence in one of several proposed fenced units at James Campbell NWR.	NA

NPMPP has worked with the USFWS and DOFAW to identify appropriate mitigation measures to compensate for the take of the Covered Species. The mitigation proposed consists of a two-tiered approach for the Hawaiian hoary bat. For this species, initial mitigation efforts (Tier 1) are designed to compensate for estimated take, and a second tier of take (authorized take level) was established for which additional mitigation would be required in the event that take is higher than estimated. One mitigation level is presented for the Hawaiian duck, Hawaiian stilt, Hawaiian moorhen, Hawaiian short-eared owl, and Hawaiian goose due to the low anticipated level of take. The following discussion describes the mitigation proposed for each species or species group including the mitigation approach; mitigation locations; and the mitigation activities for each of the Covered Species, the rationale for their selection, and the details associated with implementing the mitigation specific to each Covered Species to aid in the assessment of their environmental impacts.

2.5.2.1 Mitigation for Potential Impacts to the Hawaiian Hoary Bat

A tiered approach was used for determining the requested authorized take levels for the Hawaiian hoary bat given the uncertainty surrounding the prediction of take and the estimation of actual mortality. Two tiers were created relative to the estimated take under low wind speed curtailment to provide flexibility in case of lower or higher than estimated fatality rates. The first tier was established at the estimated take level, and a second tier of take was established for which additional mitigation would be required. Take levels for this species are not additive among tiers but rather represent the total requested take amount. Mitigation measures described below correspond to the two tiers of take for the Hawaiian hoary bat (Table 2-10).

Table 2-10. Proposed Bat Mitigation.

Tier	Mitigation
Tier 1	Hawaiian hoary bat research funding ($100,000) and 8 years of funding for forest restoration, fence maintenance, and acoustic monitoring at both Poamoho Ridge units (1,307 acres [529 hectares])
Tier 2	Hawaiian hoary bat research funding ($50,000) and 4 years of funding for forest restoration, fence maintenance, and acoustic monitoring at both Poamoho Ridge units (1,307 acres [529 hectares])

The proposed mitigation of research and forest restoration is consistent with Hawaiian Hoary Bat Recovery Plan (USFWS 1998) and priorities and recommendations in the Endangered Species Recovery Committee (ESRC) Bat Guidance (DOFAW 2015), including the recommended mitigation funding target of $50,000 per bat. The Hawaiian Hoary Bat Recovery Plan (USFWS 1998) describes the first two recovery priorities as: 1) research essential to the conservation of the subspecies and 2) protecting and managing current populations. Therefore, NPMPP has proposed mitigation that includes a combination of Hawaiian hoary bat research and forest restoration in an area used by Hawaiian hoary bats. NPMPP has also included land acquisition as a mitigation alternative. As described above, bat mitigation will be implemented per tier (Table 2-10).

Research Funding

The Hawaiian Hoary Bat Recovery Plan (USFWS 1998) identifies research as one of the primary actions needed to move toward recovery and delisting of the species. Although progress has been made on understanding the ecology of Hawaiian hoary bats, many basic research questions still exist. During April 2015, the ESRC held a Hawaiian hoary bat workshop, during which researchers, agency personnel, and other interested parties developed a list of research priorities, described in the ESRC Hawaiian Hoary Bat Guidance Document (DOFAW 2015), to target the collection of data that would allow for the development of more effective Hawaiian hoary bat mitigation measures. Accordingly, as part of its mitigation, NPMPP would provide funding for a research project or would contribute funding to expand an existing research project targeting one of the research priorities identified in the ESRC Hawaiian Hoary Bat Guidance Document (DOFAW 2015). Table 2-10 identifies the proposed funding amounts to mitigate for potential impacts associated with construction and operation the Project for Tiers 1 and 2.

Forest Restoration, Management, and Monitoring– Poamoho Ridge

The Hawaiian Hoary Bat Recovery Plan and the State of Hawaii's Comprehensive Wildlife Conservation Strategy recommend conservation of known occupied bat habitat (USFWS 1998; Mitchell et al. 2005). Conservation may include restoration of protected land to improve habitat quality, or the acquisition of land to protect it from development. To prevent ongoing habitat degradation of conservation lands, areas targeted for restoration in Hawaii must be fenced and managed to prevent non-native ungulates from destroying native species and introducing and fostering invasive plant species. Additionally, invasive species must be removed and a native-plant dominated community must be fostered. This approach to forest restoration and management reduces the pressures from invasive species and allows natural forest restoration processes to occur.

Based on discussions with the DLNR, Koolau Mountains Watershed Partnership (KMWP), Army Natural Resources, and Kamehameha Schools, NPMPP concluded that it would be most effective to work in collaboration with these existing conservation partnerships to fund long-term forest restoration in an area where fencing efforts are already underway. The DLNR's Poamoho Ridge was identified as the best candidate for Project mitigation efforts because it contains suitable, but degraded, bat habitat and DLNR has already secured funding for fencing around two units that are 654 acres (265 hectares) and 653 acres (264 hectares), respectively (Figure 1-5). Poamoho Ridge consists of native, high-elevation forest along the leeward summit of the central Koolau Mountains (Figure 1-5). It is located above Wahiawa in the Ewa Forest Reserve, and is proposed to be part of the State Natural Area Reserve System. Habitat along Poamoho Ridge is steadily decreasing in quality due to the presence of invasive plant species are and feral pigs (M. Zoll, DLNR, pers. comm.

2014). Forest restoration and management activities conducted by NPMPP within the fenced units would foster the growth of additional bat roosting and foraging habitat, and would support a forested corridor connected with the Ahupua`a O Kahana State Park and forested habitat managed for conservation in neighboring military reservation areas (Figure 1-5).

Forest restoration, fence maintenance, and acoustic monitoring on both Poamoho fence units are proposed for each mitigation tier with the length of the effort varying by tier. A preliminary draft management plan in Appendix E of the Project HCP describes the initial management approach for addressing mitigation needs and is summarized in the following paragraphs. Upon the initiation of Project construction, funding will be provided to develop a final management plan as part of the mitigation. This plan is subject to review by USFWS and DOFAW and requires the recommendation for approval by the ESRC.

Funding for forest restoration, management, and monitoring of the Poamoho units is proposed for each tier of mitigation. NPMPP would provide annual funds to KMWP or a similar organization for one 8-year period and potentially up to one additional 4-year period. Funding would cover the costs of two full-time employees per year performing forest restoration, management, and monitoring activities including fence maintenance, bat acoustic monitoring, feral pig control and monitoring, and invasive plant removal and monitoring, as well as needed supplies and helicopter time. All of these activities, which are part of DOFAW's ongoing watershed protection efforts, are covered under DLNR's Chapter 343 Declaration of Exemption for the Koolau Forest Watershed Protection Project (DLNR 2012).

Shortly after fence installation, management work would focus on removal of pigs. In later years, the focus would likely shift to invasive plant removal to allow for natural recruitment, and fence maintenance. It is anticipated that work would be conducted by KMWP; if not, an alternate approach would be developed in coordination with the USFWS and DOFAW. For additional information on how the mitigation acreages were derived and the allocation of staff time, please see the Project HCP.

Acoustic monitoring at Poamoho Ridge would document presence and temporal patterns of bats, and would provide valuable information on long-term patterns of bat use at this site. NPMPP initiated short-term bat acoustic monitoring at Poamoho Ridge in April 2014 to provide baseline data and verify bats occur in the area. This effort confirmed the use of the area by bat(s). During commercial operation of the Project, acoustic monitoring will include monitoring at Poamoho Ridge for the duration of mitigation commitment within the respective tiers (Table 2-10).

2.5.2.2 Mitigation for Potential Impacts to the Newell's Shearwater

The USFWS Newell's Shearwater Recovery Plan and the State of Hawaii's Comprehensive Wildlife Conservationist Strategy for Newell's shearwaters recommend efforts to reduce fallout, protect known colonies, and develop efficient predator control methods while expanding knowledge of the species' status and distribution (USFWS 1983, Mitchell et al. 2005). Although providing mitigation for this species on Oahu would be preferred, this approach is not likely the most effective for Newell's shearwater recovery because no nesting colonies are known from Oahu, and locating any breeding populations, if any exist, would take considerable effort. Combined with additional threats such as fallout potential due to heavy urbanization on Oahu, this makes conservation efforts on Oahu impractical on a scale that is within the scope of the Project. Therefore, with the concurrence of the USFWS, DOFAW, and ESRC, mitigation for the possible take of Newell's shearwater by the Project will be either focused on improving existing management measures or implementing colony-based management at a chosen breeding colony on Maui, Kauai, or elsewhere to provide a net benefit and maximize contributions to the recovery goals of the species. Mitigation actions would address one or more of the major threats to the recovery of Newell's shearwaters: 1) introduced predators, mainly cats, which can prey on adults, eggs, and fledglings; 2) feral ungulates, mainly pigs, which degrade habitat and may trample burrows; and 3) artificial lighting, which may disorient fledglings and increase their risk of collision with artificial structures (Mitchell et al. 2005).

The USFWS has created an account with the National Fish and Wildlife Foundation (NFWF) where funds for Newell's shearwater mitigation can be deposited and then used according to an appropriate Newell's shearwater conservation plan. The overall intent is that pooled resources can be used to fund larger management projects or to resolve larger research questions targeted at the recovery of Newell's shearwater than could have been supported through smaller scale investments. NPMPP will provide designated mitigation funds to the NFWF dedicated account. The USFWS, and potentially other appropriate partner organizations, will collaborate to create a Newell's shearwater conservation plan and implement the planned activities. The Newell's shearwater conservation plan funded in part by NPMPP contributions will be developed in coordination with DOFAW, reviewed by appropriate species experts, and include appropriate biological measures of success which will be determined when the conservation plan is developed.

Based on a review of data from Kauai, USFWS and DOFAW estimated $28,000 would be required to mitigate for one adult Newell's shearwater and $11,000 for one Newell's shearwater chick or egg, plus administration costs of 20 percent (A. Nadig, USFWS, and A. Amlin, DOFAW, pers. comm. 2014). Therefore, to mitigate for potential effects to Newell's shearwaters NPMPP would provide NFWF $160,800 in funding.

2.5.2.3 Mitigation for Potential Impacts to Waterbirds (Hawaiian Stilt, Hawaiian Coot, Hawaiian Moorhen, and Hawaiian Duck)

Mitigation Approach

The Recovery Plan for Hawaiian Waterbirds (USFWS 2011b) identifies habitat loss and degradation and predation by introduced mammals as the primary threats to the Hawaiian stilt, Hawaiian moorhen, and Hawaiian coot. It also identifies these factors as the most important causes of decline of the Hawaiian duck. Appropriate habitat management of USFWS (2011e) core wetlands is the first recovery criterion listed in the USFWS Recovery Plan for Hawaiian Waterbirds for each of the resident waterbird species. Therefore, mitigation proposed by NPMPP includes management activities at Hamakua Marsh. Hamakua Marsh is a core wetland and therefore the implementation of management at this site is consistent with the USFWS recovery objectives.

Mitigation Location - Hamakua Marsh

Hamakua Marsh is a DLNR-owned waterbird sanctuary located on the edge of the town of Kailua and is adjacent to Kawainui Marsh, the DLNR-owned and managed waterbird management area (Figure 1-4). The Hamakua Marsh Mitigation Area is managed as breeding habitat for Hawaiian stilts, Hawaiian coots, and Hawaiian moorhens and is likely to provide future habitat for the Hawaiian duck, should a population become established on Oahu through planned recovery efforts. The marsh is identified as a core wetland in the USFWS (2011e) Recovery Plan for Hawaiian Waterbirds. DOFAW is responsible for long term management of the area, but DOFAW has also received support for predator control efforts through a mitigation agreement for potential impacts to waterbirds associated with the Kahuku Wind Project HCP (SWCA 2010). Monitoring of the mitigation efforts for the Kahuku Wind Project identified on-going mortality associated with the listed waterbirds being struck by vehicles in a shopping center parking area because they were being fed by the public (L. Salbosa, DOFAW, pers. comm. 2013).

Hamakua Marsh has an unprotected perimeter in an area of high human traffic, which has resulted in a number of negative impacts including the death and disturbance of listed waterbirds and an accumulation of trash at the site. The approximate 1,555-foot (474-meter) length of the north boundary of Hamakua Marsh abuts a shopping center along the Kawainui Canal (Figure 1-4). Local residents, shopping center restaurants employees and visitors, and others frequently use the area in ways that jeopardize resident listed waterbirds. Local residents and nearby restaurants often discard bread or other food in the parking area for the local birds to consume. Attracted by the food, waterbirds leave the marsh and forage for crumbs in the parking area, and these birds are regularly killed by vehicles and occasionally killed by people (L. Salbosa, DOFAW, pers. comm. 2013). Dog owners throw tennis balls into the marsh for their dogs to retrieve, which disturbs nesting birds or can result in direct predation (L. Salbosa, DOFAW, pers. comm. 2013). Finally, open access to the wetland invites trespassing and the illegal disposal of garbage, degrading nesting habitat.

Proposed Mitigation Activities

To address the complex management problems at Hamakua Marsh, NPMPP proposes to fund the design, construction, and limited-term maintenance of a partial fence, as well as fund a part-time staff position that would act as an onsite monitor and public outreach biologist. The proposed fence would create a boundary between the shopping center and the edge of the Hamakua Marsh Mitigation Area, controlling access to limit the illegal dumping of garbage, reducing the movement of waterbirds into the parking lot, and eliminating the use of the marsh by dogs (Figure 1-4). The part-time biologist would serve to educate local shop owners and the public about the harm caused by feeding waterbirds, as well as monitoring the area for waterbird fatalities. Although the fence would impede movement of birds from the marsh to the parking area, USFWS, DOFAW, and NPMPP agreed that the benefits of the fence would be magnified by an active public outreach program managed by an onsite biologist.

The fence would be approximately 1,555 feet (474 meters) long and 4 feet (1.2 meters) high, and would include up to 20 informational signs, which would serve to educate the public about the resident waterbirds and actions they can take to support them, reinforcing the message from the part-time biologist. Figure 2-5 depicts an example of what the proposed fence may look like that is consistent with design criteria, and NPMPP would work with agencies to ensure fence design and construction will meet mitigation objectives. Funding for the part-time biologist and fence maintenance would be provided for 2 years.

Figure 2-5. Example of Proposed Fence at Hamakua Marsh

2.5.2.4 Mitigation for Potential Impacts to the Hawaiian Short-eared Owl

The State of Hawaii's Comprehensive Wildlife Conservationist Strategy (Mitchell et al. 2005) recommends a combination of conservation actions, monitoring, and research to address threats to the Hawaiian short-eared owl. These recommendations include continuing conservation efforts at refuges and wildlife sanctuaries, expanding survey efforts to monitor population status and trends on Oahu, and conducting research into limiting factors such as "sick owl syndrome" and vehicle collisions. Due to the low level of anticipated impact to Hawaiian short-eared owls and a general desire to maximize the positive effects of investments in mitigation, DOFAW will use the Endangered Species Trust Fund to consolidate contributions for Hawaiian short-eared owl mitigation from approved projects into a general fund. This fund will be used for the expressed purpose of mitigating impacts to Hawaiian short-eared owls. The overall intent is that pooled resources can be used to fund larger management projects or to resolve larger research questions targeted at the recovery of Hawaiian short-eared owls on Oahu than could have been supported through smaller scale investments. In consultation with DOFAW, all parties agreed $25,000 would be required to mitigate for impacts to Hawaiian short-eared owls.

2.5.2.5 Mitigation for Potential Impacts to the Hawaiian Goose

Mitigation Approach

Given the small size of the Hawaiian goose population on Oahu, the USFWS and DOFAW have proposed a mitigation approach consisting of funding for habitat management to reduce potential predation in suitable habitat. Consistent with this recommendation, NPMPP proposes to fund the construction of a hogwire fence in one of several proposed fenced units in the James Campbell NWR being managed as Hawaiian goose habitat (Figure 1-6). Details regarding the appropriate amount of fencing will be determined in consultation with the USFWS and DOFAW.

The proposed fence construction will significantly reduce the predation risk from dogs, which have been identified as a predator of concern for the Hawaiian goose at this site (J. Charrier, USFWS, pers. Comm. 2015), and will increase productivity and survival of the Hawaiian goose should the population grow and use the managed area. The area proposed for management activities contains suitable Hawaiian goose nesting habitat and is in proximity to the area where an adult pair of Hawaiian geese nested in the winter of 2013-2014. This area remains an area of frequent use for the Oahu resident Hawaiian geese (J. Charrier, USFWS, pers. comm. October 2015). Furthermore, the area is expected to be used by Hawaiian geese into the future, and those birds are expected to benefit from these actions because: 1) the species exhibits strong site fidelity and natal philopatry (Banko et al. 1999), 2) the population is assumed to grow over time at least partially due to natural reproduction, and 3) USFWS is committed to providing long term fence maintenance and management of the area. Therefore, this effort is anticipated to reduce threats to the current Oahu resident Hawaiian geese as well as future offspring or arrivals. Specifically, this effort will increase productivity and survival of the Hawaiian goose should the population grow and, as expected, use the managed area.

The James Campbell NWR Comprehensive Conservation Plan and associated NEPA EA address the proposed mitigation activities. Therefore, this EIS tiers to the exiting NEPA EA (USFWS 2011a) and impacts to individual resources are not discussed further here.

2.5.3 Post-construction Monitoring

A Post Construction Monitoring Plan (PCMP) will be implemented as a means to document impacts to the Covered Species as a result of operation of the Project, and to ensure compliance with the authorized provisions and take limitations of the HCP and the associated ITP and ITL (see Appendix A of the Project HCP). The monitoring protocol is consistent with post-construction mortality monitoring being conducted for five other wind projects in Hawaii and elsewhere in the continental U.S. (Arnett 2005, Kerns et al. 2005, Kaheawa Wind Power, LLC 2006, Arnett et al. 2009, SWCA 2011a, SWCA 2011b, Tetra Tech 2012a).

Key components of the PCMP for the Project include:

- Use of NPMPP technical staff and/or contracted biologists with expertise in turbine-bird/bat interaction studies and implementation of wind energy post-construction monitoring protocol;
- Standardized carcass searches conducted under the operating turbines as described in the Post-construction Monitoring Plan. Search intensity or approach may be modified with approval of the USFWS and DOFAW based on the results of standardized monitoring;
- USFWS, DOFAW, and ESRC approval is required to implement interim monitoring as described in the Post-construction Monitoring Plan;
- Carcass removal and searcher efficiency trials during standardized carcass searches to adjust observed fatality numbers for bias associated with the removal of carcasses by scavengers or other means and the ability of searchers to locate carcasses, respectively (see Appendix A of the Project HCP);
- A Wildlife Education and Incidental Reporting Program for reporting incidental observations of Project-related fatalities made by onsite staff;
- A protocol for the recovery, handling, and reporting of downed wildlife (see Appendix A of the Project HCP); and
- NPMPP will evaluate new technologies and/or methods in post-construction mortality monitoring that may become available during the permit term for logistical and economic feasibility as well as their potential to increase monitoring effectiveness.

3.0 AFFECTED ENVIRONMENT

This chapter presents the environmental, cultural, and socioeconomic resources that have the potential to be affected by the Proposed Action as described in Chapter 2. Resource areas include geology and soils; hydrology and water resources; air quality and climate change; noise; hazardous and regulated materials and wastes; natural hazards; vegetation; wildlife; threatened and endangered species; socioeconomic resources; historic, archeological and cultural resources; land use; recreation and tourism; visual resources; transportation; public health and safety; environmental justice; public infrastructure and services; military interests, and agriculture. For most resources, impacts would be limited to the wind farm site (specifically areas coinciding with and immediately adjacent to the Project facilities; Figure 1-2) and HCP mitigation areas. However, for some resources, a wider geographic area is considered to capture all direct and indirect effects of the Project. The analysis area and the existing conditions for each resource are described below.

3.1 Geology and Soils

Geologic resources consist of the earth's surface and subsurface materials, such as soil and bedrock. The analysis area for geology and soils includes all areas that will be disturbed by construction of the Project, as well as areas that would be disturbed by activities implemented in the mitigation areas.

3.1.1 Geology

The island of Oahu is the third largest of the Hawaiian islands and is composed primarily of the remains of two extinct shield volcanoes, Waianae and Koolau (Hunt 1996). Secondary geologic processes, including subsidence, landslides and slumping, weathering, erosion, sedimentation, and rejuvenated volcanism, have resulted in substantial modification of these two shield volcanoes (Hunt 1996). The remnants of these two volcanoes comprise the existing Waianae and Koolau mountain ranges, both of which consist of large valleys, gullies, and gulches separated by steep ridges. The Waianae Range occurs in western Oahu and the Koolau Range occurs in eastern Oahu with the central portion of Oahu, which has been less affected by erosion, forming the saddle between these two ranges (Hunt 1996). The outer edge of Oahu consists of a flat coastal plain, underlain by sedimentary deposits, which varies in width from a narrow strip to an area several miles wide (Hunt 1996). In southern Oahu and other areas where this coastal plain is extensive, the surface of the coastal plain is composed mainly of emerged Pleistocene reefs and associated marine sediments (Hunt 1996). The wind farm site and waterbird, and bat mitigation areas lie within the Koolau Range.

The Koolau Range is comprised primarily of Koolau Basalt. The Honolulu volcanic series, which formed during rejuvenated volcanism, also occur in the southeastern end of the Koolau range (Hunt 1996). The primary constituents of the Koolau Basalt include tholeiitic basalt lavas, feeder dikes of tholeiitic basalt, and lesser amounts of talus breccia, explosion breccia, cinder, and spatter (Hunt 1996). Erosion of the Koolau Volcano exposed rift zones observed due to the presence of dike complexes (Garcia 1979; HBWS 2009). These dike complexes consist of dense, usually vertical, geological structures created by solidification of molten rock within surrounding porous lava flows (HBWS 2009). Weathering of basaltic rock in the Koolau Range produced erodible, clay-rich soils (Hunt 1996); however, these residual and alluvial soils, have been removed by streams and surface runoff and accumulated in valley floors (HBWS 2009).

3.1.1.1 Wind Farm Site

Located at the base of the northern part of the Koolau Range, just above the coastal plain near the town of Kahuku, the wind farm site ranges in elevation from approximately 3 feet (1 meter) above mean sea level (amsl) on the northern edge to 614 feet (187 meters) amsl on the southern edge. The Project Area consists of steep, dissected ridges surrounding gently sloping valleys (Hobdy 2013a). A detailed geotechnical investigation of the wind farm site will be conducted prior to construction.

3.1.1.2 Hamakua Marsh (waterbird)

The Hamakua Marsh Mitigation Area is located on the edge of the town of Kailua and is adjacent to Kawainui Marsh, the DLNR-owned and managed waterbird management area. Elevations in the Hamakua Marsh Mitigation Area range from approximately 3 feet (1 meter) amsl to approximately 23 feet (7 meters) amsl. Hamakua Marsh is a smaller wetland that was historically connected to and immediately downstream of Kawainui Marsh. Kawainui Marsh is located in the Koolau caldera and historically (around 4000 BC) was a bay connected to the ocean (DLNR 2013). Hamakua Marsh is a remnant floodplain that once linked Kawainui Marsh to Kaelepulu Pond (Ducks Unlimited 1992).

3.1.1.3 Poamoho Ridge (bat)

The Poamoho Ridge Mitigation Area is located in the Ewa Forest Reserve above Wahiawa along the leeward summit of the central Koolau Range. Elevations in the Poamoho Ridge Mitigation Area range from approximately 1,332 feet (406 meters) amsl to approximately 2,648 feet (807 meters) amsl. The mitigation area is located on a steep mountainous land in the Koolau Range. The area is characterized by undulating hills and steep ridges deeply transected by streams (U.S. Army 2010).

3.1.2 Soils

3.1.2.1 Project Area

Under the ALISH classification, the majority of agricultural lands found within the DLNR portion of the wind farm site are not classified, while the majority of agricultural lands within the Malaekahana Hui West portion of the wind farm site are classified as Prime Agricultural Lands (Hawaii State Department of Agriculture 1977). Prime Agricultural Lands are defined as "land best suited for the production of food, feed, forage, and fiber crops" (Hawaii State Department of Agriculture 1977). The majority of the soils found within the DLNR portion of the wind farm site, are classified as Category E (least productive soils) under the University of Hawaii's Land Study Bureau's (LSB's) Detailed Land Classification System, while the majority of the soils found within the Malaekahana Hui West portion are classified as Category B (more productive) (University of

Hawaii Land Study Bureau 1972). Further information on the ALISH and LSB classification systems can be found in Section 3.20 – Agriculture.

Soil types mapped in the wind farm site by the Natural Resources Conservation Service (NRCS) are listed in Table 3.1-1 and displayed in Figure 3.1-1. The dominant soil types in the wind farm site include Paumalu-Badland complex and Lahaina silty clay (3 to 7 and 7 to15 percent slopes) soils. Paumalu-Badland complex soils, which make up approximately 36 percent of the Project Area, are well-drained silty clay Paumulu soils and Badland soils which consist of barren land remaining after Paumulu soils were removed by wind and water erosion (Foote et al. 1972). Lahaina silty clay soils, which make up approximately 31 percent of the wind farm site, consist of very deep, well drained soils that formed in alluvium and residuum weathered from basic igneous rock. Mokuleia clay loam and coral outcrops (found at elevations below 100 feet amsl) make up approximately 7 and 5 percent of the wind farm site, respectively. The only soil type found within the wind farm site that is listed by the NRCS as having a hydric soil component is the Haleiwa silty clay (zero to 2 percent slopes) soil type. This soil type is found along the southeast boundary and makes up approximately 1 percent of the wind farm site (NRCS 2013).

Portions of the wind farm site, particularly the eastern side, have previously or are currently used to support agricultural activities. A discussion of the classification of the soils within the site relative to agricultural productivity is provided as part of Section 3.20 – Agriculture.

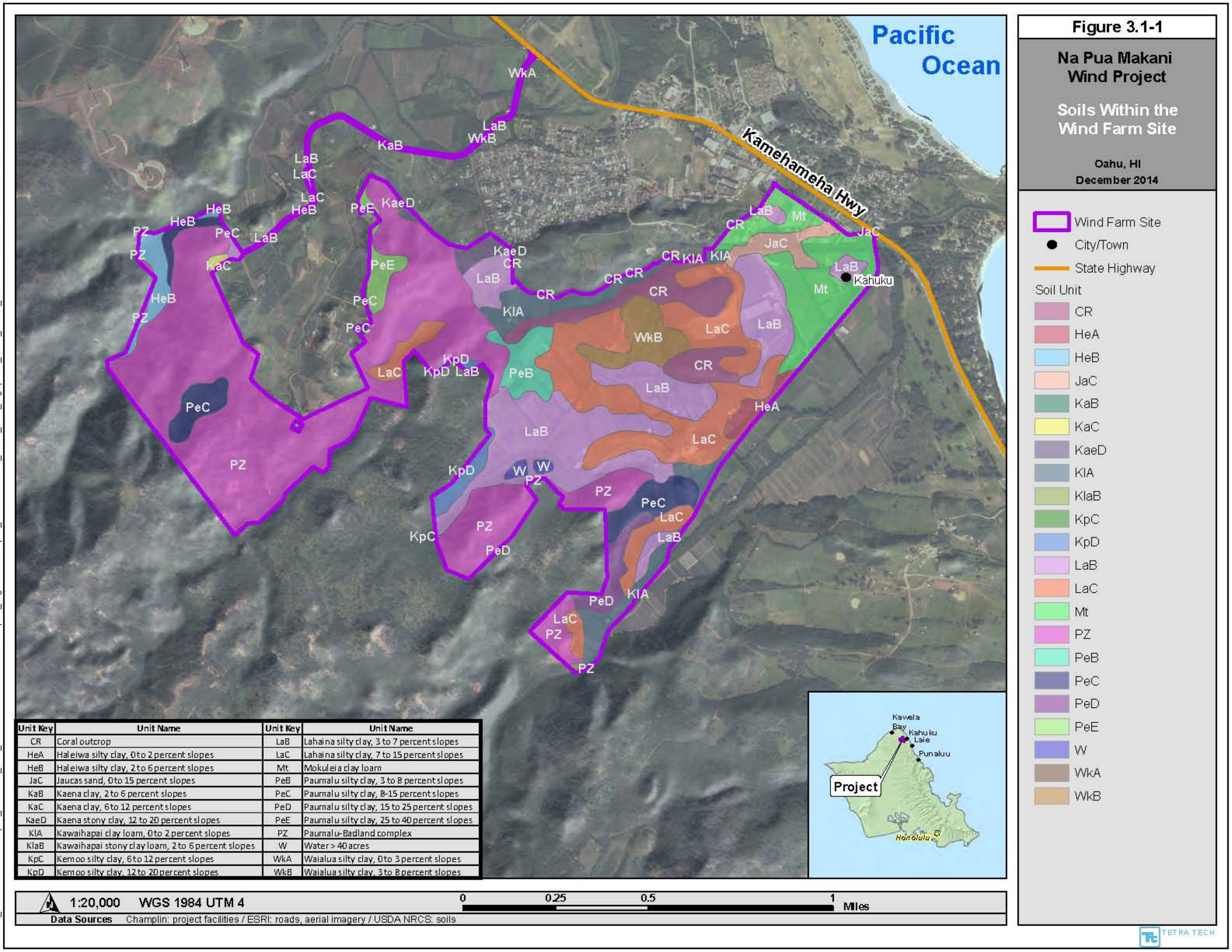
Table 3.1-1. Soil Types in the Wind Farm Site

Soil Name (Map Unit Symbol)	Slope (%)	Description	Permeability	Runoff	Erosion Hazard	Acres within the Wind Farm Site
Coral Outcrop (CR)	N/A	Coral or cemented calcareous sand; found on exposed ocean shore, coastal plains, and foot of the uplands	N/A	N/A	N/A	32.8
Haleiwa silty clay (HeA)	0-2	Deep, well drained soils that formed in alluvium derived from basic igneous material. Found on fans and in drainageways along the coastal plains	Moderate	Slow	Slight	6.4
Haleiwa silty clay (HeB)	2-6	Deep, well drained soils that formed in alluvium derived from basic igneous material. Found on fans and in drainageways along the coastal plains	Moderate	Slow	Slight	10.1
Kaena clay (KaB)	2-6	Deep, poorly drained soils formed on alluvium and colluvium	Slow	Slow	Slight	0.2
Jaucas sand (JaC)	0-15	Excessively drained, calcareous soils that occur as narrow strips on coastal plains adjacent to the ocean	Rapid	Very slow to slow	Slight (water erosion) to severe (wind erosion)	10.4
Kaena clay (KaC)	6-12	Very deep, poorly drained soils on alluvial fans and talus slopes	Slow	Slow to Medium	Slight	1.1

Table 3.1-1. Soil Types in the Project Area (continued)

Soil Name (Map Unit Symbol)	Slope (%)	Description	Permeability	Runoff	Erosion Hazard	Acres within the Wind Farm Site
Kaena stony clay (KaeD)	12-20	Very deep, poorly drained soils on alluvial fans and talus slopes	Slow	Medium	Moderate	6.8
Kawaihapai clay loam (KlA)	0-2	Well-drained soils in drainageways and on alluvial fans on the coastal plains	Moderate	Slow	Slight	32.6
Kawaihapai stony clay loam (KIaB)	2-6	Well-drained soils in drainageways and on alluvial fans on the coastal plains	Moderate	Slow	Slight	0.5
Kemoo silty clay (KpD)	12-20	Well-drained soils on uplands; developed from basic igneous rocks	Moderate to moderately rapid	Medium	Moderate	7.7
Lahaina silty clay (LaB)	3-7	Very deep, well drained soils that formed in alluvium and residuum weathered from basic igneous rock, found on uplands	Moderate	Slow	Slight	118.7
Lahaina silty clay (LaC)	7-15	Very deep, well drained soils that formed in alluvium and residuum weathered from basic igneous rock, found on uplands	Moderate	Medium	Moderate	100.0
Mokuleia clay loam (Mt)	Nearl y level	Well-drained soils along coastal plains; formed in recent alluvium deposited over coral sand	Moderate	Very slow	Slight	46.7
Paumalu silty clay (PeB)	3-8	Well-drained silty clay soils on uplands	Moderately rapid	Slow	Slight	13.0
Paumalu silty clay (PeC)	8-15	Well-drained silty clay soils on uplands	Moderately rapid	Slow to medium	Slight to moderate	27.3
Paumalu silty clay (PeD)	15-25	Well-drained silty clay soils on uplands	Moderately rapid	Medium	Moderate	10.3
Paumalu silty clay (PeE)	25-40	Well-drained silty clay soils on uplands	Moderately rapid	Medium	Moderate to severe	8.6
Paumalu-Badland complex (PZ)	10-70	Well-drained silty clay soils on uplands (Paumulu); barren land remaining after Paumalu soils were removed by wind and water erosion (Badland)	Well-drained silty clay soils on uplands	Medium to rapid (Paumalu); Rapid (Badland)	Moderate to severe (Paumalu); Very severe (Badland)	251.6
Waialua silty clay (WkA)	0-3	Moderately well-drained soils formed in alluvium weathered from basic igneous rock.	Moderate	Slow	Slight	0.8
Waialua silty clay (WkB)	3-8	Well-drained soils on alluvial fans	Moderate	Slow	Slight	18.5
Water (W)	N/A	N/A	N/A	N/A	N/A	2.5
					Total	**706.6**

Source: Foote et al. 1972.;NRCS 2014.



Unit Key	Unit Name	Unit Key	Unit Name
CR	Coral outcrop	LaB	Lahaina silty clay, 3 to 7 percent slopes
HeA	Haleiwa silty clay, 0 to 2 percent slopes	LaC	Lahaina silty clay, 7 to 15 percent slopes
HeB	Haleiwa silty clay, 2 to 6 percent slopes	Mt	Mokuleia clay loam
JaC	Jaucas sand, 0 to 15 percent slopes	PeB	Paumalu silty clay, 3 to 8 percent slopes
KaB	Kaena clay, 2 to 6 percent slopes	PeC	Paumalu silty clay, 8-15 percent slopes
KaC	Kaena clay, 6 to 12 percent slopes	PeD	Paumalu silty clay, 15 to 25 percent slopes
KaeD	Kaena stony clay, 12 to 20 percent slopes	PeE	Paumalu silty clay, 25 to 40 percent slopes
KIA	Kawaihapai clay loam, 0 to 2 percent slopes	PZ	Paumalu-Badland complex
KlaB	Kawaihapai stony clay loam, 2 to 6 percent slopes	W	Water > 40 acres
KpC	Kemoo silty clay, 6 to 12 percent slopes	WkA	Waialua silty clay, 0 to 3 percent slopes
KpD	Kemoo silty clay, 12 to 20 percent slopes	WkB	Waialua silty clay, 3 to 8 percent slopes

3.1.2.2 Hamakua Marsh (waterbird)

Soil types in the Hamakua Marsh Mitigation Area are listed in Table 3.1-2. Soils in this area are mapped almost exclusively as Marsh (16.4 acres [6.6 hectare]), with small amounts of Pappaa clay (1.8 acres [0.7 hectare]), water (4.4 acres [1.8 hectares]), and Jaucas sand (0.1 acre [<0.1 hectare]) also occurring in the mitigation area.

Table 3.1-2. Soil Types in the Hamakua Marsh Mitigation Area

Soil Name (Map Unit Symbol)	Slope (%)	Description	Permeability	Runoff	Erosion Hazard	Acres within the Mitigation Area
Marsh (MZ)	N/A	Wet, periodically flooded areas covered dominantly with grasses and bulrushes or other herbaceous plants; hydric soils	N/A	N/A	N/A	16.4
Jaucas sand (JaC)	0-15	Excessively drained, calcareous soils that occur as narrow strips on coastal plains, adjacent to the ocean.	Rapid	Very slow to slow	Water erosion slight; wind erosion severe where vegetation has been removed	0.1
Papaa clay (PYE)	20-35	Well-drained soils on uplands; formed in colluvium and residuum derived from basalt	Slow	Medium	Moderate to severe	1.8
Water (W)	N/A	N/A	N/A	N/A	N/A	4.4
					Total	**22.7**
Source: Foote et al. 1972. Soil descriptions from NRCS 2014 and Foote et al. 1972.						

3.1.2.3 Poamoho Ridge (bat)

Soil types found in the Poamoho Ridge Mitigation Area are listed in Table 3.1-3. The primary soil type found in the Poamoho Ridge mitigation area is Rough Mountainous Land. This soil type is characterized as very steep land, which is typically not stony, broken by numerous intermittent drainage channels (Foote et al. 1972).

Table 3.1-3. Soil Types in the Poamoho Ridge Mitigation Area

Soil Name (Map Unit Symbol)	Slope (%)	Description	Permeability	Runoff	Erosion Hazard	Acres within the Mitigation Area
Poamoho Ridge Mitigation Area						
Rock land (rRk)	level to very steep	Areas where exposed rock covers 25 to 90 percent of the surface	--	--	--	1.4
Rough mountainous land (rRT)	--	Very steep land broken by numerous intermittent drainage channels; typically not stony	--	--	--	1,271.8
					Total	**1,273.2**
Source: Foote et al. 1972. Soil descriptions from NRCS 2014.						

3.2 Hydrology and Water Resources

Hydrology and water resources include groundwater, surface water features, and other resources such as watersheds and floodplains. Surface water features include lakes, rivers, streams, and wetlands. Groundwater refers to the subsurface hydrologic resources, often described in terms of depth to the aquifer or water table, water quality, and surrounding geologic composition. Surface waters, including wetlands and other Waters of the United States (WoUS), within the wind farm site and mitigation areas are subject to jurisdiction under Section 404 of the CWA and Section 10 of the Rivers and Harbor Act. Additional regulations related to hydrology and water resources are outlined in Chapter 5. The analysis area for direct and indirect impacts to hydrology and water resources includes the wind farm site and mitigation areas.

Stream flow and other hydrologic processes in Hawaii are influenced by the climatic and geological features of the area, including topography, rainfall, fog drip, and wind patterns (HBWS 2009). Hawaii streams typically have steep profiles, due to the steep terrain and numerous waterfalls, and are characteristically flashy, due to localized, heavy storms (DAR 2013). The upper reaches of many Hawaii streams are within or near areas where volcanic dikes have impounded ground water to a high level; streams that intersect dike-impounded groundwater are often perennial due to continual recharge from this groundwater source (CWRM 2008). The majority of the perennial streams on Oahu are located within the Koolau Range watersheds. Many streams in the Koolau Range, as well as most on the leeward side of the island, are perennial in their headwaters but intermittent in the lower reaches (HBWS 2009).

Groundwater in Hawaii provides about 99 percent of the domestic water and 50 percent of freshwater used in the State (Oki et al. 1999). The State Water Code (HRS §174C) defines groundwater as “any water found beneath the surface of the earth, whether in perched supply, dike-confined, flowing, or percolating in underground channels or streams, under artesian pressure or not, or otherwise.” Groundwater occurs within aquifers, underground beds or layers of permeable rock, sediment, or soil through which water can easily move. Volcanic-rock aquifers are found throughout the Hawaii islands and are locally overlain by sedimentary deposits (Oki et al. 1999).

The State Commission on Water Resource Management (CWRM) has assigned hydrologic units or aquifer sector areas across the Hawaii islands, generally based on regional geology which describes how water is held and its natural movement (CWRM 2008). These aquifer sector areas also serve as management boundaries for the regulation and allocation of groundwater resources (HBWS 2009). The CWRM administers water use regulation programs with the objective of protecting in-stream flows and maintaining sustainable yields of groundwater in the state (CWRM 2008). The CWRM defines sustainable yield as “the maximum rate at which water may be withdrawn from a water source without impairing the utility or quality of the water source as determined by the commission” (CWRM 2008).

3.2.1 Surface Water

3.2.1.1 Wind Farm Site

The wind farm site lies within the Oio and Malaekahana watersheds of the Koolau Loa District of Oahu (Figure 3.2-1). The Oio Watershed is approximately 6,704 acres (2,713 hectares) with a maximum elevation of 1,850 feet (564 meters; Hawaii Statewide GIS Program 2013). The Malaekahana Watershed is approximately 4,450 acres (1,800 hectares) with a maximum elevation of 2,123 feet (647 meters; Hawaii Statewide GIS Program 2013). Average annual rainfall in the wind farm site ranges from approximately 60 inches (152 centimeters) in the upper elevations to 45 inches (114 centimeters) in the lower elevations near Kahuku (Giambelluca et al. 2013).

The National Hydrography Dataset identified three streams within the wind farm site (Figure 3.2-2). These streams include: Ohia Stream on the northwestern border of the wind farm site, Keaaulu Stream which runs through the middle of the wind farm site, and Malaekahana Stream on the southern border of the wind farm site (Figure 3.2-2). Field surveys conducted in 2013, 2014, and 2015 identified Malaekahana Stream as a perennial stream throughout the wind farm site (Hobdy 2013b, SWCA 2015). The other two streams, Ohia and Keaaulu, are considered intermittent non-Relatively Permanent Waters as they only flow for 1 to 5 days, one to three times a year, following larger rains storms (Hobdy 2013b). Keaaulu Stream is a tributary of Malaekahana Stream and joins Malaekahana Stream at the eastern edge of the wind farm site (Hobdy 2013b). Additionally, the National Hydrography Dataset identified one ditch/canal as being located in the southern portion of the wind farm site. During non-wetland water delineation surveys conducted by SWCA (2015; see Appendix I of the Final EIS), this ditch/canal appeared to have been filled in and was no longer active. SWCA determined that this ditch was likely excavated in uplands and was not observed to contribute flow to another potentially jurisdictional water (SWCA 2015).

Malaekahana Stream is approximately 6 miles (10 kilometers) long flowing from an elevation of approximately 2,000 feet (610 meters) along the summit ridge of the Koolau Mountains to near Makahoa Point, at the southern edge of Kahuku, where it enters the ocean (Hobdy 2013b). The average width of Malaekahana Stream within the wind farm site is 6 to 10 feet (2 to 3 meters) with an ordinary high water mark (OHWM) of approximately 3 feet (1 meter; Hobdy 2013b).

Keaaulu Stream is approximately 4.8 miles long (7.7 kilometers long) from its headwaters, at an elevation of approximately 1,400 feet (427 meters), to its confluence with Malaekahana Stream at Kamehameha Highway (Hobdy 2013b). This stream's watershed is approximately 1,100 acres (445 hectares) and annual rainfall averages approximately 110 inches (279 centimeters) at its headwaters to approximately 45 inches (114 centimeters) at its junction with Malaekahana Stream (Hobdy 2013b). During these intermittent flow events, the stream flow attains a noticeable but somewhat indistinct OHWM of approximately 2 feet (0.6 meter; Hobdy 2013b). During surveys by SWCA (2015) it was noted that the majority of the upper (mauka) portion of Keaaulu Stream within the wind farm site appeared ephemeral due to weak or absent indicators of flow and/or an ordinary high water mark (SWCA 2015). The average width of Keaaulu Stream within the wind farm site is 2 to 6 feet (0.2 to 1.8 meters).

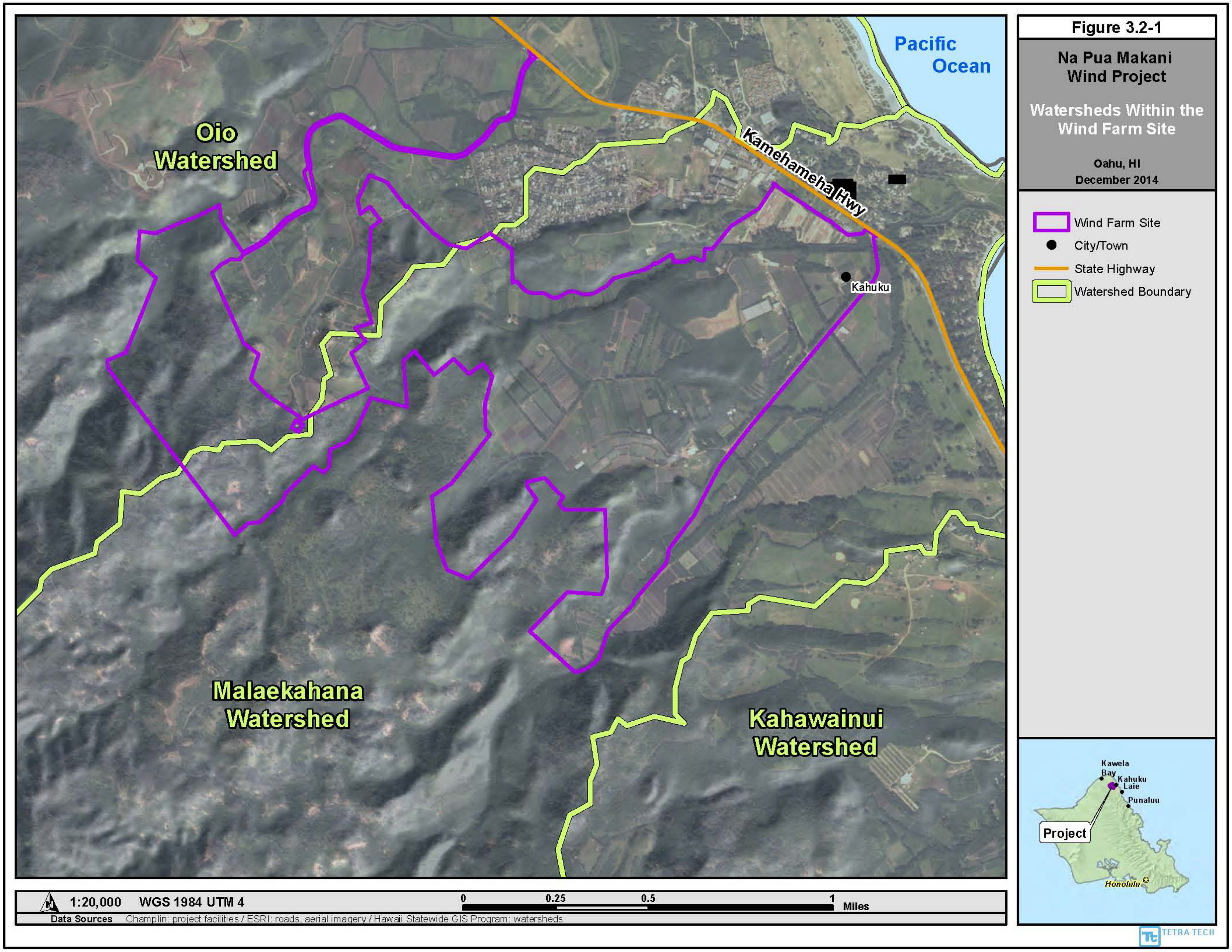


Figure 3.2-1
Na Pua Makani Wind Project
Watersheds Within the Wind Farm Site
Oahu, HI
December 2014
Wind Farm Site
City/Town
State Highway
Watershed Boundary
Pacific Ocean
Oio Watershed
Malaekahana Watershed
Kahawainui Watershed
Kamehameha Hwy
Kahuku
Kawela Bay
Laie
Punaluu
Project
Honolulu
1:20,000
WGS 1984 UTM 4
0
0.25
0.5
1
Miles
Data Sources Champlin: project facilities / ESRI: roads, aerial imagery / Hawaii Statewide GIS Program: watersheds
TETRA TECH

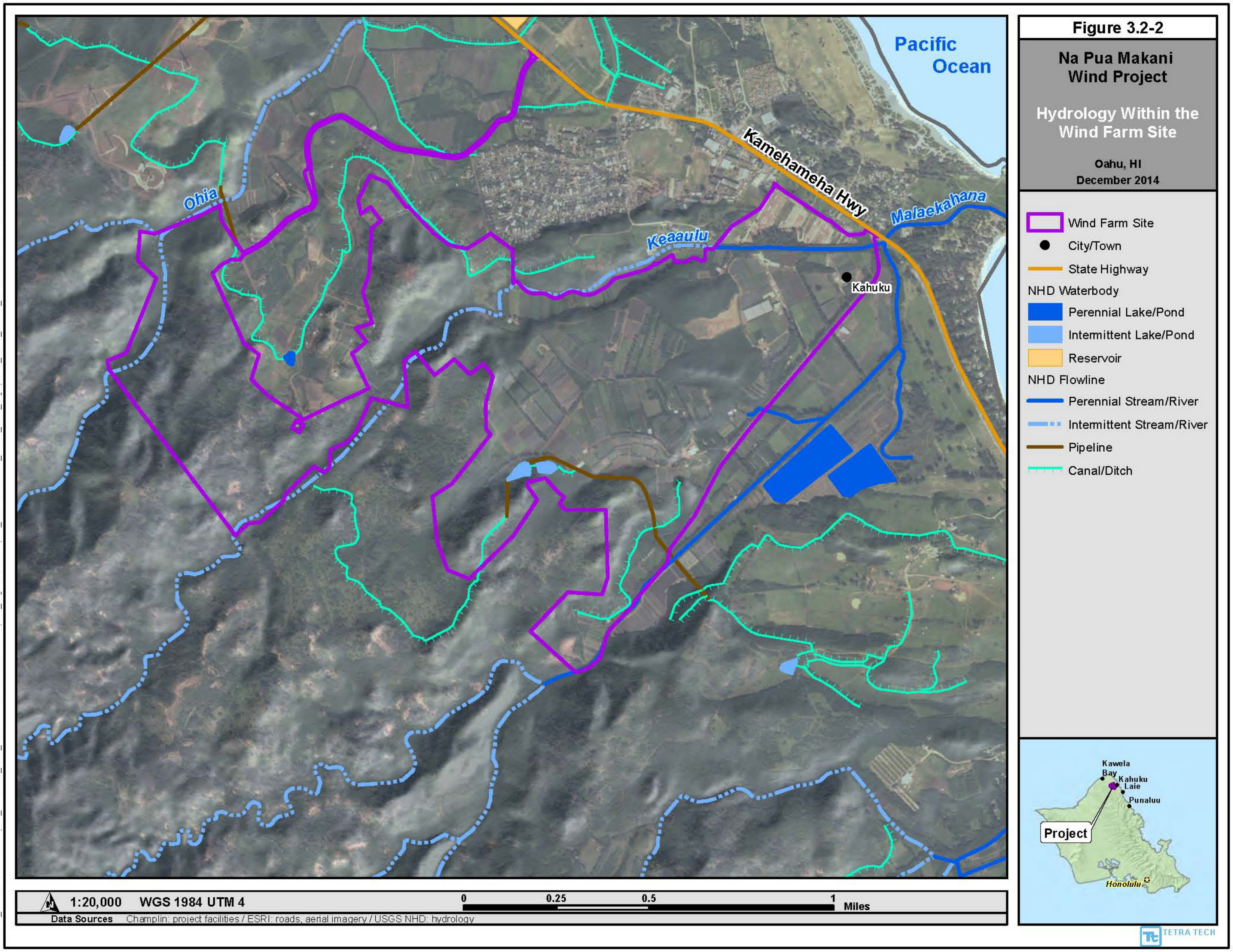


Figure 3.2-2
Na Pua Makani Wind Project
Hydrology Within the Wind Farm Site
Oahu, HI
December 2014
Wind Farm Site
City/Town
State Highway
NHD Waterbody
Perennial Lake/Pond
Intermittent Lake/Pond
Reservoir
NHD Flowline
Perennial Stream/River
Intermittent Stream/River
Pipeline
Canal/Ditch
Pacific Ocean
Kamehameha Hwy
Malaekahana
Keaaulu
Ohia
Kahuku
Kawela Bay
Laie
Punaluu
Project
Honolulu
1:20,000
WGS 1984 UTM 4
0
0.25
0.5
1
Miles
Data Sources
Champlin: project facilities / ESRI: roads, aerial imagery / USGS NHD: hydrology
TETRA TECH

Ohia Stream is approximately 5.0 miles (8.0 kilometers) long and flows from an elevation of 1,700 feet (518 meters) at the summit of the Koolau Range to Kii Wetlands in the James Campbell National Wildlife Refuge (NWR) north of Kahuku where it enters the ocean (Hobdy 2013b). Average annual rainfall ranges from approximately 125 inches (318 centimeters) at its headwaters to approximately 45 inches (114 centimeters) at the coast. Similar to Keaaulu Stream, a noticeable, although somewhat indistinct, OHWM of approximately 2 feet (0.6 meter) in height is evident during intermittent flow events along Ohia Stream (Hobdy 2013b). The average width of Ohia Stream within the wind farm site is 3 to 6 feet (1 to 2 meters).

A preliminary jurisdictional determination was issued by the U.S. Army Corps of Engineers (USACE) on April 6, 2015 (USACE 2015) concluding that Keaaulu, Ohia, and Malaekahana streams may be WoUS requiring a Department of Army permit for any activity resulting in the discharge and/or placement of dredged or fill materials into these waters. USACE also confirmed that the ditch/canal located in the southern portion of the wind farm site was determined to not be a WoUS. In addition to Ohia and Keaaulu streams, Lamaloa Gulch, located to the south of the wind farm site also routes and discharges runoff generated in the wind farm site into Malaekahana Stream (Belt Collins Hawaii LLC 2016a).

The National Wetland Inventory (NWI) identified three wetland features within the wind farm site (Figure 3.2-3) (USFWS 2013a). These features were mapped by the NWI as freshwater emergent and freshwater forested/shrub wetlands. However, wetland surveys conducted in 2013 determined that these areas did not qualify as wetlands. These features were assessed following USACE Guidelines in the summer of 2013 and were identified as two small former plantation ponds and an associated ditch system (Hobdy 2013b). Neither of the man-made ponds had positive indicators of wetland hydrology and hydric soils, and they were no longer functioning as wetlands, having reverted to upland sites (Hobdy 2013b). The ditch and former ponds, originally excavated out of a sloping upland site, have not been functional for more than 30 years and are currently overgrown with predominantly upland grasses and trees. If additional wetlands are identified as the Project progresses, a formal wetland delineation would occur.

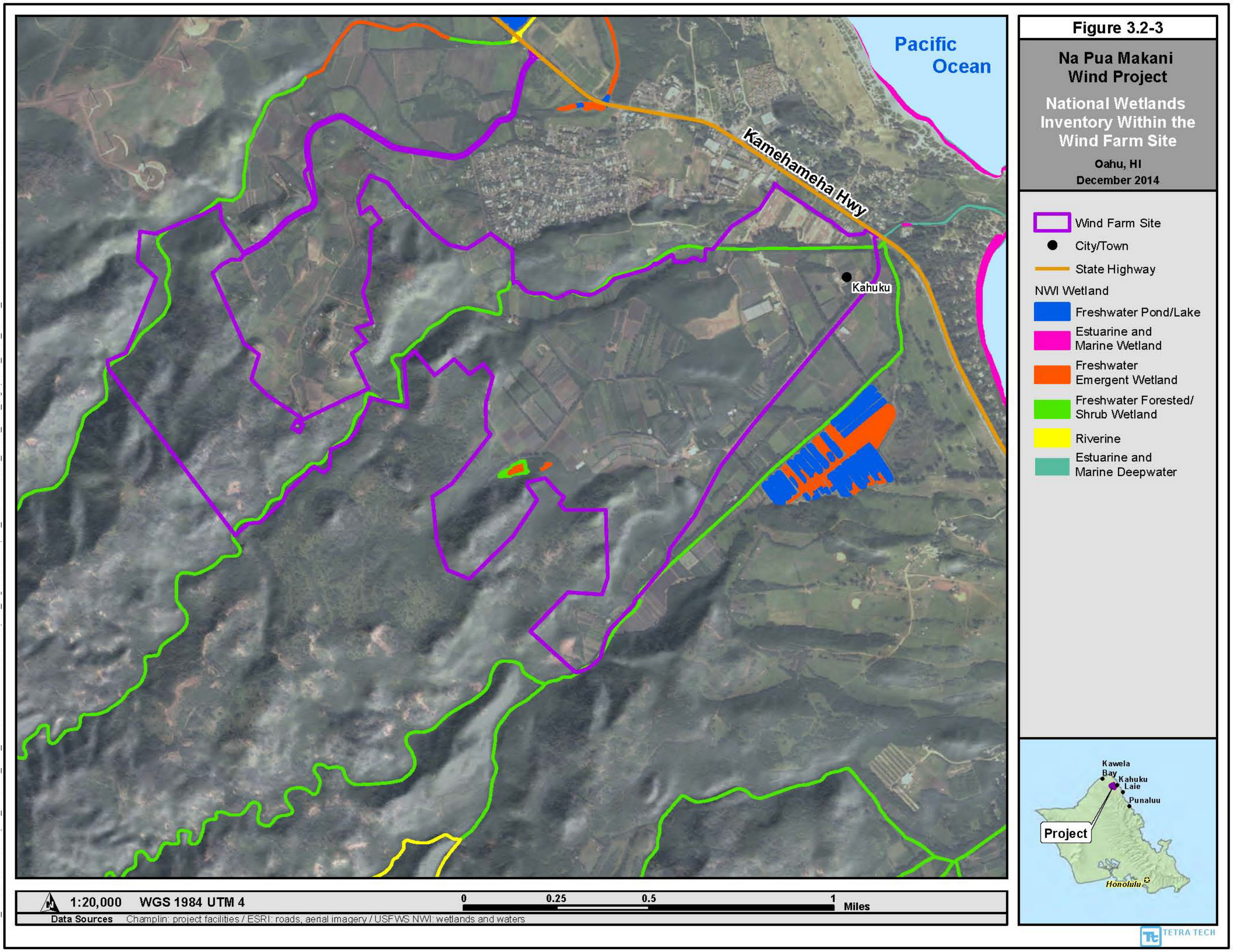


Figure 3.2-3
Na Pua Makani Wind Project
National Wetlands Inventory Within the Wind Farm Site
Oahu, HI
December 2014
Wind Farm Site
City/Town
State Highway
NWI Wetland
Freshwater Pond/Lake
Estuarine and Marine Wetland
Freshwater Emergent Wetland
Freshwater Forested/ Shrub Wetland
Riverine
Estuarine and Marine Deepwater
Pacific Ocean
Kamehameha Hwy
Kahuku
Kawela Bay
Laie
Punaluu
Project
Honolulu
1:20,000
WGS 1984 UTM 4
0
0.25
0.5
1
Miles
Data Sources Champlin: project facilities / ESRI: roads, aerial imagery / USFWS NWI: wetlands and waters
TETRA TECH

3.2.1.2 Hamakua Marsh (waterbird)

Hamakua Marsh, the 34-acre (14-hectare) proposed waterbird mitigation area, lies within the Kaelepulu Watershed of the Koolau Poko District (Figure 3.2-4). This watershed is approximately 3,466 acres (1,403 hectares) with a maximum elevation of 1,621 feet (494 meters; HBWS 2012; DAR and Bishop Museum 2008). Average annual rainfall in the mitigation area is approximately 40 inches (Giambelluca et al. 2013).

The Hamakua Marsh Mitigation Area is located adjacent to Kawainui Marsh, the largest remaining wetland in Hawaii. Both Hamakua and Kawainui Marshes were designated as Ramsar Wetlands of International importance in 2005 for their biological, historical, and cultural significance (USACE 2008). The majority of the Hamakua Marsh Mitigation Area consists of freshwater emergent wetland (Figure 3.2-5) (USFWS 2013a). Hamakua Marsh used to be fed by Kawainui Stream which flowed from Kawainui Marsh. Currently, the northeastern edge of the mitigation area is bordered by Hamakua Canal, a manmade canal (Figure 3.2-4). In 1952 Kawainui Stream was deepened to create Hamakua Canal to help flood control (DLNR 2013). The flood control canal restricted flow to Hamakua Marsh, altering hydrology of the marsh.

3.2.1.3 Poamoho Ridge (bat)

The 1,273-acre (501-hectare) Poamoho Ridge Mitigation Area lies primarily within the Kaukonahua Watershed, although the northern parcel also lies within the Poamoho and Helemano watersheds (Figure 3.2-6). The Kaukonahua Watershed stretches across the Schofield plateau, from the ridgeline of the Koolau Range to the ridgeline of the Waianae Range. Average annual rainfall at Poamoho Ridge averages approximately 195 inches (495 centimeters; Giambelluca et al. 2013). Five perennial and one intermittent stream have been mapped by the NHD within the Poamoho Ridge Mitigation Area (Figure 3.2-6). The NWI mapped all of these stream segments as containing riverine wetlands (Figure 3.2-7) (USFWS 2013a). The five perennial streams include Poamoho Stream, three tributaries of the North Fork Kaukonahua Stream and Helemano Stream. Wetland and other waters of the U.S. surveys have not been conducted within the Poamoho Ridge Mitigation Area in association with the Project.

3.2.2 Groundwater

3.2.2.1 Wind Farm Site

The wind farm site is located in the Koolau Loa Aquifer system (aquifer code 30601) of the Windward Aquifer sector (aquifer code 306) (DLNR 2008). This aquifer system has sustainable yields of 36 to 41 million gallons per day (mgd) (136 to 155 million liters per day; CWRM 2008).

The upper aquifer in the wind farm site consists of a basal, unconfined aquifer and the lower aquifer consists primarily of a basal, confined flank aquifer with the eastern portion of the wind farm site consists of a basal confined dike aquifer (HDOH 1992). The majority of the aquifer in the wind farm site is currently used for drinking water and the remainder is a potential source of drinking water and the entire area has a high vulnerability to contamination (HDOH 1992).

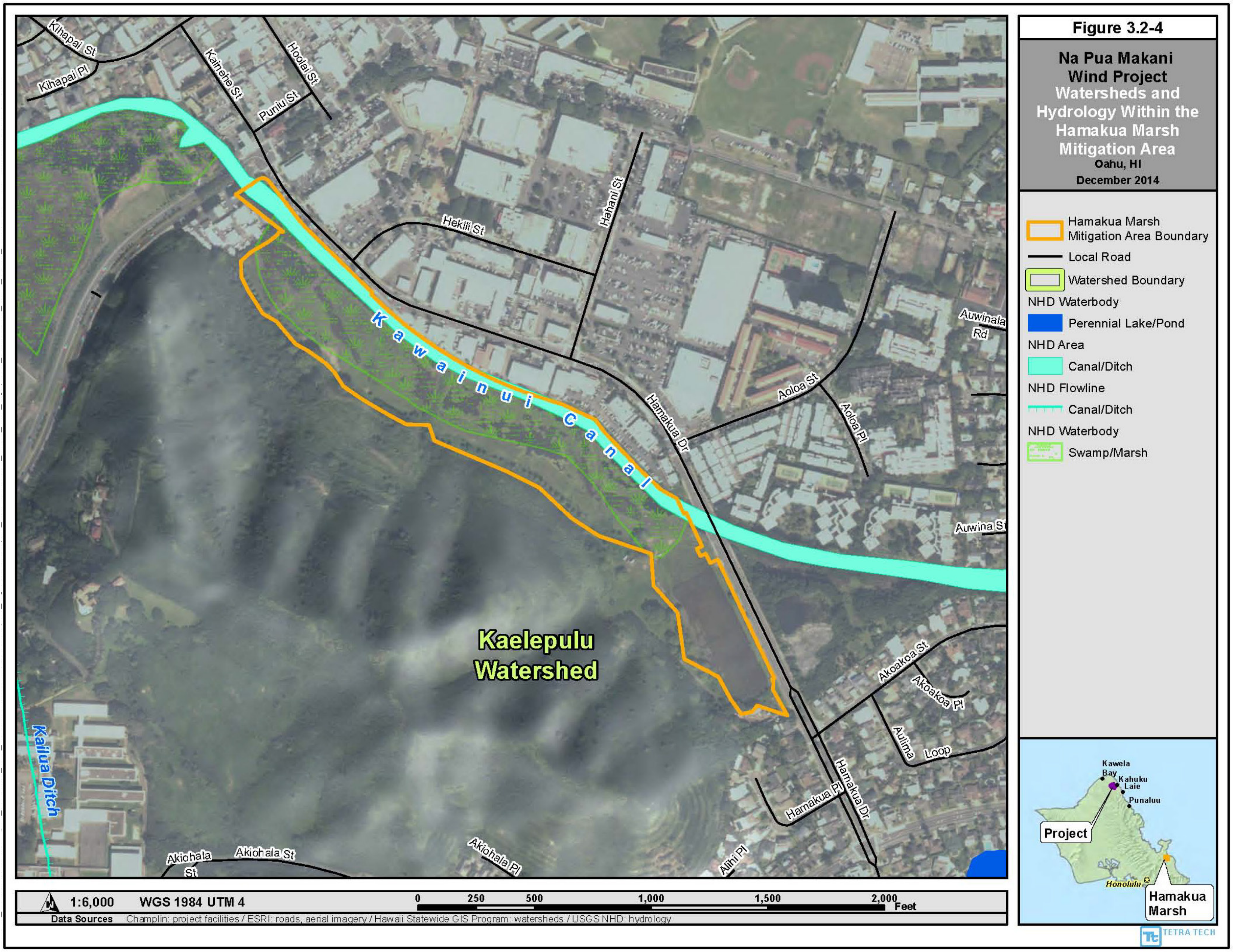


Figure 3.2-4
Na Pua Makani Wind Project
Watersheds and Hydrology Within the Hamakua Marsh Mitigation Area
Oahu, HI
December 2014
Hamakua Marsh Mitigation Area Boundary
Local Road
Watershed Boundary
NHD Waterbody
Perennial Lake/Pond
NHD Area
Canal/Ditch
NHD Flowline
Canal/Ditch
NHD Waterbody
Swamp/Marsh
Kawainui Canal
Kaelepulu Watershed
Kailua Ditch
Kihapai St
Kihapai Pl
Kainehe St
Hoolai St
Puniu St
Hekili St
Hahani St
Hamakua Dr
Aoloa St
Aoloa Pl
Auwinala Rd
Auwina St
Akoakoa St
Akoakoa Pl
Aulima Loop
Hamakua Pl
Akiohala St
Akiohala Pl
Alihi Pl
Kawela Bay
Kahuku
Laie
Punaluu
Project
Honolulu
Hamakua Marsh
1:6,000
WGS 1984 UTM 4
0
250
500
1,000
1,500
2,000
Feet
Data Sources Champlin: project facilities / ESRI: roads, aerial imagery / Hawaii Statewide GIS Program: watersheds / USGS NHD: hydrology
TETRA TECH

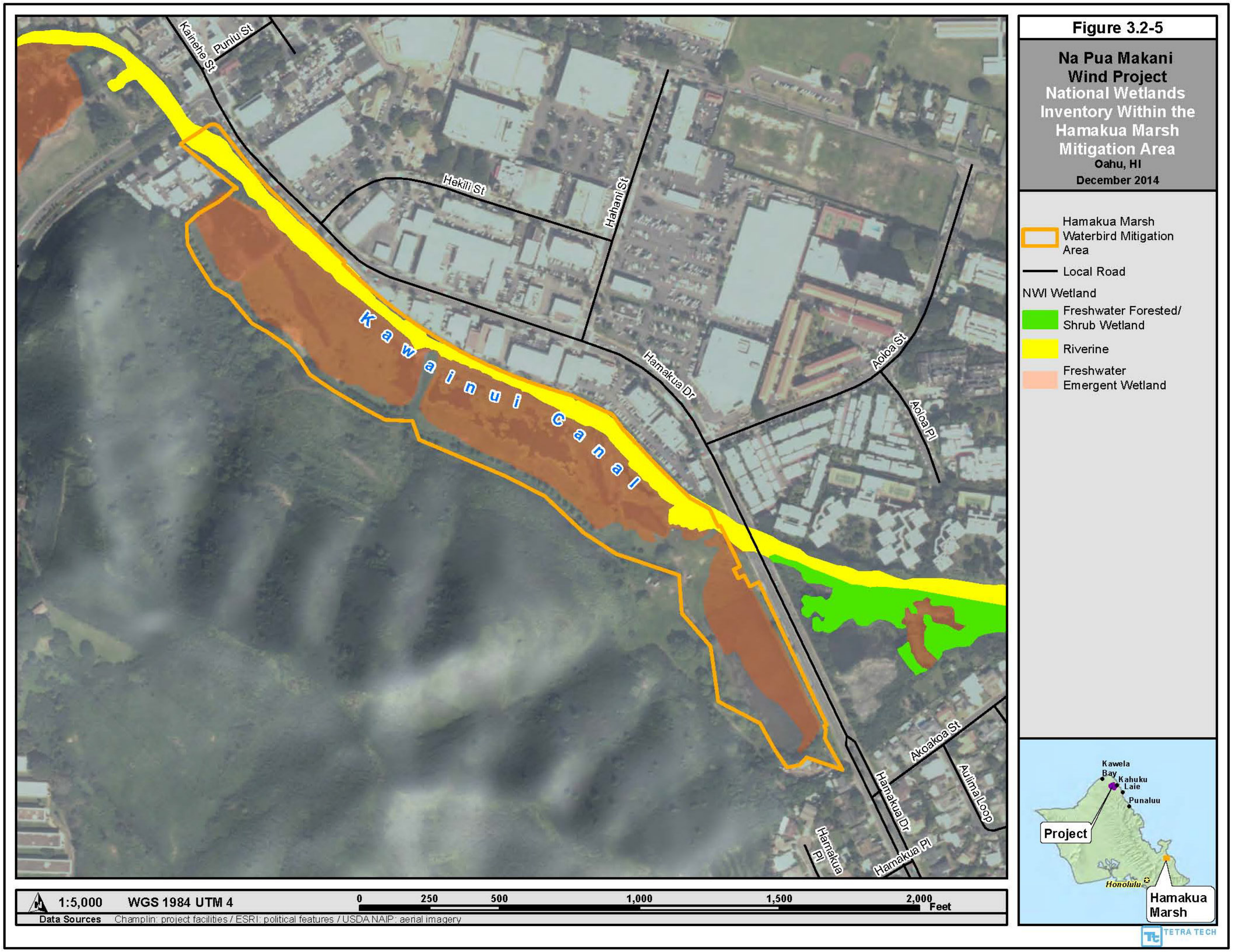


Figure 3.2-5
Na Pua Makani Wind Project
National Wetlands Inventory Within the Hamakua Marsh Mitigation Area
Oahu, HI
December 2014
Hamakua Marsh Waterbird Mitigation Area
Local Road
NWI Wetland
Freshwater Forested/ Shrub Wetland
Riverine
Freshwater Emergent Wetland
Kawainui Canal
Kainehe St
Puniu St
Hekili St
Hahani St
Hamakua Dr
Aoloa St
Aoloa Pl
Akoakoa St
Auilima Loop
Hamakua Pl
Kawela Bay
Kahuku
Laie
Punaluu
Project
Honolulu
Hamakua Marsh
1:5,000
WGS 1984 UTM 4
0 250 500 1,000 1,500 2,000 Feet
Data Sources Champlin: project facilities / ESRI: political features / USDA NAIP: aerial imagery
TETRA TECH

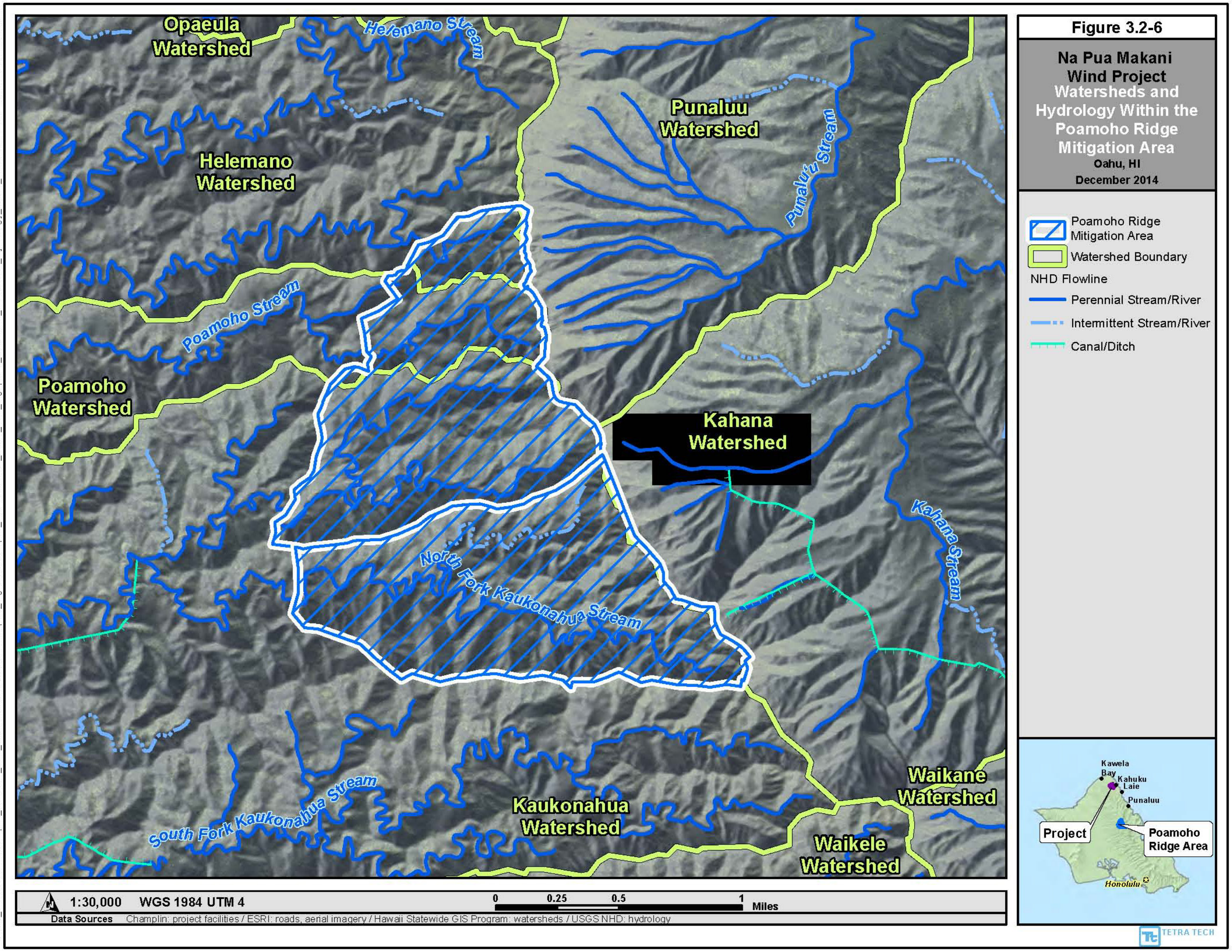


Figure 3.2-6
Na Pua Makani Wind Project
Watersheds and Hydrology Within the Poamoho Ridge Mitigation Area
Oahu, HI
December 2014

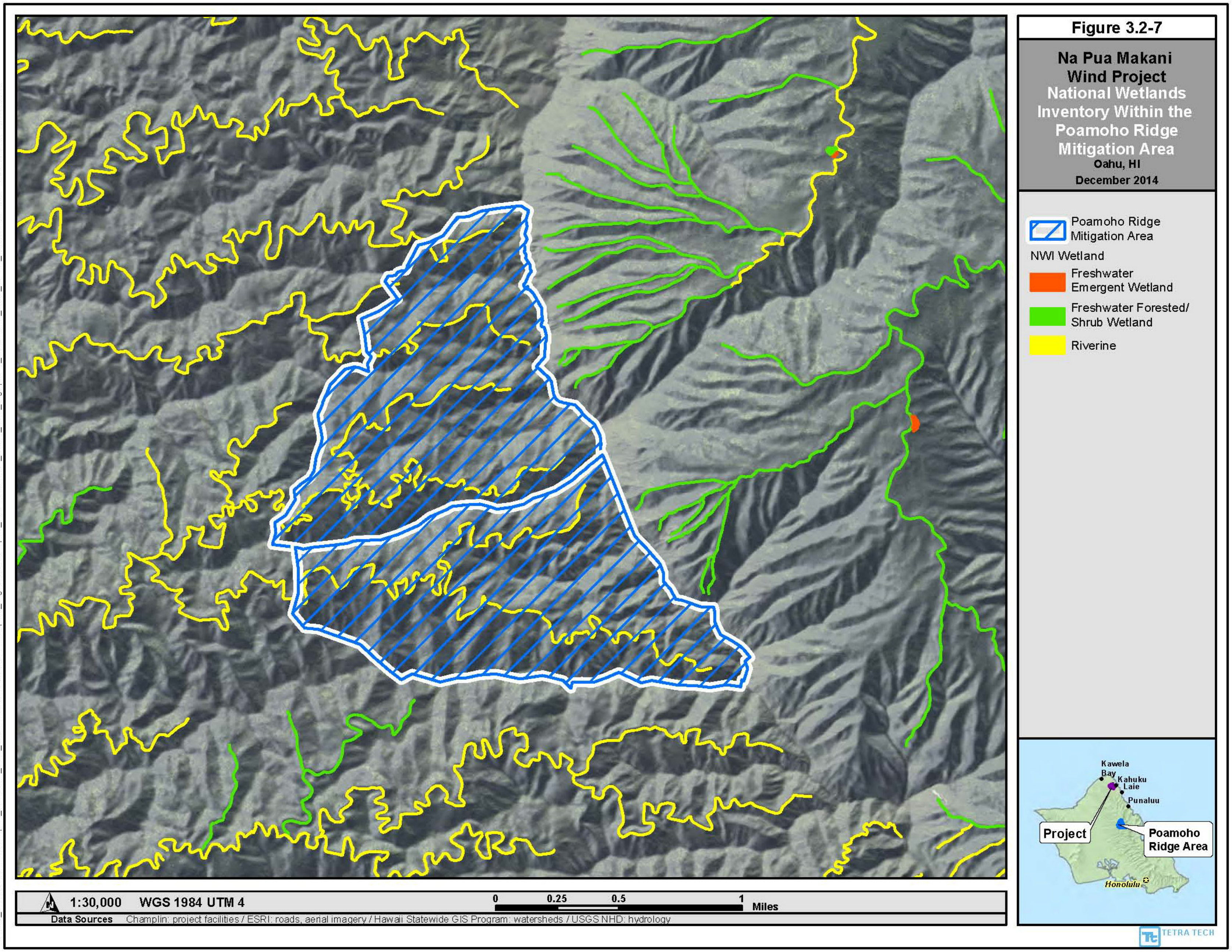


Figure 3.2-7
Na Pua Makani Wind Project
National Wetlands Inventory Within the Poamoho Ridge Mitigation Area
Oahu, HI
December 2014
Poamoho Ridge Mitigation Area
NWI Wetland
Freshwater Emergent Wetland
Freshwater Forested/ Shrub Wetland
Riverine
Kawela Bay
Kahuku
Laie
Punaluu
Project
Poamoho Ridge Area
Honolulu
1:30,000
WGS 1984 UTM 4
0
0.25
0.5
1
Miles
Data Sources
Champlin: project facilities / ESRI: roads, aerial imagery / Hawaii Statewide GIS Program: watersheds / USGS NHD: hydrology
TETRA TECH

According to records from the CWRM, four wells serve the wind farm site within the Malaekahana Hui West, LLC-owned lands. Well No. 4057-06 is permitted to withdraw 0.670 mgd for irrigation to a turf farm. Well No. 4057-07 is permitted to withdraw 0.300 mgd for irrigation of diversified agriculture. Well Nos. 3957-01 and 3759-03 are permitted to withdraw 1.244 mgd for truck farms, taro, and domestic purposes.

Soils in the wind farm site primarily consist of well-drained silty clay soils. These soils, as well as the limited amount of existing impervious structures or surfaces (e.g., buildings, roads), allow for precipitation to infiltrate into the groundwater system in the wind farm site. A runoff coefficient (C value) can be assigned to a particular area or land use (e.g., industrial, agricultural land) to estimate the amount of runoff to the amount of precipitation received. The existing C Value assigned to agriculture areas within the Project Area is 0.3, whereas impervious surfaces such as buildings and yards are assigned a C Value of 0.9 (Belt Collins Hawaii LLC 2016a).

3.2.2.2 Hamakua Marsh (waterbird)

The Hamakua Marsh Mitigation Area is located in the DLNR Waimanalo Aquifer system (aquifer code 30604) of the Windward Aquifer sector (aquifer code 306) and has sustainable yields of 10 to 13 mgd (38 to 49 million liters per day; CWRM 2008).

The Hamakua Marsh Mitigation Area consists of an upper aquifer defined as basal, unconfined sedimentary; and a lower aquifer defined as lower basal, confined, dike (HDOH 1992). The lower, freshwater (less than 250 mg/l of chloride) aquifer is currently used for drinking water. The upper aquifer is slightly saline (250-1,000 mg/l of chloride).

3.2.2.3 Poamoho Ridge (bat)

The Poamoho Ridge Mitigation Area is located in the Wahiawa Aquifer system (aquifer code 30501) of the Central Aquifer sector (aquifer code 305) and has sustainable yields of 104 to 141 mgd (394 to 534 million liters per day; CWRM 2008). The Poamoho Ridge Mitigation Area aquifer is a high-level, unconfined dike aquifer consisting of freshwater that is currently used as a source of drinking water (HDOH 1992). This aquifer has a high vulnerability to contamination.

3.3 Air Quality and Climate Change

3.3.1 Air Quality

Under the authority of the Clean Air Act (CAA), the Environmental Protection Agency (EPA) has established nationwide air quality standards to protect public health and welfare. These Federal standards, known as National Ambient Air Quality Standards (NAAQS), represent the maximum allowable atmospheric concentrations for six criteria pollutants: ozone, nitrogen dioxide, carbon monoxide, sulfur dioxide, lead, and particulate matter (i.e., inhalable particulate matter [PM_{10}] [1] and

[1] PM_{10} is defined as particulate matter that is 10 microns or less in aerodynamic diameter. These particles are typically considered “coarse” particles.

fine particulate matter [$PM_{2.5}$] [2]). The Clean Air Branch of the Hawaii Department of Health (HDOH) is responsible for implementing air pollution control in the state and has established Hawaii ambient air quality standards (HAAQS). Table 3.3-1 lists the State and Federal ambient air quality standards.

Table 3.3-1. State and Federal Ambient Air Quality Standards

Air Pollutant	Averaging Time	Standards		
		Hawaii State Standard	Federal Primary Standard[1/]	Federal Secondary Standard[2/]
Carbon Monoxide (CO)	1-hour 8-hour	9 ppm 4.4 ppm	35 ppm 9 ppm	None
Nitrogen Dioxide (NO_2)	1-hour eff. 1/22/2010 Annual	--- 0.04 ppm	0.100 ppm 0.053 ppm	--- 0.053 ppm
PM_{10}	24-hour Annual[3/]	150 μg/m³ 50 μg/m³	150 μg/m³ ---	150 μg/m³ ---
$PM_{2.5}$	24-hour Annual	---	35 μg/m³ 15 μg/m³	35 μg/m³ 15 μg/m³
Ozone (O_3)	8-hour	0.08 ppm	0.075 ppm	0.075 ppm
Sulfur Dioxide (SO_2)	1-hour eff. 6/2/2010 3-hour 24-hour Annual	--- 0.5 ppm 0.14 ppm 0.03 ppm	0.075 ppm --- 0.14 ppm 0.03 ppm	0.5 ppm
Lead (Pb)	Calendar Quarter	1.5 μg/m³	0.15 μg/m³	0.15 μg/m³
Hydrogen Sulfide	1-hour	0.025 ppm	None	None

Source: State standards HAR § 11-59; Federal standards 40 CFR Part 50

1/ ***Primary Standards*** set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children and the elderly.

2/ ***Secondary Standards*** set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

3/ Due to a lack of evidence linking health problems to long-term exposure to coarse particle pollution, EPA revoked the annual PM_{10} standard effective December 17, 2006. However, the State still has an annual standard.

Based on measurements of ambient criteria pollutant data, EPA designates areas of the United States as having air quality equal to or better than NAAQS (i.e., attainment) or worse than NAAQS (i.e., non-attainment). The CAA general conformity rule requires that projects occurring in nonattainment and maintenance areas be consistent with the applicable State Implementation Plan. Maintenance areas are areas that previously violated Federal ambient air quality standards, but which have now come into attainment of those standards. Because Hawaii is, and always has been, in attainment for all pollutants, a general conformity analysis is not required for the Project.

Issues related to air quality that have been raised during the public scoping process for this Project include 1) the effects the Project could have on ambient air quality, 2) whether the Project would be in compliance with Federal and State air quality standards, and 3) the levels of air emissions that would be generated by the Project. These issues are addressed in this section as well as the air quality portion of Chapter 4.

[2] $PM_{2.5}$ is defined as particulate matter that is 2.5 microns or less in aerodynamic diameter. These particles are typically considered "fine" particles.

The analysis area for the air quality analysis includes the full extent of the island of Oahu. This analysis area includes the entire Project footprint, the extent of proposed mitigation areas (see Chapter 2 for more details), as well as the full extent of potential project related impacts to air quality.

3.3.1.1 Existing Conditions

In general, air quality in the state of Hawaii is among the best in the nation, primarily because of consistent trade-winds and limited emission sources. The HDOH and EPA maintain a network of air quality monitoring stations throughout the islands. Data collected from these monitoring stations indicate that criteria pollutant levels consistently remain well below State and Federal ambient air quality standards (HDOH 2012).

The most recent publicly available information for Hawaii regarding air quality are from 2012 (HDOH 2012). Excluding the exceedances that were due to the Kilauea Volcano located on the island of Hawaii, the State of Hawaii was in attainment of all NAAQS and HAAQS in 2012 (HDOH 2012). The EPA considers volcanos to be natural uncontrollable events and the State of Hawaii requests exclusion of any volcano-related exceedances on an annual basis.

The closest air quality monitoring station to the Project is the Pearl City Station, which is located approximately 18 miles to the south of the Project on the leeward side of the island. The station is located on the roof of the Leeward Health Center within an area that contains commercial, residential, and light industrial developments. Other air quality monitoring stations on the island of Oahu include the Honolulu, Sand Island, Kapolei, and Kapolei NCore stations (HDOH 2012).

The highest 24-hour PM_{10} reading recorded at the Pearl City Station in 2012 was 37 micrograms per cubic meter, while the highest 24-hour $PM_{2.5}$ reading was 20.1 micrograms per cubic meter (HDOH 2012). The annual mean 24-hour PM_{10} readings recorded at the Pearl City Station in 2012 was 17.9 micrograms per cubic meter, while the annual mean 24-hour $PM_{2.5}$ readings was 6.3 (HDOH 2012). These measurements are all below the Federal and State standards (HDOH 2012). No data is available from the Pearl City Station regarding other air pollutants such as CO, NO_2, O_3, SO_2, lead, or hydrogen sulfide; however, readings recorded at other air quality monitoring stations on the island of Oahu are all below the Federal and State standards (HDOH 2012).

The sources of air pollutants located near the Project include windblown dust originating from overgrazed areas, vehicular emissions on the Kamehameha Highway, fires, agricultural emissions, and natural volcanic emissions from the volcano on the island of Hawaii. However, pollution from these sources likely move rapidly through the area as a result of the northeast trade winds that are present for much of the year. In summary, the analysis area is currently in attainment of all criteria pollutant levels established by the EPA and the State of Hawaii.

3.3.2 Climate Change

Climate refers to the average weather conditions in a region over a long period of time. The climate of a location is affected by its latitude, elevation, and proximity to the ocean. Climatic regions are typically characterized by temperature, humidity, wind patterns, and rainfall. Greenhouse gases (e.g., CO, methane, and nitrous oxide) are chemical compounds found in the earth's atmosphere that can trap heat.

Issues related to climate change that have been raised during the public scoping process for this Project include 1) the levels of greenhouse gases that would be generated by this Project, 2) the effect this Project would have on local weather and climate conditions, and 3) the effect climate change could have on this Project and the local area. These issues are addressed in this section as well as the climate change portion of Chapter 4 (Section 4.5).

The analysis area for purposes of this climate change analysis is the island of Oahu because climate acts on a regional scale. Data used in this analysis comes from historic records regarding Oahu's climate conditions, as well as current research on possible changes that could occur to Oahu's climate.

3.3.2.1 Existing Conditions

Hawaii's climate is characterized by two seasons: summer (May through September) and winter (October through April). In general, the Hawaiian Islands have relatively mild temperatures and moderate humidity throughout the year (except at high elevations), with persistent northeasterly trade winds and infrequent severe storms (NOAA 2007). However, summer is typically warmer and drier, with minimal storm events.

The trade winds are prevalent 80 to 95 percent of the time during the summer months, when high pressure systems tend to be located north and east of Hawaii. During the winter months, the high pressure systems are located farther to the south, thereby decreasing the prevalence of the trade winds to about 50 to 80 percent of the time (WRCC 2013).

Despite the strong marine influence resulting from Hawaii's insularity, some mountainous areas exhibit semi-continental conditions. Combined with the rugged and irregular topography, the result is a diverse climatic condition across the various regions of the state, including significant geographic differences in rainfall amounts, which range from 20 inches to 300 inches (51 to 762 centimeters; WRCC 2013).

EPA's 2012 report on global climate change found that "[t]he Earth's climate is changing," and that "[s]cientists are confident that many of the observed changes in the climate can be linked to the increase in greenhouse gases in the atmosphere, caused largely by people burning fossil fuels to generate electricity, heat and cool buildings, and power vehicles" (EPA 2012). Like other small islands, Hawaii is considered vulnerable to global climate change because extreme events (such as rising sea levels, changes in the frequency of extreme weather, coral-reef bleaching, and ocean acidification) can have major impacts to islands (Kwong, 2009). Over the past century, the average temperature in the Pacific Islands region has increased by 0.4 degrees Fahrenheit (°F) (-17.6 degrees Celsius [°C]), and global sea levels have risen by 4 to 8 inches (10 to 20 centimeters; CIER 2007). The State of Hawaii recognizes the potential effects that global climate change can have on the state, and have established a State policy framework to address Hawaii's greenhouse gas emissions in order to minimize these risks (via Act 234, Session Laws of Hawaii 2007).

The wind farm site and mitigation areas are located in the lowland and mountainous areas on the windward side of Oahu, respectively. The Western Regional Climate Center describes this region as moderately rainy, having frequent trade-wind showers; partly cloudy to cloudy days are common in this region and temperatures are more uniform and mild than other parts of the Hawaiian Islands (WRCC 2013). The annual temperatures in this region range from approximately 63 to 88°F (17 to 31°C, and monthly precipitation ranges between 3.4 and 0.2 inches (8.6 to 0.5 centimeters; WC 2013).

3.4 Noise

Noise would potentially affect the local environment during both construction and operation of the Project. Sounds originate with a source whether it is a human voice, motor vehicles on a roadway, or a wind turbine generator (WTG). Sound levels are presented on a logarithmic scale to account for the large range of acoustic pressures that the human ear is exposed to and is expressed in units of decibels (dB). For the purposes of the Project acoustic analysis, sound levels are expressed in A-weighted decibels (dBA), which compensates for the frequency response of the human auditory system. At any location, both the magnitude and frequency of environmental noise may vary considerably over the course of the day and week. For construction activities, this variation in noise levels would be caused primarily by changes in equipment operations and activity locations. For operational noise conditions, this variation would result primarily from operational conditions such as higher wind speeds and other changing weather conditions. Two measures commonly used by Federal, State, and local governments to relate the time-varying quality of environmental noise to its known effect on people are the equivalent sound level (L_{eq}) and the day-night sound level (L_{dn}). The L_{eq} is the level of steady sound with the same total (equivalent) energy as the time-varying sound of interest, averaged over a given time period, often daytime (7 a.m. to 10 p.m.) and nighttime (10 p.m. to 7 a.m.) periods. The L_{dn} is the 24-hour L_{eq} with 10 dBA added to the nighttime sound levels between the hours of 10 p.m. and 7 a.m. to account for the greater sensitivity of people to sound during the nighttime hours.

Estimates of noise sources and outdoor acoustic environments, and the comparison of relative loudness, are presented in Table 3.4-1. Appendix C of this Supplemental Final EIS is the Noise Technical Report for the Project and provides greater detail on the technical aspects and background of acoustical analysis conducted to support the Project.

Table 3.4-1. Sound Pressure Levels (L_P) and Relative Loudness of Typical Noise Sources and Acoustic Environments

Noise Source or Activity	Sound Level (dBA)	Subjective Impression	Relative Loudness (perception of different sound levels)
Jet aircraft takeoff from carrier (50 ft)	140	Threshold of pain	64 times as loud
50-hp siren (100 ft)	130		32 times as loud
Loud rock concert near stage Jet takeoff (200 ft)	120	Uncomfortably loud	16 times as loud
Float plane takeoff (100 ft)	110		8 times as loud
Jet takeoff (2,000 ft)	100	Very loud	4 times as loud
Heavy truck or motorcycle (25 ft)	90		2 times as loud

Table 3.4-1. Sound Pressure Levels (L_P) and Relative Loudness of Typical Noise Sources and Acoustic Environments (continued)

Noise Source or Activity	Sound Level (dBA)	Subjective Impression	Relative Loudness (perception of different sound levels)
Garbage disposal Food blender (2 ft) Pneumatic drill (50 ft)	80	Loud	Reference loudness
Vacuum cleaner (10 ft)	70	Moderate	1/2 as loud
Passenger car at 65 mph (25 ft)	65		
Large store air-conditioning unit (20 ft)	60		1/4 as loud
Light auto traffic (100 ft)	50	Quiet	1/8 as loud
Quiet rural residential area with no activity	45		
Bedroom or quiet living room Bird calls	40	Faint	1/16 as loud
Typical wilderness area	35		
Quiet library, soft whisper (15 ft)	30	Very quiet	1/32 as loud
Wilderness with no wind or animal activity	25	Extremely quiet	
High-quality recording studio	20		1/64 as loud
Acoustic test chamber	10	Just audible	
	0	Threshold of hearing	
Adapted from: Beranek 1988; EPA 1971			

3.4.1 Regulatory Framework

A review of noise regulations and guideline criteria applicable to the Project was completed at the Federal, State, and county level. Details on Federal guidelines and requirements are included in the Project Noise Impact Assessment (see Appendix C). The Noise Control Act of 1972 (EPA 1972), along with its subsequent amendments (Quiet Communities Act of 1978 [42 USC 4901-4918]) (EPA 1978), delegates the authority to regulate environmental noise to each state.

3.4.1.1 State of Hawaii Community Noise Regulations

The State of Hawaii regulates noise through the Hawaii Administrative Rule (HAR), Title 11, Chapter 46, "Community Noise Control", promulgated on September 11, 1996, and limits sound generated by new or expanded developments (HDOH 1996). The Hawaii Community Noise Regulations (HAR 11-46) provide for the prevention, control, and abatement of noise pollution in the State. The purpose of these rules is to "provide for the prevention, control, and abatement of noise pollution in the State from the following noise sources: stationary noise sources; and equipment related to agricultural, construction, and industrial activities" (HAR 11-46). Sound from routine ongoing maintenance activities is considered part of routine operation and the combined total of the ongoing maintenance and routine operation are subject to the sound level limits. However, the Community Noise Control Regulation is not applicable to most moving sources, i.e., transportation and vehicular movements. Sound from Project construction and the occasional, major equipment overhauls is regulated as construction activity.

The State of Hawaii's limits on noise produced by stationary sources are identified by three receiving zoning class districts and time periods and are enforceable at the facility property boundaries. For mixed zoning districts, the primary land use designation is used to determine the applicable zoning district class and maximum permissible sound level. For the purposes of identifying impact conditions, Class A use on Class C Land has been defined at the residential structure, i.e., agricultural portions of the surrounding properties were considered Class C receivers and the residences considered Class A receivers. This is considered a conservative regulatory assessment approach.

As wind energy generation projects may operate at any time during the day or night, the more stringent nighttime permissible sound level will become the controlling limit. The daytime and nighttime maximum permissible noise limits are provided in dBA according to zoning districts in Table 3.4-2. The State of Hawaii's limits on noise are assumed to be absolute and independent of the existing acoustic environment; therefore, no baseline sound survey is required to assess conformity.

Table 3.4-2. Hawaii Maximum Permissible Sound Levels by Zoning District

Receiving Zoning Class District	Maximum Permissible Sound Level	
	Daytime (7:00am – 10:00pm)	Nighttime (10:00pm – 7:00am)
Class A Zoning districts include all areas equivalent to land zoned residential, conservation, preservation, public space, or similar type.	55	45
Class B Zoning districts include all areas equivalent to lands zoned for multi-family dwellings, apartment, business, commercial, hotel, resort, or similar type.	60	50
Class C Zoning districts include all areas equivalent to lands zoned agriculture, county, industrial, or similar type.	70	70
Source: Hawaii Administrative Rules §11-46, "Community Noise Control"		

The maximum permissible sound levels are assessed and at any point at or beyond the property line of the facility. Noise levels may exceed the prescribed limits up to 10 percent of the time within any 20-minute period. Sound level for impulsive noise, as measured with a fast meter response, is 10 dBA above the maximum permissible sound levels for the given receiving zoning class district. Pursuant to HAR 11-46-7 and HAR 11-48-8, a permit may be obtained for operation of an excessive noise source beyond the maximum permissible sound levels. Factors that are considered in granting of such permits include whether the activity is in the public interest and whether the best available noise control technology is being employed. The standard provides further exemptions to these limits and further guidance on application, compliance procedures, and penalties. The State Department of Health is responsible for the implementation, administration, and enforcement of the statutes.

3.4.2 Existing Acoustic Environment

The noise analysis area for the Project includes Tax Map Keys (TMKs), or parcels, located within 1.2 miles (2 kilometers) (Figure 3.4-1) of the Project and the mitigation areas where noise-producing activities may occur. The HCP mitigation areas are not included in the detailed noise analysis because Project operational noise would not occur in these locations; therefore, providing ambient sound levels in these areas is not necessary. Project components, such as wind turbines and the substation, would be located on agriculturally zoned TMKs or HAR 11-46 Class C districts. The remaining TMKs within the noise analysis area are mostly agriculturally zoned; however, north and west of Project there are Class A (mostly residential) and Class B (mostly commercial) TMKs. The most restrictive land use from a noise perspective are the Class A TMKs located approximately 1,575 feet (480 meters) from the nearest proposed wind turbine.

Existing ambient sound levels were monitored in April 2014 at locations dispersed through the acoustic analysis area (Figure 3.4-1). Baseline sound levels provide the basis for establishing what the expected change in sound levels would be at noise-sensitive areas (NSAs) in the analysis area, such as residences and schools. They also provide information on how sound levels vary both spatially and temporally depending on proximity to area sound sources. Diurnal effects result in sound levels that are typically quieter during the night than during the daytime, except during periods when evening and nighttime insect noise may dominate the soundscape. Sources of sound include passing vehicles on nearby roads, agricultural activities (e.g., off-road vehicles), leaf or grass rustle during elevated wind conditions, wildlife, and insect noise. Closer to the coastline, breaking waves also contribute to the overall existing soundscape.

Baseline sound levels were collected at integer wind speeds where the Project would operate ranging from cut-in to cut-out wind speed conditions, or approximately 10 to 39 feet per second (ft/s; 3 to 12 meters per second [m/s]). New sound sources would be at least partially obscured through a mechanism referred to as acoustic masking. Other factors such as insect noise, agricultural activities, as well as wind-generated sound contributing to ambient levels as airflow interact with foliage and grasslands, increase masking effects. Wind farms, in comparison to conventional energy projects, are somewhat unique in that the sound generated by each individual wind turbine will increase as the wind speed across the site increases, up to a certain maximum sound level. The baseline sound survey confirmed that as wind speeds increase the background ambient sound levels also increase resulting in greater masking effects. The lowest background sound levels typically occur on windless nights when the Project would not be operating. Thus, it is important that baseline sound level monitoring document the existing sound levels, day and night, for wind speeds in the range between the wind turbine cut-in and the maximum rated power.

Using mapping and aerial photography of the wind farm site, Tetra Tech selected three long-term MP locations along the Project's site limit to be representative of NSAs nearest to the Project. Tetra Tech attempted to locate monitoring equipment at the structures of the nearest NSA; however, when Champlin requested access from property owners or leases for deployment of monitoring equipment, none were agreeable. As a result, Tetra Tech was restricted to placing long-term monitoring equipment at the Project site limit. To supplement and confirm the applicability of the long-term data collection, short-term measurements were made from public rights-of-way adjacent to NSAs, such as sidewalks that did not require land owner access permission. Table 3.4-3 provides the locations of the long-term (LT-#) and short-term (ST-#) monitoring equipment.

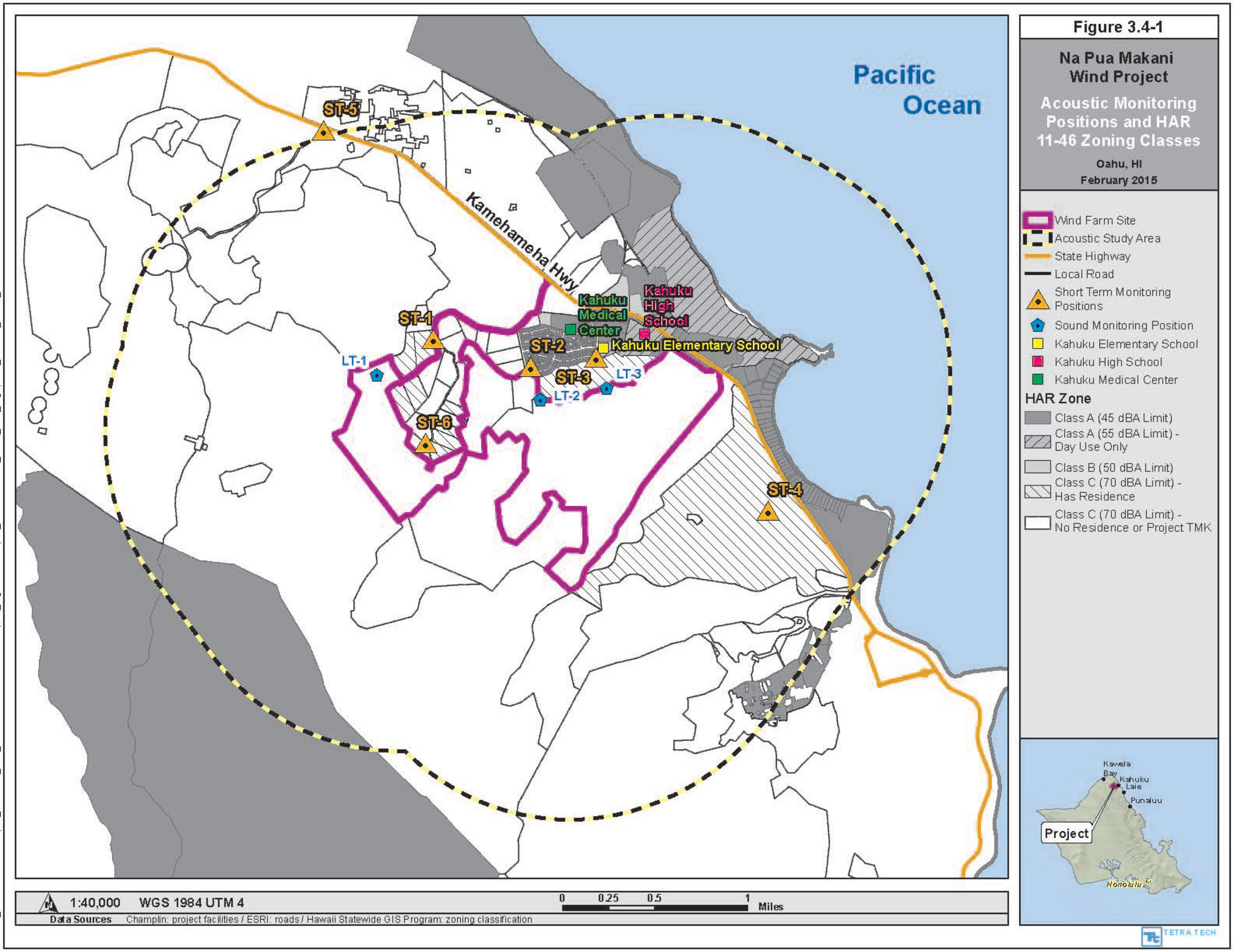


Figure 3.4-1
Na Pua Makani Wind Project
Acoustic Monitoring Positions and HAR 11-46 Zoning Classes
Oahu, HI
February 2015
Wind Farm Site
Acoustic Study Area
State Highway
Local Road
Short Term Monitoring Positions
Sound Monitoring Position
Kahuku Elementary School
Kahuku High School
Kahuku Medical Center
HAR Zone
Class A (45 dBA Limit)
Class A (55 dBA Limit) - Day Use Only
Class B (50 dBA Limit)
Class C (70 dBA Limit) - Has Residence
Class C (70 dBA Limit) - No Residence or Project TMK
Pacific Ocean
Kamehameha Hwy
ST-1
ST-2
ST-3
ST-4
ST-5
ST-6
LT-1
LT-2
LT-3
Kahuku Medical Center
Kahuku High School
Kahuku Elementary School
Kawela Bay
Kahuku
Laie
Punaluu
Project
Honolulu
1:40,000
WGS 1984 UTM 4
0
0.25
0.5
1
Miles
Data Sources
Champlin: project facilities / ESRI: roads / Hawaii Statewide GIS Program: zoning classification
TETRA TECH

Table 3.4-3. Long-Term Monitoring Position Location Summary

Monitoring Position	UTM Coordinates (NAD83 UTM Zone 14 N) Easting (m)	Northing (m)	Distance to Nearest Project WTG (m)	Distance to Nearest Existing Kahuku WTG (m)	SLM Serial Number
LT-1	606,540.04	2,396,927.75	68.1	326.7	1350 & 14027964
LT-2	607,962.82	2,396,713.27	495.8	1,674.2	3140
LT-3	608,537.47	2,396,811.61	220.6	2,197.0	1403045
ST-1	607,030.73	2,397,241.57	640.6	670.6	1403045
ST-2	607,875.34	2,396,999.59	783.1	1,517.3	1403045
ST-3	608,444.81	2,397,077.41	496.2	2,017.1	1403045
ST-4	609,940.67	2,395,748.07	1,270.4	3,863.1	1403045
ST-5	606,075.81	2,399,058.66	2,235.9	474.6	14027964 & 1403045
ST-6	606,962.96	2,396,334.02	349.2	1,055.4	14027964
1 meter = 3.3 feet					

The short-term measurements demonstrated that the long-term measurements are sufficiently conservative for estimating baseline conditions in the acoustical study area and are not discussed further. Additional information on the short-term measurement and more in-depth documentation of the baseline sound survey is provided in Appendix C. For example, long-term monitoring results show lower sound levels at the Project site limit than those experienced in the more densely populated areas where the NSAs are located. As a result, the long-term baseline sound levels may underestimate the actual sound levels in these areas. Table 3.4-4 provides the monitored sound levels under hub-height wind speed conditions at each long-term measurement position.

The wind turbines under consideration for the Project reach their highest operational sound power levels at approximately 23 ft/s (7 m/s). During this wind speed condition, existing sound levels for the acoustic analysis area range from 45 dBA L_{eq} to 49 dBA L_{eq} during the day and 43 dBA L_{eq} to 48 dBA L_{eq} at night. Impact conditions will be assessed against the monitored baseline sound levels during 23 ft/s (7 m/s) wind speeds to ascertain the Project contribution at NSAs.

Table 3.4-4. Baseline Monitoring Results at Integer Wind Speeds

Monitoring Position	Time of Day	dBA Leq by Wind Speed (m/s) Calm	3	4	5	6	7	8	9	10+
LT-1	7AM-10PM	40	45	47	50	50	49	51	52	55
	10PM-7AM	N/A[1/]	43	43	44	47	48	49	50	52
LT-2	7AM-10PM	46	41	45	50	47	46	47	46	48
	10PM-7AM	47	51	42	46	48	46	44	47	45
LT-3	7AM-10PM	42	45	45	44	46	45	45	45	49
	10PM-7AM	44	44	43	40	42	43	43	45	45

1/ There were no periods of calm wind conditions during the nighttime monitoring period.

1 meter = 3.3 feet

3.4.2.1 Hamakua Marsh (waterbirds)

At the Hamakua Marsh Mitigation Area existing ambient sound levels are expected to be low. However, they may be sporadically elevated due to roadway noise or periods of human activity adjacent to the marsh.

3.4.2.2 Poamoho Ridge (bats)

At the Poamoho Ridge Mitigation Area noise levels are low and primarily consist of existing sources (e.g., wind). Sources of sound include ongoing DLNR restoration activities (e.g., off-road vehicles, helicopters), leaf or grass rustle during elevated wind conditions, wildlife and insect noise.

3.5 Hazardous and Regulated Materials and Wastes

The Institute of Hazardous Materials Management (IHMM 2014) defines a hazardous material as any item or agent (biological, chemical, or physical) that has the potential to cause harm to humans, animals, or the environment, either by itself or through interaction with other factors.

The term may also have specific definitions for certain purposes, such as the definitions used by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA).

Hazardous materials and wastes are subject to many regulations at the Federal, State, and local levels. The primary Federal agencies responsible for regulating hazardous materials and wastes are EPA, the Occupational Safety and Health Administration (OSHA), and the U.S. Department of Transportation.

Petroleum products and solid waste are included in this section. Common petroleum products include gasoline and diesel fuel. Solid waste is generally defined as discarded material. EPA defines solid waste as ”any garbage or refuse, sludge from a wastewater treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semi-solid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities” (EPA 2013).

The analysis area for hazardous and regulated materials and wastes includes all areas that could be affected by conditions at the wind farm site, the routes of travel to and from the Project, as well as the mitigation areas.

3.5.1 Wind Farm Site

A Phase I Environmental Site Assessment (Tetra Tech 2014a) of the wind farm site was performed in 2014 to assess the potential presence of hazardous materials on the site. The Phase I was conducted in accordance with ASTM International Standard E1527-13, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process, and included a visual site inspection, interviews with persons familiar with the property, and a review of current and historical property records.

The Phase I assessment did not find evidence that hazardous materials, solid waste, or petroleum products have been released to the environment in or around the wind farm site. There was no evidence of the presence of storage of hazardous materials; improper disposal of hazardous wastes, dumping, or landfilling; or wastewater such as pits, ponds, or lagoons. There were no solid waste dumpsters or waste staging areas at the wind farm site.

No evidence of the presence of underground storage tanks was observed. Four 500-gallon (1,893-liter) aboveground storage tanks (ASTs) labeled "United States Army JP-8" (jet fuel) were observed in grassy areas located on the northeastern portion of the wind farm site. The ASTs were observed to be intact and empty. No areas of ground staining or evidence of a release were observed adjacent to or in proximity to the ASTs. Based on an interview with the Site Manager, the four ASTs have never been used and will reportedly be used to hold water for an aquaponic system. In addition, an approximately 1,000-gallon (3,785-liter) water AST was observed adjacent to a water pump house.

An empty metal 55-gallon (208-liter) drum with a hand pump was observed in a vegetated area on the northern portion of the wind farm site. The drum was labeled as "fuel", and no areas of ground staining or evidence of a release were observed adjacent to the 55-gallon (208-liter) metal drum. The drum was observed to be dented and rusted, however there were no visible perforations.

Heavy construction equipment, which may contain hydraulic components, was observed in a construction area along a dirt road on the eastern portion of the wind farm site. There was no evidence or leaks or spills observed in association with the heavy construction equipment.

Four pole-mounted transformers were observed on the northeastern portion of the wind farm site. In addition, one pole-mounted transformer was observed adjacent to the northern corner and one pole-mounted transformer was observed along the eastern boundary of the wind farm site. The transformers are owned and maintained by the Hawaiian Electric Company, Inc., and were not labeled with respect to polychlorinated biphenyls (PCBs) content. No evidence of leaks or spills was observed in association with the transformers.

Portions of the wind farm site are being used and/or have been used for agricultural purposes. Signage was observed across the wind farm site indicating the historical application of pesticides. No pesticides, herbicides, or landscaping chemicals were observed to be stored at the wind farm site; however, the interiors of buildings (warehouse building and sheds) were not inspected and the individual or contractor responsible for pesticide application was not interviewed. No evidence of herbicide or pesticide misuse was observed on the wind farm site during the site visit. No indications of the presence of onsite agricultural chemical mixing areas (current or past), chemical dumping or improper storage were observed.

A 4,510-square foot (419-square meter) warehouse building located on the eastern portion of the wind farm site was constructed in 1975. Based on the date of construction of the warehouse building, asbestos containing materials and lead based paint may potentially be present.

3.5.2 Hamakua Marsh (waterbird)

Hamakua Marsh lies in the eastern portion of Kawainui Marsh. Document review of available resources did not find evidence that hazardous materials, solid waste or petroleum products have been released to the environment at Hamakua Marsh.

Kapaa Landfill, Kapaa Industrial Park, Kapaa Refuse Transfer Station and the former Kalaheo Sanitary Landfill are located west of Kawainui Marsh, but no evidence has been found that the proximity of these properties introduced hazardous materials to Hamakua Marsh. Some sections of Kapaa Quarry Road, which runs along the western border of Kawainui Marsh, have a history of illegal dumping, particulary rubbish and bulky items (DLNR 2011).

During vegetation management and removal at Hamakua Marsh, herbicides are being used in accordance with applicable Best Management Practices (BMPs). The use of herbicides is limited to all applicable State and Federal regulations, and the herbicides must be used according to EPA restrictions and labeling (USACE Undated).

3.5.3 Poamoho Ridge (bat)

The Poamoho Biological Surveys Report (DLNR Undated) states that chemical weed control treatment is used at Poamoho Ridge to target weeds. Neither the amount nor the type of chemical used is described in the report. Site access is limited, making dumping of hazardous materials, solid waste or petroleum products unlikely. No additional information was found about any evidence that hazardous materials, solid waste or petroleum products have been released to the environment at Poamoho Ridge.

3.6 Natural Hazards

A natural hazard is a naturally occurring event that could negatively affect people, infrastructure, and/or the environment. Many natural hazards can be triggered by another event, though they may occur in different geographical locations, for example, an earthquake can trigger a tsunami in an entirely different geographic area. Natural hazards that can affect the Hawaiian Islands and Oahu include hurricanes and tropical storms, tsunamis, earthquakes, flooding, and wildfire. Because natural hazards occur on a regional scale, the analysis area for impacts associated with natural hazards includes the island of Oahu.

3.6.1 Hurricanes and Tropical Storms

Hurricanes develop over warm tropical oceans, and have sustained winds that exceed 74 mph (119 kph). Based on the Saffir-Simpson Hurricane Wind Scale (NOAA 2013a) there are five categories of hurricanes:

- Category 1 has sustained winds between 74 and 95 mph (119 and 153 kph);
- Category 2 has sustained winds between 96 and 110 mph (154 and 177 kph);
- Category 3 has sustained winds between 111 and 129 mph (179 and 208 kph);
- Category 4 has sustained winds between 130 and 156 mph (209 and 251 kph; and
- Category 5 is sustained winds greater than 157 mph (253 kph).

The Central Pacific Hurricane season runs from June 1 to November 30. Hurricanes are relatively rare in Hawaii; only five hurricanes have caused serious damage to the islands since 1950 (Businger 1998). No recorded hurricane has made landfall on the island of Oahu, although a few of these hurricanes have affected Oahu through high winds and flooding.

Tropical storms are similar to hurricanes, except that the sustained winds are below 74 mph (119 kph). These events can also produce torrential rains. Tropical storms occur more frequently in than hurricanes and typically pass sufficiently close to Hawaii every 1 to 2 years to affect the weather in some part of the Islands (WRCC 2013).

The topography of the Hawaiian Islands can funnel and amplify winds across ridges and through island channels. Additionally, the mountainous topography focuses rains on mountain slopes, in some cases resulting in destructive flash floods and landslides in the valleys below (Businger 1998). As a result, even a relatively weak tropical storm can potentially result in considerable damage (Businger 1998).

3.6.2 Tsunamis

Tsunamis are large, rapidly moving ocean waves triggered both by disturbances around the Pacific Rim (i.e., teletsunamis) and by earthquakes and landslides near Hawaii (i.e., local tsunamis) (USGS 2013). Tsunami waves travel at speeds of 300 to 600 mph, and the first wave may not be the largest one (Pacific Disaster Center 2013). Tsunami hazards include not only the powerful waves, but also large debris within the waves and flooding of low-lying areas (Pacific Disaster Center 2013). Tsunamis have resulted in more lost lives in Hawaii than all other natural disasters combined (Pacific Tsunami Museum 2013). Approximately 221 people in Hawaii were killed by tsunamis in the 20th century (USGS 2013). Twenty-six tsunamis with flood elevations greater than 3.3 feet (1 meter) have made landfall in the Hawaiian Islands during recorded history, and 10 of these had significant damaging effects on Oahu (Fletcher et. al. 2002). This translates to a recurrence interval of one large tsunami making landfall on the Hawaiian Islands once every 7 years and a damaging tsunami reaching Oahu every 19 years (Fletcher et. al. 2002). However, since 1976, there have been no large tsunamis recorded in all of Hawaii (Fletcher et. al. 2002).

A small portion of the northeastern edge of the wind farm site, near Kamehameha Highway, is within the Civil Defense Tsunami Evacuation Zone (NOAA 2013b). No portions of the Poamoho Ridge and Hamakua Marsh mitigation areas are within Civil Defense Tsunami Evacuation Zone.

3.6.3 Earthquakes and Seismicity

Earthquakes in Hawaii are often linked with volcanic activity, and are an important part of the island-building process (USGS 2001). On the island of Hawaii, numerous small volcanic earthquakes are triggered by eruptions and magma movement within the presently active volcanoes of Kilauea, Mauna Loa, and Lo`ihi. Tectonic earthquakes tend to produce larger earthquakes and occur in areas of structural weakness at the base of these active volcanoes or deep within the Earth's crust beneath the Island of Hawaii (USGS 2001). Occasionally, these larger tectonic earthquakes may be felt in Oahu, including the Honomu Earthquake of 1973 which occurred beneath the Hamakua Coast of the island of Hawaii.

The Uniform Building Code (UBC) was developed to regulate building codes in specific areas to account for seismic hazards. The UBC's seismic hazard classification system is based on expected ground shaking strength and probability of shaking occurring within a specified time (USGS 2001). Hawaii has four UBC seismic hazard zones. According to the U.S. Geological Survey (USGS), Zone 0 means that there is "no chance of severe ground shaking" and a seismic hazard rating of 4 means that there is a "10 percent chance of severe shaking in a 50-year interval" (USGS 2001). The entire island of Oahu has a UBC seismic risk zone ranking of 2A (USGS 2001), which indicates a low level of seismic risk.

3.6.4 Flooding

Potential flood hazards are identified by the Federal Emergency Management Agency (FEMA) National Flood Insurance Program and are mapped on the Flood Insurance Rate Maps. The maps classify land into zones depending on the potential for flood inundation.

3.6.4.1 Wind Farm Site

The wind farm site lies within several flood zones. Designations for these flood zones include (FEMA 2013a; 2013b):

- Zone A – areas mapped as being within the 100-year (1-percent-annual-chance) floodplain; however, hydraulic analysis has not been conducted in these areas and base flood elevations are not listed.
- Zone AE – area mapped as being within the 100-year (1-percent-annual-chance) floodplain and base flood elevations have been derived from detailed hydraulic analyses for these areas.
- Zone AEF – areas that lie within the floodway of a stream. The floodway is the channel of the stream plus any adjacent areas that must be kept free of encroachment so that the 1-percent-annual chance flood can be carried without substantial increases in flood heights.
- Zone D – areas where analysis of flood hazards has not been conducted and flood hazards are undetermined.
- Zone X – areas determined to be outside the 0.2-percent-annual-chance (or 500-year) floodplain.
- Zone XS – areas between the limits of the 100-year (1-percent-annual-chance) and 500-year (0.2-percent-annual-chance) floodplains, including areas inundated by 100-year flooding with average depths of less than 1 foot.

According to the Flood Insurance Rate Maps, the wind farm site is located predominantly within Flood Zones D and X (Figure 3.6-1). Small portions of the wind farm site are located in Flood Zones A, AE, AEF, and XS. The portions of the wind farm site mapped as Zone AEF include areas adjacent to Malaekahana and Keaaulu streams. Improvements within the floodway are limited to surface pavements and power transmission lines which are not expected to change the conveyance capacity of the floodway (Belt Collins Hawaii LLC 2016a). All the proposed wind turbines would be located within areas classified as Zone X or Zone D.

3.6.4.2 Hamakua Marsh (waterbird)

The Hamakua Marsh mitigation area lies within areas designated by FEMA as Flood Zones AE, AEF, and X (Figure 3.6-2). The classifications for flood zones AE and X are as defined above under wind farm site. Much of the northern portion of the mitigation area is mapped as being within a Zone AEF (Figure 3.6-2). Zone AEF is defined as the areas that lie within the floodway of a stream. The floodway is the channel of a stream plus any adjacent areas that must be kept free of encroachment so that the 1-percent-annual-chance flood can be carried without substantial increases in flood heights (FEMA 2013a).

3.6.4.3 Poamoho Ridge (bat)

The Poamoho Ridge Mitigation Area lies within areas designated by FEMA as Flood Zone D, where analysis of flood hazards has not been conducted and flood hazards are undetermined.

3.6.5 Wildfire

Fire is believed to have been infrequent in the lowlands of the Hawaiian Islands prior to human settlement. Wildfires have increased in frequency with Polynesian and European colonization, the introduction and spread of invasive species, and the cessation of feral and domestic ungulate grazing (LaRosa et al. 2008). Fires of volcanic origin occurred in Hawaii prior to human colonization and continue today; however, these fires are intermittent and geographically localized (LaRosa et al. 2008). Currently, wildfires in the Hawaiian Islands occur most commonly in lowland communities, with human activity as the primary cause. From the early- to mid-20th century, the number of fires throughout Hawaii has increased six-fold and the average acres burned has increased five-fold (Cuddihy and Stone 1990).

Wildfires have resulted in extensive damage to life and property and pose an ecological threat to endemic flora and fauna in the Hawaiian Islands (Chu et al. 2002). Hawaii’s native ecosystems are not adapted to wildfire; therefore, wildfire can result in impacts to native species and can facilitate the proliferation of non-native invasive species (LaRosa et al. 2008). Other effects of wildfire include increased soil erosion and runoff and decreased water quality.

Since 2000, 114 wildfires have occurred in the vicinity of the wind farm site, including 10 in the adjacent Kahuku Training Area that were ignited due to military training activities (The Center for Environmental Management of Military Lands 2014). All these fires have been small in size (less than 2.5 acres [1 hectare] on average), with the largest fire covering 10.1 acres.

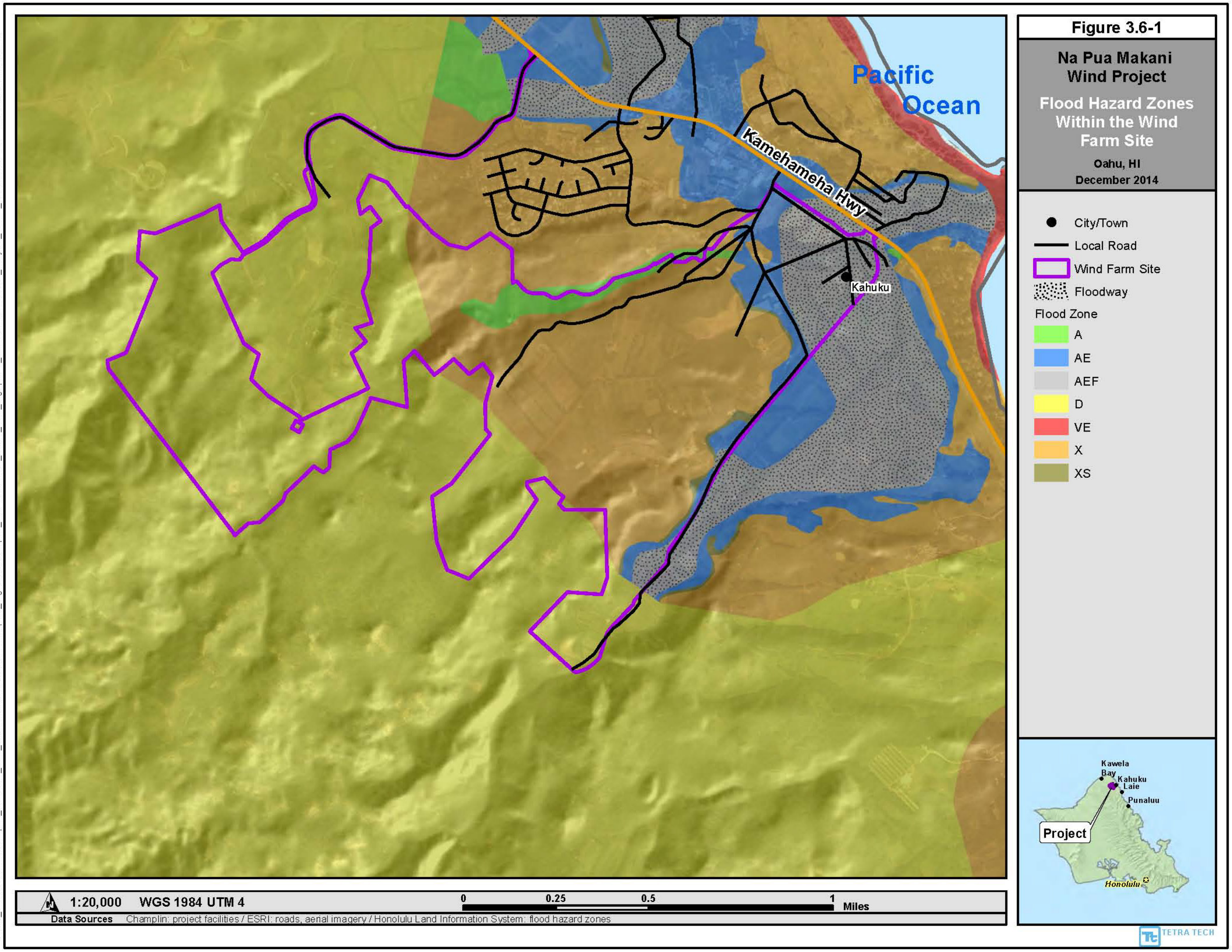


Figure 3.6-1
Na Pua Makani Wind Project
Flood Hazard Zones Within the Wind Farm Site
Oahu, HI
December 2014
City/Town
Local Road
Wind Farm Site
Floodway
Flood Zone
A
AE
AEF
D
VE
X
XS
Pacific Ocean
Kamehameha Hwy
Kahuku
Kawela Bay
Kahuku
Laie
Punaluu
Project
Honolulu
1:20,000
WGS 1984 UTM 4
0
0.25
0.5
1
Miles
Data Sources
Champlin: project facilities / ESRI: roads, aerial imagery / Honolulu Land Information System: flood hazard zones
TETRA TECH

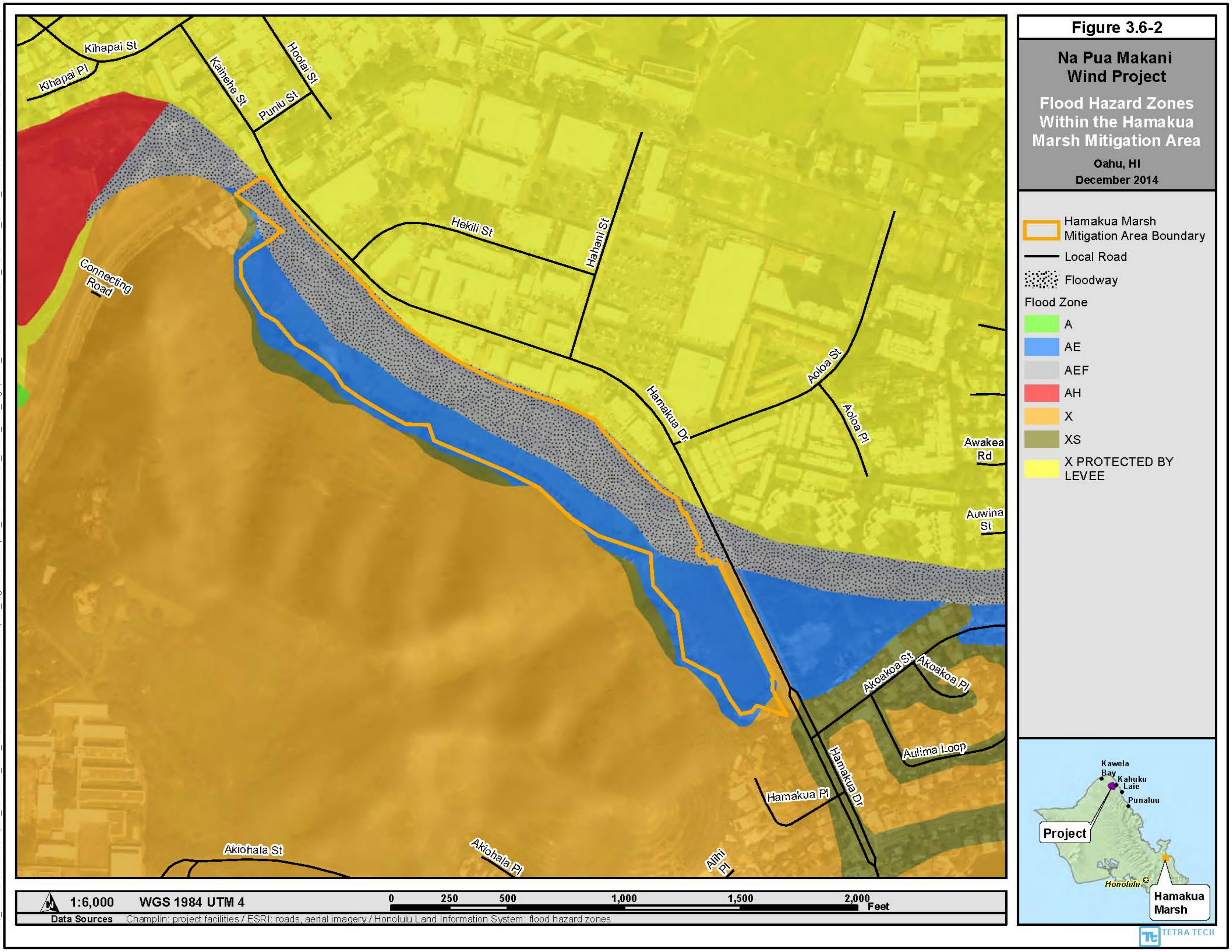


Figure 3.6-2
Na Pua Makani Wind Project
Flood Hazard Zones Within the Hamakua Marsh Mitigation Area
Oahu, HI
December 2014
Hamakua Marsh Mitigation Area Boundary
Local Road
Floodway
Flood Zone
A
AE
AEF
AH
X
XS
X PROTECTED BY LEVEE
Kihapai St
Kihapai Pl
Kaiehe St
Hoolai St
Puniu St
Hekili St
Hahani St
Connecting Road
Hamakua Dr
Aoloa St
Aoloa Pl
Awakea Rd
Auwina St
Akoakoa St
Akoakoa Pl
Aulima Loop
Hamakua Pl
Akiohala St
Akiohala Pl
Alihi Pl
1:6,000
WGS 1984 UTM 4
0
250
500
1,000
1,500
2,000
Feet
Data Sources Champlin: project facilities / ESRI: roads, aerial imagery / Honolulu Land Information System: flood hazard zones
Kawela Bay
Kahuku
Laie
Punaluu
Project
Honolulu
Hamakua Marsh
TETRA TECH

eFuels within the wind farm site include a variety of grass, grass and shrub, and shrub communities, as well as small patches of timber. Additionally, much of the wind farm site is located in existing agricultural fields which are generally unburnable as currently utilized (Beavers 2014). Grasses comprise a substantial portion of the surface fuels in the wind farm site, including in the timber and shrub communities. Dominant grasses in these communities include highly flammable guinea grass (*Urochloa maxima*) and California grass (*Urochloa* [*Brachiaria*] *mutica*). Additionally, there are patches of common ironwood (*Casuarina equisetifolia*) and eucalyptus (*Eucalyptus* spp.) trees in the wind farm site, both of which can contribute to fire control problems under dry conditions (Beavers 2014).

Climatic conditions in the vicinity of the wind farm site include high relative humidity, with monthly average humidity never dropping below 65 percent, and high precipitation, with average monthly rainfall never dropping below 1.5 inches (3.8 centimeters). These conditions tend to prohibit the production of fires (Beavers 2014). Live herbaceous moisture in the wind farm site is high (exceeding 120 percent) indicating that fire behavior will generally be dampened by the presence of live fuels (Beavers 2014). Additionally, an analysis of potential fire behavior in the wind farm site under the 50th, 80th, and 97th percentile weather conditions, using weather data from the Kahuku Remote Automated Weather Station (RAWS), determined that even under extreme weather conditions (97th percentile), probability of ignition was extremely low (43 percent probability) (Beavers 2014). Weather at these extreme conditions normally produces ignition probabilities in excess of 90 percent (Beavers 2014).

3.7 Vegetation

General vegetation communities and plant species found within the wind farm site and mitigation areas are briefly described below. Federal or State threatened, endangered, or candidate plant species are discussed in Section 3.9 – Threatened and Endangered Species. The analysis area for vegetation includes the Project construction footprint, as well as areas that would be disturbed by activities implemented in the mitigation areas plus a 0.25-mile (0.4-kilometer) buffer around these areas. This area encompasses the areas where potential direct effects to vegetation could occur as well as areas where indirect effects to vegetation, such as invasive plant species introduction and spread or increased fire risk could occur. Existing vegetation conditions in the wind farm site are based on botanical surveys conducted in the wind farm site in 2013 (Hobdy 2013a). Existing vegetation conditions in the mitigation areas were derived from various management plans, cited below as appropriate.

3.7.1 Wind Farm Site

Botanical surveys of the wind farm site were conducted in June 2013 (Hobdy 2013a; see Appendix E of the Final EIS). The objectives of these surveys were to characterize vegetation communities within the wind farm site and to determine the presence of Federal or State threatened, endangered, or candidate, plant species. As stated above, Federal and State threatened, endangered, and candidate plant species are discussed in Section 3.9 – Threatened and Endangered Species.

The wind farm site is surrounded by agricultural farm lands to the north and east and by undeveloped forested lands to the west and south (Hobdy 2013a). Vegetation in the wind farm site consists mostly of low, windblown shrubs and trees on the ridge tops with larger trees and brush on slopes and in gullies.

Prior to European colonization, the lower, more gently sloping lands in the wind farm site and vicinity would have been extensively farmed by the large Hawaiian population that lived in the lower valleys and along the seashore (Hobdy 2013a). The ridges would have been covered by native shrubs such as ulei (*Osteomeles anthyllidifolia*), akia (*Wikstroemia oahuensis*), iliahi aloe (*Santalum ellipticum*), and uhaloa (*Waltheria indica*) (Hobdy 2013a). Much of the area was converted for sugar cane (*Saccharum officinarum*) production in the late 1800s. The lowlands were cleared, plowed, burned, and harvested, while the steeper land was used to pasture plantation horses and mules (Hobdy 2013a). Sugar cane production was discontinued in the 1980s and the land was put into crop agriculture or left idle (Hobdy 2013a).

Currently, the vegetation within the wind farm site is predominantly non-native shrubland and forest dominated by a mixture of aggressive non-native weedy species that took over following the abandonment of agricultural production of sugar cane. Only a few persistent native plants have been able to compete and survive (Hobdy 2013a). Common ironwood, a non-native tree, was the most abundant species observed in the wind farm site during field surveys in 2013. Other common non-native species observed were koa haole (*Leucaena leucocephala*), octopus tree (*Schefflera actinophylla*), parasol leaf tree (*Macaranga tanarius*), Java plum (*Syzygium cumini*), Formosa koa (*Acacia confusa*), strawberry guava (*Psidium cattleianum*), Koster's curse (*Clidemia hirta*), beggarstick (*Bidens alba*), Guinea grass, pitted beardgrass (*Bothriochloa pertusa*), spanish clover (*Desmodium incanum*), huehue haole (*Passiflora suberosa*), and Jamaica vervain (*Stachytarpheta jamaicensis*).

A total of 134 plant species were identified during botanical surveys, only 19 of which were native species, including 5 endemic species. Native species present were largely intermixed with non-native species with the exception of a few ridge tops where a number of native shrub species also occur. The native shrub ulei was also seen forming large monotypic patches on ridge tops. Other common native species observed in the wind farm site include uhaloa, huehue (*Cocculus orbiculatus*), and akia. Each of the native species present in the wind farm site is known from multiple islands, and none are rare. No Federal or State threatened, endangered, or candidate plant species were detected. Additionally, no plant species proposed for listing or special status plant species were detected. No portion of the wind farm site has been designated as critical habitat for any listed plant species. Table 3.7-1 lists the native plant species recorded in the wind farm site by Hobdy (2013a). A complete list of plant species observed during botanical surveys of the wind farm site is provided in Appendix E of the Final EIS.

Table 3.7-1. Native Hawaiian Plants Observed in the Wind Farm Site

Scientific Name	Common Name	Status1/	Abundance2/
FERNS			
Dicranopteris linearis	uluhe, staghorn fern	indigenous	rare
Nephrolepis exaltata	nianiau, sword fern	indigenous	uncommon
Psilotum nudum	moa; whisk fern	indigenous	rare
Pteridium aquilinum var. *decompositum*	kilau, bracken fern	endemic	rare
Sphenomeris chinensis	palaa	indigenous	rare
MONOCOTS			
Carex wahuensis	Oahu sedge	endemic	rare
Chrysopogon aciculatus	piipii, golden beardgrass	indigenous	uncommon
Dianella sandwicensis	ukiuki	indigenous	uncommon
Heteropogon contortus	pili grass	indigenous	rare
DICOTS			
Cassytha filiformis	kaunaoa pehu	indigenous	rare
Cocculus orbiculatus	Huehue	indigenous	common
Styphelia (*Leptecophylla*) *tameiameiae*	Pukiawe	indigenous	rare
Osteomeles anthyllidifolia	ulei	indigenous	common
Peperomia latifolia	alaala wai nui	endemic	rare
Psydrax odorata	alahee	indigenous	rare
Santalum ellipticum	iliahi aloe, coast sandalwood	endemic	uncommon
Scaevola (*taccada*) *sericea*	naupaka kahakai	indigenous	rare
Waltheria indica	uhaloa	indigenous	common
Wikstroemia oahuensis	akia	endemic	common

1/ endemic = native only to Hawaii; indigenous = native to Hawaii and elsewhere
2/ Abundance within wind farm site: common = widely scattered or locally abundant; uncommon = sparsely scattered or in a few small patches; rare = few isolated individuals

3.7.2 Hamakua Marsh (waterbird)

The Hamakua Marsh Mitigation Area is located on the edge of the town of Kailua and is adjacent to Kawainui Marsh, the largest remaining wetland in Hawaii (USACE 2008). Hamakua Marsh is a smaller wetland that was historically connected to and immediately downstream of Kawainui Marsh. Both Hamakua and Kawainui Marshes were designated as Ramsar Wetlands of International importance in 2005 for their biological, historical, and cultural significance (USACE 2008). Hamakua Marsh used to be fed by Kawainui Stream which flowed from Kawainui Marsh. Currently, the northeastern edge of the mitigation area is bordered by the manmade Hamakua Canal. Currently, Hamakua Marsh is designated as a Hawaii State Wildlife Sanctuary and is managed by the Division of Forestry and Wildlife (DOFAW).

Vegetation communities within the mitigation area consists of a mix of upland tree, shrub, and groundcover species along the Hamakua Canal and emergent and aquatic wetland vegetation adjacent to and within the marsh. Vegetation surveys of the marsh conducted in 1992, as part of the environmental assessment for the Hamakua Wetland Protection and Enhancement Project, found that the vegetation along Hamakua Canal was dominated by non-native tree and shrub species including red mangrove (*Rhizophora mangle*), kiawe (*Prosopis pallida*), Christmas berry (*Schinus terebinthifolius*), fiddlewood (*Citharexylum spinosum*), koa haole, Chinese banyan (*Ficus microcarpa*) (Ducks Unlimited, Inc. 1992). Ground cover along the canal was dominated by non-native invasive grasses. The non-native shrub, Indian fleabane (*Pluchea indica*), and non-native groundcover, pickleweed (*Batis maritima*), occurred in the transition zone between the canal and the wetland areas (Ducks Unlimited, Inc. 1992). Seashore paspalum (*Paspalum vaginatum*), a non-native grass species, was the dominant emergent species within the marsh. Common native emergent species observed within the marsh include bulrush (*Schoenoplectus* [*Bolboschoenus*] *maritimus*), water hyssop (*Bacopa monnieri*), and ditchgrass (*Ruppia maritima*) (Ducks Unlimited, Inc. 1992).

3.7.3 Poamoho Ridge (bat)

Consisting of native, high-elevation forest, the Poamoho Ridge Mitigation Area is located almost entirely in the Ewa Forest Reserve above Wahiawa along the leeward summit of the central Koolau Range. Vegetation communities in the mitigation area include ohia (*Metrosideros* spp.)/olapa (*Cheirodendron* spp.) native wet forest, ohia/koa (*Acacia koa*) native wet forest, and mixed windswept native shrubland along summit areas (U.S. Army 2008). Native wet forest vegetation includes *Metrosideros* spp., *Cheirodendron* spp., *Cibotium* spp, *Ilex anomala, Pritchardia martii, Myrsine sandwicensis,* and *Perrottetia sandwicensis.* Native understory vegetation includes fern and moss species (OANRP 2012). Habitat along Poamoho Ridge is steadily decreasing in quality due to the presence of invasive plant species are and feral pigs (M. Zoll, DLNR, pers. comm. 2013). Additional, threats to native vegetation include slugs, ants, rats, and potentially fire. The DLNR has secured funding and is in the process of installing fencing around the mitigation area parcels to deter feral pig use. However, funding for long-term forest restoration and management of this area including fence maintenance, pig removal, and invasive species removal has not been secured.

3.8 Wildlife

This section describes the non-listed wildlife in the vicinity of the Project including common wildlife species, migratory and endemic bird species that are protected under the Migratory Bird Treaty Act (MBTA), and other indigenous avian species of concern. Threatened and endangered species are addressed in detail in Section 3.9. The analysis area for impacts to wildlife includes the wind farm site and the mitigation areas. This encompasses all potential effects to wildlife and wildlife habitats including habitat loss and alteration and direct mortality within the footprint of the Project (area of disturbance associated with Project structures), as well as areas extending beyond where wildlife could be exposed to disturbance. This area also includes potential beneficial effects of HCP mitigation activities.

3.8.1 Surveys Completed

Field surveys to document wildlife within the wind farm site included walk-through general biological surveys (Hobdy 2013a), avian count surveys (Tetra Tech 2014b), and radar and audiovisual surveys for bats and seabirds (Sanzenbacher and Cooper 2013). General wildlife surveys were conducted in June 2013 (see Appendix E of the Final EIS). Avian point count surveys were conducted monthly from October 2012 to October 2013 at two locations within and representative of the wind farm site and two points near wetland habitat in the vicinity of the wind farm site. The radar and audiovisual surveys for endangered seabirds and acoustic monitoring for bats are discussed in Section 3.9 – Threatened and Endangered Species.

3.8.2 Wind Farm Site

Wildlife habitat in the wind farm site consists of agricultural lands, grassland, shrub-scrub, and dryland forest. The existing vegetation includes many introduced species and there are no contiguous patches of native vegetation present. Vegetation communities are described in detail in Section 3.7.1. The wind farm site provides habitat for a variety of birds, most of which are non-native, as well as for several non-native mammal species and numerous invertebrates. There are no wetlands or waterbodies within the wind farm site and there are no areas where congregations of birds occur.

3.8.2.1 Non-listed Wildlife

Twenty-six avian species were observed during field surveys or incidentally within the wind farm site in 2012 and 2013. Songbirds and waterbirds (primarily cattle egrets) were the most common. Most are widespread and common introduced species associated with low elevation habitats throughout Oahu, or indigenous species that occur in lowland habitats throughout the Hawaiian Islands as residents or migrants, and may use the wind farm site for foraging or nesting (Table 3.8-1).

Table 3.8-1. Bird Species Observed in the Wind Farm Site

Common Name	Scientific Name	Status[1/]	Protected Status[2/]
Barn owl	*Tyto alba*	non-native; resident	MBTA
Black-crowned night heron	*Nycticorax nycticorax*	indigenous; resident	MBTA
Bristle-thighed curlew	*Numenius tahitiensis*	indigenous; migrant	MBTA
Cattle egret	*Bubulcus ibis*	non-native; resident	MBTA
Common myna	*Acridotheres tristis*	non-native; resident	none
Common peafowl	*Pavo cristatus*	non-native; resident	none
Common waxbill	*Estrilda astrild*	non-native; resident	none
Great frigatebird	*Fregata minor*	indigenous; resident	MBTA
House finch	*Carpodacus mexicanus*	non-native; resident	MBTA
Japanese bush-warbler	*Cettia diphone*	non-native; resident	none
Japanese white-eye	*Zosterops japonicas*	non-native; resident	none
Laysan albatross	*Phoebastria immutabilis*	indigenous; breeder	MBTA
Northern cardinal	*Cardinalis cardinalis*	non-native; resident	MBTA
Nutmeg mannikin	*Lonchura punctulata*	non-native; resident	none
Pacific golden-plover	*Pluvialis fulva*	indigenous; migrant	MBTA
Red avadavat	*Amandava amandava*	non-native; resident	none
Red junglefowl	*Gallus gallus*	non-native; resident	none
Red-billed leiothrix	*Leiothrix lutea*	non-native; resident	none
Red-crested cardinal	*Paroaria coronate*	non-native; resident	none
Red-vented bulbul	*Pynonotus cafer*	non-native; resident	none
Red-whiskered bulbul	*Pycnonotus jocosus*	non-native; resident	none
Rock pigeon	*Columba livia*	non-native; resident	none
Spotted dove	*Streptopelia chinensis*	non-native; resident	none
White-rumped shama	*Copsychus malabaricus*	non-native; resident	none
White-tailed tropicbird	*Phaethon lepturus*	indigenous; migrant	MBTA
Zebra dove	*Geopelia striata*	non-native; resident	none
1/ indigenous = native to Hawaii and elsewhere 2/ MBTA = Migratory Bird Treaty Act			

Aside from the Hawaiian hoary bat (*Lasiurus cinereus semotus*) (addressed in detail in Section 3.9), all land mammals in Hawaii are introduced. Four mammalian species were observed during biological surveys. In addition to the Hawaiian hoary bat, three species of introduced mammals were also observed during general biological surveys including: small Indian mongoose (*Herpestes auropunctatus*), domestic cat (*Felis catus*), and domestic dog (*Canis lupis familiaris*). All of these species are widespread in the Hawaiian Islands and on Oahu. See the Biological Survey Report (Hobdy 2013a) in Appendix E of the Final EIS for additional discussion of invasive species.

Twenty species of invertebrates were also identified during the general biological surveys (Hobdy 2013a). This includes 18 species of insects and two species of mollusk (see Appendix E of the Final EIS). With the exception of the globe skimmer (*Pantala flavescens*), an indigenous dragonfly, all invertebrates are widespread introduced species. The globe skimmer is widespread in Hawaii and across the planet (Howarth and Mull 1992).

Development activities have the potential to affect wildlife through direct mortality (during construction or through collision with turbines), habitat alteration or removal, or though noise and disturbance associated with increased human activity in the wind farm site. Indirectly, construction activities can also result in the introduction and spread of non-native species.

3.8.2.2 MBTA-protected Species and Other Avian Species of Concern

This section describes the MBTA-protected species that occur in the vicinity of the wind farm site. Hawaii has 317 documented bird species, which include introduced, indigenous, and endemic residents, as well as wintering and breeding migrants and birds that only pass through Hawaiian waters in migration (Pyle and Pyle 2009). Hawaii and, consequently, the wind farm site are situated within the West Pacific Flyway, one of the world's main bird migratory routes. Birds that move along the West Pacific Flyway consist primarily of shorebirds, waterfowl, and seabirds. Some of these species hold cultural significance in Hawaii. While many species of migrant or wintering seabirds pass near the Hawaiian Islands, they rarely approach land and are at very low risk of being affected by land-based wind energy development.

Migratory birds, as well as some non-migratory birds that are native to the Hawaiian Islands, are afforded protection under the MBTA. Additionally, numerous species introduced to the Hawaiian Islands are protected under the MBTA, even though they are non-native. The following describes each of these groups in detail.

Shorebirds (curlews, plovers, sanderlings, tattlers, and turnstones)

Shorebirds are a group of birds that live along coastlines and are associated with a variety of freshwater and marine wetland habitats. Shorebirds that occur in the Hawaiian Islands are primarily migratory, traveling for thousands of miles across the ocean between breeding grounds in Alaska and Siberia to wintering grounds in Hawaii and farther south. They are typically present in Hawaii from August through April, with peaks in diversity and number during the middle of fall migration (October-November; Engilis and Naughton 2004).

The U.S. Pacific Islands Regional Shorebird Conservation Strategy (Engilis and Naughton 2004) identifies four shorebirds of primary conservation importance in the Hawaiian Islands including the Hawaiian stilt, bristle-thighed curlew, Pacific golden-plover, and wandering tattler. The Hawaiian stilt (an ESA-listed species covered under the Project HCP and addressed in detail in Section 3.9) is endemic to the main Hawaiian Islands and is the only resident, breeding shorebird in the region. The Hawaiian Islands provide essential habitat for the other three species as a majority their global populations overwinter there.

The Pacific golden-plover is indigenous to the Hawaiian Islands and is one of the most ubiquitous wintering birds. This species is ranked by the U.S. Shorebird Conservation Strategy as a species of high concern (Engilis and Naughton 2004). This species winters across the tropical Pacific from Hawaii to Japan, and use the widest range of habitats among shorebird species from sea level to 13,000 feet (3,960 meters) elevation (Mitchell et al. 2005). They are most common in uplands, parks, pastures, and open wetlands. Pacific golden-plovers exhibit high sight fidelity (returning year after year) to their wintering grounds. Population trends for this species are largely unknown, although it is common in the Hawaiian Islands and an average of 14.1 Pacific golden-plovers per party-hour has been recorded during Honolulu Christmas Bird Counts since 1990 (National Audubon Society 2014).

The Bristle-thighed curlew is indigenous to the Hawaiian Islands and has an International Union for Conservation of Nature and Natural Resources (IUCN) red-list ranking of vulnerable. It is ranked by the U.S. Shorebird Conservation Strategy as a species of high concern (Engilis and Naughton 2004). Winter range for this species includes islands throughout the Pacific. Within the Hawaiian Islands, the largest concentrations of this species overwinter in the Northwest Hawaiian Islands; smaller concentrations overwinter in the main Hawaiian Islands, particularly Oahu and Hawaii (Mitchell et al. 2005). This species prefers undisturbed, predator-free habitats, and most bristle-thighed curlews on Oahu overwinter on grassy areas, wetlands, and vegetated dunes. Population trends for this species are largely unknown and an average of 0.05 bristle-thighed curlews per party-hour has been recorded during Honolulu Christmas Bird Count since 1990 (National Audubon Society 2014).

Wandering tattler is indigenous to the Hawaiian Islands and is ranked by the U.S. Shorebird Conservation Strategy as a species of moderate concern (Engilis and Naughton 2004). This species winters in the Pacific Ocean from the Hawaiian Islands through the archipelagos to the south (Mitchell et al. 2005). In Hawaii, this species forages in intertidal habitats as well as human-modified areas such as grassy areas around airports and golf courses. Population trends for this species are largely unknown, although wandering tattlers are not common in the Hawaiian Islands and an average of 0.39 wandering tattlers per party-hour has been recorded during Honolulu Christmas Bird Count since 1990 (National Audubon Society 2014).

Other common winter visitors include the ruddy turnstone and sanderling. Winter visitors that occur annually, but in small numbers, include the black-bellied plover, lesser yellowlegs, least sandpiper, pectoral sandpiper, sharp-tailed sandpiper, dunlin, and long-billed dowitcher. Other shorebird species occur as irregular or accidental migrants in Hawaii.

Threats to shorebirds in the Hawaiian Islands include habitat loss associated with land development; introduction of invasive, non-native plants (degradation of habitat) and non-native animals (predation, disease, competition); human disturbance; and contaminants (sewage discharge, oil spills, radioactive wastes, pesticides; Engilis and Naughton 2004). The Pacific golden-plover has been documented as a fatality at operational wind facilities in Hawaii.

Table 3.8-2 provides a list of the MBTA-protected shorebird species documented in the vicinity of the wind farm site. Shorebird habitat on Oahu is diverse and includes tidal flats, estuaries, playas, ephemeral and permanent marshes, managed wetlands, and urban grasslands. The James Campbell NWR, located approximately 0.75 mile (1.2 kilometers) to the north the wind farm site, is an important wintering area for shorebirds. Shorebirds can also be seen near the wind farm site at the Kahuku aquaculture facilities and the Kahuku golf course. There is no suitable habitat for shorebirds within the wind farm site; therefore, these species are only likely to pass through when flying between wetland habitats outside of the wind farm site.

Waterfowl (Ducks and Geese)

Close to 30 species of migratory waterfowl winter in the Hawaiian Islands, including species of diving ducks, dabbling ducks, sea ducks, and geese. These species are typically present from September through May, and are associated with wetland habitats (USFWS 2011a). There are also several resident waterfowl species that are afforded protection under the MBTA including the mallard, Hawaiian duck, Hawaiian coot, and Hawaiian goose. The Hawaiian duck, Hawaiian coot, and Hawaiian goose are ESA-listed species covered under the Project HCP and are addressed in detail in Section 3.9.

Table 3.8-2 provides a list of the MBTA-protected waterfowl species documented in the vicinity of the wind farm site. There is no suitable habitat for migratory waterfowl within the wind farm site; however species that frequent the wetlands around the wind farm site, including northern shovelers, northern pintail, wigeons, and teal (USFWS, pers. comm. 2014). These species are only likely to pass through when flying between wetland habitats outside of the wind farm site.

Table 3.8-2. Species Protected by the Migratory Bird Treaty Act in the Vicinity of the Wind Farm Site

Species	Occurrence[1/]	Documented During Project Surveys?[2/]
Seabirds		
Wedge-tailed shearwater (*Puffinus pacificus*)	Br	Yes
Laysan albatross (Phoebastria immutabilis)	Br	Yes
Black-footed albatross (*Phoebastria nigripes*)	Br	
Red-tailed tropic bird (*Phaethon rubricauda*)	Br	Yes
Red-footed booby (*Sula sula rubripes*)	Res	
Arctic tern (Sterna paradisaea)	Mig	
Bonaparte’s gull (Chroicocephalus Philadelphia)	Mig*	
Brown booby (Sula leucogaster)	Res	
Brown noddy (*Anous stolidus*)	Mig*	
Caspian tern (Hydroprogne caspia)	Mig*	
Common tern (*Sterna hirundo*)	Mig*	Yes
Franklin’s gull (*Laris pipixcan*)	MIg	

Table 3.8-2. Species Protected by the Migratory Bird Treaty Act in the Vicinity of the Wind Farm Site (continued)

Species	Occurrence[1/]	Documented During Project Surveys?[2/]
Glaucous-winged gull (*Larus glaucescens*)	Mig*	
Great frigatebird (*Fregata minor*)	Res	Yes
Gull-billed tern (Gelochelidon nilotica)	Mig*	
Herring gull (Larus argentatus)	Mig	
Laughing gull (Leucophaeus atricilla)	Mig	
Least tern (Sternula antillarum)	Mig	
Masked booby (Sula dactylatra)	Res	
Ring-billed gull (*Larus delawarensis*)	Mig	
Sandwich tern (Thalasseus sandvicensis)	Mig*	
Thayer's gull (*Larus thayeri*)	Mig*	
Western gull (Larus occidentalis)	Mig*	
White tern (*Gygis alba*)	Mig*	
White-tailed tropic bird (*Phaethon lepturus dorotheae*)	Res	Yes
Shorebirds		
Bar-tailed godwit (*Limosa lapponica*)	Mig*	
Black-bellied plover (*Pluvialis squatarola*)	Mig/Win	
Bristle-thighed curlew (*Numenius tahitiensis*)	Mig/Win	Yes
Common snipe (Gallinago gallinago)	Mig*	
Curlew sandpiper (*Calidris ferruginea*)	Mig*	
Dunlin (Calidris aplina)	Mig/Win	
Gray-tailed tattler (*Tringa brevipes*)	Mig*	
Greater yellow-legs (*Tringa melanoleuca*)	Mig*	
Hawaiian stilt (Himantopus mexicanus knudseni)	Res	Yes
Killdeer (Charadrius vociferous)	Mig*	
Least sandpiper (*Calidris minutilla*)	Mig/Win	
Lesser yellowlegs (*Tringa flavipes*)	Mig/Win	
Long-billed dowitcher (*Limnodromus scolopaceus*)	Mig/Win	
Marbled godwit (*Limosa fedoa*)	Mig*	
Marsh sandpiper (*Tringa stagnatilis*)	Mig*	
Pacific golden-plover (*Pluvialis fulva*)	Mig/Win	Yes
Pectoral sandpiper (*Calidris melanotos*)	Mig	
Red knot (Calidris canutus)	Mig*	
Ruddy turnstone (*Arenaria interpres*)	Mig/Win	Yes
Ruff (Philomachus pugnax)	Mig*	
Sanderling (*Calidris alba*)	Mig/Win	Yes
Semipalmated plover (Charadrius semipalmatus)	Mig*	
Sharp-tailed sandpiper (*Calidris acuminate*)	Mig	
Short-billed dowitcher (*Limnodromus griseus)*	Mig*	
Semipalmated sandpiper (*Calidris pusilla*)	Mig*	
Solitary sandpiper (*Tringa solitaria*)	Mig*	
Spotted sandpiper (*Actitis maclaria*)	Mig*	
Stilt sandpiper (Calidris himantopus)	Mig*	
Terek sandpiper (*Xenus cinereus*)	Mig*	
Wandering tattler (*Heteorscelus incanus*)	Mig/Win	
Western sandpiper (*Calidris mauri*)	Mig*	
Whimbrel (Numenius phaeopus)	Mig*	
White-rumped sandpiper (*Calidris fuscicollis*)	Mig*	
Wilson's phalarope (*Phalaropus tricolor*)	Mig*	
Wilson's snipe (Gallinago delicate)	Mig*	
Waterfowl		
American widgeon (*Anas americana*)	Mig	
Black brant (Branta bernicla)	MIg	

Table 3.8-2. Species Protected by the Migratory Bird Treaty Act in the Vicinity of the Wind Farm Site (continued)

Species	Occurrence[1/]	Documented During Project Surveys?[2/]
Blue-winged teal (*Anas discors*)	Mig	
Bufflehead (Bucephala albeola)	Mig	
Canvasback (Aythya valisineria)	Mig*	
Cinnamon teal (*Anas cyanoptera*)	Mig*	
Common merganser (*Mergus merganser*)	Mig*	
Eurasian widgeon (*Anas Penelope*)	Mig	
Cackling goose (*Branta hutchinsii*)	Mig*	
Canada goose (Branta Canadensis)	Mig	
Fulvous whistling duck (*Dendrocygna bicolor*)	Res	
Gadwall (Anas strepera)	Mig*	
Garganey (Anas querquedula)	Mig*	
Green-winged teal (*Anas carolinensis*)	Mig	
Greater scaup (*Aythya marila*)	Mig	
Greater white-fronted goose (*Anser albifrons*)	Mig*	
Hooded merganser (Lophodytes cucullatus)	Mig*	
Lesser scaup (*Aythya affinis*)	MIg	
Mallard (Anas platyrhynchos)	Mig/Res	
Northern pintail (*Anas acuta*)	Mig	
Northern shoveler (*Anas clypeata*)	MIg	
Redhead (Aythya Americana)	Mig*	
Ring-necked duck (*Aythya collaris*)	Mig	
Tufted duck (Aythya fuligula)	Mig*	
Hawaiian duck (*Anas wyvilliana*)	Res	Yes
Hawaiian coot (*Fulica alai*)	Res	Yes
Hawaiian goose (Branta sandvicensis)	Res	
Wading Birds		
Black-crowned night heron (*Nycticorax nycticorax*)	Res	
Cattle egret (*Bubulcus ibis*)	Res	
Great blue heron (*Ardea Herodias*)	Mig*	
Snowy egret (*Egretta thula*)	Mig*	
White-faced ibis (*Plegadis chihi*)	Mig*	
Landbirds		
Mourning dove (*Zenaida macroura*)	Res	
Barn owl (*Tyto alba*)	Res	
Northern cardinal (Cardinalis cardinalis)	Res	Yes
House finch (Carpodacus mexicanus)	Res	Yes

Sources: USFWS (2005), Mitchell et al. (2005), Engilis and Naughton (2004)
1/Occurrence: Br = breeding season; Win = winter; Res = resident (present year round); Mig = migration; Mig* = irregular or accidental migrant
2/ Includes surveys conducted in wetlands adjacent to the wind farm site.

Threats to waterfowl include loss and degradation of wetland habitats and the introduction of non-native plants (habitat degradation) and non-native animals (predation, competition). To date, no waterfowl species have been documented as fatalities at operational wind facilities in Hawaii.

Seabirds (Albatrosses, Terns, Boobies, Frigatebirds, Shearwaters, Petrels, and Gulls)

Seabirds spend a substantial portion of their lives in the marine environment, many only returning to land to breed. More than 98 percent of all seabirds nest in colonies (USFWS 2005). During the nesting season, adult seabirds make frequent trips between nesting colonies and the ocean to forage. Seabirds that breed in the Hawaiian Islands typically disperse after the breeding season to waters elsewhere in the Pacific, typically hundreds of miles away from the Hawaiian Islands (USFWS 2005). A smaller number of species are resident, occurring throughout the year. Most species only occur in the Hawaiian Islands during migration. Seabirds that breed in or migrate through the Hawaiian Islands are typically present from approximately mid-March through mid-December (USFWS 2005).

Table 3.8-2 provides a list of MBTA-protected seabirds documented in the vicinity of the wind farm site. The wind farm site does not provide suitable breeding or foraging habitat for any seabird species; therefore, seabirds are most likely to pass through during migration or in transit between inland breeding habitat and the ocean.

Threats to seabirds include invasive (non-native) species, interactions with fisheries when at sea, pollution, habitat loss and degradation disturbance and climate change. Human development has resulted in the potential for new conflicts associated with nighttime lighting and collisions with structures such as transmission lines, communications towers, and wind energy facilities (USFWS 2005). Increases in nighttime lighting have been associated with the attraction, disorientation, and grounding (fall out) of fledgling seabirds on their first nocturnal flight to the ocean (USFWS 1983, 2011c). Disorientation exposes birds to increased risk of collision with power lines or structures, or increased risk of injury or death from impacts by vehicles or predation by non-native mammals if they become grounded. More recently, widespread use of shielded lights has reduced but not eliminated this threat (USFWS 2011c).

Wedge-tailed shearwaters, Laysan albatross, great frigatebirds, and white-tailed tropic birds have observed in the vicinity of the Project and/or been documented as fatalities at operational wind facilities in Hawaii. These species are addressed in detail below. A Cook's petrel (*Pterodroma cookii*), a very infrequent, vagrant species in Hawaii was also documented as a fatality. The Hawaiian petrel and Newell's shearwater are both ESA-listed seabird species covered by the Project HCP and are addressed in detail in Section 3.9.

The wedge-tailed shearwater is indigenous to the Hawaiian Islands and is an abundant seabird occurring throughout the tropical and subtropical Indian and Pacific Oceans. Its population appears stable and is ranked by the North American Waterbird Conservation Plan as a species of low concern (Mitchell et al. 2005). Wedge-tailed shearwaters breed throughout the northwest Hawaiian Islands and offshore islets of most of the main Hawaiian Islands including Oahu (Mitchell et al. 2005). A small number of wedge-tailed shearwaters have nested along the coast at the James Campbell NWR; however, nesting been generally unsuccessful due to the uncontrolled presence of nonnative predator (USFWS 2011a). Attraction to nighttime lighting on Oahu is a management concern for this species.

The Laysan albatross is indigenous to the Hawaiian Islands and has an IUCN red-list ranking of vulnerable. Approximately 95 percent of the global population breeding population of this species occurs in the Hawaiian Islands (approximately 590,000 pairs) with the largest colonies occurring on Midway Atoll and Laysan; less than 100 pairs breed on the main Hawaiian Islands (Mitchell et al.

2005). A small breeding colony is located at Kaena Point on Oahu (Mitchell et al. 2005). Population trends for this species are unknown.

The great frigatebird is indigenous to the Hawaiian Islands and is ranked by the North American Waterbird Conservation Plan as a species of moderate concern (Mitchell et al. 2005). There are five subspecies of which one breeds on isolated islands in the western and central Pacific (USFWS 2005). Great frigatebirds do not breed on the main Hawaiian Islands, although large numbers roost on offshore islets of the main Hawaiian Islands including Oahu (Mitchell et al. 2005). Population trends for this species appear stable to cyclic (Pyle and Pyle 2009).

The white-tailed tropic bird is indigenous to the Hawaiian Islands and is ranked under the North America Waterbird Conservation Plan as a species of high concern (Mitchell et al. 2005). This species breeds year round on oceanic islands and offshore islets, typically choosing inaccessible spots on cliffs to nest. There are five subspecies of white-tailed tropic bird, one of which breeds in the western and central Pacific. On Oahu, a few pairs nest on the southeastern portion of the island (Mitchell et al. 2005). Population trends are unknown for this species.

Wading Birds (Herons, Egrets)

There are five species of MBTA-protected wading birds that have been documented in the vicinity of the wind farm site including the black-crowned night heron, cattle egret, great blue heron, snowy egret, and white-faced ibis. All were documented at the James Campbell NWR; the cattle egret was documented during Project-specific avian point count surveys. The great blue heron, snowy egret, and white-faced ibis occur in Hawaii as irregular or accidental migrants and are unlikely to occur in the wind farm site.

The black-crowned night heron is an indigenous species, resident in the Hawaiian Islands. Black-crowned night herons are associated with all types of wetland habitats including fresh, brackish, and saltwater swamps, rivers, streams, impoundments, salt marshes, ditches, ponds, and reservoirs. Nesting occurs in colonies from December to February in Hawaii. During the nesting season, black-crowned night herons are susceptible to human disturbance (Mitchell et al. 2005). This species is also a predator of waterbird chicks. A small concentration of this species occurs within the James Campbell NWR, where it is known to forage and breed, and within nearby aquaculture farms (Mitchell at el. 2005; USFWS 2011a). An average of 0.81 black-crowned night herons per party-hour has been recorded during the Honolulu Christmas Bird Count since 1990 (National Audubon Society 2014). There is no habitat for this species within the wind farm site; therefore, it is only likely to pass through when in transit between wetland habitats. This species has not been documented as a fatality at operational wind facilities in Hawaii.

The cattle egret is a widespread, resident, introduced species in the Hawaiian Islands. One of the largest and oldest known rookeries on Oahu is located near Kahuku and this species was observed during Project-specific avian point count surveys. Fatalities of this species have occurred at operational wind facilities in Hawaii, and fatalities of cattle egrets could occur at the Project. The cattle egret has had stable populations with an average 3.24 birds per party-hour recorded during Honolulu Christmas Bird Counts since 1990 (National Audubon Society 2014).

Other Landbirds

There are a number of passerines (perching birds) that are protected by the MBTA, but not native to Hawaii, that occur in the vicinity of the wind farm site. These include the mourning dove, barn owl, northern cardinal, and house finch. These species are common and widespread in Hawaii. The northern cardinal and house finch were observed during Project surveys.

3.8.3 Mitigation Areas

This section describes wildlife resources in the Hamakua Marsh and Poamoho Ridge mitigation areas. Information on wildlife was derived from existing management plans, including Wetland Restoration and Habitat Enhancement Plan for the Kawainui Marsh (Helber Hastert & Fee 2011) and the USAG-HI Integrated Natural Resource Management Plan (Poamoho Ridge; U.S. Army 2010).

3.8.3.1 Hamakua Marsh (waterbird)

The Hamakua Marsh Mitigation Area is located within the Hamakua Marsh Waterbird Sanctuary, managed by DOFAW. It is managed as breeding habitat for Hawaiian stilts, Hawaiian coots, and Hawaiian moorhens (addressed in detail in Section 3.9 – Threatened and Endangered Species) and also provides potential habitat for many species of migrant waterfowl and shorebirds. The marsh is identified as a core wetland in the USFWS (2011e) Recovery Plan for Hawaiian waterbirds. Indigenous species commonly seen at Hamakua Marsh include the black-crowned night heron, Pacific golden-plover, ruddy turnstone, wandering tattler (DOFAW 2013a). Mallard/Hawaiian duck (*Anas platyrhynchos/Anas wyvilliana*) hybrids are also seen at the marsh (DOFAW 2013a).

Non-native and invasive predators pose a significant threat to waterbird populations at Hamakua Mash. Rats (*Rattus* spp.), house mice (*Mus musculus*), Indian mongoose (*Herpestes javanicus*), feral cats, dogs, feral pigs (*Sus scrofa*), cattle egrets, and bullfrogs (*Rana catesbeiana*) may all prey upon waterbird eggs and chicks, as well as contribute to the degradation of wetland habitat (DOFAW 2013a; Helber Hastert & Fee 2011). Mortality associated with vehicle collisions in the adjacent shopping-center parking area and dumping of trash in the marsh are additional threats to these species. Since July 2011, the DOFAW has been actively managing Hamakua Marsh through predator control and vegetation maintenance.

3.8.3.2 Poamoho Ridge (bat)

Poamoho Ridge Mitigation Area is located above Wahiawa within the Ewa Forest Reserve in the south east portion of the U.S. Army Garrison-Hawai'i (USAG-HI) Kawailoa Training Area within the Maimano Management Unit. Poamoho Ridge is State-owned (DLNR) forested habitat occurring along the leeward summit of the central Koolau Mountains and is part of the State Natural Area Reserve System. Wildlife habitat in the Poamoho Ridge consists of native wet forest, characterized by scattered shrubby Ohia and other native trees such as lapa lapa with dense uluhe fern understory. This habitat supports numerous rare and endangered plants (discussed in Section 3.7 – Vegetation) and wildlife, including damselflies, tree snails, forest birds, and fish (U.S. Army 2010). The Poamoho Ridge Mitigation Area also supports breeding, roosting, and foraging habitat for the

Hawaiian hoary bat (addressed in detail in Section 3.9 – Threatened and Endangered Species). Twenty-seven introduced species have also been observed within the Kawailoa Training Area, including invertebrates, fish, amphibians, reptiles, and mammals (U.S. Army 2010).

Native wildlife species in the Poamoho Ridge Mitigation Area are currently being threatened by non-native ungulate activity in the area (i.e., feral pigs). Non-native ungulates modify native forest habitat through physical destruction of vegetation and the introduction of non-native plant species. Without management intervention, habitat in the area will continue to degrade.

3.9 Threatened and Endangered Species

This section describes the threatened and endangered species potentially occurring in the vicinity of the Project. The analysis area for threatened and endangered species includes the wind farm site and the mitigation areas. Eight State and/or Federally threatened and endangered species are known to occur, or have the potential to occur, in the vicinity of the wind farm site including the Hawaiian hoary bat (*Lasiurus cinereus semotus*), Newell's shearwater (*Puffinus newelli*), Hawaiian goose (*Branta sandvicensis*), Hawaiian stilt (*Himantopus mexicanus knudseni*), Hawaiian coot (*Fulica alai*), Hawaiian moorhen (*Gallinula chloropus sandvicensis*), Hawaiian duck (*Anas wyvilliana*), and Hawaiian short-eared owl (*Asio flammeus sandwichensis*) (Table 3.9-1). These species are covered under the Project HCP. No portion of the wind farm site has been designated as critical habitat for any listed wildlife species.

Table 3.9-1. Listed Species with the Potential to Occur in the Wind Farm Site

Common Name	Scientific name	Status[1/]	Year Federally -listed	Status in Wind Farm Site
Hawaiian hoary bat	*Lasiurus cinereus semotus*	FE, SE	1970	Potential detection during biological survey (Hobdy 2013a) although not detected during July – October 15, 2013 bat acoustic surveys (Tetra Tech 2013b). Assumed present based on presence at Kahuku Wind Project
Newell's shearwater	*Puffinus newelli*	FT, ST	1975	None known; potential to occur in transit
Hawaiian goose	*Branta sandvicensis*	FE, SE	1967	None known; lack of suitable habitat; one detection adjacent to wind farm site during radar surveys (Sanzenbacher and Cooper 2013); present at James Campbell NWR; potential in transit or may be attracted to maintained vegetated areas in search plots for post-construction monitoring
Hawaiian stilt	*Himantopus mexicanus knudseni*	FE, SE	1970	None known; potential to occur in transit
Hawaiian coot	*Fulica alai*	FE, SE	1970	None known; potential to occur in transit
Hawaiian moorhen	*Gallinula chloropus sandvicensis*	FE, SE	1967	None known; potential to occur in transit
Hawaiian duck	*Anas wyvilliana*	FE, SE	1967	None known; potential in transit should an intensive and successful Hawaiian duck reintroduction and feral mallard management effort be conducted by USFWS and/or DOFAW
Hawaiian short-eared owl	*Asio flammeus sandwichensis*	SE (Oahu only)	NA	None known; suspected based on presence at Kahuku Wind Project and James Campbell NWR
[1/] State Endangered =SE, Federal Threatened =FT, Federal Endangered =FE				

The bird and bat species covered under the Project HCP, as well as some others addressed in Section 3.10 – Wildlife, are culturally important species under native Hawaiian belief systems. These culturally important species hold a significant place in the traditional cultural landscape of Kahuku for many Hawaiian and Polynesian descents, and are recognized in the Kumulipo, or Hawaiian Creation Chant, as ancestors, protectors, creators, and/or elders of the Hawaiian people (see Section 3.11 – Historic, Archeological, and Cultural Resources for additional discussion).

Four additional listed wildlife species were considered but excluded from further analysis because they are unlikely to occur in the vicinity of the Na Pua Makani wind farm and thus would not be impacted by the Project. These include the Hawaiian petrel (*Pterodroma sandwichensis*), blackline Hawaiian damselfly (*Megalagrion nigrohamatum nigrolineatum*), oceanic Hawaiian damselfly (*M. oceanicum*), and crimson Hawaiian damselfly (*M. leptodemas*). The Hawaiian petrel is not known or expected to breed on Oahu. As the species is highly pelagic, except when breeding, it is very unlikely that individuals would transit the wind farm site. Additionally, there is no suitable habitat present for the Hawaiian damselfly species which require habitat where the Koolau core-dike complex geological formation is exposed and rainfall exceeds 75 inches per year (Polhemus 2007, USFWS 2012b). As a result, these species are not covered under the Project HCP, and are not discussed further here. See the Project HCP for more detail on these species (Tetra Tech 2014c).

No Federal or State threatened, endangered, or candidate plant species were detected within the wind farm site during surveys. Additionally, no plant species proposed for listing or special status plant species were detected. No portion of the wind farm site has been designated as critical habitat for any listed plant species. Therefore, no listed plant species are discussed in detail here.

Sources of information on the presence of threatened and endangered species in the wind farm site include:

- A walk-through general biological survey of the wind farm site conducted in June 2013 (Hobdy 2013a),
- Avian point count surveys conducted between October 2012 to October 2013 within, and in the vicinity of, the wind farm site (Tetra Tech, Inc. 2014c),
- Radar and audiovisual surveys and associated risk-of-collision analysis for threatened and endangered seabirds and bats conducted in the fall (October-November) of 2012 and spring (April) and summer (June) of 2013 (Sanzenbacher and Cooper 2013),
- Ongoing AnaBat® SD2 (Anabat) acoustic monitoring for bats (ground-based and installed on met towers) within the wind farm site (Tetra Tech 2013b), and
- Recovery plans for the Newell's shearwater (USFWS 1983), Hawaiian hoary bat (USFWS 1998), Hawaiian goose (USFWS 2004), and Hawaiian waterbirds (USFWS 2011e).

Details of the radar/audiovisual surveys and acoustic bat surveys are provided in the Project HCP. Results are described below where appropriate. The following subsections summarize the status and ecology; distribution, abundance and population trends; threats; and presence on Oahu and potential for occurrence in the analysis area for the wildlife species covered under the Project HCP. Further details on each of these species can be found in the Project HCP.

3.9.1 Hawaiian Hoary Bat

3.9.1.1 Status and Ecology

The Hawaiian hoary bat is the only fully terrestrial native mammal in the Hawaiian Islands. Hawaiian hoary bats are found in both wet and dry areas from sea level to 13,000 feet (2,962 meters) above mean sea level (amsl), with most observations occurring below 7,500 feet (2,286 meters) amsl (USFWS 2012a) and have been observed in a variety of habitats including open pastures and more heavily forested areas in both native and non-native habitats (Mitchell et al. 2005, Gorressen et al. 2013). Typically, this species feeds over streams, bays, along the coast, over lava flows, or at forest edges. The Hawaiian hoary bat is an insectivore, and prey items include a variety of native and non-native night-flying insects, including moths, beetles, crickets, mosquitoes, and termites (Whitaker and Tomich 1983). Hawaiian hoary bats are known to roost solitarily in tree foliage and have only rarely been seen exiting lava tubes, leaving cracks in rock walls, or hanging from human-made structures. Foliage roosting has been documented in native and non-native vegetation including hala (*Pandanus tectorius*), coconut palms (*Cocos nucifera*), kukui (*Aleurites moluccana*), pukiawe (*Styphelia* [*Leptecophylla*] *tameiameiae*), Java plum (*Syzygium cumini*), kiawe, avocado (*Persea americana*), pink shower trees (*Cassia javanica*), \`ohi\`a trees (*Metrosideros polymorpha*), fern clumps, and mature eucalyptus plantations; they are also suspected to roost in Sugi pine (*Cryptomeria japonica*) stands (USFWS 1998, Mitchell et al. 2005, Gorressen et al 2013).

Although the Hawaiian hoary bat may migrate between islands and within topographical gradients on the islands, long-distance migration like that of the mainland hoary bat is not known (USFWS 1998, Gorressen et al. 2013). Seasonal and altitudinal differences in bat activity have been suggested (Menard 2001, Gorressen et al. 2013).

Breeding activity takes place between April and August with pregnancy and birth of approximately two young occurring from April to June (mean young per year = 1.83 young per year based on mainland hoary bat; Bogan 1972, Koehler and Barclay 2000, USFWS 1998). Lactating females have been documented from June to August and post-lactating females have been documented from September to December (Menard 2001). Until weaning, young are completely dependent on the female for survival.

3.9.1.2 Distribution, Abundance, and Population Trends

Confirmed reports of the Hawaiian hoary bat are known from all the main islands except Niihau and Kahoolawe (HBMP 2007), although this species is most often seen on Hawaii, Maui, and Kauai (Kepler and Scott 1990). Today, the largest known breeding populations are thought to occur on Kauai and Hawaii. Recent studies on Oahu and Molokai, suggest that populations persist on those two islands (Day and Cooper 2002, 2008; SWCA 2011b), and breeding was recently documented on Oahu (A. Nadig, USFWS, pers. comm. August 2013). Relatively little research has been conducted on the Hawaiian hoary bat and data regarding its habitat and population status are very limited. Population estimates for this species range from hundreds to a few thousand; however, these estimates are based on limited and incomplete data due to the difficulty in estimating populations of patchily distributed bats (USFWS 2012a).

3.9.1.3 Threats

The main threats to the Hawaiian hoary bat, as identified in the recovery plan (USFWS 1998), are reduction in tree cover, habitat loss, increases in pesticide use, reduction in prey availability due to the introduction of non-native insects, and predation. It is unknown what effect these threats have on local population dynamics. Observation and specimen records do suggest that this species is now absent from historically occupied areas; however, the magnitude of any population decline is unknown.

The hoary bat is one of the bat species most frequently killed by turbines in the continental United States, primarily during fall migration (Kunz et al. 2007). Hawaiian hoary bats have been killed at several wind farms in the Hawaiian Islands, with documented fatalities as shown in Table 3.9-2, and collision with wind turbines is considered as a potential emerging threat to the species (USFWS 2011d). As mentioned above, Hawaiian hoary bats have seasonal elevation movements (Gorressen et al. 2013), but are not known to have large migration movements similar to mainland hoary bats.

Table 3.9-2. Hawaiian Hoary Bat Fatalities Observed at Existing Wind Farms

Project	Island	Operation Commencement	Number of Turbines	Number of bat fatalities observed
Kaheawa Wind Power I	Maui	June 2006	20	8
Kaheawa Wind Power II	Maui	July 2012	14	3
Auwahi	Maui	December 2012	8	5
Kawailoa	Oahu	November 2012	30	25
Kahuku	Oahu	March 2011 (Idled August 2012 – August 2013)	12	4
Pakini Nui	Hawaii	April 2007	14	1
Source: L. Gibson, USFWS, July 2015 pers. comm..				

3.9.1.4 Presence on Oahu and Potential Occurrence within the Wind Farm Site and Mitigation Areas

Historically, Hawaiian hoary bats have been observed on Oahu (Baldwin 1950, Tomich 1986). However, populations on Oahu have been characterized as extremely low, and it was suggested that detections on Oahu could represent migrant or vagrant individuals (Kepler and Scott 1990). Recent studies document the persistence of the species on the island and in the vicinity of the Project (Day and Cooper 2008, SWCA 2011b). A bat was potentially detected in the wind farm site in 2013 during a night survey using a handheld detector (Hobdy 2013a). Hawaiian hoary bats were not observed during radar surveys at the Project site in October – November 2012 and April – June 2013 (Sanzenbacher and Cooper 2013). Two Anabat detectors were installed in summer 2013, and between July 2013 and February 6, 2015, an average of 0.30 bat passes per detector night were recorded. Because of detector malfunctions, the Anabat detectors were replaced with Wildlife Acoustics detectors on February 6, 2015. Between February 6, 2015 and July 31, 2015, an average of 0.27 bat passes per detector night were recorded. To provide consistent baseline information, the Wildlife Acoustics detectors were deployed for one year, February 2015 to February 2016.

Bat activity is anticipated to be low at the wind farm site due to the low level of activity detected at the adjacent Kahuku Wind Project (0.01 bat passes/detector/night; SWCA 2010). This level of bat activity is low in comparison to similar studies on both the mainland and Hawaii (F. Bonaccorso, USGS-BRD, pers. comm. 2013; Kepler and Scott 1990; Menard 2001).

Hawaiian hoary bats are also known to occur in the vicinity of the Poamoho Ridge Mitigation Area and have been documented within the Poamoho Ridge Mitigation Area, The Poamoho Ridge Mitigation Area is located in the Ewa Forest Reserve (Figure 1-4), and is part of the State Natural Area Reserve System. The Oahu Army Natural Resources Program (OANRP) has deployed acoustic bat detectors on this property and bats were detected in low numbers (OANRP 2012). Bats have also been documented within the Poamoho Ridge parcel via acoustic monitoring efforts initiated by the Project in coordination with the Koolau Mountains Watershed Partners and DLNR in April 2014, and nearby monitoring studies have documented bats in similar habitats (F. Bonaccorso, USGS-BRD, pers. comm., 2014).

3.9.2 Newell's Shearwater

3.9.2.1 Status and Ecology

The Newell's shearwater is a migratory, highly pelagic seabird endemic to the Hawaiian Islands. Like other procellariids (shearwaters, petrals, fulmars, and prions), the Newell's shearwater spends up to 80 percent of its life at sea, only returning to land to breed.

The Newell's shearwater is a colonial, burrow- and crevice-nesting species whose breeding colonies are typically located at middle to high elevations (range 525 to 3,937 feet [160 to 1,200 meters] amsl), often in isolated locations (Ainley et al. 1997). Most Newell's shearwaters excavate burrows on densely-vegetated mountain slopes of 65 percent or greater. Vegetation typically consists of open native forest dominated by ohia with a dense understory of uluhe fern (*Dicranopteris linearis*). On East Maui, nests have been documented in areas dominated by cover of `ama`u (*Sadleria cyatheoides*), a native fern species (Wood and Bily 2008). However, breeding has also been documented on sparsely-vegetated slopes along the Na Pali coast on Kauai and on Lehua Islet (VanderWerf et al. 2004, Mitchell et al. 2005).

The breeding season for the Newell's shearwater begins in April when adults arrive at the nesting colony, and egg-laying begins in early June. Pairs produce one egg, and both parents incubate the egg and brood and feed the chick. Parents forage offshore, returning to the colony at night to feed the chick. Young leave the nesting colony in October and November, with a few birds still fledging into December. Adults do not care for young after they fledge (Ainley et al. 1997). Newell's shearwaters exhibit strong philopatry, returning to their natal colony to breed and returning to the same nesting site over many years (USFWS 2005, Griesemer and Holmes 2011).

3.9.2.2 Distribution, Abundance, and Population Trends

The Newell's shearwater only breeds in Hawaii and was once abundant on all the main Hawaiian islands. Currently, 75 to 90 percent of the breeding population occurs on Kauai, with smaller colonies on the islands of Hawaii, Maui, and Molokai, and possibly on Oahu, and there is an isolated record of breeding from Lehua Islet near Niihau (Ainley et al. 1997, Reynolds and Ritchotte 1997, Day and Cooper 2002, Day et al. 2003, VanderWerf et al. 2004, VanderWerf et al. 2007, Day and Cooper 2008, Wood and Bily 2008, USFWS 2011c).

The only available population estimate for Newell's shearwaters is approximately 84,000 individuals, based on at-sea data collected between 1984 and 1993 (Spear et al. 1995 as cited in Griesemer and Holmes 2011). Trends in ornithological radar data (detections of shearwater-like targets) and reporting of seabird fallout (the number of downed fledglings collected after attraction to artificial light), suggest that the population of Newell's shearwaters has declined (between 50 and 75 percent) over the last two decades (Day et al. 2003, Holmes et al. 2009). Additionally, three colonies known to be active between 1980 and 1994 were documented as inactive in 2006 to 2007, suggesting a narrowing of the breeding range (Holmes et al. 2009).

3.9.2.3 Threats

Important factors in the decline of the Newell's shearwater include loss of breeding habitat, predation by introduced mammalian predators, and historical hunting by humans (USFWS 1983). Other threats include collisions with power lines and other human-made structures, disorientation and fall out associated with light attraction, impacts to habitat associated with climate change, and decline in food resources due to overfishing (USFWS 2005).

Historically, breeding habitat has been lost due to periodic volcanic activity and other natural disasters, and the conversion of lowlands for agriculture and urban development. As breeding colonies are now mostly isolated from humans and at high elevations, the current threats to habitat are degradation by non-native ungulates such as feral pigs and goats (*Capra hirca*). These animals crush burrows, compact the soil, and facilitate the invasion of aggressive non-native plants such as strawberry guava and rose myrtle (*Rhodomyrtus tomentosa*) which displace native vegetation and significantly alter vegetation structure and substrate, reducing the suitability of breeding habitat (Troy and Holmes 2008, Holmes et al. 2009).

The 5-year review (USFWS 2011c) characterizes predation as a severe threat. Dog and cat depredation is particularly problematic in coastal areas when birds become grounded due to the effects of light attraction.

Urbanization and the resulting increase in night-time lighting have been associated with the attraction, disorientation, and grounding (fall out) of fledgling Newell's shearwaters on their first nocturnal flight to the ocean (USFWS 1983, 2011b). Disorientation exposes birds to increased risk of collision with power lines or structures, or increased risk of injury or death from impacts by vehicles or predation by non-native mammals, if they become grounded. More recently, widespread use of shielded lights has reduced but not eliminated this threat (USFWS 2011c). Adult Newell's shearwaters are not attracted to lights to the same degree as fledglings, but adults do collide with power lines (Ainley et al. 2001, Griesemer and Holmes 2011). The USFWS five-year status review for the Newell's shearwater also identifies wind farms as a new potential threat to this species

(USFWS 2011c); however, there have been no reported Newell's shearwater fatalities due to collision with turbines (D. Bruns, USFWS, pers. comm. 2013).

3.9.2.4 Presence on Oahu and Potential Occurrence within the Wind Farm Site and Mitigation Areas

No Newell's shearwater breeding colonies have been identified on Oahu, although suitable breeding habitat is present in the steep, uluhe fern-covered slopes of the Koolau and Waianae mountain ranges. Figure 3.9-1 displays potential suitable Newell's shearwater breeding habitat on Oahu based on topography, forest type, and elevation identified as important nesting colony parameters (Ainley et al. 1997)[3]. The recovery of downed Newell's shearwaters at interior locations on Oahu since the 1950s suggests the potential presence of a colony on the leeward slopes of the Koolau Range above Honolulu (Figure 3.9-1; Tetra Tech 2014c, Pyle and Pyle 2009).

The wind farm site itself, consisting of low elevation habitat dominated by aggressive non-native species, is not appropriate Newell's shearwater nesting habitat. However, Newell's shearwaters could fly through the wind farm site when moving between potential unknown nesting colonies in the Koolau or Waianae mountain ranges and the ocean.

Radar surveys conducted in 2012 and 2013 documented a low level of use by shearwater-like targets, although none of these targets were confirmed to be Newell's shearwaters (Sanzenbacher and Cooper 2013). Surveyors observed one unidentified petrel or shearwater during surveys in June 2013. Surveyors were only able to confirm that this unidentified bird was not a wedge-tailed shearwater (*Puffinus pacificus*), which is a non-listed species. The observed low passage rates are consistent with results of radar surveys conducted at the two operational Oahu wind farms (Kahuku and Kawailoa), which also did not confirm the presence of any Newell's shearwaters (Table 3.9-3; Day and Cooper 2008, Cooper et al. 2009).

Newell's shearwater habitat is potentially present at the Poamoho mitigation area based on topography, forest type, and elevation. Figure 3.9-1 displays potential breeding habitat on Oahu (Ainley et al. 1997).

[3] A 500 foot elevation contour identifies the lower expected limit of potential nesting colonies (Ainley et al. 1997). Based on habitat description from Ainley et al. (1997), suitable habitat includes slopes greater than or equal to 65 percent in native shrubland/sparse ohia, native wet cliff vegetation, open koa-ohia forest, open ohia forest, ohia forest, uncharacterized forest, uncharacterized shrubland (USGS 2011).

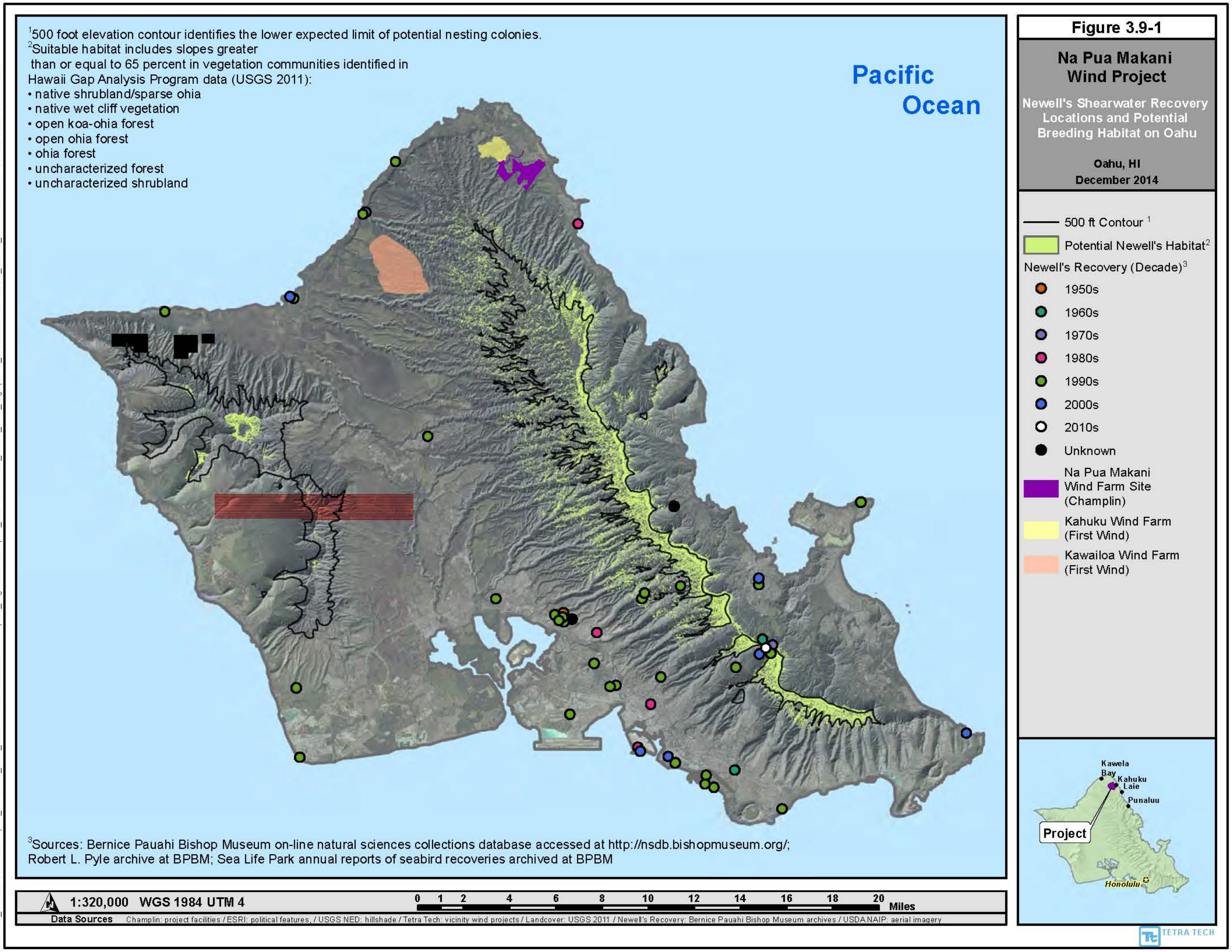


Figure 3.9-1
Na Pua Makani Wind Project
Newell's Shearwater Recovery Locations and Potential Breeding Habitat on Oahu
Oahu, HI
December 2014
[1]500 foot elevation contour identifies the lower expected limit of potential nesting colonies.
[2]Suitable habitat includes slopes greater than or equal to 65 percent in vegetation communities identified in Hawaii Gap Analysis Program data (USGS 2011):
• native shrubland/sparse ohia
• native wet cliff vegetation
• open koa-ohia forest
• open ohia forest
• ohia forest
• uncharacterized forest
• uncharacterized shrubland
Pacific Ocean
500 ft Contour [1]
Potential Newell's Habitat[2]
Newell's Recovery (Decade)[3]
1950s
1960s
1970s
1980s
1990s
2000s
2010s
Unknown
Na Pua Makani Wind Farm Site (Champlin)
Kahuku Wind Farm (First Wind)
Kawailoa Wind Farm (First Wind)
[3]Sources: Bernice Pauahi Bishop Museum on-line natural sciences collections database accessed at http://nsdb.bishopmuseum.org/; Robert L. Pyle archive at BPBM; Sea Life Park annual reports of seabird recoveries archived at BPBM
1:320,000 WGS 1984 UTM 4
0 1 2 4 6 8 10 12 14 16 18 20 Miles
Data Sources Champlin: project facilities / ESRI: political features, / USGS NED: hillshade / Tetra Tech: vicinity wind projects / Landcover: USGS 2011 / Newell's Recovery: Bernice Pauahi Bishop Museum archives / USDA NAIP: aerial imagery
Kawela Bay
Kahuku
Laie
Punaluu
Project
Honolulu
TETRA TECH

Table 3.9-3. Newell's Shearwater-Like Targets Flight Characteristics from Oahu Wind Energy Facilities[1]

Project	Season	Passage Rate (shearwater-like targets per hour)1/	Flight Height (mean ± SE agl)	Percent Below Maximum Blade Tip Height/Percent Below Met Tower Height2/
Kahuku	Summer (2008)	0.2 ± 0.1	None measured	NA
	Fall (2007)	0.3 ± 0.2	None measured	NA
Kawailoa	Summer (2009)	0.60 ± 0.07	Not reported	NA
	Fall (2009)	1.41 ± 0.15	Not reported	NA
Na Pua Makani	Spring (2013)	0.52 ± 0.09	482 ± 108 ft (147 ± 33 m)	71% / 29%
	Summer (2013)	0.34 ± 0.09	430 ± 66 ft (131 ± 20 m)	86% / 14%
	Fall (2012)	0.43 ± 0.09	600 ± 98 ft (183 ± 30 m)	80% / 10%
	Mean	Not calculated	499 ± 56 ft (152 ± 17 m)	79% / 17%

Sources: Sanzenbacher and Cooper 2013, Day and Cooper 2008, Cooper et al. 2009.
1/ Shearwater-like targets are birds that: fly >30 mph (48 kph), have directional flight toward potential breeding habitat, are not confirmed visually or aurally to be another species.
2/ Assumes maximum turbine tip height is 656 ft (200 m); met tower height 262 ft (80 m).
agl = above ground level

3.9.3 Hawaiian Goose

3.9.3.1 Status and Ecology

The Hawaiian goose is the only surviving endemic goose in the Hawaiian Islands. The Hawaiian goose, a year-round resident, typically resides on a single island and makes movements of up to 6 miles (10 kilometers). The Hawaiian goose, a sedentary and largely terrestrial species, nests from sea level to high elevations in a variety of habitats including beach strand, shrubland, grassland, and on old lava flows. At higher elevations, the species typically nests under native vegetation. At lower elevation sites, non-native plants often provide protective cover (Banko et al. 1999, Mitchell et al. 2005).

The Hawaiian goose typically nests between October and March. Clutch size is typically three to five eggs and the young are able to fly at approximately 10 to 12 weeks (USFWS 2004). Pair formation typically occurs in the second year of life and approximately 80 percent of all birds are paired in any given year, and 40 to 60 percent of these pairs will attempt to nest (Banko 1988, Banko et al 1999). Low elevation nests face high predation pressure, particularly where mongoose are present (Black and Banko 1994, USFWS 2004).

Studies show differences in survival and mortality of the Hawaiian goose based on sex, but factors associated with the release and subsequent management of captive-raised geese into the wild under differing conditions complicate interpretation of the results (Black et al. 1997). On the island of Hawaii, Hu (1998) found that annual mortality of wild females at least 4 years old was 13.2 percent, while annual mortality for wild males at least 3 years old was 11.3 percent. The differential survival of males versus females appears to be true in released birds, as well, resulting in males outnumbering females among birds older than 1 year old in populations on Hawaii, Maui, and Kauai (Banko et al. 1999).

3.9.3.2 Distribution, Abundance, and Population Trends

Fossil evidence suggests that the endemic Hawaiian goose occurred on all of the main Hawaiian Islands, but populations on all but the island of Hawaii were extirpated by the early 1900s. As a result of recovery and management efforts initiated beginning in the 1950s, populations have recovered from a low of 30 birds on the island of Hawaii to a statewide population of approximately 2,000 birds (Banko et al. 1999, USFWS 2004). Populations are increasing on Kauai and Molokai, while the populations on Hawaii and Maui populations are stable (HNP 2009, Pyle and Pyle 2009, USFWS 2011b). Birds typically remain on the islands on which they were hatched, but birds may range over larger areas following the fledging of young. A recent effort to translocate young Hawaiian geese from Kauai to Hawaii has resulted in the occurrence of birds in unexpected locations, including on Oahu. Distributions of the birds are strongly influenced by the locations of release sites of captive-bred birds (Banko et al. 1999).

Management actions have established populations on Kauai, Maui, and Molokai and expanded the range of the population on Hawaii, but the distribution of the birds is strongly influenced by the locations of release sites of captive-bred birds (Banko et al. 1999). Birds typically remain on the islands on which they were hatched, but birds may range over larger areas following the fledging of young. A recent effort to translocate Hawaiian geese from Kauai to Hawaii and Maui, however, has resulted in the unexpected occurrence of birds on Oahu, where it is suspected the species was once resident, but for which there is no historical record (USFWS 2004).

3.9.3.3 Threats

The 2004 draft recovery plan for Hawaiian goose (USFWS 2004) lists predation by non-native mammals as the greatest factor limiting Hawaiian goose populations. Feral cats, dogs, rats, and mongoose are each likely to be main predators on Oahu, where the few birds present are close to human populations. Other threats to the species include lack of access to seasonally important lowland habitats, insufficient nutritional resources for breeding females and for goslings, human-caused disturbance and mortality (e.g., road mortality), behavioral problems related to captive propagation, and inbreeding depression (USFWS 2011b).

3.9.3.4 Presence on Oahu and Potential Occurrence within the Wind Farm Site and Mitigation Areas

The Hawaiian goose is a recent arrival on Oahu, with a pair arriving during the winter of 2014 after dispersing from their translocation site on Hawaii. This pair bred and produced three goslings in 2014 (A. Nadig, USFWS, pers. comm. March 2014). As translocation efforts are expected to continue until 2016, the Hawaiian goose population on Oahu may grow as a result of additional translocated birds arriving as well as on-island reproduction. Habitats on Oahu that are most likely to support the Hawaiian goose are lowland areas managed as golf courses, habitat for Hawaiian waterbirds, and grazed agricultural areas. In addition, areas where vegetation is mowed can be attractive to the

Hawaiian goose, and these areas include resorts, playing fields, housing developments, and could include areas maintained beneath operational wind turbines.

Thus, given the proximity of the wind farm site to recently occupied habitat, it is possible that the Hawaiian goose will use the wind farm site to forage and possibly to nest during the ITL and ITP permit term. In addition to the potential use of the wind farm site, the Hawaiian goose has the potential to fly through the wind farm site in transit between foraging areas. The Hawaiian goose arrived on Oahu after the completion of avian point count surveys, so none were detected during Project surveys. However, given the potential growth of the population during the Project permit term, it is possible that in the future, flocks of Hawaiian geese will occasionally fly through the wind farm site and may forage within maintained areas under the wind turbines.

3.9.4 Waterbirds

Four State- and Federally-listed threatened and endangered waterbirds, the Hawaiian stilt, the Hawaiian coot, the Hawaiian moorhen, and the Hawaiian duck have the potential to occur in the wind farm site. All four of these waterbirds, with the exception of the threat of hybridization with feral mallards (*Anas platyrhynchos*) for the Hawaiian duck, face the same suite of threats; thus, to avoid repetition, threats to these three species are discussed together.

3.9.4.1 Hawaiian Duck

Status and Ecology

The Hawaiian duck is a small dabbling duck endemic to the Hawaiian Islands. The Hawaiian duck is similar in appearance to the much more common and widespread mallard but is genetically distinct and differs in size, plumage, and behavior. The Hawaiian duck is about 20 to 30 percent smaller than the mallard, has a deeper, brown plumage and dark tail, and is more shy and secretive.

Hawaiian ducks are found from sea level to 9,843 feet (3,000 meters) in elevation and utilize a variety of wetland habitats, including freshwater marshes, flooded grasslands, coastal ponds, streams, montane pools, forest swamplands, agricultural and artificial wetlands, and irrigation ditches (USFWS 2011e). Ephemeral wetlands are important habitat for Hawaiian duck foraging (Engilis et al. 2002). Hawaiian ducks are opportunistic feeders, eating snails, insect larvae, earthworms, tadpoles, crayfish, mosquito larvae, mosquito fish (*Gambusia affinis*), aquatic invertebrates, grass seeds, rice, green algae, and seeds and leaf parts of wetland plants (Swedberg 1967, USFWS 2011e).

Hawaiian ducks breed year-round, although the majority of nesting records are from March through June (Giffin 1983). Nesting occurs on the ground near water, but little else is known of specific Hawaiian duck nesting habits (USFWS 2011e). Clutch size ranges from 2 to 10 eggs and incubation lasts approximately 28 days, with most chicks hatching in April through June (Swedberg 1967). Only females incubate eggs, and they abandon nests quickly if disturbed (Giffin 1983). Young leave the nest as soon as the entire clutch has hatched; however, young remain with the female after leaving the nest and have been observed with the female parent after developing flight at approximately 65 days old (Engilis et al. 2002). The species breeds each year and is capable of double-clutching, at least in captivity (DOFAW unpublished data as cited in Engilis et al. 2002).

Hawaiian ducks are non-migratory but exhibit some seasonal, altitudinal, and inter-island movements; however, these movements are not well understood (Engilis et al. 2002). The species may use different habitats for nesting, feeding, and resting, and may move seasonally among areas (Engilis and Pratt 1993, Gee 2007). These movements between the islands may be driven by food resources and rainfall. There is no information on the lifespan and survivorship from wild or captive flocks of Hawaiian ducks (Engilis et al. 2002).

Distribution, Abundance, and Population Trends

Hawaiian ducks historically occurred on all the main Hawaiian Islands except Lanai and Kahoolawe (USFWS 2011e). By the 1960s, Hawaiian ducks were found in small numbers only on Kauai and probably on Niihau (USFWS 2011e). From the late 1950s through the early 1990s, Hawaiian ducks were reintroduced to Oahu, Maui, and Hawaii (Paton 1981, Bostwick 1982, Engilis et al. 2002) through captive propagation and release. Populations of Hawaiian ducks still exist on Kauai, Niihau, Maui, and Hawaii, but the species is strongly affected by hybridization with feral mallards on Oahu and Maui. Very few pure Hawaiian ducks persist on Maui (USFWS 2011e), and genetic studies show that the Oahu Hawaiian duck population is heavily compromised through hybridization with feral mallards, and few ducks with predominantly Hawaiian duck characteristics remain (Browne et al. 1993, Fowler et al. 2009, USFWS 2011d; A. Amlin, DOFAW, pers. comm. 2014).

Winter biannual waterbird surveys estimated the Hawaiian duck population at 2,200 birds, including 2,000 on Kauai and 200 on Hawaii as well as approximately 350 and 50 Hawaiian duck-like birds (presumed hybrids) on Oahu and Maui, respectively (Engilis et al. 2002). Based on the biannual waterbird counts, the Hawaiian duck population appears to be increasing overall, due to increases in the population on Kauai; pure Hawaiian duck populations are declining on other islands (USFWS 2011e). However, population trends may be inaccurate due to incomplete survey coverage and difficulty in distinguishing Hawaiian ducks from hybrids.

Presence on Oahu and Potential for Occurrence in the Wind Farm Site and Mitigation Areas

Hawaiian ducks are believed to have been extirpated on Oahu by the 1960s and the population of Hawaiian duck-like birds on Oahu is comprised of mallard-Hawaiian duck hybrids (USFWS 2011e). Although pure Hawaiian ducks were released on Oahu between 1968 and 1982 (Engilis and Pratt 1993), feral mallards were not removed from the reintroduction sites prior to the releases, resulting in extensive hybridization and genetic introgression of mallards into the reestablished Hawaiian duck population on Oahu (USFWS 2011e).

The Recovery Plan for Hawaiian Waterbirds identifies the removal of feral mallards on all islands as a critical element in the recovery of the species (USFWS 2011e). In addition to feral mallard management, reintroduction is critical for development of a population of pure Hawaiian ducks on Oahu. The Recovery Plan for Hawaiian Waterbirds (USFWS 2011e) prioritizes the establishment of self-sustaining populations of Hawaiian ducks on Maui and/or Molokai; however, DOFAW has also initiated planning of Hawaiian duck recovery efforts that includes populations on Oahu (A. Amlin, DOFAW, pers. comm. 2014). Therefore, Hawaiian ducks may occur in the Project vicinity during the ITL and ITP permit term and are likely to occupy habitats currently used by hybrid individuals.

During biannual winter counts from 1999 – 2003, Hawaiian duck-like birds (presumed hybrids) were reported in low numbers (less than 15) at the following wetlands within 5 miles (8 kilometers) of the Project: James Campbell NWR (core wetland), Kahuku aquaculture ponds (supporting wetland), Laie wetlands (supporting wetland), the Kuilima Wastewater Treatment Plant at Turtle Bay (supporting wetland), and the Turtle Bay Golf Course Ponds (USFWS 2011e). These areas represent potential areas of future Hawaiian duck occupancy.

Assuming reintroduction is successful, suitable habitat for Hawaiian ducks in the wind farm site is very limited. A small stretch of the Malaekahana Stream along the southern border of the Project Area could be suitable habitat for Hawaiian ducks; however, the abundance of high quality habitat at managed wetland areas outside of the wind farm site would minimize the importance of this area. Therefore, if Hawaiian ducks were to occur in the wind farm site, their occurrence would be primarily limited to their transit of the area when flying between wetland habitats outside of the wind farm site.

No Hawaiian duck-like birds were observed within the wind farm site during 20 avian point count surveys conducted over a 1-year period (Tetra Tech 2014b). Surveyors recorded 61 Hawaiian duck-mallard hybrid detections in wetland areas adjacent to the Project during these surveys. While these hybrids are not listed by the State or Federal government, their presence indicates the suitability of habitat in the vicinity of the Project and the potential future use of wetland areas in the vicinity of the Project by Hawaiian ducks, should they be successfully reintroduced to Oahu.

3.9.4.2 Hawaiian Stilt

Status and Ecology

The Hawaiian stilt is an endemic subspecies of the black-necked stilt, a moderately sized wading bird. Hawaiian stilts are associated with a variety of aquatic habitats, primarily within the lower elevation coastal plains of Hawaii, but are limited to habitats with a water depth of less than 9 inches (24 centimeters), and sparse low-growing vegetation or exposed tidal mudflats (Robinson et al. 1999, USFWS 2011e). Nesting generally occurs from mid-February through August on freshly exposed mudflats interspersed with low-growing vegetation (USFWS 2011e). Nesting season varies among years, possibly depending on water levels. Hawaiian stilts generally lay 3 to 4 eggs in a simple scrape on the ground adjacent to freshwater or brackish ponds (USFWS 2011e, Shallenberger 1977). Eggs are incubated for approximately 24 days (Coleman 1981 as cited in USFWS 2011e, Chang 1990). Chicks leave the nest within 24 hours of hatching, but remain with both parents for several months after hatching (Coleman 1981 as cited in USFWS 2011e).

Hawaiian stilts are opportunistic feeders, eating a wide variety of invertebrates and other aquatic organisms that occur in shallow water and mudflats, including water boatmen, beetles, polychaete worms, small crabs, fish, and possibly brine fly larvae (Shallenberger 1977, Robinson et al. 1999, USFWS 2011e). Hawaiian stilts typically feed in shallow flooded wetlands that are ephemeral in nature and have been documented moving within and between islands in order to exploit these seasonal food resources (Ueoka 1979 as cited in USFWS 2011e; Engilis and Pratt 1993; Reed et al. 1994, 1998b).

Little information on Hawaiian stilt life span is reported in recent accounts of life history information (Reed et al. 1998a, Robinson et al. 1999, USFWS 2011e), but Hawaiian stilts have been documented to survive at least 15 years in the wild and captivity.

Distribution, Abundance, and Population Trends

The Hawaiian stilt is found on all of the main Hawaiian Islands except Kahoolawe and is non-migratory except for seasonal movements between adjacent islands (Reed et al. 1994, 1998b; USFWS 2011e). Long-term census data show year-to-year variability in the number of Hawaiian stilts observed but indicate statewide populations have been relatively stable or slightly increasing through the late 1980s (Engilis and Pratt 1993, Reed and Oring 1993). Bi-annual Hawaiian waterbird surveys from 1998 through 2007 documented an average Hawaiian stilt population of 1,484 birds, ranging from approximately 1,100 to 2,100 birds (DOFAW 1976 – 2008 as cited in USFWS 2011e). The annual variability is at least partially a result of rainfall patterns and reproductive success (Engilis and Pratt 1993). Available habitat is thought to limit the carrying capacity for Hawaiian stilts.

Presence on Oahu and Potential Occurrence within the Wind Farm Site and Mitigation Areas

Oahu, with approximately 450 to 700 birds counted on the island per year between 1976 and 2008, supports the largest number of Hawaiian stilts in the Hawaiian Islands accounting for 35 to 50 percent of the state's population (DOFAW 1976 – 2008 as cited in USFWS 2011e). On Oahu, Hawaiian stilts can be found in large concentrations at James Campbell NWR, the Kahuku aquaculture ponds, and the Pearl Harbor National Wildlife Refuge (USFWS 2011e). Both the James Campbell NWR and Kahuku aquaculture ponds are within 5 miles (8 kilometers) of the wind farm site, and are core and supporting wetlands for Hawaiian waterbirds, respectively. Core wetlands are "areas that provide habitat essential for survival and recovery, supporting large populations of Hawaiian waterbirds," and supporting wetlands are "areas that provide habitat important for survival and recovery, but may support only smaller waterbird populations or may be occupied only seasonally" (USFWS 2011e). Based on winter counts of adults from 1999 – 2003, other wetlands within 5 miles (8 kilometers) of the Project where stilts have been observed include the Kahuku airstrip ponds, Coconut Grove Marsh, the Turtle Bay Golf Course Ponds, and the Kuilima Wastewater Treatment Plant at Turtle Bay (USFWS 2011e).

There is no suitable habitat for Hawaiian stilts in the wind farm site. Stilts require wetlands, marshes, or ponds, which are not present in the wind farm site. Extreme rain events could result in flooding in low-lying areas, which would offer temporary habitat for Hawaiian stilts, but such events would create an abundance of available habitat throughout the vicinity of the Project; so stilts would still not likely use the wind farm site. Therefore, if Hawaiian stilts occur in the wind farm site, this occurrence would be primarily limited to their transit of the area when flying between wetland habitats outside of the wind farm site.

No Hawaiian stilts were observed within the wind farm site during avian point count surveys conducted in the wind farm site (Tetra Tech 2014b). Surveyors recorded forty Hawaiian stilt detections in wetland areas adjacent to the Project during avian point count surveys (Tetra Tech 2014b). Reed et al. (1998b) studied movement patterns of Hawaiian stilts at the James Campbell NWR and noted that few individuals moved from the James Campbell NWR to wetlands outside of the refuge and the adjacent shrimp ponds. Based on the known biology of the species and results of avian point counts, the frequency of Hawaiian stilts transiting the wind farm site is likely to be low.

Hawaiian stilts require habitats with wetlands and marshes. In addition to the James Campbell NWR Mitigation Area, the Hamakua Marsh Mitigation Area is managed as breeding habitat for Hawaiian stilts, Hawaiian coots, and Hawaiian moorhens and may also provide potential habitat for migrant waterfowl and shorebirds.

3.9.4.3 Hawaiian Coot

Status and Ecology

The Hawaiian coot is a non-migratory species endemic to the Hawaiian Islands. Previously considered a subspecies of the American coot (*Fulica americana*), and originally listed under the ESA as such, the Hawaiian coot is now regarded as a distinct species (AOU 1998; USFWS 2011e).

Hawaiian coots are associated with lowland wetland habitats that have emergent vegetation interspersed with open water, which typically occur along the coastal plains, from sea level up to 850 feet (260 meters; Pratt and Brisbin 2002; USFWS 2011e). Hawaiian coots are generalist feeders, consuming seeds and leaves of aquatic plants, snails, crustaceans, and aquatic or terrestrial insects, tadpoles, and small fish (Schwartz and Schwartz 1949 as cited in USFWS 2011e). They forage in mud, sand, or near the surface of the water, and they can dive up to 48 inches (120 centimeters) below the water surface (USFWS 2011e).

Hawaiian coots nest on open freshwater and brackish ponds, flooded taro fields, shallow reservoirs, and irrigation ditches (Shallenberger 1977; Pratt and Brisbin 2002). They construct floating or semi-floating nests of aquatic vegetation in open water or at the outer margins of emergent vegetation around relatively deep bodies of water, respectively (Byrd et al. 1985 as cited in USFWS 2011e; Pratt and Brisbin 2002). Although previously thought to breed from early spring through fall, Hawaiian coots are now thought to breed opportunistically in response to rainfall, as active nests have been found year-round, but peak breeding occurs March – September (Shallenberger 1977; Byrd et al. 1985 as cited in USFWS 2011e; Pratt and Brisbin 2002). Clutch size averages five eggs and chicks are able to swim as soon as their down has dried but are attended by parents for up to several months after hatching (Shallenberger 1977, Byrd et al. 1985 as cited in USFWS 2011e, Pratt and Brisbin 2002). There is limited information on Hawaiian coot life history parameters and survivorship. Chang (1990) calculated a 28 percent fledging success rate for Hawaiian coots.

Hawaiian coots are non-migratory, but they exhibit pronounced irregular movements based on rainfall (Pratt and Brisbin 2002). Movements are associated with a reduction in water levels and food availability (USFWS 2011e). Hawaiian coots commonly wander and larger water bodies of water may have large concentrations of birds during the non-breeding season (Pratt and Brisbin 2002). As movements are associated with fall and winter rain events, which occur after the peak breeding season, movements between wetlands are most likely to occur after independence of young.

Distribution, Abundance, and Population Trends

Hawaiian coots historically occurred on all the main Hawaiian Islands except Lanai and Kahoolawe, as these islands lacked suitable wetland habitat (USFWS 2011e). Hawaiian coots are now also present on Lanai due to the creation of artificial wetlands or wetland-like features such as water treatment sites. Hawaiian coots occur in the greatest numbers on Oahu, Maui, and Kauai (Shallenberger 1977) and were likely once fairly common in large natural marshes and ponds on these islands.

Engilis and Pratt (1993) estimated a statewide Hawaiian coot population of 2,000 to 4,000 birds. Winter biannual waterbird surveys from 1997 through 2006 indicated average Hawaiian coot populations of approximately 2,000 birds (DOFAW 1976 – 2008 as cited in USFWS 2011e). These biannual counts indicate short-term population fluctuations and a slight long-term increase in population between 1976 and 2008 (DOFAW 1976 – 2008 as cited in USFWS 2011e). As Hawaiian coots disperse readily and exploit seasonally flooded wetlands, their populations naturally fluctuate according to climatic and hydrologic conditions (USFWS 2011e).

Presence on Oahu and Potential Occurrence within the Wind Farm Site and Mitigation Areas

During 1995 – 2007, the Hawaiian coot population on Oahu has fluctuated between approximately 500 and 1,000 birds (DOFAW 1976 – 2008 as cited in USFWS 2011e). Large concentrations of Hawaiian coots have been observed at the James Campbell NWR (core wetland), the Kahuku aquaculture ponds (supporting wetland), the Kuilima wastewater treatment plant (supporting wetland), the Ka`elepulu Pond in Kailua, the Pearl Harbor National Wildlife Refuge, and the Hawaii Prince Golf Course (USFWS 2011e). James Campbell NWR, Kahuku aquaculture ponds, and Kuilima wastewater treatment plant are within 5 miles (8 kilometers) of the wind farm site. Based on winter counts of adults from 1999 – 2003, other wetlands within 5 miles (8 kilometers) of the wind farm site where Hawaiian coots have been observed in smaller numbers include Coconut Grove Marsh, Laie wetlands (supporting wetland), and the Turtle Bay golf course ponds.

There is no suitable habitat for Hawaiian coots in the wind farm site. Extreme rain events could result in flooding of low-lying areas in the wind farm site, which would offer temporary habitat for Hawaiian coots ; however, such events would create an abundance of available habitat throughout the general Project vicinity; thus, Hawaiian coots would still not likely use the wind farm site specifically. Therefore, occurrence of Hawaiian coots in the wind farm site would primarily be limited to their transit of the area when flying between wetland habitats outside of the wind farm site.

No Hawaiian coots were observed within the wind farm site during Project avian point count surveys (Tetra Tech 2014b). Surveyors recorded 14 Hawaiian coot detections during avian point count surveys in wetland areas adjacent to the Project (Tetra Tech 2014b). Based on the known biology of the species and the results of avian point counts, the frequency of Hawaiian coots transiting the wind farm site is likely to be low.

Hawaiian coots inhabit habitats with wetlands and marshes. In addition to the James Campbell NWR Mitigation Area, the Hamakua Marsh Mitigation Area is managed as breeding habitat for Hawaiian stilts, Hawaiian coots, and Hawaiian moorhens and may also provide potential habitat for migrant waterfowl and shorebirds.

3.9.4.4 Hawaiian Moorhen

Status and Ecology

The Hawaiian moorhen is a non-migratory subspecies endemic to the Hawaiian Islands. The Hawaiian moorhen is predominantly associated with lowland wetland habitats that have emergent vegetation interspersed with open water including: natural ponds, marshes, streams, springs or seeps, lagoons, grazed wet meadows, taro and lotus fields, shrimp aquaculture ponds, reservoirs, sedimentation basins, sewage ponds, and drainage ditches (Shallenberger 1977, Nagata 1983, Banko 1987, Bannor and Kiviat 2002). They appear to have a preference for freshwater habitat over brackish water (Engilis and Pratt 1993, USFWS 2011e). The Hawaiian moorhen requires “relatively dense marginal vegetation” near open water (Berger 1981), floating or barely emergent mats of vegetation, and water depth less than 3 feet (1 meter).

Little specific information on the diet of the Hawaiian moorhen is available; however, they are apparently opportunistic feeders, and their diet likely varies by habitat (Shallenberger 1977). This diet includes algae, aquatic insects, mollusks, snails, seeds, other plant parts (Schwartz and Schwartz 1949 as cited in USFWS 2011e, Telfer [unpubl. data] as cited in USFWS 2011e). Although the Hawaiian moorhen typically forages in and along areas of dense vegetation, they also forage on open ground (Bannor and Kiviat 2002, USFWS 2011e).

Hawaiian moorhens typically nest over shallow water (less than 24 inches [60 centimeters] deep) along emergent vegetation edges and also in wet meadows or on solid ground in the presence of tall vegetative cover (USFWS 2011e). Hawaiian moorhens nest year round, but breeding activity is concentrated between March and August and is influenced by both vegetation height and water levels (Shallenberger 1977, Byrd and Zeillemaker 1981 as cited in USFWS 2011e, Chang 1990). Clutch size ranged from 4.9 to 5.6 eggs in two studies (Chang 1990, Byrd and Zeillemaker 1981 as cited in USFWS 2011e) and average brood size observed during a study on Oahu was 4.4 chicks per brood (Smith and Polhemus 2003 as cited in USFWS 2011e).

Hawaiian moorhens are non-migratory and generally sedentary; however, they readily disperse in spring, presumably to breed (Nagata 1983). As with other Hawaiian waterbirds, dispersal may be related to the timing of wet and dry periods (Engilis and Pratt 1993) with dispersal occurring with the creation of new seasonal habitat during periods of flooding. Inter-island movement has not been documented in the Hawaiian moorhen (USFWS 2011e). Given the short duration of dependence, sedentary nature of the species, and timing of dispersal events, Hawaiian moorhens are unlikely to move between wetland areas when caring for dependent young. There is no information on the lifespan and annual survival of the Hawaiian moorhen (Bannor and Kiviat 2002, USFWS 2011e).

Distribution, Abundance, and Population Trends

The Hawaiian moorhen historically occurred on all of the main Hawaiian Islands except Lanai (likely due to a lack of wetland habitat) and probably Niihau (Munro 1960, Banko 1987). From the late 19th to the mid-20th centuries, moorhen populations on all but Kauai and Oahu were extirpated. Reintroduction efforts on the islands of Maui, Molokai, and Hawaii all failed, although there are unsubstantiated reports of moorhens from the islands of Hawaii and Maui from the late 20th century (USFWS 2011e).

Given the species' preference for densely-vegetated wetlands, DOFAW biannual waterbird surveys provide only a rough measurement of recent population trends (DOFAW 1976 – 2008 as cited in USFWS 2011e). While other approaches have been explored to develop more accurate estimates, none have been implemented (USFWS 2011e). Statewide population count estimates have been stable during the last decade (1998 – 2007) with an average count of 287 birds (DOFAW 1976 – 2008 as cited in USFWS 2011e).

Presence on Oahu and Potential Occurrence within the Wind Farm Site and Mitigation Areas

Based on results of biannual waterbird surveys, approximately half of the Hawaiian moorhen population resides on Oahu (USFWS 2011e). Although widely distributed on Oahu, the species is most common on the northern and eastern coasts. Areas supporting the largest populations include: Dillingham Ranch large pond; Amorient Aquafarm (part of Kahuku Aquaculture Farms); James Campbell NWR, Ki`i Unit (core wetland); and Waimea Valley. Amorient Aquafarm and James Campbell NWR are within 5 miles (8 kilometers) of the Project. Based on winter counts of adults from 1999 – 2003, other wetlands within 5 miles (8 kilometers) of the wind farm site where Hawaiian moorhens have been observed in smaller numbers include Coconut Grove Marsh, Laie wetlands (supporting wetland), Kahuku Prawn Farm (part of Kahuku Aquaculture Farms; supporting wetland), Punahoolapa Marsh, and the Turtle Bay golf course ponds.

There is no suitable habitat for Hawaiian moorhens in the wind farm site. Extreme rain events could result in flooding in low-lying portions of the wind farm site, which would offer temporary habitat for Hawaiian moorhens. However, such events would create an abundance of available habitat throughout the general Project vicinity and; thus, Hawaiian moorhens would still not likely use the wind farm site specifically. Therefore, occurrence of Hawaiian moorhens in the wind farm site would primarily be limited to their transit of the area when flying between wetland habitats outside of the wind farm site.

No Hawaiian moorhens were observed within the wind farm site during avian point count surveys (Tetra Tech 2014b). Surveyors recorded 16 Hawaiian moorhen detections during avian point count surveys in wetland areas adjacent to the Project (Tetra Tech 2014b). Based on the known biology of the species and the results of avian point counts, the frequency of Hawaiian moorhens transiting the wind farm site is likely to be low.

Hawaiian moorhens utilize habitats with wetlands and marshes. In addition to the James Campbell NWR Mitigation Area, the Hamakua Marsh Mitigation Area is managed as breeding habitat for Hawaiian stilts, Hawaiian coots, and Hawaiian moorhens and may also provide potential habitat for migrant waterfowl and shorebirds.

3.9.4.5 Threats to Waterbirds

Historically, the greatest limiting factors for Hawaiian waterbirds have included predation by non-native introduced animals and loss and degradation of wetland habitats (USFWS 2011e). Other threats to Hawaiian waterbirds have included hunting pressure, disease, and environmental contamination. Currently, predation by introduced animals and avian botulism may be the greatest threats to the Hawaiian stilt, Hawaiian coot, and Hawaiian moorhen (USFWS 2011e).

Predation is a major cause of waterbird mortality and nest failure (USFWS 2011e). Adult waterbirds are occasionally taken, but most depredation is of eggs and young (USFWS 2011e). Introduced mammals such as mongooses, cats, dogs, and rats are the primary predators, but depredation by both native and introduced birds (e.g., black-crowned night-heron, cattle egrets [*Bubulcus ibis*] and barn owls), introduced fish, and American bullfrogs (*Rana catesbeiana*) has also been documented (Shallenberger 1977, Berger 1981, Robinson et al. 1999, Brisbin et al. 2002).

Significant loss of wetland habitat, resulting from the conversion of land to agriculture and urbanization of lowland coastal areas, has contributed to the decline of all four waterbird species (USFWS 2011e). Additionally, waterbird habitat has been degraded through modification of hydrologic regimes, alteration of habitat structure and vegetation composition by invasive non-native plants, loss of riparian vegetation, and reductions in water quality due to grazing (USFWS 2011e). Currently, less than 70 percent of the coastal plain wetlands historically present in Hawaii remains (Dahl 1990 as cited in USFWS 2011e).

Although collision is not listed as a current threat (USFWS 2011e), waterbirds have been identified as a wildlife group at risk from collisions or other interactions with wind turbines (Erickson et al. 2001; Drewitt and Langston 2008; Arnett et al. 2007, 2008). Waterbird fatalities, however, are not typically documented in high numbers at operational wind energy facilities despite high mean use in some locations (Erickson et al. 2002, Jain 2005, Johnson and Erickson 2011). Additionally, waterbirds, shorebirds, and seabirds have shown strong avoidance of turbines at coastal wind energy facilities (Larsen and Guillemette 2007; Day et al. 2005; Desholm and Kahlert 2005; Kingsley and Whittam 2001, 2005).

3.9.5 Hawaiian Short-eared Owl

3.9.5.1 Status and Ecology

The Hawaiian short-eared owl is an endemic subspecies of the short-eared owl. It likely colonized the islands following the arrival of Polynesians due to the concurrent introduction of the Polynesian rat (*Rattus exulans*), common prey for the Hawaiian short-eared owl (USFWS 2010).

Hawaiian short-eared owls are most common in open habitats including grasslands, shrublands, and montane parklands; however, they use a broad spectrum of other habitats including wetlands, wet and dry forests, and urban areas (Mitchell et al. 2005). The Hawaiian short-eared owl has been found from sea level to 8,000 feet amsl (2,450 meters). Unlike its mainland counterpart, the Hawaiian subspecies is largely diurnal (Mitchell et al. 2005).

Little is known about the breeding biology of the subspecies, but nests have been found year round (USFWS 2010). Young remain dependent on their parents for approximately 2 months. Fledging success rates are unknown in Hawaiian short-eared owl and variable in other populations. Age at first breeding is unknown in the Hawaiian short-eared owl, but based on anecdotal information the widespread species appears to nest beginning at 1 year of age (Wiggins et al. 2006). Life span and annual survival rates of the Hawaiian short-eared owl is not known.

Hawaiian short-eared owls primarily consume small mammals, but their diet includes a variety of bird species, and insects (Snetsinger et al. 1994, Mostello 1996, USFWS 2010). Hawaiian short-eared owls forage in a variety of habitats, and their prey likely varies with the habitat.

3.9.5.2 Distribution, Abundance, and Population Trends

Hawaiian short-eared owls historically occurred on all of the southeastern Hawaiian Islands including adjacent islets (Pyle and Pyle 2009). They are considered sacred by native Hawaiians, but early Caucasian settlers killed them, and populations showed declined by the late 1800s (Perkins 1895). Klavitter (2009), in a summary of their natural history, noted substantial population size decreases on all occupied islands, especially Oahu. However, Pyle and Pyle (2009) suggest all populations have stabilized in the 2000s, although the populations show episodic peaks and “die-offs.”

3.9.5.3 Threats

Hawaiian short-eared owls are susceptible to many of the same factors that threaten other native Hawaiian birds, including: loss and degradation of habitat, predation by introduced mammals, and disease, as well as pesticide poisoning, food shortages, and vehicle collisions (Mitchell et al. 2005). Hawaiian short-eared owls persist in modified landscapes and at elevations where extensive exposure to avian malaria (*Plasmodium relictum*) and avian pox (*Poxvirus avium*) is certain. This suggests an ability to overcome some of these threats. When foraging, short-eared owls typically fly low over open areas, often at dusk or dawn. When these areas are traversed by roads, the species may be pre-disposed to collisions with vehicles.

3.9.5.4 Presence on Oahu and Potential Occurrence within the Wind Farm Site and Mitigation Areas

Hawaiian short-eared owls are rare on Oahu (Pyle and Pyle 2009, Klavitter 2009). While none were detected during biological surveys for the Project (Hobdy 2013a, Sanzenbacher and Cooper 2013, Tetra Tech 2014b), the species was detected once during pre-construction avian point count surveys and once during pre-construction radar surveys for the neighboring Kahuku Wind Project (Day and Cooper 2008, SWCA 2010). Habitat within the wind farm site is similar to that at the Kahuku Wind Project and is consistent with the habitat used by Hawaiian short-eared owls throughout the Hawaiian Islands. However, given the diurnal and crepuscular activity pattern exhibited by this species and the few records of use in the vicinity, the likelihood of the species breeding in the area is low, and for this reason in combination with the lack of detection during Project biological surveys, the species is assumed to occur as an irregular visitor to the wind farm site.

Hawaiian short-eared owls are known to use a broad spectrum of habitats, including wetlands, wet and dry forests and urban areas, although most commonly found in open habitats. The Poamoho Mitigation area is predominantly forested, while the Hamakua Marsh is a wetland. The likelihood of the species breeding at the Hamakua Marsh mitigation areas is low based on the same reasoning as noted above for the wind farm site.

3.10 Socioeconomic Resources

The primary analysis area for the socioeconomic analysis is the Koolau Loa District with emphasis on the individual communities in the Project vicinity. Koolau Loa is the northeastern district of Oahu, extending from Waimea Bay on the north shore to Kaaawa on the east coast. One of the mitigation areas (Nene Mitigation Area) is also located in the Koolau Loa District. The other two mitigation areas, the Poamoho Ridge and Hamakua Marsh mitigation areas, are located in the Wahiawa District and the Koolaupoko District, respectively. These two districts form a secondary area of analysis for the socioeconomics assessment.

Data are presented for the Census County Divisions (CCDs) and Census Designated Places (CDPs) in the primary and secondary analysis areas. CCDs are county subdivisions that are delineated by the U.S. Census Bureau, in cooperation with State and local officials, for the purposes of presenting statistical data. CDPs are the statistical counterparts of incorporated places delineated for settled concentrations of population that are identifiable by name but are not legally incorporated under the laws of the state in which they are located. There are seven districts on the island of Oahu, including the Koolau Loa District. These districts are identified as CCDs by the U.S. Census. The U.S. Census identifies seven communities (CDPs) in the Koolau Loa District: Hauula, Kaaawa, Kahuku, Kawela Bay, Laie, Punaluu, and Pupukea. The community of Kahuku is nearest to the proposed Na Pua Makani Wind Project. Data for the City and County of Honolulu and the State of Hawaii are also provided for comparison, where appropriate. The City and County of Honolulu (referred to as Honolulu County below) includes the city of Honolulu and the rest of the island of Oahu.

3.10.1 Population

An estimated total of 20,111 people lived in the Koolau Loa District in 2012 (Table 3.10-1). The majority of the resident population in Honolulu County lives in the District of Honolulu. The Koolau Loa District is relatively sparsely populated accounting for just 1.5 percent of the total population in Honolulu County. Population increased in the district from 2000 to 2012, but at a slower rate than the State and Honolulu County averages, 6 percent versus 12 percent and 9 percent, respectively (Table 3.10-1).

The majority (95 percent) of the population in the Koolau Loa District was concentrated in the seven communities in 2012, with community populations ranging from 279 (Kawela Bay) to 4,823 (Pupukea). Kahuku had an estimated 2012 population of 2,626. The estimated population in Laie was 5,560 (Table 3.10-1). Estimated population change in these communities from 2000 to 2012 ranged from a decrease of 32 percent (Kawela Bay) to an increase of 33 percent (Punaluu). The population in Kahuku experienced a relatively large increase over this period, with a net gain of 529 residents or 25 percent. The population in Laie also experienced a relatively large increase, with a net gain of 975 residents or 21 percent (Table 3.10-1).

Table 3.10-1. Population, 2000 and 2012

Area	2000	2012	2000 to 2012	
			Absolute Change	Percent Change
State of Hawaii	1,211,537	1,362,730	151,193	12
Honolulu County	876,156	955,215	79,059	9
Koolau Loa District	18,899	20,111	1,212	6
Hauula	3,651	3,521	-130	-4
Kaaawa	1,324	1,086	-238	-18
Kahuku	2,097	2,626	529	25
Kawela Bay	410	279	-131	-32
Laie	4,585	5,560	975	21
Punaluu	881	1,173	292	33
Pupukea	4,250	4,823	573	13
Source: U.S. Census Bureau 2000, 2012				

Population data are summarized for the two other districts that contain mitigation areas in Table 3.10-2. The Koolaupoko District contains the large communities of Kailua and Kaneohe, as well as the Marine Core Base Hawaii, and accounted for about 12 percent of the total population in Honolulu County in 2012. The Wahiawa District contains a major portion of the military area in the center of the island. Population in these districts grew at much slower rates between 2000 and 2012 than the State and Honolulu County averages, with the Koolaupoko District experiencing a net decrease in population over this period (Table 3.10-2).

Table 3.10-2. Population for Mitigation Areas, 2000 and 2012

District	Mitigation Area	2000	2012	Absolute Change	Percent Change
Koolaupoko	Hamakua Marsh (waterbird)	117,994	115,897	-2,097	-2
Wahiawa	Poamoho Ridge (bat)	38,370	40,021	1,651	4
Source: U.S. Census Bureau 2000, 2012					

3.10.2 Economic Conditions

The education and health care sector was the largest employer in the Koolau Loa District in 2012, accounting for 30 percent of total employment compared to 20 percent and 22 percent statewide and in Honolulu County, respectively (Table 3.10-3). The relatively high concentration of employment in this sector reflects the presence of the Brigham Young University (BYU) Hawaii campus. The campus has a full-time enrollment of nearly 3,000 students and is located southeast of the proposed Project in Laie. Tourism is the second largest sector by employment in the Koolau Loa District, accounting for 19 percent of total District employment in 2012.

The education and health care and tourism sectors are also the largest sectors in Kahuku, each accounting for about one-quarter of total employment in 2012. The education and health care sector accounted for 42 percent of employment in Laie, with tourism accounting for an additional 25 percent (Table 3.10-3).

Table 3.10-3. Employment, 2012

Economic Sector	State of Hawaii	Honolulu County	Koolau Loa District	Kahuku CDP	Laie CDP	Kawela Bay CDP
Employed Civilian Population	642,284	447,382	9,124	1279	2,437	136
Armed Services	39,220	38,528	161	14	10	5
Percent of Employed Civilian Population1/						
Agriculture/Resource Extraction	2	1	1	0.2	1	2
Construction	8	7	11	13	7	7
Manufacturing	3	4	2	4	0.4	0
Wholesale & Retail Trade	14	14	11	14	7	12
Transportation & Utilities	6	6	3	3	2	2
Information	2	2	2	1	2	2
Finance & Real Estate	7	7	4	3	4	7
Professional, Scientific & Management	10	10	6	3	5	18
Education & Health Care	20	22	30	25	42	18
Tourism (Arts & Services)	16	14	19	26	25	16
Public Administration	8	10	5	6	3	11
Other	5	4	5	3	3	4

Note:
1/ Percentages may not sum exactly due to rounding.
Source: U.S. Census Bureau 2012

Following a county-wide trend, employment in the construction industry increased in the Koolau Loa District between 2000 and 2012, nearly doubling in Kahuku and Laie over the same period (U.S. Census Bureau 2000, 2012).

Education and health care was the largest sector in the Koolaupoko District, accounting for 24 percent of total employment. Armed services is the largest sector in the Wahiawa District, accounting for about 37 percent of total employment in 2012, compared to 6 percent and 8 percent Statewide and in Honolulu County, respectively.

The annual average unemployment rate in the Koolau Loa District was approximately twice the state and Honolulu County averages in 2012, 8 percent versus 4.2 percent and 3.6 percent, respectively (U.S. Census Bureau 2012). Unemployment rates among the communities within the

Koolau Loa District ranged from 2.5 percent in Laie to 8.8 percent in Punaluu. The average annual unemployment rate in Kahuku was 5.9 percent in 2012.

3.10.3 Housing

The Koolau Loa District had an estimated 6,434 housing units in 2012, with 19 percent (1,251 units) of this total identified as vacant. Almost two-thirds (65 percent) of the vacant total – 13 percent of the total housing stock – were identified for seasonal, recreational, or occasional use. Housing for seasonal, recreational, or occasional use represented 6 percent and 3 percent of the total housing stock in Hawaii and Honolulu County, respectively. The high relative share of this type of housing in the Koolau Loa District reflects the importance of tourism to the local economy. A total of 811 units were identified for seasonal, recreational, or occasional use, with an estimated 85 housing units available for rent (Table 3.10-4).

There were an estimated 612 housing units in Kahuku in 2012, almost all (97 percent) of which were occupied. A total of 12 of the 19 vacant units were identified as for seasonal, recreational, or occasional use, with no units identified as available for rent. In Kawela Bay, almost 70 percent of the 419 housing units were identified as vacant, with the majority (80 percent, 230 units) used for seasonal, recreational, or occasional use, with just 13 units available for rent. In Laie, 19 percent or 215 of the 1,110 housing units were identified as vacant, with slightly more than half this total (52 percent) used for seasonal, recreational, or occasional use, and just 17 units available for rent (Table 3.10-4).

Table 3.10-4. Housing, 2012

Geographic Area	Hawaii	Honolulu County	Koolau Loa CCD	Kahuku CDP	Kawela Bay CDP	Laie CDP
Total housing units	519,811	337,389	6,434	612	419	1,110
Occupied housing units	447,453	308,490	5,183	593	131	895
Vacant housing units	72,358	28,899	1,251	19	288	215
Type of Vacant Housing Units (Number)						
For rent	19,326	6,666	85	0	13	17
Rented or sold, not occupied	3,885	2,152	14	0	8	0
For sale only	4,982	2,442	17	0	2	0
For seasonal, recreational, or occasional use	30,624	10,503	811	12	230	112
Other vacant	13,541	7,136	324	7	35	86
Total	**72,358**	**28,899**	**1,251**	**19**	**288**	**215**
Source: U.S. Census Bureau 2012						

Other forms of temporary housing located within the analysis area, include hotel and motel rooms and resort facilities. Island-wide, a total of 35,126 temporary housing units were identified in 2012, including hotel rooms, condominium hotel units, and individual vacation units, with an overall annual occupancy rate of 85 percent (HTA 2012). These data were not disaggregated by District. However, review of the Hawaiian Tourism Authority (HTA 2014b) website suggests that very little temporary housing is available in the vicinity of the Project site, save for the luxury-scale hotels and resorts in Kawela Bay. More temporary accommodations are located in Haleiwa and outside the Koolau Loa District, to the west and southeast, respectively, but these resorts are also geared to the tourist experience. Most affordable temporary lodging would likely be found in the greater Honolulu urbanized area, an approximately 1-hour drive away from the Project Area.

3.10.4 Property Values

The Project site is located on agricultural land next to a residential neighborhood to the east, and to the west, rugged open space managed by the Army for training purposes (City and County of Honolulu, Department of Planning and Permitting [DPP] 1999). Towards the community of Kahuku, further to the east, lies a small rural commercial cluster of restaurants, medical facilities and a church, along Kamehameha Highway (State Highway 83). Kahuku High and Intermediate School is also less than 1 mile from the Project Area. The community vision for the Koolau Loa District, as described in the Koolau Loa Sustainable Communities Plan, includes the preservation and enhancement of the rural character of the area, especially that of “Old Hawaii”, but acknowledges the possible expansion of wind energy in the Kahuku area (City and County of Honolulu, DPP 1999).

Median owner-occupied property values in the Koolau Loa District were approximately 124 percent of the Honolulu County median in 2012 (Table 3.10-5). Median values in the communities near the Project site ranged from just 78 percent (Kawela Bay) to 122 percent (Laie) of the County median. The median property value in Kahuku in 2012 was $488,500, equivalent to 88 percent of the County median in 2012 (Table 3.10-5).

Table 3.10-5. Median Property Values, 2012

Geographic Area	Median Property Value	Percent of County Median
Honolulu County	$557,800	100%
Koolau Loa District	$693,333	124%
Kahuku CDP	$488,500	88%
Laie CDP	$682,900	122%
Kawela Bay CDP	$433,300	78%
Koolaupoko District	$671,800	120%
Wahiawa District	$482,100	86%
Source: U.S. Census Bureau 2012		

3.10.5 Public Services

The Honolulu Police and Fire Departments have jurisdiction over the entire island. The nearest community to the Project site, Kahuku, offers law enforcement, fire protection, and medical services. The Kahuku Police Substation and Kahuku Fire Station (Station 13) are both located near the Project site and share a facility on the Kamehameha Highway.

The nearest emergency medical facility to the Project Site is Kahuku Medical Center located on Pualalea Street in Kahuku. There are also two offices of the Koolau Loa Community Health and Wellness Center, one in Kahuku on Pualalea Street, and the other along the Kamehameha Highway in Hauula.

The Project site would be serviced by the Hawaiian Electric Company, Hawaii Gas, and the Board of Water Supply, all of which serve the entire island of Oahu.

3.10.6 Tax Revenues

The State of Hawaii charges a four percent general excise tax (GET) and Use tax on nearly all monetary transactions (DOTAX 2014a). In addition, starting in 2007, Honolulu County implemented an additional 0.5 percent tax to fund a mass transit project on Oahu (DOTAX 2014b).

Total revenues for Honolulu County in 2013 were $2,093 million (Table 3.10-6). The GET and Use tax accounted for approximately eight percent of total revenue in Honolulu County in 2013.

Table 3.10-6. Honolulu County Revenues for 2013.

Revenue Type	Total ($ million)
Program revenues	
Charges for services	829.0
Operating grants and contributions	143.7
Capital grants and contributions	81.1
General revenues	
Property taxes	825.5
Other taxes	163.8
Other	50.3
Total revenues	**2,093.4**
Source: City and County of Honolulu, DBFS 2013.	

3.11 Historic, Archaeological and Cultural Resources

The heritage of the wind farm site is reflected in its cultural resources. Defined here, cultural resources are prehistoric or historic archaeological districts, landscapes, sites, or objects, traditional cultural properties, human remains, and/or historic built environment resources that include, districts, buildings, structures, landscapes, sites, and objects or places of importance to a culture or community for scientific, traditional, religious, or other reasons. Archaeological resources can include visible surface features and/or buried deposits without surface features. The information presented here summarizes the archaeological and cultural assessment work conducted for the Project described in detail in Pacific Legacy's *Archaeological Inventory Survey for the Na Pua Makani Wind Project, Kahuku, Keana, and Malaekahana Ahupuaa, Koolauloa District, Island of Oahu, Hawaii* (AIS; see Appendix F of the Final EIS) and *Cultural Impact Assessment for the Na Pua Makani Wind Project, Kahuku, Keana, and Malaekahana Ahupuaa, Koolauloa District, Island of Oahu* (CIA; see Appendix G of the Final EIS).

The assessment of potential impacts to historic, archaeological, and cultural resources within the analysis area begins with the identification and evaluation of the significance of resources as they relate to the requirements of Section 106 of the of the National Historic Preservation Act (NRHP; discussed below) and eligibility for inclusion for listing in the National Register of Historic Places (discussed below). The analysis area for cultural resources begins with defining the Area of Potential Effect (APE) or the "the geographic area or areas within which an undertaking my directly or indirectly cause alterations in the character or use of historic properties" (26 CRF 800.16(d)). For the analysis of effects to cultural and archaeological resources, the analysis area is the APE, described in more detail below.

In consultation with the State Historic Preservation Officer (SHPO), an historic, archaeological, traditional cultural properties, and architectural APE was delineated for the Project and is as follows:

- The APE is based on the Project layout as proposed at the time of this document submittal and consists of an approximately 464-acre (188-hectare) area within which the current AIS was focused. This area constitutes the maximum footprint of the Project within which all ground disturbing activities would occur and which would be occupied by permanent Project facilities (see figures included in Appendix F of the Final EIS).
- The OEQC guidelines require evaluation of a broader geographic area surrounding the Project; therefore, the assessment of impacts to historic, archaeological, and cultural resources for this Project includes the wind farm site plus adjacent areas.

This section describes the applicable Federal and State laws and regulations; the pre-contact and historical context of the APE; historical and archaeological accounts within the APE; a description of the survey methods used to identify existing historical and/or archaeological resources within the APE and associated results; and traditional cultural uses and practices.

3.11.1 Regulatory Context

3.11.1.1 Federal

There are numerous Federal regulations, executive orders, and policies that mandate the treatment of cultural resources on Federal lands, and projects that fall under the jurisdiction of Federal agencies. The following is a discussion of the most pertinent laws that would apply to the Project described in this EIS.

National Historic Preservation Act, Section 106

The principal Federal law addressing cultural resources is the National Historic Preservation Act (NHPA) of 1966, as amended (54 United States Code, Section 300101 et seq.), and its implementing regulations (36 CFR, Part 800), which address compliance with Section 106 of the NHPA. The regulations describe the process for identifying and evaluating historic properties, for assessing the effects of Federal actions on historic properties, and for consulting with interested parties, including the SHPO, to develop measures that would avoid, reduce, or minimize adverse effects. The term “historic properties” refers to cultural resources that are listed on, or meet specific criteria of eligibility for listing on the NRHP.

In order to be eligible for the NRHP, cultural resources must be at least 50 years old (generally), meet most of the seven aspects of integrity, and meet at least one of the four criteria listed below. Integrity is the property’s ability to convey its demonstrated historical significance through location, design, setting, materials, workmanship, feeling, and association. There are also considerations for resources that may have achieved national significance but are fewer than 50 years old. Criteria for listing on the NRHP (36 CFR, 60.4) are as follows:

A. Association with events that have made a significant contribution to the broad patterns of our history;
B. Association with the lives of persons significant to our past;
C. Resources that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
D. Resources that have yielded or may be likely to yield information important in prehistory or history.

Section 106 of the NHPA describes the procedures for identifying and evaluating eligible properties, for assessing the effects of Federal actions on eligible properties, and for consulting to avoid, reduce, or minimize adverse effects. Eligible properties need not be formally listed on the NRHP. As part of the Section 106 process, agencies are required to consult with the SHPO. Section 106 does not require the preservation of historic properties, but it ensures that the decisions of Federal agencies concerning the treatment of these places result from meaningful considerations of cultural and historic values and of the options available to protect the properties. If a project is an undertaking, as defined by 36 CFR 800.3, it is subject to Section 106 and consideration under other Federal requirements. Section 106 regulations of the NHPA also include provision for Native Hawaiian consultation regarding cultural significance of potential religious and sacred artifacts (16 USC 470a [a][6][A] and [B]).

3.11.1.2 State

State Regulatory Setting

HRS Chapter 6E, Historic Preservation, requires the identification, evaluation, and assessment of adverse effects of State and local undertakings on cultural resources. Implementation of these requirements is accomplished by HAR § 13-198, the Hawai'i Register of Historic Places (HRHP) and NRHP programs, and HAR § 13-276, Rules Governing Standards for Archaeological Inventory Surveys and Reports. The conduct of this Project has followed these procedures.

Criteria Considerations

Identified archaeological and cultural resources are evaluated for eligibility for inclusion on the HRHP with reference to the evaluation criteria enumerated in HAR § 13-198-8, as follows:

> *In deciding whether a property should be entered and ordered into the HRHP, the review board shall evaluate whether the property meets or possesses, individually or in combination, the following criteria or characteristics:*
>
> *(1) The quality of significance in Hawaiian history, architecture, archaeology, and culture, which is present in districts, sites, buildings, structures, and objects of State and local*

importance that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

a. *That are associated with events that have made a significant contribution to broad patterns of our American or Hawaiian history;*
b. *That are associated with the lives of persons significant in our past;*
c. *That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic value, or that represent a significant and distinguishable entity whose components may lack individual distinction; or*
d. *That have yielded, or may be likely to yield, information important in prehistory or history;*

The State of Hawai'i recognizes the above criteria under HAR §13-275-6 and has also added a fifth HRHP significance criterion to the evaluation process:

e. *That have an important value to the Native Hawaiian people or to another ethnic group of the State due to associations with cultural practices once carried out or still carried out, at the property or due to associations with traditional beliefs, events or oral accounts – these associations being important to the group's history and cultural identity.*

(2) *Environmental impact, i.e., whether the preservation of the building, site, structure, district, or object significantly enhances the environmental quality of the State;*

(3) *The social, cultural, educational, and recreational value of the building, site, structure, district, or object, when preserved, presented, or interpreted, contributes significantly to the understanding and enjoyment of the history and culture of Hawaii, the pacific area, or the nation.*

HAR §§ 13-276-7 and -8 require that significance evaluations be included in all survey reports as well as recommendations such as mitigation commitments. It is required that the significance evaluations and mitigation recommendations are presented in a summary table listing all sites in order to carry out the mandates of HRS § 6E.

3.11.2 Existing Conditions

The following section provides the environmental and cultural setting of the Project as presented in Pacific Legacy's AIS (Pacific Legacy 2015a; see Appendix F of the Final EIS) and CIA (Pacific Legacy 2015b; see Appendix G of the Final EIS). The cultural setting of the Hamakua Marsh and Poamoho Ridge mitigation areas was derived from existing sources cited as appropriate below.

3.11.2.1 Wind Farm Site

Pre-contact and Historical Context

The wind farm site encompasses the three ahupuaa (the main units of traditional Hawaiian land division, typically extending from the coast to the nearest mountain top or ridge and indicative of the exchange of resources between the land and sea [mauka to makai]) of Kahuku, Keana, and Malaekahana within the moku or district of Koolauloa (Figure 1 in Appendix F of the Final EIS). These ahupuaa have traditional information extending from the pre-Contact era to the historic era which describe what kinds of natural resources were found, what stories and mythological figures are associated with the area, as well as the chronicles and conflicts may have occurred there. These facets of the cultural landscape help to provide a connection for modern day cultural practitioners to the land and their ancestors who dwelt in these ahupuaa and are integral to understanding the cultural, historic, and spiritual significance of these lands. Of the three wind farm site ahupuaa, Kahuku, which literally translates as “the projection,” has the most information and is described in detail below.

Traditional accounts of the natural resources and existing conditions of the Kahuku ahupuaa indicate that during Hawaiian settlement prior to the arrival of Europeans, many parts of the landscape were used for traditional agriculture, habitation, and ceremony, varying from moderate to intense. At the time of the initial Contact period, a good portion of the land lay fallow due to severe population decline and was overgrown in some areas with exotic plant species. Thus, there are several conflicting accounts of what the landscape was like and how it was used prior to European contact (see below).

Several themes are tied to Kahuku’s landscape during the pre-Contact period. One is the abundance of the hala tree, or Pandanus, and its importance to ancient Kahuku’s cultural identity. The wearing of hala, in the form of plaited lau (leaves) hala or lei made of the hala fruit/seed was a way in which the people of Kahuku represented their homeland. Fresh water springs were mentioned in several traditional accounts of the Kahuku area, including tales of the adventurer Makanikeoe who is said to have discovered Punahoolapa and Punamano springs; Rock Spring and Kaainapele Spring were also said to be located in the Kahuku area. Agricultural terraces, made possible by the presence of the natural springs, were said to existing in northern Kahuku, although there is some debate as to whether these features originated in the pre-contact era or post European contact (Handy and Handy 1991). Finally, the presence of fish and fishing practices of pre-contact Kahuku is also recalled in legends. The story of Punamano spring alludes to locals net fishing at the beach at night, indicating the traditional fishing methods in Kahuku.

The Kahuku area is also known for landmarks including Kahuku Point, or Kalaeokahipa, and the great cave of Pohukaina. Kalaeokahipa Ridge, located approximately 2 miles north of the wind farm site, is believed to have been an area where the deities Kanaloa and Kane once lived. The cave, thought to be located a considerable distance inland from the Turtle Bay Resort area, had an entrance in Kahuku and was said to be a refuge and storage place of “much wealth” for Oahu chiefs.

The Kahuku area is associated with a number of supernatural beings or demigods. These include Mano-niho-kahi, a man-eating shark associated with an underground canal in Kahuku; Ku-ilio-loa the “great dog” or dog-man with a human body and supernatural powers; and Kamapuaa, a supernatural being and deity attributed to agriculture, rain, and fertility.

Much less pre-contact information is known about the Keana and Malaekahana ahupuaas. The former derives its name from a cave on the inland side of Kahuku school. Traditional sites associated with legendary stories of Keana include two large stones in the Keana Cave or Rock Shelter that are said to be the remains of two boys who failed to follow their mother’s orders to stay silent during a thunderstorm in accordance with the kapu (law) of the god of thunder Kane-hekili and a pool of water called Polou said to be the place where the "floating island" of Kahuku attached to the Island of Oahu. Malaekahana is derived from the name of the mother of the Hawaiian goddess Laie-i-ka-wai and her twin sister Laie-lohelohe and is also the name of a large bay and stream within the land division. Several legendary stories reference Malaekahana as a locality. Agricultural terraces were associated with Kaukanalaau Stream in the Malaekahana area.

Historical and Archaeological Accounts

At the time of European contact, the Kahuku area was a rich cultivated landscape. Lieutenant James King remarked: "nothing can exceed the verdure of the hills, the variety of wood and lawn, and the rich cultivated valleys which the whole face of the country displayed" (Cook and King 1784:115, as cited in Handy and Handy 1991:462). This comment indicates the wealth of the Kahuku region. However, a short time later, the explorer George Vancouver paints a picture of an area in great decline:

> Our examination confirmed the remark of Capt. King excepting that in point of cultivation or fertility, the country did not appear in so flourishing a state, nor to be so numerously inhabited, as he represented at that time, occasioned most probably by the constant hostilities that existed since that period (Vancouver 1798 vol. 3:71, as cited in Handy and Handy 1991:462).

Handy and Handy write of the abandoned terraces which once dotted the Kahuku landscape and the population decline:

> In 1833 Hall (1839) observed at Kahuku that "much taro land now lies waste because the diminished population of the district does not require its cultivation (Handy and Handy 1991:462)

Based upon these descriptions, it is evident that the Kahuku area was once fairly densely inhabited and that agricultural activities flourished. However, after European contact it appears that there was a marked population decline with an associated decrease in agricultural activity.

Ranching in the Kahuku area began in the 1850s when the Kahuku Ranch was established on land purchased from Kamehameha III (Korn 1958). The ranch grew and soon the once rich vegetation of Kahuku began to disappear, as the result of free-range overgrazing (Stride et al. 2003:16). This took a toll on the natural resources, the small unprotected family gardens, and the native population -- "At the same time the hala forests began to disappear, the Hawaiian population also began to disappear" (Stride et al. 2003). Presumably the population continued to decline between the 1830s and the 1850s.

By the 1890s, James Campbell had control of a large portion of the Kahuku tract which laid the groundwork for the creation of the Kahuku Plantation (Stride et al. 2003). This was the start of large-scale commercial agriculture that altered the landscape of Kahuku with agriculture and a railroad segment that changed the landscape and redefined the region.

Much of the uplands above Kahuku Village were once planted in sugar cane and pineapple. These fields were established wherever possible except on steep hillsides and on the crests of ridges and knolls (Stride et al. 2003).

The plantation continued to expand into the 1930s when Japanese, Filipino, and Portuguese worked the fields (Stride et al. 2003). The plantation was responsible for shaping the town of Kahuku and the life of its workers by introducing "concrete stoves for laborer's cottages and sanitation drains that were used as models for other plantations…Kahuku…introduced the first plantation day nursery and high school…baseball diamond, the first golf course …" (Stride et al. 2003:22). The growth quickly slowed when in 1955 the last of locomotives hauling sugar cane stopped. In 1971, the Kahuku Plantation closed (Stride et al. 2003).

Archaeological Investigations

Thirty-nine archaeological studies have been conducted in various locations within a 1.6-mile (2.5-kilometer) radius around the proposed Project. A summary of the findings of these reports is provided in the AIS in Appendix F of the Final EIS.

Two previous archaeological studies have been conducted in portions of the wind farm site. These were conducted by Cultural Surveys Hawaii (Stride et al. 2003) and International Archaeological Research Institute (Morrison 2009) and are described in more detail below.

In 1992, Cultural Survey Hawaii (CSH) conducted a literature review and field investigation of approximately 785 acres of land encompassing the western portion of the wind farm site (Stride et. al 2003). The CSH survey identified seven sites composed of 16 features: overhang shelters (N=8) (one of which contained human remains), walls (N=3), terraces (N=3) an enclosure (N=1), and a U-shaped temporary shelter (N=1). These sites are located outside of the Project APE. The results of the CSH survey indicate that although the current Project Area and vicinity was severely impacted by large-scale commercial agriculture, the area still has the potential to contain significant cultural resources.

In 2009, International Archaeological Research Institute, Inc. (IARII) conducted archival research for the western portion of the wind farm site for West Wind Works, LLC (Morrison 2009). This research included review of early historic documents, historic maps, and previous archaeological investigations in the area. IARII's research indicated that at the time of first European contact (in 1779) the general Kahuku area was densely settled and intensively cultivated. However, drastic population decline and education in agricultural practices were evident within 20 years (by 1794). In the mid-1800s, cattle and sheep ranching was being practiced in Kahuku, which led to dramatic vegetation change in the area. Sugar and pineapple cultivation began in the late 1800s resulting in extensive land modifications of the area. IARII's research indicates that the wind farm site was extensively modified by these commercial agricultural activities (McIntosh and Cleghorn 2013). IARII concluded that it is unlikely that any cultural remains would be found within the western portion of the wind farm site and that no further archaeological work was needed.

During the initial consultations with the SHPD, the adequacy of the previous archaeological field work in the project area was discussed thoroughly. The previous field work was conducted over two decades ago, in 1992. Perspectives on what types of remains constitute archaeological sites have changed considerably over the last few decades. Previously, remains associated with early historic agricultural systems were not thought of as being important, because at that time active large scale sugar and pineapple plantations were still dominating the landscapes in the Hawaiian Islands. Military remains were also not considered important to our history. Because of changing viewpoints, SHPD recommended that the APE should be completely covered by a pedestrian survey.

In 2014, Pacific Legacy conducted a pedestrian survey of close to 100 percent of the APE (excluding only areas that were too steep to traverse) to identify archaeological sites. Information presented here reflects input from SHPD, which recommended that many of sites identified in the Draft AIS that were given a distinct site number be combined resulting in fewer site numbers but still consisting of the same amount of total features. The survey identified 28 new (not identified during previous archaeological investigations) archaeological sites consisting of 113 distinct features. A majority of these features (72) were within a single site that is associated with agricultural development and intensive use for the cultivation of sugar cane by the former Kahuku Sugar Plantation. Of the remaining sites, 22 were traditional Hawaiian pre-Contact activities, 3 were historic, and 2 were related to World War II military activities in the area.

Survey data were used by Project engineers to refine the location of proposed facilities to avoid archaeological features. This resulted in a revision of the APE. Fourteen of the documented sites and three features of the Kahuku Sugar Plantation site, are now located outside of the APE and would not be affected by the Project. Of these, all but the three features of the plantation site are traditional pre-Contact sites and relate to habitation, agricultural, and burial practices. The remaining 14 sites (and 88 features) within the APE are described below.

Sixty-nine features composing 39 components of the site associated with historic sugar plantation activities were documented within the APE, most of which were associated with water control or transport. Features included ditches, concrete culverts, concrete foundations, retaining walls, walls, valves, wells, iron pipes and pipelines, pump houses, a concrete footing, tanks, and an aqueduct. Eight pre-Contact Native Hawaiian sites were documented within the APE including a stone mound determined to be a marker (see discussion of hand excavation below), a platform used for habitation, agricultural terraces (four sites), a modified outcrop, and a cave that functioned as a habitation site. The two historic sites associated with World War II activities included a bivouac site (an alignment and hearth) and site containing two bunkers. Three non-sugar plantation historic era sites associated with agriculture (terraces and terraced soil furrows) or other functions (artifact scatter) were also documented within the APE.

Subsurface backhoe testing was also conducted at select locations within the APE to determine if subsurface cultural deposits were present. Test trenches were located where cultural deposits were likely to be present, focusing on areas where ground disturbing activities are proposed. No subsurface cultural resources were identified in any of the trenches. Hand-excavated test units were placed at two sites to collect cultural material (a stone mound thought to be a potential burial and a cave with a marine shell midden; see the AIS in Appendix F of the Final EIS for further information). No human remains or other cultural material were identified in the stone mound. The test unit in the cave identified marine shell midden, non-human bone, crab claws, and basalt flakes. Charcoal samples from this test unit were submitted for identification and radiocarbon dating. Preliminary significance assessments of the archaeological and cultural resources recorded in the APE were made and are presented in the AIS (see Appendix F of the Final EIS). The AIS was accepted by SHPD (December 18, 2015) with approval of the stated mitigation recommendations for the 14 sites.

Traditional Cultural Uses and Practices

In accordance with HRS Chapter 343, Act 50, and the OEQC "Guidelines for Assessing Cultural Impact" a CIA was conducted by Pacific Legacy. The objective of a CIA is to promote and protect cultural beliefs, practices, and resources of Native Hawaiians and other ethnic groups as well as other collective groups associated with the subject area and surrounding areas (OEQC 2011). The general purpose of a CIA is to protect and preserve all cultural practices and resources that may be impacted by the proposed Project. Types of cultural practices and beliefs may include those relating to subsistence, commercial, residential, agricultural, access-related, as well as religion and spirituality as well as "traditional cultural properties or other types of historic sites, both manmade and natural, including submerged cultural resources, which support such cultural practices and beliefs" (OEQC 2011).

To gather information about the cultural resources within the wind farm site and surrounding area oral history interviews were conducted with five people knowledgeable about the area, including two noted kupuna and two cultural practitioners familiar with the area (Mooney et al. 2015b; see Appendix G of the Final EIS). The continued use of the general area for agriculture, including various food crops and small-scale animal husbandry, following the closure of the Kahuku Plantation was indicated by two interviewees. Traditional Hawaiian practices in and around the wind farm site include pig hunting and plant gathering, according to the testimony of two interviewees; however, neither informant expressed that the area in which these cultural practices were occurring were exceptional, legal, or even ideal as the lands are private and/or reserved for military use. Further, the locations in which the activities occur do not appear to be within the APE. Two of the informants also indicated that the area in general has a mystical past and retains some supernatural qualities, which is reportedly a common belief in the area. One of the informants, a professor from BYU, provided information on the cultural significance of wildlife species including threatened and endangered species covered by the HCP, described in detail below. Transcripts of each interview are included in the CIA in Appendix G of the Final EIS.

Culturally Important Species

Based on testimony from Dr. Ka'ili, ancestral deities may take the form of birds and bats (collectively, manu) that occur in the vicinity of the wind farm site. These deities include ancestral guardians ('Aumakua), parental/caretaker birds (Makua), guardian/protector birds (Kia'i), offspring of parental/caretaker birds (Keiki), and manifestations/vessels of ancestors and gods (Kinolau). Listed species that are identified in the Hawaiian Creation Chant (Kumulipo) as manu include Hawaiian hoary bat, Newell's shearwater, Hawaiian goose, Hawaiian stilt, Hawaiian coot, Hawaiian moorhen, and Hawaiian short-eared owl. Hawaiian ducks also are recognized in traditional Hawaiian folklore as guardians of a legendary blind king. Harming of these birds therefore may be interpreted as causing harm to ancestral spirits. The traditional name of the dominant wind at Kahuku is Ahamanu, which translates as "gathering of birds" (manu) and further indicates the significance of these species to local traditional culture.

3.11.2.2 Hamakua Marsh

Hamakua Marsh is part of the larger Kawainui Marsh located west of the town of Kailua, Oahu. The Kawainui-Hamakua Marsh complex is the largest remaining lowland emergent wetland in the state of Hawaii. In 1966, USACE constructed a levee along the northern edge of the marsh to enhance its flood storage capacity and protect the community of Kailua from flooding. This levee was later modified in 1997.

The Hamakua Marsh Mitigation Area is within the Kailua ahupuaa of the Koolaupoko district. In 1979, the Kawainui Marsh was deemed eligible for listing on the National Register of Historic Places as a significant cultural and archaeological resource. The Kawainui-Hamakua Marsh cultural complex includes several prehistoric and historic archaeological sites dating back to early Polynesia migration, pre-contact Hawaii (approximately 1,500 years ago) to historic times. Recorded cultural resources within the complex consist of three Hawaiian heiau (Ulupo Heiau, Pahukini Heiau, and Holomakani Heiau), prehistoric occupation and habitation sites, and series of dry farming agricultural terraces, extensive wetland agricultural system-aquaculture, retaining walls, and remnants of historic house foundations.

3.11.2.3 Poamoho Ridge

The Poamoho Ridge area is characterized as undeveloped, steep mountainous terrain, zigzagging ridges, and deep gulches with shallow drainages and dense vegetation. The Poamoho Ridge Mitigation Ara is located in the ahupuaa of Paalaya and Kamananui within the Waialua district (Hawaiian Studies Institute 1987). Prior to European contact, Kamananui was the ritual and political center of Waialua with a dense population and taro fields in the lowlands that were irrigated by a 2-mile-long ditch (Kirch and Sahlins 1994). Rainfall agricultural was practiced within along slopes and upland plains. Kamananui ahupuaa also includes two heiau.

3.12 Land Use

Comprehensive plans, land use policies, and zoning regulations determine the type and extent of land uses allowable in specific areas and often protect environmentally sensitive land uses. Land use impacts typically result from actions that negatively affect or displace an existing use or affect the suitability of an area for its current, designated, or formally planned use. For purposes of the land use evaluation, the analysis area includes the wind farm site and HCP mitigation areas. The mitigation areas include the Hamakua Marsh for water birds, Poamoho Ridge for the Hawaiian hoary bat, and the James Campbell National Wildlife Refuge for the Hawaiian goose.

Public comments on the Draft EIS requested an expanded discussion of existing agricultural uses and activities within the wind farm site. Therefore, the discussion of agriculture has been moved to a new section, Section 3.20 – Agriculture.

3.12.1 Existing Conditions

3.12.1.1 Wind Farm Site

The wind farm site is located in Kahuku town. The western portion of the wind farm site is located on land owned by the State and administered by the DLNR (TMK (1) 5-6-008:006). The eastern portion of the wind farm site is located on land owned by Malaekahana Hui West, LLC (TMK (1) 5-6-006:018) (Figure 1-2).

Existing land use within the wind farm site is influenced by elevation and terrain. Lower-elevation portions of the wind farm site are cultivated for agriculture. Higher-elevation lands are dominated by a mixture of non-native weedy vegetation and common native vegetation, and are not actively used for agriculture.

Research completed to prepare the archaeological assessment indicates much of the DLNR lands were once farmed in pineapple, while the Malaekahana Hui West portion of the wind farm site was farmed in sugar cane until the 1970s. Plantation cultivation occurred from the late 1800s to the 1970s, when the Kahuku Plantation closed (Continental Pacific 2013). After sugar cane production ceased, cultivation of truck crops began and continues today on the Malaekahana Hui West lands. Malaekahana Hui West currently leases approximately 245 acres (99.0 hectares) of the wind farm site's farm lands to individual farmers. The DLNR portion of the Project site (234 acres; 95 hectares) is currently vacant lands with the exception of approximately 11 acres of actively farmed land.

The immediately adjacent lands surrounding the wind farm site are vacant and agricultural lands, both active and fallow. West of the Project boundary are active military training lands known as the Kahuku Training Area (KTA). North of the Project is the adjacent Kahuku Wind Farm, with 12 wind turbines and a nameplate generating capacity of 30 MW, and the residential community known as Kahuku Mauka Village. East of the Project boundary is Kamehameha Highway near the core of Kahuku town that includes Kahuku Intermediate and Kahuku High School (Figure 1-2).

The wind farm site is located almost entirely within the state agricultural land use district, with only a small portion of wind farm site (2.1 acres [0.8 hectare]) near Kamehameha Highway falling within the State urban land use district. All of the Project facilities are located within the State agricultural land use district (Figure 3.12-1).

The wind farm site is located within the boundaries of the Koolau Loa planning region of Oahu. The comprehensive plan applicable to this area is the Koolau Loa Sustainable Communities Plan, which designates the wind farm site for agricultural, military, and rural residential use (see Figure 3.12-2) (City and County of Honolulu, DPP 2012).

The wind farm site is located within the City and County of Honolulu agricultural zoning districts: AG-2 General Agricultural and AG-1 Restricted Agricultural (Figure 3.12-3). For further discussion on the consistency with Federal, State, and county regulations and policies and county plans, refer to Chapter 5.0.

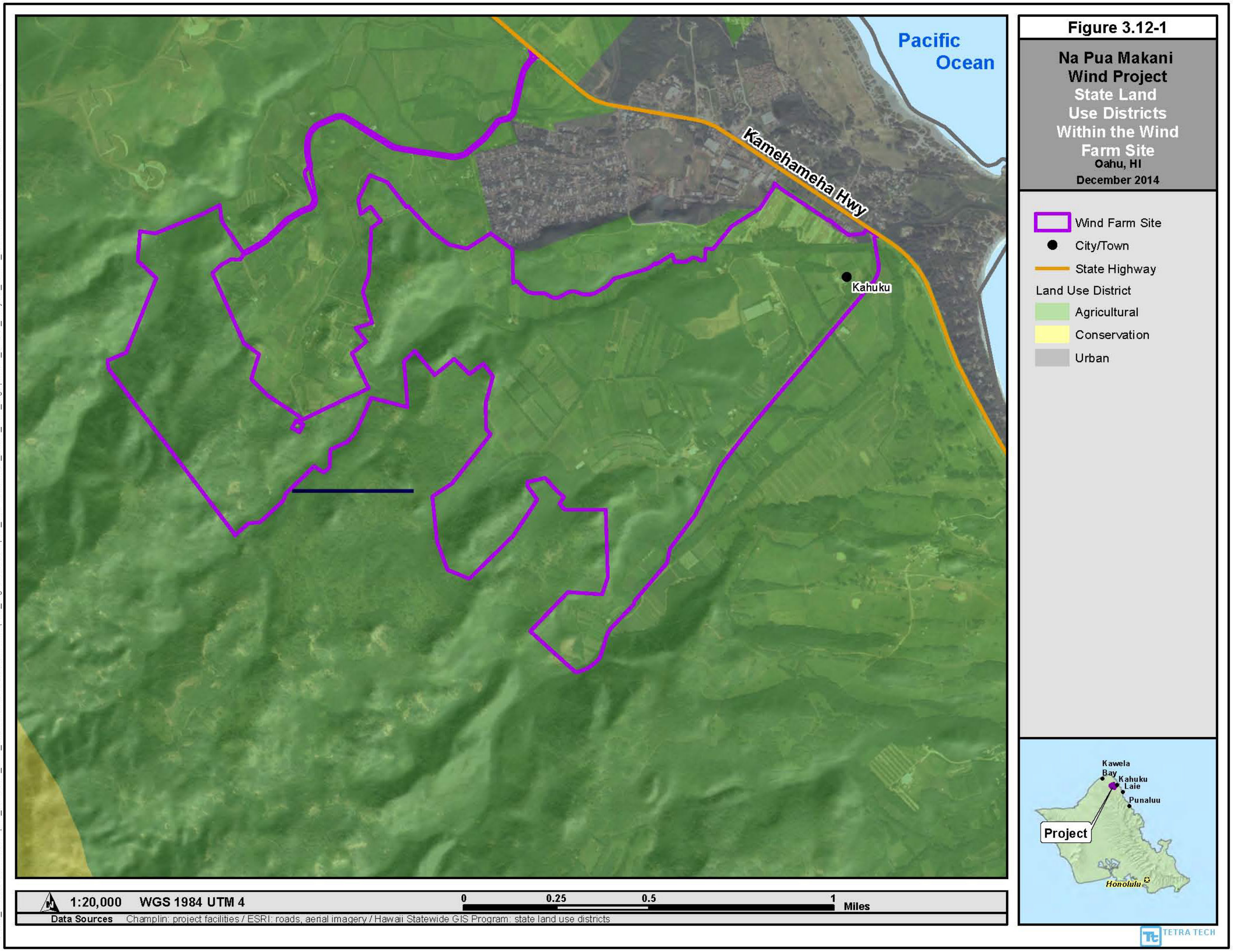


Figure 3.12-1
Na Pua Makani Wind Project
State Land Use Districts Within the Wind Farm Site
Oahu, HI
December 2014
Wind Farm Site
City/Town
State Highway
Land Use District
Agricultural
Conservation
Urban
Pacific Ocean
Kamehameha Hwy
Kahuku
Kawela Bay
Laie
Punaluu
Project
Honolulu
1:20,000
WGS 1984 UTM 4
0
0.25
0.5
1
Miles
Data Sources Champlin: project facilities / ESRI: roads, aerial imagery / Hawaii Statewide GIS Program: state land use districts
TETRA TECH

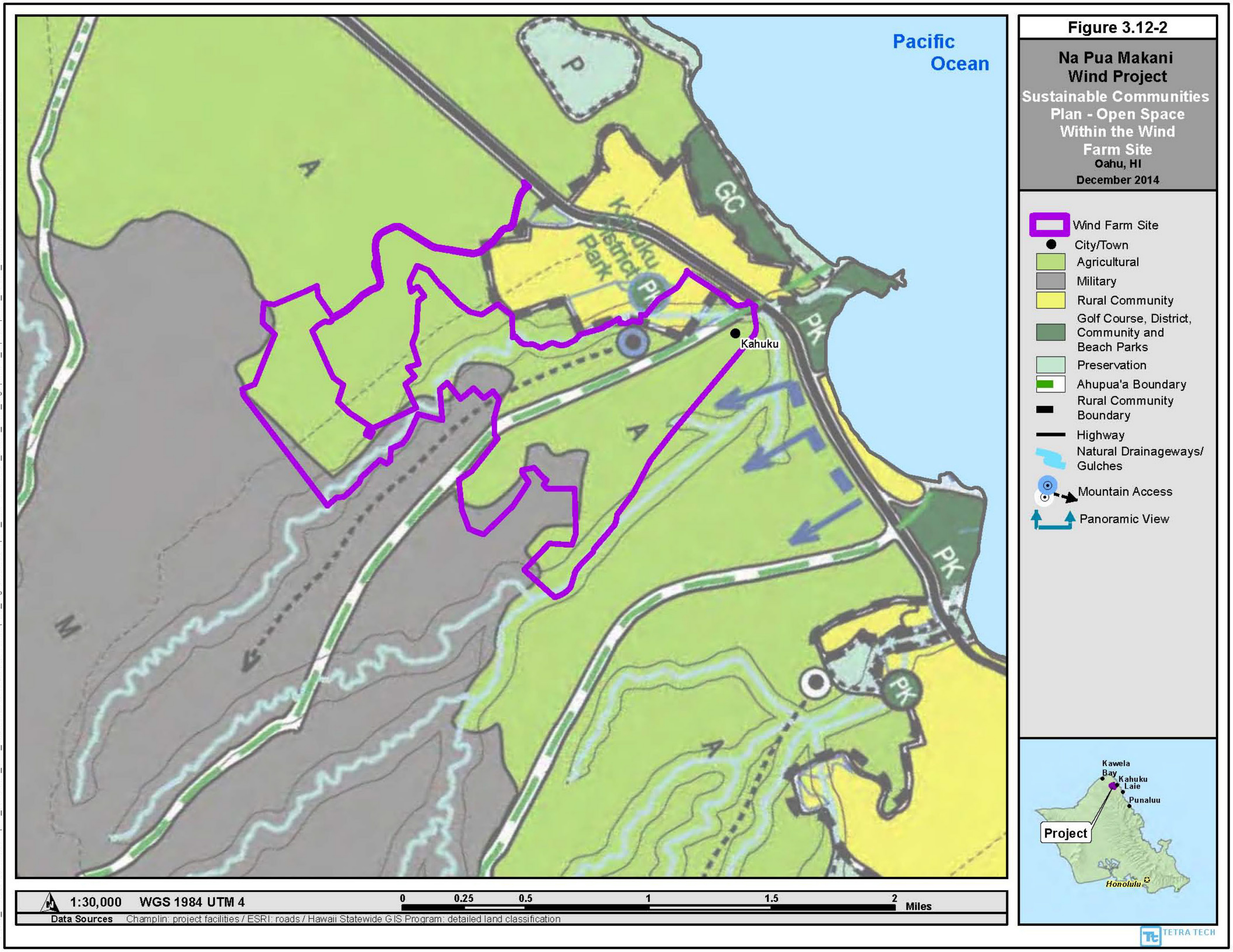


Figure 3.12-2
Na Pua Makani Wind Project
Sustainable Communities Plan - Open Space Within the Wind Farm Site
Oahu, HI
December 2014
Pacific Ocean
Kahuku
Kahuku District Park
GC
PK
P
A
M
Wind Farm Site
City/Town
Agricultural
Military
Rural Community
Golf Course, District, Community and Beach Parks
Preservation
Ahupua'a Boundary
Rural Community Boundary
Highway
Natural Drainageways/ Gulches
Mountain Access
Panoramic View
Kawela Bay
Kahuku
Laie
Punaluu
Project
Honolulu
1:30,000
WGS 1984 UTM 4
0 0.25 0.5 1 1.5 2 Miles
Data Sources Champlin: project facilities / ESRI: roads / Hawaii Statewide GIS Program: detailed land classification
TETRA TECH

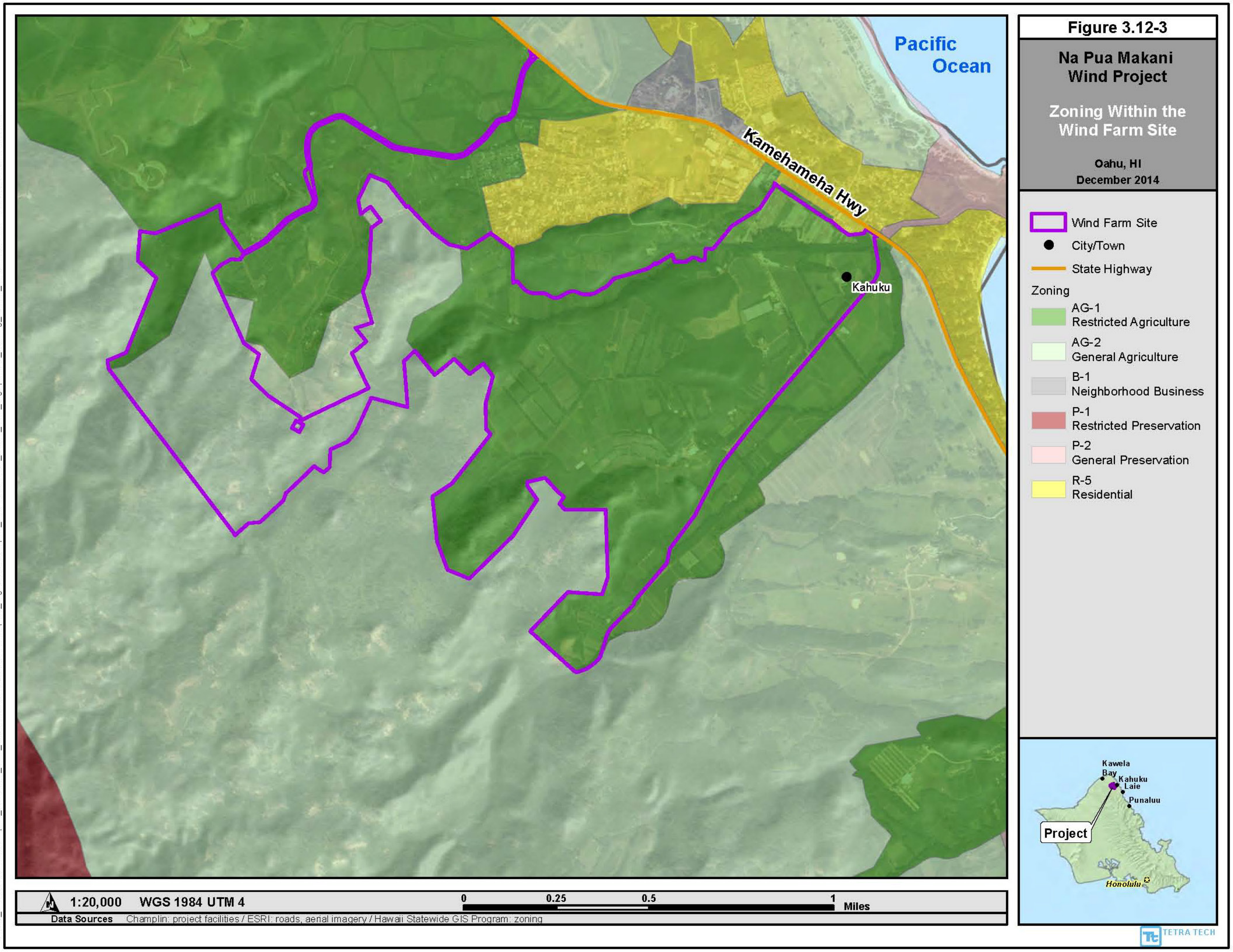


Figure 3.12-3
Na Pua Makani Wind Project
Zoning Within the Wind Farm Site
Oahu, HI
December 2014
Pacific Ocean
Kamehameha Hwy
Kahuku
Wind Farm Site
City/Town
State Highway
Zoning
AG-1 Restricted Agriculture
AG-2 General Agriculture
B-1 Neighborhood Business
P-1 Restricted Preservation
P-2 General Preservation
R-5 Residential
Kawela Bay
Kahuku
Laie
Punaluu
Project
Honolulu
1:20,000 WGS 1984 UTM 4
0 0.25 0.5 1 Miles
Data Sources Champlin: project facilities / ESRI: roads, aerial imagery / Hawaii Statewide GIS Program: zoning
TETRA TECH

3.12.1.2 Hamakua Marsh (waterbird)

The proposed waterbird mitigation area, known as the Hamakua Marsh, is a waterbird sanctuary that is State-owned and administered by DNLR (TMKs (1) 4-2-003:017 and 030; (1) 4-2-016:002, 004, 013, and 015; and (1) 4-2-038:024). Hamakua Marsh is located on the western edge of the town of Kailua and adjacent to Kawainui Marsh, a DLNR-owned and managed waterbird management area.

Hamakua Marsh is a smaller wetland that was historically connected to and immediately downstream (southeast) of Kawainui Marsh. Both Hamakua and Kawainui Marshes were designated as Ramsar Wetlands of International importance in 2005 for their biological, historical, and cultural significance (USACE 2008). Currently, Hamakua Marsh is designated as a Hawaii Sate Wildlife Sanctuary and is managed by the DOFAW.

Immediately adjacent to the Hamakua Marsh to the north, east and south are commercial and residential areas. The Kawainui Marsh conservation lands are immediately adjacent to the south and west. The Hamakua Marsh area provides a buffer between urban land uses and conservation and fallow lands.

The Hamakua Marsh mitigation area is predominately located within the State urban land use district, with some slivers within the State conservation land use district. The area is also located within the boundaries of the Koolaupoko planning region of Oahu. The comprehensive plan applicable to this area is the Koolaupoko Sustainable Communities Plan, which designates the Hamakua Marsh for Open Space/Preservation areas (City and County of Honolulu, DPP 2000). The Hamakua Marsh mitigation area is a mix of several classifications of the City and County of Honolulu zoning districts, including P-2 General Preservation, P-1 Restricted Preservation, R-10 / R-5 / R-7.5 Residential, and B-1 / B-2 / BMX-3 Neighborhood Business, Community Business, Community Business Mixed Use.

3.12.1.3 Poamoho Ridge (bat)

The Poamoho Ridge mitigation area is owned and managed by the State (DLNR) and comprises two land areas within TMKs (1)7-2-001:006 (portion), (1)6-3-001:001 (portion), (1)5-3-011:001 (portion), and (1)5-2-001:001 (portion). Poamoho Ridge mitigation area is located near the ridgeline of the Koolau Mountain Range, within the Ewa Forest Reserve (Poamoho Section), which itself is a portion of the Army's Kawailoa Training Area see Section 3.19 Military).

The existing land use for the Poamoho Ridge is forest reserves as it is located entirely in the Ewa Forest Reserve. Immediately to the south is military owned Schofield Barracks. And over the ridge to the east are vacant ridge lands, and further east are the coastal towns of Kaawa and Punaluu.

The Poamoho Ridge bat mitigation area is located within the State conservation land use district. The Poamoho Ridge bat mitigation area is not located within the boundaries of a planning region of Oahu. The Poamoho Ridge mitigation area is within the City and County of Honolulu P-1 Restricted Preservation zoning district.

3.13 Recreation and Tourism

This section identifies recreation and tourism resources in the vicinity of the wind farm site and the HCP mitigation areas. Recreation resources were identified through review of a number of information sources, including the Koolau Loa Sustainable Communities Plan (City and County of Honolulu, DPP 2012) and Koolaupoko Sustainable Communities Plan (City and County of Honolulu, DPP 2000), the Hawaii Tourism Authority website (HTA 2014a), the Hawaii State Parks website (DLNR 2014), and the City and County of Honolulu online GIS mapping system (HoLIS 2014). The analysis area for recreation and tourism includes the area within 5 miles of the wind farm site, and within 1 mile of the bat and waterbird mitigation areas.

3.13.1 Wind Farm Site

Publicly-owned or –managed recreation and tourism resources near the wind farm site include resources owned or managed by the USFWS, DOFAW, DLNR Division of State Parks, and the City and County of Honolulu Department of Parks and Recreation (DPR). Public recreation resources in the analysis area include a national wildlife refuge, three State forest reserves, five State sea bird sanctuary islands, one State recreation area, one district park, one community park, one neighborhood park, nine beach parks, a State wayside, a public golf course, and one undeveloped park property. Designated trails are found in three of the forest reserves and along the western edge of the KTA.

Important privately-owned recreation and tourism resources near the wind farm site include the Turtle Bay Resort and its two associated golf courses, the Kahuku Motocross Course and the Hukilau Beach Park. The Polynesian Cultural Center is also located nearby in Laie town.

Identified public and private recreation and tourism resources are shown on Figure 3.13-1. Table 3.13-1 provides a brief description of each of these areas, identifies the owner or management agency, and indicates the distance and direction of each of these resources from the wind farm site and the respective mitigation areas. Table 3.13-1 is organized by type; Federal areas are first, followed by State-managed areas then by county-managed resources, and finally by private recreation and tourism resources.

There are no designated trails within or in close proximity to the wind farm site. The nearest designated trails are located in the westernmost portion of the KTA, in that area designated as the Pupukea-Paumalu Forest Reserve; the two designated hiking trails (Pupukea Summit Trail and Kaunala Trail) are accessed from the Waianae Valley. A third trail, the Koolau Summit Trail, is also accessed from the Waianae Valley; it runs along the southeastern boundary of the KTA, following the spine of the Koolau Mountain Range. Three additional trails are located within the Hauula Forest Reserve; one of these extends and provides the only discernable public access into the Kaipapau Forest Reserve.

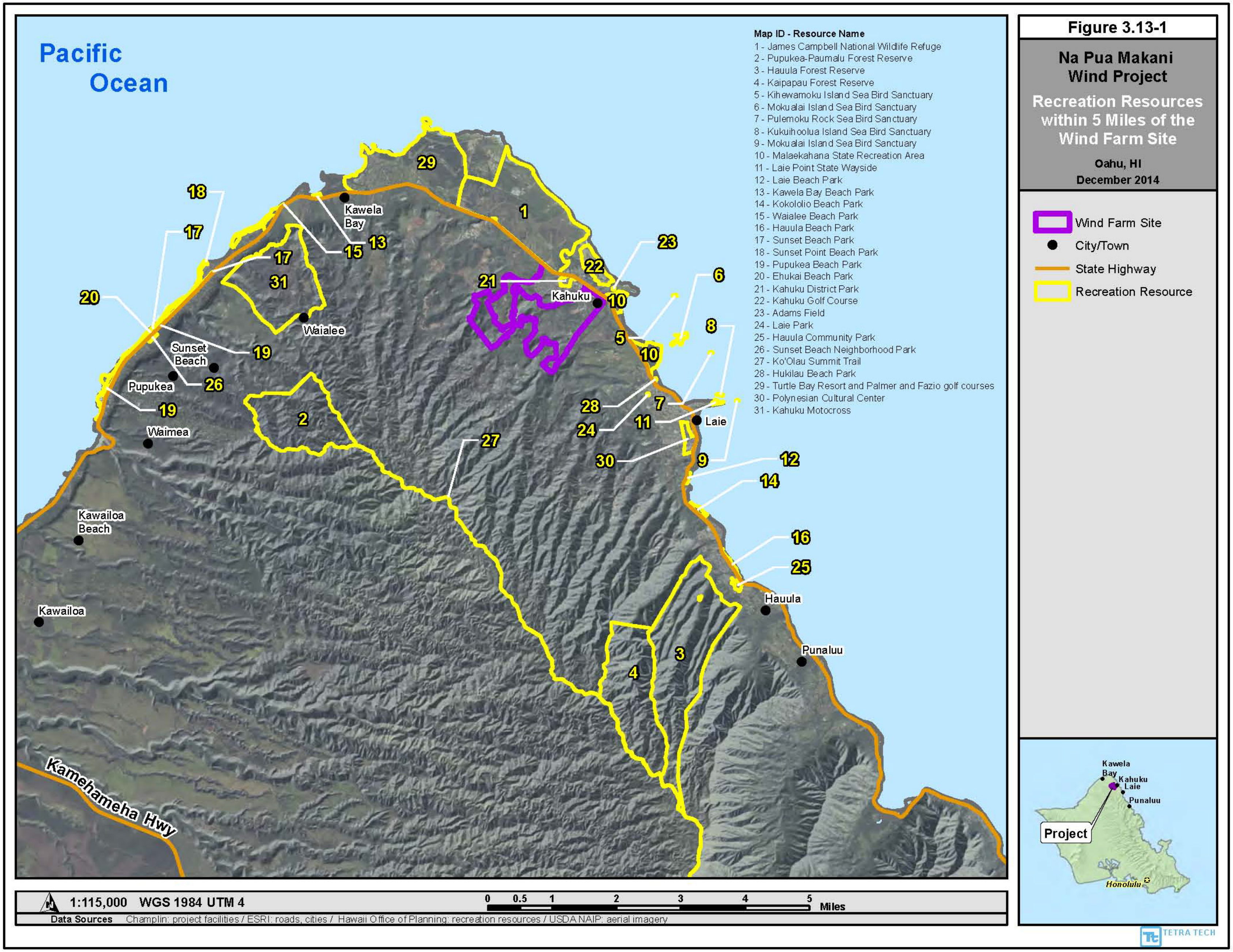


Figure 3.13-1
Na Pua Makani Wind Project
Recreation Resources within 5 Miles of the Wind Farm Site
Oahu, HI
December 2014
Wind Farm Site
City/Town
State Highway
Recreation Resource
Pacific Ocean
Map ID - Resource Name
1 - James Campbell National Wildlife Refuge
2 - Pupukea-Paumalu Forest Reserve
3 - Hauula Forest Reserve
4 - Kaipapau Forest Reserve
5 - Kihewamoku Island Sea Bird Sanctuary
6 - Mokualai Island Sea Bird Sanctuary
7 - Pulemoku Rock Sea Bird Sanctuary
8 - Kukuihoolua Island Sea Bird Sanctuary
9 - Mokualai Island Sea Bird Sanctuary
10 - Malaekahana State Recreation Area
11 - Laie Point State Wayside
12 - Laie Beach Park
13 - Kawela Bay Beach Park
14 - Kokololio Beach Park
15 - Waialee Beach Park
16 - Hauula Beach Park
17 - Sunset Beach Park
18 - Sunset Point Beach Park
19 - Pupukea Beach Park
20 - Ehukai Beach Park
21 - Kahuku District Park
22 - Kahuku Golf Course
23 - Adams Field
24 - Laie Park
25 - Hauula Community Park
26 - Sunset Beach Neighborhood Park
27 - Ko'Olau Summit Trail
28 - Hukilau Beach Park
29 - Turtle Bay Resort and Palmer and Fazio golf courses
30 - Polynesian Cultural Center
31 - Kahuku Motocross
Kawela Bay
Kahuku
Waialee
Sunset Beach
Pupukea
Waimea
Laie
Hauula
Punaluu
Kawailoa Beach
Kawailoa
Kamehameha Hwy
Project
Honolulu
1:115,000 WGS 1984 UTM 4
0 0.5 1 2 3 4 5 Miles
Data Sources Champlin: project facilities / ESRI: roads, cities / Hawaii Office of Planning: recreation resources / USDA NAIP: aerial imagery
TETRA TECH

Table 3.13-1. Recreation and Tourism Resources Near the Wind Farm Site and the Proposed Bat and Waterbird Mitigation Areas

GIS ID No.	Recreation Resource Name	Direction from Wind Farm Site or Mitigation Area	Distance from Wind Farm Site or Mitigation Area (Miles)	Owner/ Jurisdiction	Description
Recreation Resources Within 5 Miles of the Wind Farm Site					
1	James Campbell NWR	North	0.01	USFWS	Wildlife refuge consisting of over 160 acres of wetland habitat, primarily devoted to the recovery of Hawaii's four endemic water birds
2	Pupukea-Paumalu Forest Reserve	West	2.48	DoD/ DLNR, Division of Forestry and Wildlife (DOFAW)	Forest habitat conservation area, part of the Kahuku Training Area, open to public on weekends and Federal holidays for hiking and hunting; contains two designated trails, the Pupukea Summit Trail and Kaunala Trail
3	Hauula Forest Reserve	South	3.68	DOFAW	Forest habitat conservation area; contains three designated trails, the 2.5 mile Hauula Loop Trail, the 3 mile Maakua Gulch Trail (currently closed) and the 2.5 mile Maakua Ridge Trail; all trails begin in Hauula town
4	Kaipapau Forest Reserve	South	4.01	DOFAW	Forest habitat conservation area accessible via Hauula Loop Trail
5	Kihewamoku Island Sea Bird Sanctuary	Southeast	1.08	DOFAW	Small island off the windward coast that is protected for sea bird habitat
6	Mokuauia Island Sea Bird Sanctuary	Southeast	1.23	DOFAW	Small island off the windward coast that is protected for sea bird habitat
7	Pulemoku Rock Sea Bird Sanctuary	Southeast	1.82	DOFAW	Small island off the windward coast that is protected for sea bird habitat
8	Kukuihoolua Island Sea Bird Sanctuary	Southeast	2.27	DOFAW	Small island off the windward coast that is protected for sea bird habitat
9	Mokualai Island Sea Bird Sanctuary	Southeast	2.56	DOFAW	Small island off the windward coast that is protected for sea bird habitat
10	Mālaekahana State Recreation Area	East	0.03	DLNR, Division of State Parks	Wooded windward coast beach park with picnicking and camping; area divided into two sections
11	Laie Point State Wayside	Southeast	2.29	DLNR, Division of State Parks	Small windward coast park with scenic views and shore fishing; no facilities
12	Laie Beach Park	Southeast	2.61	City and County of Honolulu Department of Parks and Recreation (DPR)	Undeveloped windward coast beach park

Table 3.13-1. Recreation and Tourism Resources Near the Wind Farm Site and the Proposed Bat and Waterbird Mitigation Areas (continued)

GIS ID No.	Recreation Resource Name	Direction from Wind Farm Site or Mitigation Area	Distance from Wind Farm Site or Mitigation Area (Miles)	Owner/ Jurisdiction	Description
13	Kawela Bay Beach Park	Northwest	2.82	DPR	Secluded North Shore beach park with no developed facilities
14	Kokololio Beach Park	Southeast	2.96	DPR	Windward coast beach park with camping
15	Waialee Beach Park	West	3.28	DPR	Undeveloped North Shore beach park
16	Hauula Beach Park	Southeast	3.81	DPR	Windward coast beach park popular for camping and picnicking
17	Sunset Beach Park	West	4.05	DPR	North Shore beach park popular for summer swimming/snorkeling and winter surfing; picnic areas provided
18	Sunset Point Beach Park	West	4.15	DPR	Undeveloped North Shore beach park at eastern end of Sunset Beach
19	Pupukea Beach Park	West	4.34	DPR	North Shore beach park popular in summer for diving and snorkeling
20	Ehukai Beach Park	West	4.93	DPR	North Shore beach park popular for surfing; home to the Bonsai Pipeline
21	Kahuku District Park	East	0.18	DPR	15.9 acre district park located in Kahuku town. Facilities include baseball and soccer fields, tennis, basketball and volleyball courts, and restrooms
22	Kahuku Golf Course	Northeast	0.16	DPR	Municipal golf course located east of Kahuku town
23	Adams Field	Northeast	0.14	DPR	Undeveloped park located east of Kahuku town
24	Laie Park	Southeast	1.39	DPR	Community-based park with basketball and tennis courts, open play field with lights
25	Hauula Community Park	Southeast	4.26	DPR	Community park with sport field and multi-purpose building, offering variety of recreation, cultural and educational activities
26	Sunset Beach Neighborhood Park	Northwest	4.86	DPR	Community park with sport field and multi-purpose building, offering variety of recreation, cultural and educational activities
27	Koolau Summit Trail	East	2.42	Varies by location	North-south trail along the summit ridgeline of Koolau Mountain Range

Table 3.13-1. Recreation and Tourism Resources Near the Wind Farm Site and the Proposed Bat and Waterbird Mitigation Areas (continued)

GIS ID No.	Recreation Resource Name	Direction from Wind Farm Site or Mitigation Area	Distance from Wind Farm Site or Mitigation Area (Miles)	Owner/ Jurisdiction	Description
28	Hukilau Beach Park	Southeast	1.37	Private	Beach park located at northern end of Laie town
29	Turtle Bay Resort, Palmer and Fazio golf courses	North	1.40	Private	Private resort at northeastern corner of Oahu, with two challenging golf courses open to public
30	Polynesian Cultural Center	Southeast	2.07	Private	Very popular tourist attraction in Laie town.
31	Kahuku Motocross Course	Northwest	2.26	DoD/Private	A portion of the Army's Kahuku Training Area leased to the Hawaii Motorsports Association; open to the public on weekends and Federal holidays
Recreation Resources Within 1 Mile of the Hamakua Marsh Waterbird Mitigation Area					
32	Ulupo Heiau Cultural Park/State Monument	West	0.88	DLNR, Division of State Parks	Sacred cultural site now listed on National and State Registers of Historic Places
33	Kawainui Marsh Regional Park	Adjacent	0	DPR	Large regional park consisting primarily of Kawainui Marsh; other parks listed below are located around its perimeter
34	Hamakua Marsh/ Hamakua Marsh Wildlife Sanctuary	Within	0	DPR	Marsh and protected wildlife area in which mitigation area is proposed
35	Kailua District Park	East	0.26	DPR	18-acre park with swimming pool, tennis and basketball courts, and other developed facilities
36	Kawai Nui Neighborhood Park	North	0.82	DPR	Typical small neighborhood park with picnic area, restrooms, and open play area
37	Keolu Hills Neighborhood Park	Southwest	0.94	DPR	Typical small neighborhood park with picnic area, restrooms, and open play area
38	Kaelepulu Mini Park	East	0.56	DPR	Typical small neighborhood park with picnic area, restrooms, and open play area
39	Pohakupu Mini Park	Southeast	0.76	DPR	Typical small neighborhood park with picnic area, restrooms, and open play area
40	Enchanted Lake Community Park	Southeast	0.40	DPR	Typical small neighborhood park with picnic area, restrooms, and open play area

Table 3.13-1. Recreation and Tourism Resources Near the Wind Farm Site and the Proposed Bat and Waterbird Mitigation Areas (continued)

GIS ID No.	Recreation Resource Name	Direction from Wind Farm Site or Mitigation Area	Distance from Wind Farm Site or Mitigation Area (Miles)	Owner/ Jurisdiction	Description
41	Kailua Beach Park	East	0.85	DPR	Popular beach park with parking, picnic areas, restrooms and rinse areas
42	Kalama Beach Park	East	0.80	DPR	Popular beach park with parking, picnic areas, restrooms and rinse areas
43	Mid-Pacific Country Club	Southeast	0.75	Private	Private golf course
44	Windward YMCA	West	0.50	Private	Private recreational/ educational facility with swimming pool and fitness center
Recreation Resources Within 1 Mile of the Poamoho Ridge Bat Mitigation Area					
45	Ewa Forest Reserve	Within and extending west	0	DoD/ DOFAW	Forest habitat conservation area, part of the Kawailoa Training Area
46	Poamoho Ridge Trail & Poamoho Hele Loa Access	Adjacent/North side	0	DoD/ DOFAW	Primitive access road and hiking trail along the northern boundary of the Ewa Forest Preserve to Poamoho Ridge
47	Schofield-Waikane Trail	Adjacent/South side	0	DoD/ DOFAW	Trail along the southern boundary of the Ewa Forest Preserve to Poamoho Ridge
48	Ahupuaa O Kahana State Park	East	0	DLNR, Division of State Parks	One of a few publicly owned ahupuaa in the state, established as a "living park" to foster native Hawaiian cultural traditions and cultural landscape
49	Sacred Falls State Park	Northeast	0.99	DLNR, Division of State Parks	This state park and its trails are closed indefinitely following a fatal May 1999 landslide
27	Koolau Summit Trail	Adjacent/East side	0	Varies by location	North-south trail along the summit ridgeline of Koolau Mountain Range
1 mile = 1.6 kilometers					

The Pupukea-Paumalu Forest Reserve is open to the public for hunting and hiking on weekends and Federal holidays, when the area will not be used by the military for training purposes. An area in the northwestern corner of the KTA is also open to the public for recreational purposes; this area is under lease by the Hawaii Motor Sports Association for motocross racing on weekends and Federal holidays (U.S. Army 2010).

The open space map in the Koolau Loa Sustainable Community Plan indicates a “mountain access” route that begins in Kahuku and extends to the southwest, passing through the wind farm site. No other information regarding this route is included in the plan; it does not appear to be a formal trail or recognized public access, and is therefore not considered further in this analysis. The Koolau Loa Sustainable Community Plan also notes the presence of scenic views that are considered important. These include views along and outward from the coast from Makahoa Point, Kalanai Point, and other beach access areas, as well as a scenic view westward from the Kamehameha Highway up the Malaekahana valley. While not specifically recreational resources, these scenic views form a part of the overall character and attraction of the area, and the Hawaiian islands in general. Scenic views are addressed in Chapters 3.14, and are therefore not considered further in this analysis of recreation resources.

The public facilities map in the Koolau Loa Sustainable Community Plan (City and County of Honolulu, DPP 2012) identifies a future bike route along the Kamehameha Highway. Similarly, the Hawaii Bike Master Plan (HIDOT 2002) calls for shared bike usage on the Kamehameha Highway in the future. This signage project is a Class III priority recommendation, to occur more than 20 years in the future. However, the Koolau Loa Sustainable Communities Plan notes that recreational use of the highway, and in particular the number of organized bicycling events that use it, has been increasing and sometimes causes delays.

3.13.2 Hamakua Marsh (waterbirds)

The Hamakua Marsh Mitigation Area is located near the western edge of the city of Kailua, adjacent to the Kawainui Canal. It is located within the Hamakua Marsh, in an area known as the Hamakua Marsh Wildlife Sanctuary. This marsh is one of a number of public recreation and tourism resources in the area, and is popular for bird watching.

In terms of acreage, the Kawainui Regional Park, which contains the Kawainui Marsh, is the largest nearby recreation and tourism resource. This park is described as an area of cultural and archaeological significance, a habitat for endangered species and introduced wildlife, a critical flood control basin, an aesthetic open space resource, and an area providing a variety of recreational and educational opportunities. The 1994 Master Plan (Wilson Okamoto 1994) indicates a number of smaller parks around the edges of the Kawainui Marsh; of those, only the Ulupo Heiau Cultural Park (home to the Ulupo Heiau State Monument) along the southeastern side is within one mile of the waterbird mitigation area. The portion of the waterbird mitigation area south of Kailua Road (HI Highway 61) is identified in the Master Plan as the Puu O Ehu Wetland.

Other public recreation and tourism resources in the vicinity include district and community parks in Kailua and the surrounding residential areas, and beach access points along the coast. The nearest of these is the Kailua District Park, an 18-acre recreation facility with a swimming pool, tennis and basketball courts, baseball fields, and other developed active recreation facilities, located approximately 0.3 mile (0.4 kilometer) east of the waterbird mitigation area. Community parks in the analysis area include the Kawai Nui Neighborhood Park, Kaelepulu Mini Park, Enchanted Lake Community Park, Kaelepulu Mini Park, and Keolu Hills Neighborhood Park. The Kailua Beach Park, Kalama Beach Park, and a number of beach access points are located along the coast, about a mile from the waterbird mitigation area. All of these identified public recreation and tourism resources are managed by the City and County of Honolulu, Department of Parks and Recreation, except for the State-owned Ulupo Heiau Cultural Park.

There are also a number of private recreational and tourism resources in the vicinity of the waterbird mitigation area. These include the Mid-Pacific Country Club golf course, located to the east of the mitigation area, and the Windward YMCA, located along the north side of Kailua Road about 0.6 mile (1.0 kilometer) west of the waterbird mitigation area.

Identified public and private recreation resources are listed in Table 3.13-1 including a brief description of each of these areas, the owner or management agency, and the distance and direction of each of these resources from the Hamakua Marsh mitigation area.

The Kawainui Marsh Master Plan calls for the development of a Kawai Nui Gateway Park, to be located at the northeastern corner and along the northeastern side of the Kawainui Regional Park, east of the flood control levee and about 0.5 mile (0.8 kilometer) north of the waterbird mitigation area; however, this park has not yet been developed. The 2001 Trails Plan (Helber Hastert & Fee 2001) for the park includes a pedestrian and/or multipurpose trail around the perimeter of the park, but not into the waterbird mitigation area. The trails plan shows the trail running along the top of the flood control levee along the eastern side of the park, and recommends a new parking lot at the southeastern corner of the park, north of Kailua Road. A primitive dirt parking lot is present on the north side of Kailua Road and a pathway is evident along the levee, but the parking lot improvements and the remainder of the trail do not appear to have been completed to date.

3.13.3 Poamoho Ridge (bat)

Recreation and tourism resources within 1 mile of the Poamoho Ridge mitigation area are few, and public access is limited. The Poamoho parcels are located near the ridgeline of the Koolau Mountain Range, within the Ewa Forest Reserve (Poamoho Section), which itself is a portion of the Army's Kawailoa Training Area (KLOA; see Section 3.19). Nearby recreation and tourism resources are limited to the Ahupuaa O Kahana State Park and Sacred Falls State Park and three trails, described in Table 3.13-1.

Aside from three hiking trails, there are no developed recreation facilities within the 1-mile analysis area for the Poamoho Ridge mitigation area. An access road and trail run along the northern boundary of the Ewa Forest Preserve (Poamoho Ridge Trail), and a second trail runs along the southern boundary of the Ewa Forest Preserve (Schofield-Waikane Trail); both are accessed from the west near Wahaiwa, and run to the ridgeline of the Koolau Mountain Range. According to DOFAW's Na Ala Hele Trail & Access Program website (DOFAW 2013b), hiking the Schofield-

Waikane Trail requires written authorization from the Army's Director of Public Works for access, as well as a hiking permit from DOFAW. Accessing the Poamoho Ridge Trail also requires a DOFAW permit, and access to this trail is limited to no more than 20 four-wheel-drive vehicles and 100 people per day (DOFAW 2013b). Use of these trails is limited to weekends and Federal holidays only, when the Army would not be using the area for training. There are no trails leading to the Poamoho Ridge mitigation area from the east. The third trail in the vicinity is the Koolau Summit Trail, which runs north-south along the ridgeline of the Koolau Mountain Range, passing along the eastern edge of the Poamoho Ridge mitigation area. The trail extends from Pupukea at the north end to Kipapa at the south. Limited access notwithstanding, both the Ewa Forest Preserve and the adjacent Ahupuaa O Kahana State Park are designated hunting areas for wild pigs and goats (DOFAW 1999).

Sacred Falls State Park is closed indefinitely following a fatal May 1999 landslide; it is unknown when or if it will re-open to the public. The nearby Oahu Forest National Wildlife Refuge is closed to the public (USFWS 2013b) and therefore does not represent a recreation resource.

Identified recreation resources are listed in Table 3.13-1 including a brief description of each of these areas, the owner or management agency, and the distance and direction of each of these resources from the Poamoho Ridge mitigation area.

3.14 Visual Resources

Visual resources are the natural and built features of the landscape that contribute to the public's experience and appreciation of the environment. The analysis area for visual resources is defined as the area within 10 miles (16 kilometers) of the Na Pua Makani wind farm site. As discussed in more detail in Chapter 4, the 10-mile (16-kilometer) area represents the approximate zone of visual influence for the Project, based on the viewshed analysis undertaken to assess the potential for Project components to be visible. Section 3.14 summarizes existing visual resource conditions on a regional and local basis. Section 4.16 of Chapter 4 provides additional information for specific viewing locations employed in the visual assessment for the Project.

3.14.1 Regional Setting

The Island of Oahu is located in the Hawaiian High Islands Ecoregion, which contains a variety of landforms, including Fresh, massive volcanic shields and cinderlands reaching over 13,000 feet (3,962 meter) elevation; high sea cliffs up to 3,000 feet (914 meters) in height; raised coral plains; and amphitheater-headed valley/ridge systems with alluvial/colluvial bottoms . The topography of Oahu was created by two erupting volcanoes, leaving two mountain ranges separated by a broad valley, or central plain. The Koolau Mountains occupy the eastern side of the island and the Waianae Mountains occupy the western side.

3.14.2 Wind Farm Site

The wind farm site is located in the northeastern portion of Oahu. The visual setting surrounding the wind farm site consists of steep, dissected ridges surrounding gently sloping valleys, with elevations ranging from approximately 3 feet (1 meter) above mean sea level (amsl) on the northern edge to 614 feet (187 meters) amsl on the southwestern edge. The wind farm site exhibits the typical landscape character of Oahu, with a mixture of dense forests, urbanized use, and agricultural lands. Lands adjacent to the wind farm site include agricultural lands to the north; residential, community infrastructure, and agricultural lands to the east; a mixture of agricultural lands and undeveloped forest lands to the south; and undeveloped forest lands to the west.

Higher–elevation portions of the Project Area occur on vegetated ridges not actively used for agriculture and appear more natural, while cultivated lands occupy most of the lower–elevation areas. The agricultural areas support a wide array of crops being cultivated by lessees and landowners, and include some areas of fallow agricultural land. The colors and textures of agricultural lands appear more natural when compared to the developed communities.

The operational Kahuku Wind Power Project abuts the Project Area to the northwest. The James Campbell National Wildlife Refuge is approximately 0.01 mile (0.02 kilometer) to the north and Malaekahana State Recreation Area is approximately 0.03 mile (0.05 kilometer) to the east.

A number of primarily residential communities are located along the Kamehameha Highway, including Kahuku, Laie, Hauula, Punaluu, Kahana and Kaaawa. The Kamehameha Highway is the only arterial roadway linking these areas with the North Shore.

3.14.3 Mitigation Areas

3.14.3.1 Hamakua Marsh (waterbird)

The proposed waterbird mitigation area/sanctuary, known as the Hamakua Marsh, is State-owned and administered by the State of Hawaii DLNR. Hamakua Marsh is located on the western edge of the town of Kailua and adjacent to Kawainui Marsh, a DLNR-owned and managed waterbird management area.

Immediately adjacent to the Hamakua Marsh are commercial and residential areas. The Hamakua Marsh area provides a buffer between these residential and commercial areas and conservation and fallow farm lands.

The Hamakua Marsh is located within the boundaries of the Koolaupoko planning region of Oahu. The comprehensive plan applicable to this area is the Koolaupoko Sustainable Communities Plan, which designates the Hamakua Marsh for Open Space/Preservation areas (City and County of Honolulu, DPP 2012).

3.14.3.2 Poamoho Ridge (bat)

The Poamoho Ridge mitigation area is also owned and managed by the State (DLNR) and comprises two land areas located near the ridgeline of the Koolau Mountain Range, within the Ewa Forest Reserve, which is a portion of the Army's Kawailoa Training Area.

The existing landscape character for the Poamoho Ridge is forest as it is located entirely in the Ewa Forest Reserve. Immediately to the south is military owned Schofield Barracks. And over the ridge to the east are vacant ridge lands, and further east are the coastal towns of Kaawa and Punaluu.

3.14.4 Applicable Plans

Public agencies use planning policy to establish visual resource management objectives to protect and enhance visual resources. Goals, objectives, policies, implementation strategies, and guidance are typically found in comprehensive plans, and local specific plans.

The wind farm site is not identified as a scenic vista or viewshed in the county or State plans or studies. The wind farm site is located within the Koolau Loa area of Oahu, which spans the northern half of Oahu's windward coast. The KooLoa Sustainable Communities Plan (2012) identifies the need to "preserve the region's rural character and its natural, cultural, scenic and agricultural resources."

Scenic and visual resources referenced in The Koolau Loa Sustainable Communities Plan include sections of the Kamehameha Highway, a State-designated scenic highway, Turtle Bay Golf Course, Kahuku Golf Course, Kahuku Training Area, numerous parks and recreation areas (City and County of Honolulu, DPP 2012).

The Koolau Loa Sustainable Communities Plan designates the lands containing the wind farm site as rural. Policies listed in the Plan pertaining to electrical systems include:

- Provide adequate and reliable electrical service.
- Locate and design system elements such as renewable energy facilities (e.g., wind and solar), electrical sub-stations, communication sites, and transmission lines, including consideration of underground transmission lines, to avoid or mitigate visual impacts on scenic and natural resources, as well as public safety considerations.
- Discourage the use and installation of overhead utility lines and poles. Strong consideration should be given to placing replacement and new transmission lines underground to enhance viewplanes, increase highway safety and improve utility service.
- Encourage the development and use of renewable energy sources and energy conservation measures.

There were no other scenic resource policies in the Koolau Loa Sustainable Communities Plan pertaining to lands in the wind farm site. In addition there were no other applicable jurisdictions or land use plans identifying scenic resources in the wind farm site.

3.15 Transportation

This section addresses public and privately owned transportation infrastructure, including harbors, airports, highways, and roadways. A discussion of transportation and traffic includes the movement of motor vehicles, ships, airplanes, pedestrians, and bicyclists. The analysis area for transportation and traffic includes the routes of travel to and from Project Area, including the construction access routes, as described in Section 2.4.6, and the mitigation areas.

3.15.1 Existing Conditions

3.15.1.1 Harbors

There are two deep draft harbors in Oahu: Honolulu and Kalaeloa Barbers Point harbors. Project cargo would be transported to Kalaeloa Harbor which is a heavy lift berthing facility that is able to accommodate the equipment and materials for the Project, namely the turbines.

3.15.1.2 Airports

The Project is approximately 22 miles (35 kilometers) north of the Honolulu International Airport and is approximately 38 miles (61 kilometers) driving distance from the airport using Interstate H-3. The Project is approximately 15 miles (24 kilometers) east of the Dillingham Airfield and is approximately 24 miles (39 kilometers) driving distance from the Dillingham Airfield. Other farther away public airports on Oahu include Kalaeloa Airport. There are no privately-owned runways on Oahu. However, there are several military airports serving Oahu including Hickam Air Force Base, Marine Corps Base Hawaii Kaneohe Bay, and Wheeler Army Airfield.

The Applicant is required to receive approval from the Federal Aviation Administration (FAA) for the construction of the Project. Pursuant to 14 CFR 77, temporary or permanent structures higher than 200 feet amsl or exceeding any obstruction standards should generally be marked or lighted. This review process ensures that there are no adverse impacts to air traffic and determines the lighting plan that would be required at the Project.

3.15.1.3 Highways and Roadways

Wind Farm Site

State and county highways and roadways comprise the majority of the proposed construction route, as described in Section 2.4.6, to the wind farm site. These roads are further identified in Tables 2-3, 2-4, and 2-5 with the construction route segment, ownership/jurisdiction, and approximate distance.

Access to the Project is provided through two locations off of Kamehameha Highway; via the existing Malaekahana Road and via unnamed existing State-owned roads that lead to the Kahuku Agricultural Park. Kamehameha Highway is the regional State highway that serves the Koolau Loa area as a two-lane undivided highway. Kamehameha Highway is under the jurisdiction of the State of Hawaii, Department of Transportation. The lanes are 12 feet (3.7 meters) wide with grassed and, in some sections, paved shoulders. Posted speed limits along the Highway vary between 25 and 45 mph and generally have lower speed limits near towns and schools. The posted speed limit near the access road into the wind farm site is 35 mph.

The Na Pua Makani Wind Farm Traffic Assessment Report (see Appendix B) provided the morning and afternoon peak hour traffic volumes as well as the 24-hour volume at the Malaekahana Stream Bridge Hawaii Department of Transportation count station in 2013. Table 3.15-1 provides these traffic counts revealing that the morning peak hour was between 7:00 a.m. to 8:00 a.m. while the afternoon peak was between 3:45 p.m. and 4:45 p.m.

Table 3.15-1. Existing 2013 Traffic Counts

Time	Total Traffic Volume (Both Directions)
AM Peak Hour (7:00 a.m. – 8:00 a.m.)	1,095
PM Peak Hour (3:45 p.m. – 4:45 p.m.)	1,012
24 Hour	12,187
Source: State of Hawaii, Department of Transportation, Highways Division	

To note, the traffic volumes in 2013 reflect traffic volumes in previous years. The traffic volumes over 12 years of available data show a modest increase as noted in Appendix B.

Mitigation Areas

Access to the Poamoho Ridge for the Hawaiian bat mitigation is along Paalaa Uka Pupukea Road, near the entrance of Helemano Military Reservation, to a controlled gate leading to a jeep trail to the Poamoho Ridge trail head. Access to the Poamoho Ridge requires a permit from DOFAW and four-wheel-drive vehicle. At the end of the controlled access jeep trail is the start of the trail head for the Poamoho Trail which is a several mile hike to the mitigation area. Paalaa Uka Pupukea Road is a two-lane undivided Federal roadway mainly serving Helemano Military Reservation. The posted speed limit ranges from 15 to 35 mph (24 to 56 kph).

Access to the Hamakua Marsh for the waterbirds mitigation is along Hamakua Drive. Hamakua Drive is a four-lane undivided County roadway mainly serving Kailua residential neighborhoods. The posted speed limit is 25 mph (40 kph).

3.15.1.4 Transit Systems

The City and County of Honolulu operates the island's transit system called "TheBus". TheBus provides service island-wide and 7 days a week including holidays. Routes 55 (North Shore to Kaneohe to Ala Moana) and 88A (North Shore Express) run along the Kamehameha Highway adjacent to the Project Area.

There are no TheBus routes that stop nearby the controlled gate access to enter the jeep trail to get to the Poamoho Trail head nor Paalaa Uka Pupukea Road.

TheBus Routes 56, 57, 57A, 70, and 89 run along Kailua Road near Hamakua Drive that have bus stop locations near the Hamakua Marsh.

3.15.1.5 Pedestrians and Bicyclists

In addition to vehicular traffic, the majority of the Project's construction access route is used by pedestrians and bicyclists. These uses are generally highway and roadway shoulders shared by pedestrian and bicyclist alike. The closest bike and pedestrian path to the wind farm site access road is Malaekahana Bike and Pedestrian Path along Kamehameha Highway is located south of the wind farm site approximately one mile away.

There is no bike access to the Koolau Mountain Watershed mitigation area. Hiking is available to this area but requires a permit from DOFAW.

Pedestrian access for the Hamakua Marsh is along Hamakua Drive as a sidewalk on both sides of the road while bike access is provided by a shared shoulder.

3.16 Public Health and Safety

The analysis of health and safety in this EIS examines the issues related to public health and safety as they relate to wind energy projects. The potential for injuries to workers and the general public during construction may result from 1) the movement of construction vehicles, equipment, and materials; 2) falling overhead objects; 3) falls into open excavations; and 4) electrocution. These types of incidents can be managed with standard construction practices and therefore are not discussed in detail here. Health and safety issues addressed here relate to the operation and/or failure of the Project or its components. Where applicable, discussion of Project-specific health and safety conditions is also included. Therefore, the analysis area for health and safety is the wind farm site and the surrounding community. The health and safely analysis in this EIS is based on information from scientific studies and data generated from wind projects currently operating in the United States and Europe.

3.16.1.1 Turbine Collapse and Blade Throw

Health and safety hazards related to wind turbines include collapse of the turbine tower and rotor blades breaking causing parts to fall or be thrown from the nacelle. It is not very common for a turbine to collapse or a rotor blade to be dropped or thrown from the nacelle, but such incidents do occur and are potentially dangerous for site personnel and the general public. A study by Caithness Windfarm Information Forum, documented 280 separate incidences from the 1990s through 2013 around the world of blade failure due to whole blades or pieces of blade being thrown from a turbine (CWIF 2013). Honolulu County's Land Use Ordnance provision (Article 4, Section 21-5.700) specifies that wind turbines must be set back from all property lines a minimum distance equal to the height of the system, where height shall include the height of the tower and the farthest vertical extension of the turbine.

One concern raised during scoping was the risk to public safety associated with the ability of turbines to withstand hurricane force winds. The International Electrotechnical Commission (IEC) has a set of international design standards, collectively referred to as IEC 61400, which ensure that wind turbines are appropriately engineered against damage from hazards within their planned lifetime (IEC 2005). Wind conditions are one environmental factor that must be taken into account in turbine design, and to this end, the IEC has defined wind turbine classes determined by three parameters: the average wind speed, extreme 50-year gust (defined as a 3-second average gust that has a 50 percent probability of occurring in 50 years), and turbulence. All turbine models are expected to be able to withstand a minimum average wind speed at hub height of 13.4 mph (6 meters per second), and extreme 50-year gusts of at least 94 mph (42 meters per second).

3.16.1.2 Shadow Flicker

A wind turbine's moving blades can cast a moving shadow on locations within a certain distance of a turbine. These moving shadows are called shadow flicker, and can be a temporary phenomenon experienced by people at nearby residences or public gathering places ("receptors"). The impact area depends on the time of year and day (which determines the sun's azimuth and altitude angles) and the wind turbine's physical characteristics (height, rotor diameter, blade width, and orientation of the rotor blades). Wind turbine shadow flicker generally occurs during low angle sunlight conditions, typical during sunrise and sunset. Moving shadows have the potential to induce epilepsy seizures annoyance, stress, and safety concerns including vehicle driver distraction; however, as discussed below, the rotational speed of modern wind turbines is well below the level at which these shadow flicker effects would be likely to occur.

Shadow flicker intensity for receptor-to-turbine distances beyond 4,921 feet (1,500 meters) is very low and generally considered imperceptible. Shadow flicker intensity for receptor-to-turbine distances between 3,281 and 4,921 feet (1,000 and 1,500 meters) is also low and considered barely noticeable (Tetra Tech 2012b). At this distance, shadow flicker intensity would only tend to be noticed under conditions that would enhance the intensity difference, such as observing from a dark room with a single window directly facing the turbine casting the shadow. There are no State or national standards for frequency or duration of shadow flicker from wind turbines.

Photosensitive epilepsy occurs in one in 4,000 (0.025 percent) of the population (Harding and Jeavons 1994 as cited in Harding et al. 2008). Harding et al. (2008) determined that flicker from turbines that interrupt or reflect sunlight at frequencies greater than 3 hertz poses a potential risk of inducing photosensitive seizures; at 3 hertz and below the cumulative risk of inducing a seizure should be 1.7 per 100,000 (0.0017 percent) of the photosensitive population. Harding et al. (2008) suggest that it is important to keep rotation speeds to a minimum, and in the case of turbines with three blades ensure that the maximum speed of rotation does not exceed 60 revolutions per minute, which is normal practice for large wind farms.

3.16.1.3 Fire

The presence of electrical gathering equipment and electrical cables, and oils used for lubricating, cooling and hydraulic functions within wind turbine towers and nacelles can create the potential for fire or medical emergencies. In addition, the storage and use of fuels, oils, and hydrolic fluid at various facilities such as the onsite substation, the equipment staging and laydown area and operations and maintenance building also have the potential for fire (see Section 3.18 – Public Infrastructure and Services for additional information).

In 2012, a fire at the Kahuku Wind Farm adjacent to the wind farm site destroyed the battery storage facility where the energy collected by the turbines was stored, however no one was hurt and toxic chemical levels were determined to be within safe range (Hawaii News Now 2012 and

Honolulu Civil Beat 2012). At the same building there was a fire reported in 2011 that destroyed inverters. The Na Pua Makani wind farm does not include a battery storage facility. The fire risk associated with Project operations and maintenance is similar to risks associated with other industrial and storage facilities. Operations and maintenance personnel for the Project would be trained in fire safety and response. See Section 3.6 – Natural Hazards for additional information on fire.

3.16.1.4 Noise and Vibration

Wind turbines emit low frequency noise and infrasound due to rotating blades. Low frequency noise is audible noise in the frequency range of 20 to 20,000 hertz and infrared sounds are below audible sound (i.e., less than 20 hertz) (Epsilon Associates, Inc. 2009). Low frequency noise and infrasound are thought to cause "Wind Turbine Syndrome" (WTS), a condition devised by Dr. Nina Pierpont to describe the collection of symptoms reported to her during interviews of people living near wind turbines (Pierpont 2009). She attributed reports of annoyance, sleep disturbance, headaches, nausea, and dizziness to exposure to low frequency noise and infrasound (Pierpont 2009) emitted by wind turbines. Pierpont interviewed a total of 23 people via telephone, and from them gathered information on the symptoms of another 15 people. There were no medical or diagnostic tests conducted with her investigation. Pierpont suggests that WTS is "mediated by the vestibular system—by disturbed sensory input to eyes, inner ears, and stretch and pressure receptors in a variety of body locations." (Pierpont 2009). Although WTS is not a recognized medical diagnosis and the Pierpont (2009) study was not peer-reviewed or published in a scientific journal, the topic has led to health concerns associated with wind energy projects. Pierpont states "Further research is needed to prove causes and physiologic mechanisms, establish prevalence, and explore effects in special populations, including children" (Pierpont 2009).

Crichton et al. (2013) tested the potential for symptom expectations regarding adverse health effects generated by wind turbines. This study concluded that healthy volunteers, when given information about the expected physiological effect of infrasound, reported symptoms that aligned with that information, during exposure to both infrasound and sham infrasound (Crichton et al 2013). Symptom expectations were created by viewing information readily available on the Internet, indicating the potential for symptom expectations to be created in real world settings (Crichton et al 2013). Results suggest psychological expectations could explain the link between wind turbine exposure and health complaints (Crichton et al 2013). Likewise, an expert panel review of wind turbine sound and health effects concluded that there is no evidence that the audible or sub-audible sounds emitted by wind turbines have any direct adverse physiological effects; the ground-borne vibrations from wind turbines are too weak to be detected by, or to affect, humans; and that the sounds from wind turbines could plausibly have direct adverse health consequences (Colby et al 2009).

In 2012 The Massachusetts Department of Environmental Protection (MassDEP) and the Massachusetts Department of Public Health (MDPH) convened an expert panel of seven doctors and scientists that found there is limited evidence suggesting that exposure to wind turbines could result in symptoms that could be characterized as WTS; in other words, it is possible that noise from some wind turbines can cause sleep disruption but there is not enough evidence to provide particular sound-pressure thresholds at which wind turbines cause sleep disruption (MassDEP and MDPH 2012). This same study concluded that it is difficult to find reliable and comparable infrasound and low frequency noise measurement data in the peer-reviewed literature. This study also noted that it is important to make the clear distinction between amplitude-modulated noise (the whooshing sound) from wind turbines and the infrasound and low frequency noise from turbines. The whooshing noise created by modern wind turbines that is heard is not infrasound and much of its content is not at low frequency. Most of the sound is at higher frequency and as such it will be subject to higher atmospheric attenuation than the low frequency sound (MassDEP and MDPH 2012).

In 2013, an Australian team of researchers concluded the evidence for wind turbine noise and infrasound causing health problems is poor, and that reported symptoms were in response to nocebo effect (a nocebo effect is a worsening of mental or physical heath based on fear or belief in adverse effects, and is the opposite of the well-known placebo effect, where belief in positive effects of an treatment or intervention may produce positive results (Spiegel 1997) (Chapman et al 2013). It was found that there was a large variation in health complaints and wind farm noise among residents near 49 wind farms in Australia, and only 1 in 272 residents living within 3.1 miles (5 kilometers) of a wind facility complained (Chapman et al 2013). Over 80 percent of the complaints were received after 2009 when anti wind farm groups began to add health concerns to their wider opposition and following publicity generated by the publication of Dr. Nina Pierpont's "Wind Turbine Syndrome" book (Chapman et al 2013). Low frequency noise and infrasound are not currently regulated; see Section 3.4 for noise regulations.

3.16.1.5 Electromagnetic Interference

EMF refers to electric and magnetic fields that are present around any electrical device. Electric fields arise from voltage, or electrical charges and magnetic fields arise from current, or the flow of electricity that travels along transmission lines, power collection lines, substation transformers, house wiring, and electrical appliances. The intensity of the electric field is related to the voltage of the line, and the intensity of the magnetic field is related to the current flow through the conductors. Electric and magnetic fields decrease in intensity rapidly with distance from the source (NIEHS 2002).

Research has been conducted regarding exposure to EMF and potential health impacts, including cancer and childhood leukemia. The NIEHS evaluated over 20 years of active scientific research and concluded that the evidence for an association between childhood leukemia and exposure to EMF is weak, and it is not clear whether it represents a cause-and-effect relationship (NIEHS 2002). The NIEHS also concluded that at present, the available studies indicate no association between EMF exposure and childhood cancers (NIEHS 2002). While the general consensus is that electric fields pose no risk to humans, the question of whether exposure to magnetic fields can cause biological responses or health effects continues to be the subject of research and debate. The Project would generate EMF at the substation and the underground collection system.

3.16.1.6 Stray Voltage

For safety reasons, nearly all types of electrical systems in the United States are connected to the earth or "grounded." If a system is not properly wired, the point(s) at which a system is grounded can develop a small voltage that can push current through the earth and end up contacting unintended objects (AWEA 2008). Stray voltage is the result of faulty wiring on electrical systems and is easily prevented by industry-standard practices. It is also a strictly localized issue that will not affect off-site parties or properties (CanWEA undated). Stray voltage is commonly found at agricultural operations where electrical systems and wiring are not updated and where farms have metal features that may come in contact with water and wet conditions.

The main concern with stray voltage is electrical shock. This phenomenon is rare and primarily affects cattle, whose legs are far enough apart to stand on two points where different voltage levels in the ground exist (AWEA 2008). Suspected cases of stray voltage should be investigated by an inspector from a local utility operator to investigate the farm’s existing wiring system to ensure proper installation, wire condition and code compliance. An inspector will seek to isolate the source of neutral-to-earth (ground) voltage through measurement of voltage at various points within the electrical system to determine whether the issue is related to on-farm wiring and distribution or whether the issue is related to the electrical distribution system off the farm (CanWEA undated).

3.17 Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires each Federal agency to make the achievement of environmental justice part of its mission by identifying and addressing disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations. The Executive Order further stipulates that the agencies conduct their programs and activities in a manner that does not have the effect of excluding persons from participation in them, denying persons the benefits of them, or subjecting persons to discrimination because of their race, color, or national origin.

The White House Council on Environmental Quality’s (CEQ’s) Environmental Justice Guidance under the National Environmental Policy Act (CEQ 1997a) indicates that environmental justice concerns may arise from impacts on the natural or physical environment, such as human health or ecological impacts on minority and low-income populations, or from related social or economic impacts. The CEQ guidance also indicates that the identification of disproportionate effects does not preclude the agency from going forward with the proposed action, but should heighten attention to project alternatives, mitigation and monitoring needs, and the preferences of the affected communities (CEQ 1997a, p. 10).

The State of Hawaii has developed its own legislation and guidance related to environmental justice. Act 294, signed by Governor Lingle in July 2006, aimed to accomplish two goals: 1) to define environmental justice in the unique context of Hawaii, and 2) to develop and adopt environmental justice guidance document that addresses environmental justice in all phases of the environmental review process (Kahihikolo 2008). Environmental Justice is defined for Hawaii as follows:

Environmental justice is the right of every person in Hawai`i to live in a clean and healthy environment, to be treated fairly, and to have meaningful involvement in decisions that affect their environment and health; with an emphasis on the responsibility of every person in Hawai`i to uphold traditional and customary Native Hawaiian practices that preserve, protect, and restore the `aina for present and future generations. Environmental justice in Hawai`i recognizes that no one segment of the population or geographic area should be disproportionately burdened with environmental and/or health impacts resulting from development, construction, operations and/or use of natural resources. (Kahihikolo 2008, p. 4-6)

Like the CEQ guidance, Hawaii Revised Statute (HRS) Chapter 343, indicates that the identification of disproportionate effects does not preclude the proposed action from going forward, but should result in increased attention to project alternatives, mitigation and monitoring needs, and the preferences of the affected communities (Kahihikolo 2008, p. 6-6).

The analysis area for the environmental justice analysis is the Koolau Loa District with emphasis on the individual communities in the Project vicinity, especially Kahuku and Laie. Data for Honolulu County and the State of Hawaii are provided for comparison, as appropriate.

3.17.1 Race and Ethnicity

The Environmental Justice guidelines provided by the CEQ (1997a) and similar direction provided by the EPA (1998) indicate that a minority community may be defined where either 1) the minority population comprises more than 50 percent of the total population, or 2) the minority population of the affected area is meaningfully greater than the minority population in the general population of an appropriate benchmark region used for comparison. Minority communities may consist of a group of individuals living in geographic proximity to one another, or a geographically dispersed set of individuals who experience common conditions of environmental effect.

The racial and ethnic composition of Hawaii is substantially different from that of the United States as a whole (Table 3.17-1 and Figure 3.17-1). Whites make up almost two-thirds of the total U.S. population, but account for just 23 percent of the population in Hawaii. No single group accounts for more than half of the population in Hawaii. The largest group is Asian, with 38 percent of the population in 2012, followed by Whites (23 percent). Asians make up just 5 percent of the total U.S. population. Another important difference between Hawaii and the United States as a whole is the proportion of the population reporting two or more races, 19 percent in Hawaii versus 2 percent nationally. Finally, Native Hawaiians and Other Pacific Islanders make up 9 percent of the Hawaiian population compared to 0.2 percent nationally (Table 3.17-1).

Table 3.17-1. 2012 Race and Ethnicity

Geographic Area	Total Population	Percent of Total Population					
		White[1/]	Asian[1/]	Native Hawaiian and Other Pacific Islander[1/]	Hispanic or Latino	Two or more races[1/]	Other Race[1/ 2/]
United States	309,138,711	63.7%	4.8%	0.2%	16.4%	2.0%	13.1%
Hawaii	1,362,730	22.8%	37.8%	9.3%	9.0%	19.3%	1.8%
Honolulu County	955,215	19.2%	43.1%	9.0%	8.3%	18.2%	2.2%
Koolau Loa CCD	20,111	29.0%	11.2%	22.6%	9.3%	26.8%	1.1%
Kahuku CDP	2,626	6.1%	24.2%	29.7%	11.3%	28.3%	0.5%
Kawela Bay CDP	279	77.4%	2.2%	1.1%	4.7%	9.0%	5.7%
Laie CDP	5,560	25.3%	9.7%	33.5%	3.7%	27.6%	0.1%

Source: U.S. Census Bureau 2012

1/ Non-Hispanic only. The Federal government considers race and Hispanic/Latino origin to be two separate and distinct concepts. People identifying Hispanic or Latino origin may be of any race. The data summarized in this table present Hispanic/Latino as a separate category.

2/ The "Other Race" category presented here includes Census respondents identifying as "Black or African American," "American Indian and Alaska Native," or "Some Other Race."

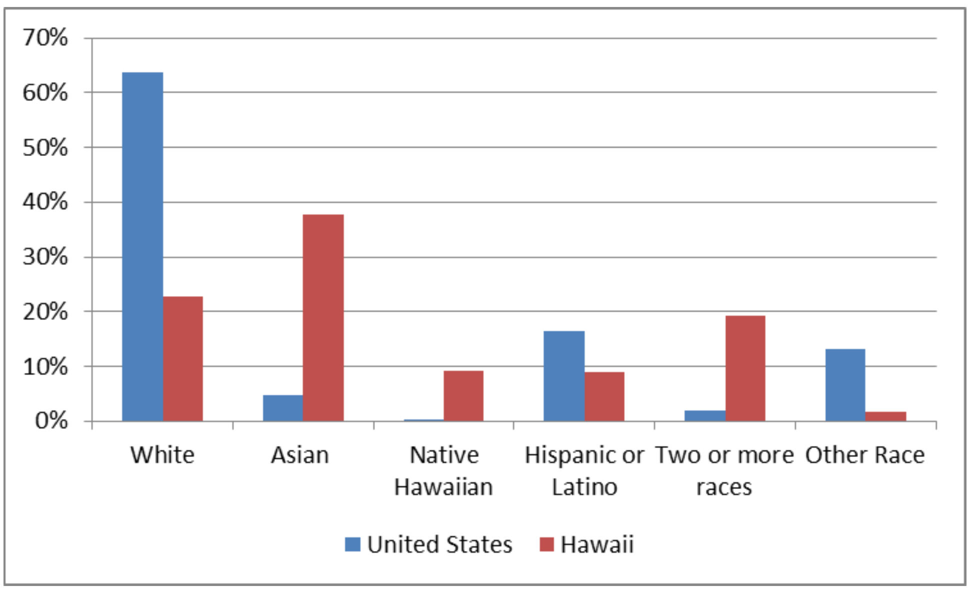


Figure 3.17-1. Racial and Ethnic Composition of the United States and Hawaii

Source: U.S. Census Bureau 2012

Substantial differences in racial composition between Hawaii and elsewhere in the United States suggest that the methodology developed by CEQ and EPA to identify minority populations is not applicable to Hawaii (Oahu Metropolitan Planning Organization and Department of Planning and Permitting 2004; Kahihikolo 2008). In racially diverse areas like Oahu, which had an overall minority population of 80.8 percent in 2012 (Table 3.17-1), it is necessary to identify those areas where minority populations are concentrated in a disproportionate way. Using 2000 Census data, the Oahu Metropolitan Planning Organization identified minority environmental justice areas based on disproportionate concentrations of particular minority groups. Kahuku, Laie, and the coastal area south to Kaneohe Bay were identified as minority environmental justice populations based on the disproportionate concentration of Native Hawaiians and Other Pacific Islanders in these areas relative to Oahu as a whole.

Data presented for Kahuku and Laie in Table 3.17-1 suggest that these communities are still minority environmental justice areas. Native Hawaiian and Other Pacific Islanders accounted for 29.7 percent and 33.5 percent of the respective populations in Kahuku and Laie in 2012 compared to just 9 percent for Honolulu County as a whole (Table 3.17-1). Kawela Bay was not identified as a minority environmental justice population in the Oahu Metropolitan Planning Organization study and that appears to remain the case, with more than three-quarters (77.4 percent) of the population identified as non-minority (i.e., White) in 2012 (Table 3.17-1).

3.17.2 Income and Poverty

The environmental justice guidelines developed by the CEQ (1997a) and EPA (1998) indicate that low-income populations should be identified based on the annual statistical poverty thresholds established by the U.S. Census Bureau. The U.S. Census Bureau defines a poverty area as a census tract or other area where at least 20 percent of residents are below the poverty level (U.S. Census Bureau 2013). Median household income and per capita income are other measures that can be used to identify low income environmental justice populations.

Using 2000 Census Data, the Oahu Metropolitan Planning Organization identified a limited number of low income environmental justice populations based on disproportionate concentrations of low-income populations. None of the low-income environmental justice populations identified by this study were located in Koolau Loa District or in the vicinity of the Project.

Data presented for median household income, per capita income, and the percent of population below the poverty level in Table 3.17-2 suggest that this is still the case. None of the identified communities or the Koolau Loa CCD had 20 percent of more of total population below the poverty level. Median household income was higher than the state median in Kahuku and Laie, and lower in Kawela Bay. This pattern was reversed with per capita income, which was lower than the state

Table 3.17-2. Income and Poverty

Geographic Area	Median Household Income		Per Capita Income		Population Below the Poverty Level (Percent)
	Dollars	Percent of State Median	Dollars	Percent of State Per Capita	
United States	53,046	Na	28,051	na	14.9%
Hawaii	67,492	100%	29,227	100%	10.8%
Honolulu County	72,292	107%	30,219	103%	9.6%
Koolau Loa CCD	69,410	103%	23,743	81%	12.9%
Kahuku CDP	68,292	101%	17,489	60%	6.1%
Kawela Bay CDP	59,792	89%	42,706	146%	7.5%
Laie CDP	70,694	105%	15,258	52%	12.4%
Source: U.S. Census Bureau 2012					

average in Kahuku and Laie, and almost 1.5 times as high in Kawela Bay (Table 3.17-2). This discrepancy is largely the result of average household size. The average household size in Kahuku and Laie was twice as large as the average household in Kawela Bay, 4.43 persons per household and 4.89 persons, respectively, versus 2.13 persons (U.S. Census Bureau 2012).

3.18 Public Infrastructure and Services

This section addresses the availability and capacity of public infrastructure and services, including utilities, waste disposal, police and fire protection, health care facilities, and education facilities. Transportation facilities are addressed in Section 3.15. The analysis area for public infrastructure and services is intended to capture all potentially affected public infrastructure in the vicinity of the wind farm site. It therefore primarily addresses public infrastructure in and near Kahuku town; some discussion of services or infrastructure farther away is also included as appropriate.

3.18.1 Public Facilities and Services Near the Wind Farm Site

3.18.1.1 Electric Utilities

HECO provides all electrical service for the Island of Oahu. Its electrical grid is independent, relatively small, and sensitive to power fluctuations. Utility-scale electricity sold by renewable energy producers is sold directly to HECO. A HECO 46-kV electric transmission line runs along Kamehameha Highway through Kahuku, turning westward north of the town away from the highway to run through the Kahuku Wind Farm. Electric power from the Project would tie into this line and subsequently flow through HECO's grid (Figure 3.18-1).

There are utility distribution lines located along the Kamehameha Highway and throughout Kahuku town, Malaekahana, and other urbanized areas. The nearest known line to the wind farm site extends along the unnamed road running southwest near the Project access road, into the Malaekahana valley.

3.18.1.2 Gas

Hawaii Gas provides natural gas and propane service to Oahu and the other Hawaiian islands. There is no gas infrastructure in the Kahuku area; this area is served by gas cylinder delivery only.

3.18.1.3 Water

The Honolulu Board of Water Supply (HBWS) is the public agency supplying potable water to most of Oahu. HBWS manages the public water system in Kahuku and Malaekahana, and most other communities along Oahu's north and northeast coasts except for Laie, which is served by a private water system. All public water systems in Koolau Loa are supplied by groundwater. Streams in Koolau Loa are not used for the drinking water supply.

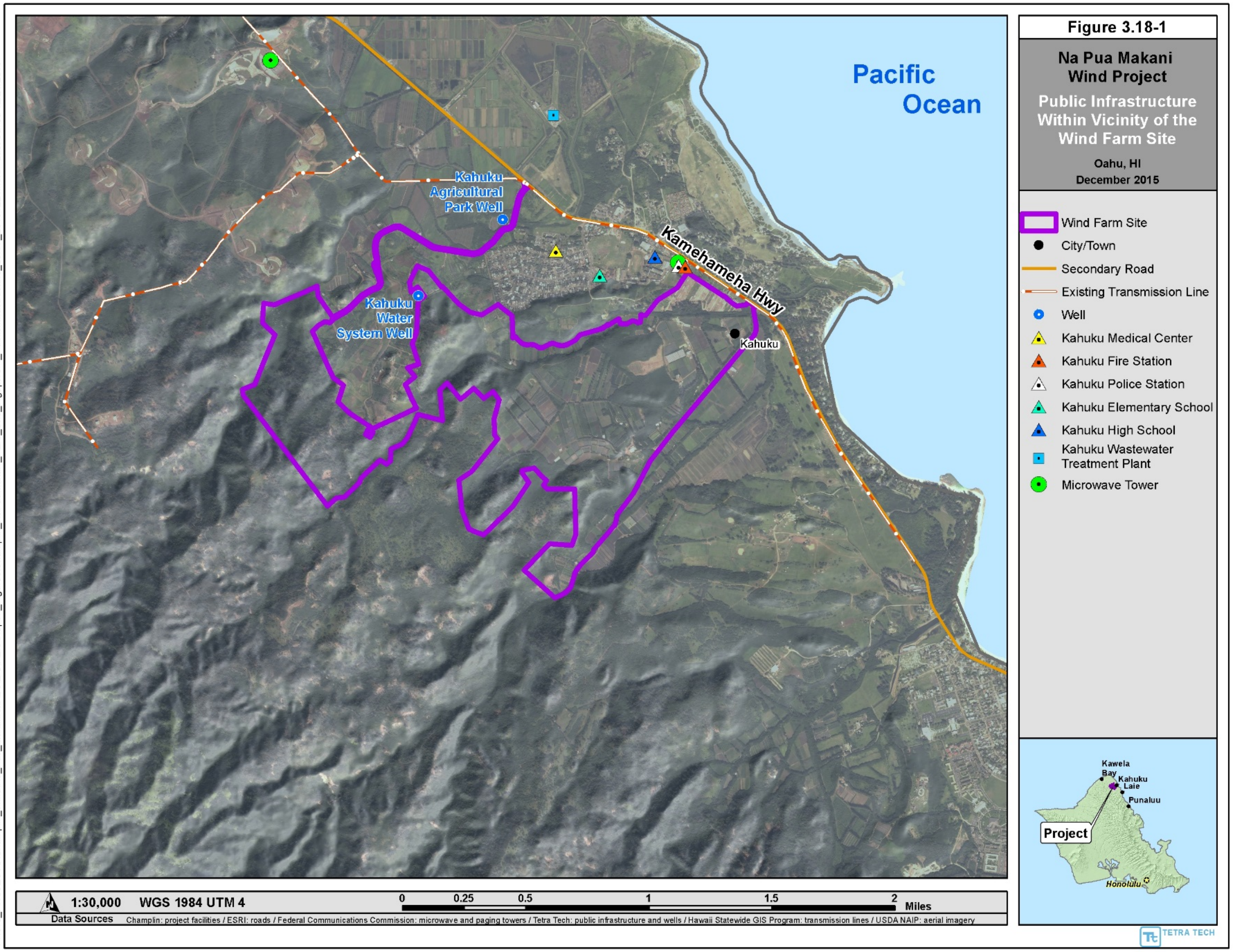


Figure 3.18-1
Na Pua Makani Wind Project
Public Infrastructure Within Vicinity of the Wind Farm Site
Oahu, HI
December 2015
Pacific Ocean
Kahuku Agricultural Park Well
Kahuku Water System Well
Kamehameha Hwy
Kahuku
Wind Farm Site
City/Town
Secondary Road
Existing Transmission Line
Well
Kahuku Medical Center
Kahuku Fire Station
Kahuku Police Station
Kahuku Elementary School
Kahuku High School
Kahuku Wastewater Treatment Plant
Microwave Tower
Kawela Bay
Kahuku
Laie
Punaluu
Project
Honolulu
1:30,000 WGS 1984 UTM 4
0 0.25 0.5 1 1.5 2 Miles
Data Sources Champlin: project facilities / ESRI: roads / Federal Communications Commission: microwave and paging towers / Tetra Tech: public infrastructure and wells / Hawaii Statewide GIS Program: transmission lines / USDA NAIP: aerial imagery
TETRA TECH

There are three public wells and water systems near the wind farm site. The water system serving Kahuku and Malaekahana is supplied by wells located west of the town. HBWS noted in a letter responding to Project scoping that “the project is in the vicinity of [HBWS] Kahuku wells, transmission mains and 228’ reservoir. We have future plans to install a second reservoir at the site and will require sufficient setback around the entire facility.” The well and reservoir are located more than 1,000 feet from the wind farm site. HBWS also provides water for the Turtle Bay Resort. The HBWS Kahuku water system is not connected to other HBWS systems. The State Department of Agriculture well supplies water to the Kahuku Agriculture Park. Based on property ownership records (HoLIS 2014), this well appears to be located at the upper end of the road through the Park, and is immediately adjacent to the wind farm site (Figure 3.18-1).

Water resources and distribution systems in the wind farm site are managed according to the HBWS’ 2009 Koolau Loa Watershed Management Plan (KLWMP; HBWS 2009). The KLWMP notes that “The water supply in Koolau Loa is generally plentiful, and water availability has not been a limiting factor for local demand.” The wind farm site is located within an area of the Koolau Loa watershed known as the Koolau Loa Aquifer System Area. The KLWMP reports that the sustainable yield for the Koolau Loa Aquifer System Area is 36 mgd (136 million liters per day), and that total public and private permitted withdrawals (as of 2000) are for 20.6 mgd (79 million liters per day). This indicates an excess availability of approximately 15.4 mgd (58 million liters per day). The KLWMP also includes projections for growth in water demand out to 2035, using three different sets of growth assumptions. Under the highest growth scenario, the projected water demand in 2017 (the anticipated year of Project construction and consequent water use) would be approximately 32 mgd (121 million liters per day); this would still leave an available excess of nearly 4 mgd (15 million liters per day).

Groundwater is also utilized via private wells and water distribution systems by public and private landowners with water use permits. Two of the largest water users are Turtle Bay Resort, which has a well-used for golf course irrigation, and the James Campbell NWR, which uses groundwater for wildlife habitat creation and maintenance. Both of their wells are east of the Kamehameha Highway. According to records from the CWRM, four wells serve the wind farm site within the Malaekahana Hui West, LLC-owned lands. Well No. 4057-06 is permitted to withdraw 0.670 mgd for irrigation to a turf farm. Well No. 4057-07 is permitted to withdraw 0.300 mgd for irrigation of diversified agriculture. Well Nos. 3957-01 and 3759-03 are permitted to withdraw 1.244 mgd for truck farms, taro, and domestic purposes. There are no public water systems or public water wells in the remainder of the wind farm site.

3.18.1.4 Wastewater

The closest developed wastewater system to the wind farm site serves development within the bounds of the town of Kahuku. Wastewater produced in Kahuku is treated at the Kahuku Wastewater Treatment Plant, located north of the town and east of the Kamehameha Highway, near the Kii Unit of the James Campbell NWR (R.M. Towill Corporation 2008).

Turtle Bay Resort is served by a private wastewater treatment facility, and uses the reclaimed water for golf course irrigation. The Kuilima Wastewater Treatment Plant is located south of the Kamehameha Highway, opposite the entrance to the resort. The treatment plant is approximately 2 miles (3.2 kilometers) northwest of the wind farm site.

3.18.1.5 Stormwater Drainage

There is no developed stormwater infrastructure within the wind farm site. The nearest stormwater infrastructure system is within the town of Kahuku. Some roadside ditches or other minimal facilities may occur along the private agricultural roads in the wind farm site.

3.18.1.6 Schools

Public schools on Oahu are operated by the Hawaii Department of Education. There are no public or private schools within the wind farm site. Two public schools are located in Kahuku Town: Kahuku Elementary and the Kahuku High and Intermediate School (KHIS). Kahuku Elementary is located on a 4.9-acre parcel, approximately 0.36 mile from the nearest proposed wind turbine (Figure 3.18-1). Kahuku Elementary School serves approximately 500 students from kindergarten to sixth grade (HDOE 2013b). Kahuku High and Intermediate School is located on four separate parcels which are combined into an approximately 21.2 acre campus. The campus includes a football field, tennis courts, baseball diamond, and a soccer field. The nearest school building is approximately 0.45 mile from a proposed wind turbine location. KHIS serves approximately 1,500 students in grades 7 through 12, with 107 teachers and 103 classrooms. KHIS draws from communities along a 26-mile (42-kilometer) span of the north and northeastern coast; the district extends from Sunset Beach on the North Shore, to Kaaawa to the south (HDOE 2013a). Kahuku Elementary School serves approximately 500 students from kindergarten to sixth grade (HDOE 2013b), with 27 teachers and classrooms. The Kahuku elementary school district encompasses Kahuku town north to Kawela Bay. Of the other community elementary schools that feed into the high school, the nearest is the Laie Elementary School, located approximately 1.5 miles (2.4 kilometers) south of the wind farm site; the others are all at least 5 miles (8 kilometers) away. The Laie elementary school district extends from Malaekahana south to the boundary between Laie and Hauula, and includes the southern half of the Malaekahana valley. There are no known private schools in the vicinity of the Project (HAIS 2012).

One university is located within the analysis area: the Brigham Young University (BYU) Hawaii campus, located in Laie town. The 100-acre (40-hectare) campus is located approximately 1.7 miles (2.7 kilometers) southeast of the wind farm site. BYU-Hawaii has a student body of about 2,500 students. BYU is a private institution operated by the Church of Jesus Christ of Latter Day Saints. BYU-Hawaii is closely linked with the adjacent Polynesian Cultural Center, discussed in Section 3.13.

3.18.1.7 Emergency and Health Services

Because of its location near Kahuku Town, the Project will be close to health care, police, fire protection and other public services. The primary health service provider in the vicinity of the wind farm site is the Kahuku Medical Center (KMC; formerly known as the Kahuku Hospital). KMC is an affiliate of the Hawaii Health System Corporation (HHSC 2014; KMC 2014), which itself is a quasi-public agency established and partially governed and funded by the State legislature (HHSC 2014). KMC is the only public medical facility serving communities along Oahu's north and northeast coasts; as such, it forms part of the "Safety Net" for Neighbor Island Acute Care and the "Safety Net" for Long-Term Care in the state of Hawaii (HHSC 2014). KMC is located in Kahuku Town (Figure 3.18-1), approximately 0.4 mile (0.6 kilometer) from the wind farm site. KMC offers a broad range of inpatient, outpatient, and ancillary services. The hospital facilities and services include patient 21 beds (all private rooms); a 24-hour emergency room; in-house laboratory, radiology and pharmacy; physical and speech therapy; and social services (KMC 2014).

Police, fire, paramedic and ambulance services are all provided by the City and County of Honolulu. Locally, these operate out of the Kahuku Police and Fire Station, located in Kahuku Town; this station is located approximately 0.1 mile (0.2 kilometer) from the wind farm site (Figure 3.18-1). Law enforcement is provided by the Honolulu Police Department; the Kahuku patrol district extends from Kawela Bay southward to Kaaawa, encompassing all of the Koolau Loa area (City and County of Honolulu, HPD 2014). The Honolulu Emergency Medical Services' Kahuku response district is similar to the police patrol district. Honolulu Emergency Medical Services has 20 advanced life support ambulances, one of which is stationed in Kahuku; a Rapid Response Paramedic unit is also stationed in Kahuku (City and County of Honolulu, EMS 2014). The Honolulu Fire Department provides emergency response for fires, emergency medical calls, hazardous materials incidents, motor vehicle accidents, natural disasters and technical rescues (City and County of Honolulu, HFD 2013). Specific equipment stationed in Kahuku is unknown. In emergencies, police, fire, paramedic and ambulance services are all dispatched in response to a standard 911 call.

3.18.1.8 Solid Wastes

Solid wastes generated during construction, not suitable for re-use onsite or recycling, would be transported for disposal at Waimanalo Gulch landfill on the Waianae coast or burned to make electricity at the H-Power (Honolulu Program of Waste Energy Recovery) facility in Kapolei; both facilities are owned by the City and County of Honolulu and operated by Waste Management. Alternatively, construction and demolition wastes could be taken to the privately-owned PVT landfill, also on the Waianae coast. Materials suitable for recycling, such as scrap steel, and wood and plastics used in shipping, would be recycled through a licensed facility. A refuse Drop-Off Convenience Facility and refuse collection yard is located near the north end of Laie.

The City and County of Honolulu is currently in the process of evaluating potential sites to supplement or replace its only municipal solid waste landfill, Waimanolo Gulch. However, the City estimates that the physical capacity of the landfill would enable it to continue to receive waste materials for at least the next 15 years (City and County of Honolulu, DES 2014), and the City has stated its intent to continue to use the landfill until it reaches full capacity (City and County of Honolulu, DES 2012). A third incinerator is under construction at the H-Power facility to enable it to divert a greater amount of waste from the landfill, potentially extending its life.

3.18.1.9 Telecommunications

Telecommunication services that are used in the vicinity of the wind farm may include a variety of radio, cell phone, internet, and radar technologies. There are six registered microwave towers in the vicinity of the wind farm site (Figure 3.18-2). One is located in Kahuku town at the Kahuku Police Station. Two are located atop Mt. Kawela within the Army's Kahuku Training Area, approximately 3.5 miles (5.6 kilometers) west of Kahuku. The tower in Kahuku and one of the two towers on Mt. Kawela are owned by the City and County of Honolulu, and presumably serve as part of the county's emergency communications system. The other tower on Mt. Kawela is a privately owned cellular communications tower. Two privately owned towers are located near Turtle Bay Resort, about 0.5 mile (0.8 kilometer) south (mauka) of the Kamehameha Highway. The final one in the vicinity is located in Sunset Beach, on the North Shore; it is also privately owned. A microwave beam path analysis has been completed to identify specific communications signal pathways within which turbines should not be placed.

The Honolulu Fire Department and several other city/county and State agencies have used very high frequency (VHF) band radios for emergency communications, and are currently in the process of migrating their communications to a more secure 800-megahertz trunking radio system (City and County of Honolulu, HFD 2013).

A Federal government communications installation is located south of Kawela Bay, approximately 0.6 mile (1.0 kilometer) south of the Kamehameha Highway within the Army's Kahuku Training Area. The installation is located at the former Opana Radar Site, famous for first detecting the incoming Japanese attack on Pearl Harbor that drew the United States into World War II. The site is now a Regional Relay Facility for Diplomatic Communications, and is operated by the U.S. State Department, Diplomatic Telecommunications Service (DTS). It is off limits to the public. DTS utilizes satellite communications as well as terrestrial wire-based communications.

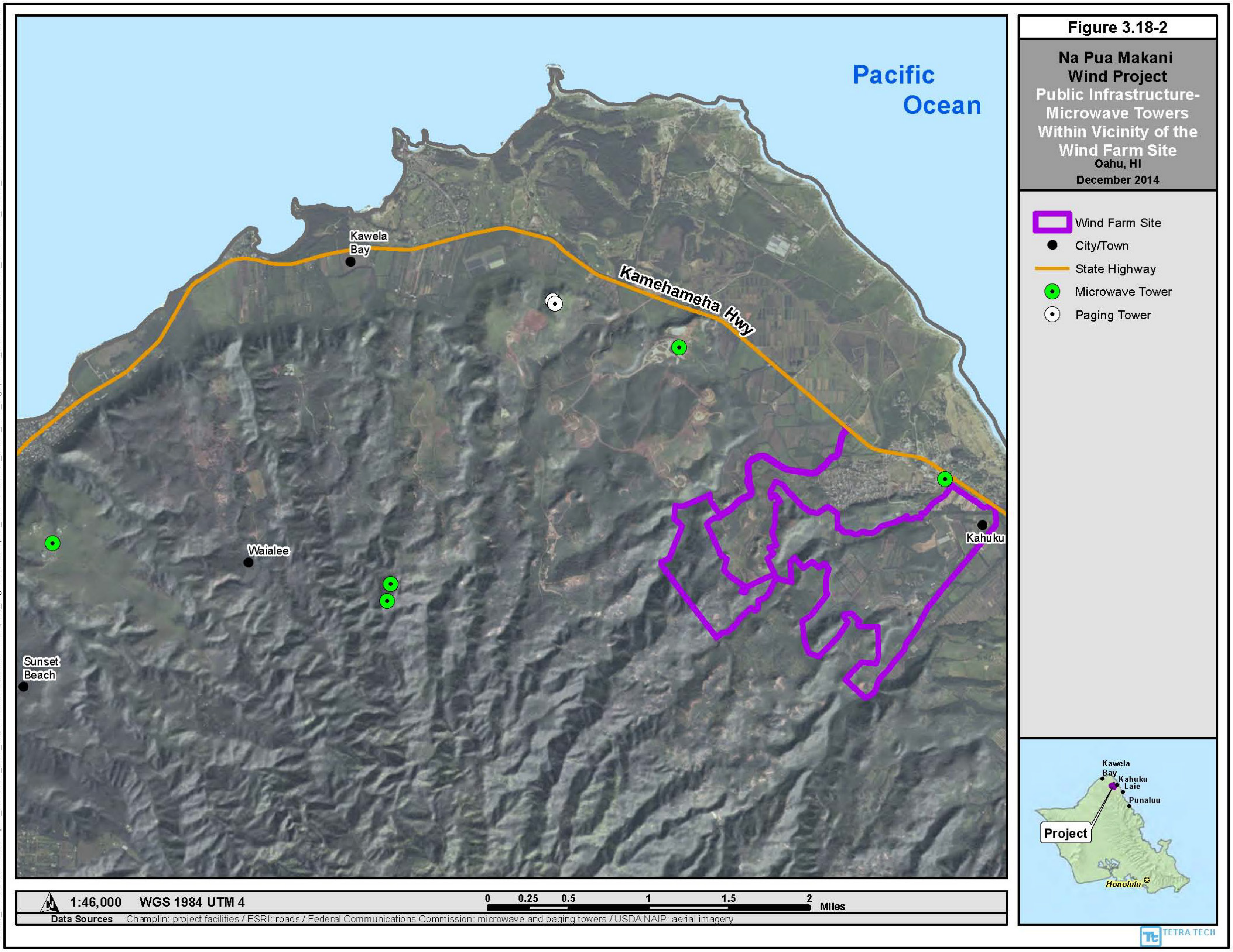


Figure 3.18-2
Na Pua Makani
Wind Project
Public Infrastructure-
Microwave Towers
Within Vicinity of the
Wind Farm Site
Oahu, HI
December 2014
Wind Farm Site
City/Town
State Highway
Microwave Tower
Paging Tower
Pacific
Ocean
Kawela
Bay
Kamehameha Hwy
Kahuku
Waialee
Sunset
Beach
Project
Punaluu
Laie
Honolulu
1:46,000
WGS 1984 UTM 4
0
0.25
0.5
1
1.5
2
Miles
Data Sources
Champlin: project facilities / ESRI: roads / Federal Communications Commission: microwave and paging towers / USDA NAIP: aerial imagery
TETRA TECH

3.18.2 Public Facilities and Services Near the Mitigation Areas

3.18.2.1 Hamakua Marsh (waterbird)

The proposed waterbird mitigation area is located in Hamakua Marsh near Kailua, and is surrounded by lands served by typical public urban infrastructure: public water and sewer services, solid waste services, electricity, telecommunications, transportation and stormwater infrastructure, police and fire services, parks and schools. Parks are addressed under Recreation, Section 3.13. Kailua Road (HI Highway 61) crosses the northern end of the conservation area, and Hamakua Drive forms its southeastern boundary. One overhead utility line crosses the central portion of the mitigation area, with one utility pole located in the marsh. Other roads, utilities and public infrastructure are located in and serve the developed areas to the east side and south of the marsh; aside from the aforementioned road and utility lines, there does not appear to be any public infrastructure within the Hamakua Marsh mitigation area.

3.18.2.2 Poamoho Ridge (bat)

The Poamoho Ridge bat mitigation area is located in an undeveloped area of the Koolau Mountain Range, where there are no existing public services or infrastructure. The nearest developed infrastructure is located in the town of Wahaiwa, approximately 3.5 miles (5.6 kilometers) to the west, and along the windward coast in the town of Kaaawa, more than 4 miles to the east. The U.S. Army's 2010-2014 Integrated Natural Resource Management Plan, Island of Oahu (U.S. Army 2010) notes the presence of two water supply reservoirs within the Schofield Barracks East Range (Ku Tree and Koolau reservoirs) approximately 3 miles west-southwest of the Poamoho Ridge parcel; neither is fed by streams emanating from within the Poamoho Ridge parcel.

There are no roads that lead to the Poamoho Ridge parcel. The nearest developed transportation infrastructure is a narrow dirt road that leads out of Wahaiwa along the northern boundary of the Ewa Forest Preserve; the road ends and turns into the Poamoho Ridge Trail about 2 miles (3.2 kilometers) west of the proposed bat conservation area. The nearest road to the east in the Kahana Valley ends over 2.5 miles (4.0 kilometers) east of the proposed bat conservation area.

3.19 Military

This chapter identifies military interests in the vicinity of the wind farm site and the associated waterbird and bat mitigation areas. The analysis areas vary by location; the analysis encompasses military interests within 5 miles of the wind farm site, and within 1 mile (1.6 kilometers) of the respective mitigation areas.

Two U.S. Army documents provide nearly all the background information presented in this Chapter. The 2010-2014 Integrated Natural Resource Management Plan, Island of Oahu (U.S. Army 2010) and the Final Implementation Plan for Oahu Training Areas (U.S. Army 2008) provide a wealth of information regarding the use and management of military facilities on Oahu; unless specifically noted otherwise, all information regarding military interests and facilities in this chapter is summarized from these two documents.

3.19.1 Military Interests Near the Wind Farm Site

The wind farm site abuts the eastern side of the Kahuku Training Area (KTA, Figure 3.19-1). KTA is the second largest maneuver training area on Oahu, containing 4,569 acres (1,849 hectares) suitable for maneuvers. The KTA is primarily utilized to conduct and support multiple infantry battalion-sized Army Training and Evaluation Program missions, which include mountain and jungle warfare, and air support training. Nearly all tactical maneuver training takes place in the northern portion of the KTA; the rugged terrain and dense vegetation in the southern portion of the KTA make it unsuitable for most training activities, except for small unit exercises conducted on foot. The portion of the KTA nearest the wind farm site is mapped as having no or limited training constraints (see U.S. Army 2010, Figures 2.6.c and 2.6.d).

Live-fire and tracer ammunition is prohibited at KTA except at the Combined Arms Collective Training Facility (CACTF). Ammunition is currently limited to blanks and pyrotechnics (e.g., smoke and incendiary devices), but no pyrotechnics are allowed within 3,281 feet (1,000 meters) of the KTA borders. There are no existing ordnance impact areas or Surface Danger Zones on KTA. The CACTF is a 24-building facility designed for urban warfare training; in the CACTF live-fire exercises are permitted using short-range training ammunition with low-velocity plastic bullets.

There are 11 designated helicopter landing zones and three parachute drop zones in the KTA. The nearest of these are located approximately 0.6 mile (1.0 kilometer) west and southwest of the wind farm site (see U.S. Army 2010, Figure 2.6.b).

There are no primary or secondary roads within the KTA; all roads within the KTA are paved or gravel tertiary roads or unimproved four-wheel-drive trails.

There are no permanent aviation assets on the KTA; all aviation support assets on the KTA are temporary in nature and associated with specific training events. Military aircraft from Wheeler Army Airfield support KTA. Wheeler Army Airfield also provides air traffic control during training exercises.

Portions of the KTA are open to the public for recreational purposes including hunting and motocross racing. The areas open to recreation are located in the northwestern and western-most portions of KTA, and are not adjacent to the wind farm site (see Section 3.13). The westernmost portion of the KTA is designated as the Pupukea-Paumalu Forest Reserve; this area is open to the public for hunting, and contains two designated hiking trails that are accessed from the Waianae Valley. No other hiking trails are located within the KTA.

There are three known telecommunications facilities within KTA. Two microwave towers are located atop Mt. Kawela, approximately 3.5 miles (5.6 kilometers) west of Kahuku; one is privately owned, and the other is owned by the City and County of Honolulu. The DTS Regional Relay Facility is located within the northern end of KTA. These are addressed in Section 3.18. There are no known permanent military telecommunications facilities within KTA.

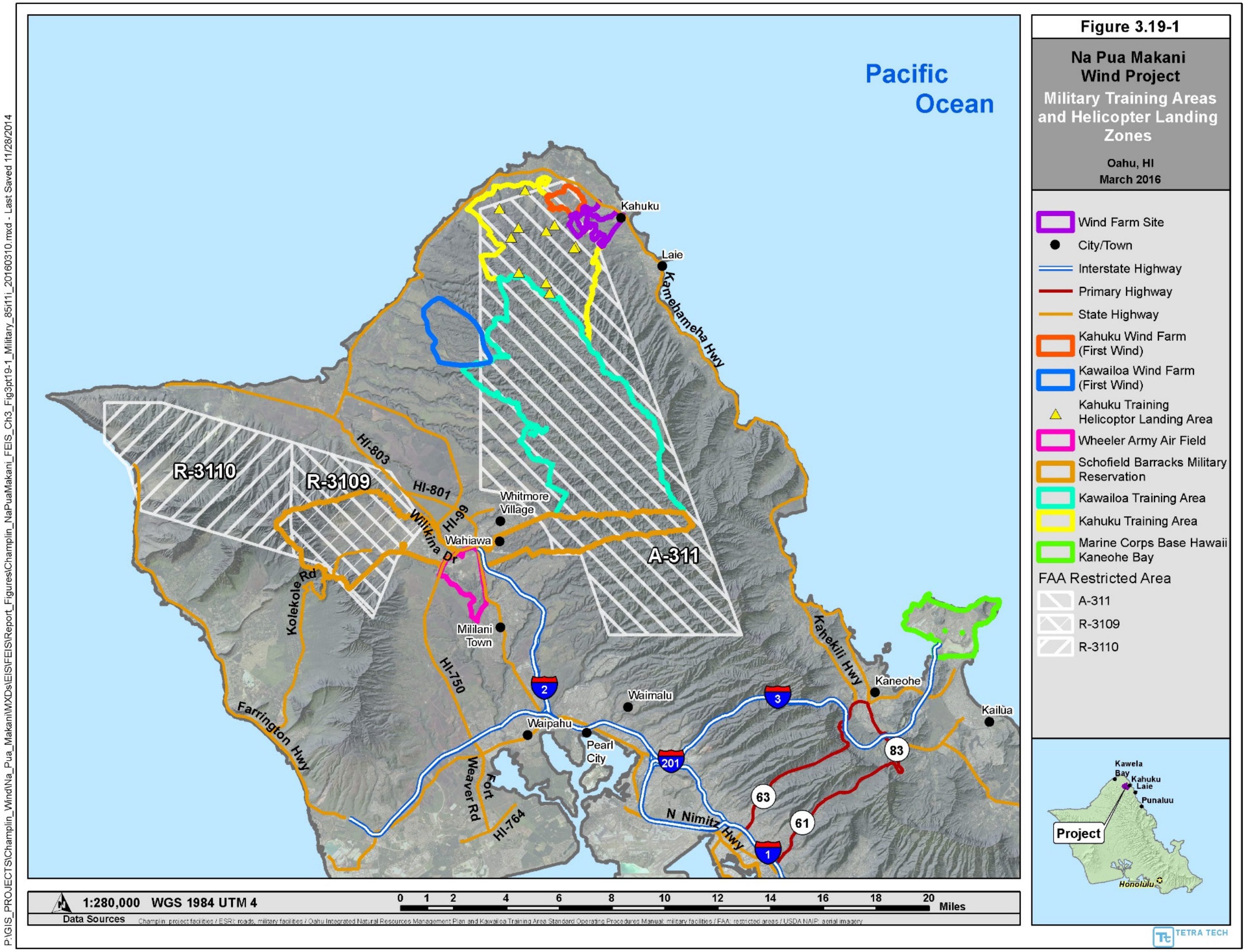


Figure 3.19-1
Na Pua Makani Wind Project
Military Training Areas and Helicopter Landing Zones
Oahu, HI
March 2016
Wind Farm Site
City/Town
Interstate Highway
Primary Highway
State Highway
Kahuku Wind Farm (First Wind)
Kawailoa Wind Farm (First Wind)
Kahuku Training Helicoptor Landing Area
Wheeler Army Air Field
Schofield Barracks Military Reservation
Kawailoa Training Area
Kahuku Training Area
Marine Corps Base Hawaii Kaneohe Bay
FAA Restricted Area
A-311
R-3109
R-3110
Pacific Ocean
Kahuku
Laie
Kamehameha Hwy
R-3110
R-3109
A-311
HI-803
HI-801
HI-99
Whitmore Village
Wahiawa
Wilikina Dr
Kolekole Rd
Mililani Town
HI-750
Kahekili Hwy
Kaneohe
Kailua
Waimalu
Waipahu
Pearl City
Farrington Hwy
Weaver Rd
Fort
HI-764
N Nimitz Hwy
2
3
201
1
63
61
83
Kawela Bay
Kahuku
Laie
Punaluu
Project
Honolulu
1:280,000 WGS 1984 UTM 4
0 1 2 4 6 8 10 12 14 16 18 20 Miles
Data Sources
TETRA TECH
P:\GIS_PROJECTS\Champlin_Wind\Na_Pua_Makani\MXDs\EIS\FEIS\Report_Figures\Champlin_NaPuaMakani_FEIS_Ch3_Fig3pt19-1_Military_85i11i_20160310.mxd - Last Saved 11/28/2014

The northern end of the U.S. Army's Kawailoa Training Area (KLOA) is also located within 5 miles (8 kilometers) of the wind farm site. KLOA is used primarily for helicopter aviation training, helicopter unit tactical training, long-range patrol, and command post displacement. KLOA is characterized by very deep ravines, dense vegetation, and tropical rainforest, and contains some of the most rugged terrain in Hawaii. Terrain is the major constraint to training in KLOA; less than one-quarter of the area is considered suitable for maneuvers. Areas with greater than 20 percent slope are considered unsuitable for all except single-file, small unit maneuvers on foot along ridgelines; most of the KLOA is shown as having slopes greater than 30 percent (see U.S. Army 2010, Figures 2.5.c and 2.5.d). Live-fire, tracer ammunition, and pyrotechnics are prohibited, while blanks are permitted under some conditions. There are 23 helicopter landing zones and one parachute drop area in KLOA; the nearest of these is over 5 miles (8 kilometers) from the wind farm site.

Access to KLOA is very limited due to the lack of improved roads, steep terrain, and dense vegetation. An improved paved roadway traverses through a small portion of the northwestern KLOA, and a few primitive four-wheel-drive tracks provide limited access to the interior of the training area. There are no developed facilities within the KLOA. Training and land management activities take place on foot or use helicopters to transport people, equipment and supplies. The Implementation Plan states that, although the U.S. Army may train via foot maneuvers in the high-elevation environmentally sensitive areas of KLOA, in practice foot maneuvers and bivouacs in the upper areas have not occurred in over ten years, and the likelihood of U.S. Army training maneuvers in those areas is low.

The U.S. Army's A-311 Alert Area overlays the KTA and KLOA (Figure 3.19-1); it is commonly referred to as the Tactical Flight Training Area (TFTA). TFTA A-311 is defined as a Special Use Airspace (SUA) which is used for helicopter training exercises, with an average of 3,500 helicopter movements per month. There are no formal flight routes; rather, flights may occur anywhere within the alert area. The alert area encompasses the airspace from ground level to 500 feet above ground level. Between the hours of 7 a.m. and 10 p.m., air traffic in the TFTA A-311 area is controlled from Wheeler Army Air Force Base. Outside of those hours the airspace is not restricted.

Operation of unmanned aircraft systems (UAS; also referred to as unmanned aerial vehicles or "drones") in the National Airspace System of the United States requires FAA-designated controlled airspace and SUA so that there would be no conflicts between commercial and military aircraft, or between manned and unmanned aircraft. An Airspace Certificate of Authorization must be obtained from the FAA to allow UAS operations within currently defined airspace used by traditional fixed-wing and rotorcraft. Locations on Oahu where SUA is designated and UAS flights are currently permitted are limited to the Wheeler Army Airfield and the associated FAA-designated restricted airspace over Schofield Barracks and the adjacent Waianae Range and Makua Valley (the Restricted Areas R-3109 and R-3110, Figure 3.19-1), and the controlled airspace of the Marine Corps Base Hawaii in Kaneohe Bay and within the Marine Corps Training Area Bellows. (DOD 2014)

UAS are not new to Hawaii; the 3rd Marine Regiment has been operating UAS since 2007, while the U.S. Army's 2nd and 3rd Brigades and Hawaii Army National Guard (HIARNG) have operated UAS out of the Wheeler Army Airfield since 2007. The Marines currently operate UAS in the controlled airspace of the Marine Corps Base Hawaii and within the Marine Corps Training Area Bellows, both near Kailua on the eastern side of Oahu, as well as in the Pohakuloa Training Area on the Big Island. All of the U.S. Army and HIARNG UAS utilize the FAA-designated restricted airspace at Schofield Barracks/Makua Valley (R-3109 and R-3110), and at the Pohakuloa Training Area. The Army/Missile Defense Agency has utilized the FAA-designated restricted airspace above the Pacific Missile Range Facility (DOD 2014). In the most recent military document that discusses UAS use in Hawaii (the EIS for the relocation of Marine UAS Squadron 3 to Hawaii; DOD 2014), it is noted that the likelihood of receiving FAA approval to operate UAS in other areas is low, and there is no mention of making a request to FAA to utilize UAS within the A-311 alert area, except for transiting across it to travel between the Marine Corps Base Hawaii and the Wheeler Army Airfield and the Schofield Barracks/Makua Valley restricted airspace.

Military and Airspace conflicts were checked using the FAA and the Department of Defense (DoD) Clearinghouse. In 2012, FAA issued a Determination of No Hazard letter, and the DoD Clearinghouse issued a letter stating “DoD will not oppose the project.”

3.19.2 Military Interests Near the Mitigation Areas

3.19.2.1 Hamakua Marsh (waterbird)

There are no military interests near the proposed waterbird mitigation area located in Hamakua marsh. The nearest military lands or facilities are located in the Marine Corps Base Hawaii, on a peninsula to the north of Kailua, about 3 miles from Hamakua Marsh.

3.19.2.2 Poamoho Ridge (bat)

The Poamoho Ridge bat mitigation area is located within the southern end of the KLOA, in a portion of the KLOA designated as the Ewa Forest Reserve as well as Oahu Elepaio Critical Habitat. The Schofield Barracks East Range (SBER) is located adjacent to the south side of the KLOA/Ewa Forest Reserve.

As noted above, the major constraint to training in KLOA is extremely rugged terrain; the same is true of the eastern end of SBER near the mitigation area. There is no developed infrastructure and no roads near the mitigation area; the nearest road ends and turns into a foot trail about 2 miles west of the mitigation area (see Section 3.14 – Recreation). The Implementation Plan states that, although the U.S. Army may train via foot maneuvers in the high-elevation environmentally sensitive areas of KLOA or SBER, in practice foot maneuvers and bivouacs in the upper areas have not occurred in more than 10 years, and the likelihood of U.S. Army training maneuvers in those areas is low. No helicopter landing zones are located near the Poamoho Ridge Mitigation Area. The active training areas within SBER are located in the western half of the range, more than 2 miles from the mitigation area. Live-fire training is not allowed on the KLOA, SBER or leased lands.

The area within the Ewa Forest Reserve is proposed in the Integrated Natural Resource Management Plan as an area off-limits to training maneuvers. The Plan proposes two small fenced areas on the KLOA within the Poamoho Ridge Mitigation Area's northern management unit, and one small fenced area in the southern management unit. Public access to KLOA is limited to hiking the Poamoho Ridge Trail and hunting within the Ewa Forest Reserve.

3.20 Agriculture

Public comments received on the Draft EIS included requests for additional information on agricultural uses and activities within the wind farm site and a more detailed analysis of the potential for Project-related impacts to agricultural resources. In response to these comments, the discussion of agriculture (originally in Section 3.12 – Land Use of the Draft EIS) has been expanded and placed in this standalone section. This section begins with an overview of agricultural land classification systems applicable to the analysis and then describes the existing agricultural uses and activities within the analysis area. The analysis area for agriculture is the wind farm site and the HCP mitigation areas. This area encompasses all areas where potential direct effects to agricultural resources could occur as well as areas where indirect effects to agricultural resources, such as changes in road access or irrigation, would occur. This section also describes the regional conditions on agriculture within the Koolauloa District to provide context for the analysis.

3.20.1 Agricultural Land Classifications

Several soil and land classification systems (collectively referred to as agricultural land classifications here) have been developed to identify high quality soils and productive agricultural lands. These classification systems provide an indication of the quality of agricultural lands within the analysis area and are briefly described below.

3.20.1.1 Land Study Bureau Agricultural Productivity Classification

The University of Hawaii Land Study Bureau (LSB) Detailed Land Classification rates the agricultural productivity of soils throughout the state based on characteristics of soil properties, topography, and climate. These include the following:

- Texture – the proportion of sand, silt, and clay in a particular soil.
- Structure – the cohesion of soil material into aggregates or clumps.
- Depth – the distance to which roots can penetrate.
- Drainage – the frequency and duration of soil saturation with moisture.
- Parent material – the geologic material from which a soil has developed.
- Stoniness – affects the productivity of land by limiting the use of machinery and the selection of crops.
- Topography – the slope and surface configuration. Cultivated lands generally have slopes of less than 20 percent. Lands with slopes between 20 and 35 percent usually are not machine tilled, but are still suitable for certain uses such as orchards and grazing.
- Climate, temperature, sunlight, and rainfall – these constitute the exterior environment of the land, versus the soil properties which constitute the interior segment.

- Rain – the basic source of irrigation. Ideally, it should fall at the place, in the quantity, and at the time when it is needed (The University of Hawaii 1972).

The productivity ratings for the above characteristics were used to classify soils as Category A, B, C, D, or E, with Category A representing the most productive soils and Category E the least productive soils. The classification also included Category U, urban lands, which were not rated for productivity.

3.20.1.2 Agricultural Lands of Importance to the State of Hawaii

The Agricultural Lands of Importance to the State of Hawaii (ALISH) is a classification system for identification of agriculturally important lands in the State of Hawaii. The ALISH classification system identifies land suitable for agricultural use and classifies identified lands primarily on the basis of soil characteristics, as well as factors such as growing season, temperature, humidity, elevation, aspect and other conditions. Three classes of agriculturally important lands have been established for the State of Hawaii:

- Prime Agricultural Land
- Unique Agricultural Land, and
- Other Important Agricultural Land.

These classifications correspond to the U.S. Department of Agriculture (USDA) Soil Conservation Service classification for prime farmlands. Prime Agricultural Lands are defined as "land best suited for the production of food, feed, forage, and fiber crops" (Hawaii State Department of Agriculture 1977). This is based on its ability to sustain high yields with relatively little input and with the least damage to the environment. Unique Agricultural Land is land other than Prime Agricultural Land and is used for the production of specific high-value crops (Hawaii State Department of Agriculture 1977). Other Agricultural Land is land that is of state-wide or local importance for the production of various crops, but may have properties such as seasonal wetness, erodibility, and other characteristics that precludes it from being characterized as Prime or Unique (Hawaii State Department of Agriculture 1977). Land considered for ALISH classification may or may not currently be in agricultural use.

3.20.1.3 NRCS Land Capability Classification

The USDA NRCS land capability classification provides an indication of soil productivity for agricultural uses. Higher ratings (Classes I and II) indicate areas that are most conducive to crop production (i.e., have the least restrictions based on soil characteristics). The NRCS land capability classification groups soils primarily on the basis of their capability to produce common cultivated crops and pasture plants without resulting in soil deterioration over a long time (NRCS 2015). Soils are divided into eight classes as follows (Soil Conservation Service 1961):

- Class I: soils with few limitations that restrict their agricultural use.
- Class II: soils have some limitations that reduce or restrict the choice of plants or that require moderate conservation practices.

- Class III: soils have severe limitations that reduce or restrict the choice of plants or that require special conservation practices, or both.
- Class IV: soils have very severe limitations that restrict the choice of plants or that require very careful management, or both.
- Class V: soils are subject to little or no erosion but have other limitations, impractical to remove, that restrict their use mainly to pasture, rangeland, forestland, or wildlife habitat.
- Class VI: soils have severe limitations that make them generally unsuitable for cultivation and that restrict their use mainly to pasture, rangeland, forestland, or wildlife habitat.
- Class VII: soils have very severe limitations that make them unsuitable for cultivation and that restrict their use mainly to grazing, forestland, or wildlife habitat.
- Class VIII: soils and miscellaneous areas with limitations that preclude commercial plant production and that restrict their use to recreational purposes, wildlife habitat, watershed, or aesthetic purposes.

3.20.1.4 Important Agricultural Lands

The City and County of Honolulu Department of Planning and Permitting (DPP), in compliance with HRS, Chapter 205, is conducting a mapping project to identify lands on Oahu that meet the statutory requirements for consideration as “Important Agricultural Lands” (IAL). IAL is a special State land use classification for an exclusive sub-set of high-quality farm land within the State Agricultural Land Use District. The purpose of identifying IAL is to ensure that high-quality farmland is protected and preserved for long-term agricultural use (HHF Planners 2014). The IAL designation does not change the range of allowable uses on the land, but lands that receive the IAL designation are granted access to financial incentives that make farming more viable (HHF Planners 2014). IAL are defined under HRS Section 205-42 as lands that:

- Are capable of producing sustained high agricultural yields when treated and managed according to accepted farming methods and technology;
- Contribute to the State’s economic base and produce agricultural commodities for export or local consumption; or
- Are needed to promote the expansion of agricultural activities and income for the future, even if currently not in production.

Standards and criteria for the identification of potentially eligible IAL lands are defined in HRS 205-44 and include:

- Land currently used for agricultural production;
- Land with soil qualities and growing conditions that support agricultural production of food, fiber, or fuel- and energy-producing crops;
- Land with sufficient quantities of water to support viable agricultural production;
- Land identified under agricultural productivity rating systems, such as the ALISH system adopted by the Board of Agriculture on January 28, 1977;

- Land types associated with traditional native Hawaiian agricultural uses, such as taro cultivation, or unique agricultural crops and uses, such as coffee, vineyards, aquaculture, and energy production;
- Land whose designation as important agricultural lands is consistent with general, development, and community plans of the county;
- Land that contributes to maintaining a critical land mass important to agricultural operating productivity; and
- Land with or near support infrastructure conducive to agricultural productivity, such as transportation to markets, water, or power.

The first three criteria listed above were ranked highest by the IAL Technical Committee for identifying potentially eligible IAL (HFF Planners 2014). To date, the City and County of Honolulu DPP has prepared draft IAL eligibility maps based on the above criteria. The next steps in the process, anticipated to occur in 2016, are formally adopting the IAL maps and Land Use Commission designation of IAL. The draft IAL maps were considered in this EIS for identifying potentially eligible IAL within the analysis area; however, it should be noted that maps may be modified prior to formal designation of IAL on Oahu. The mapping effort is being conducted in a phased approach with Phase I including county- and privately-owned lands within the State Land Use District; other lands (e.g., State-owned lands) may be considered in Phase II.

3.20.2 Regional Context

Agriculture has historically been an important activity in Hawaii for both subsistence and economic purposes (HFF Planners 2014). Due to the moderate climate, year-round growing conditions and availability of water, agriculture has been a predominant activity in the region and is reflected in its long history of agriculturally-based land use practices. The north shore of Oahu (including Waialua, Haleiwa, and Kahuku) within which the Project is located has been identified as one of the major agricultural areas on the island (HFF Planners 2014). Climate, temperature, rainfall, topography, and other characteristics of the region which influence agricultural productivity are described in Sections 3.1 – Geology and Soils and 3. 3 – Air Quality and Climate Change and are not discussed further here.

As noted in the Project AIS and CIA (Appendices F and G; Pacific Legacy 2015 a, b), traditional agriculture in the region surrounding the Project included both irrigated and non-irrigated farming with the main crops being taro, sweet potato, and breadfruit. Most crops were Polynesian introductions, but some plants were added after European contact (e.g., melons and tobacco). A wide range of economically useful trees were also important to residents of the area including hala, kukui, and koa. By the mid-1800s (post-European contact) large-scale commercial agriculture dominated cultivation of sugar cane and pineapple had replaced traditional practices. Plantations occupied major portions of the prime agricultural lands, and diversified crops (those other than sugar cane or pineapple) were located on lower quality agricultural land (HFF Planners 2014). The 25,000-acre Kahuku Ranch was established in the mid-1870s, a large portion of which became the Kahuku Plantation sugar mill which operated until 1971. In recent decades, due to the decline in the profitability of sugar and pineapple crops, the composition of agriculture in the region has shifted from large-scale commercial production to small farmers growing a variety of crops on former plantation lands (HFFP Planners 2014).

In the vicinity of the Project, former plantation lands are now used commercially for various food crops and small scale animal husbandry (Pacific Legacy 2015b). The Kahuku Agriculture Park is located adjacent to the wind farm site to the north. Active farming also takes place within and adjacent to the wind farm site by various farming entities. One of these farming entities, Keana Farms, owns and operates an agribusiness within the proposed wind farm site featuring a zipline attraction which includes a guided agricultural educational tour of the property.

Approximately 123,000 acres on Oahu are designated as State Agricultural Land Use District (see Section 3.12 – Land Use for discussion of State land use designations). This includes farmland suitable for crops, pasture, and forestry, as well as non-agricultural land that does not have the qualities necessary to be classified as one of the other land use districts (Conservation, Urban, and Rural). Within the Agricultural Land Use District on Oahu, there are approximately 88,000 acres of useable agricultural land, including both farmland and grazing land, of which 56,000 acres are suitable for crop production (HFF Planners 2014). Approximately 51,700 acres are currently contributing to agricultural production on Oahu, including areas used for grazing, temporarily fallow land (i.e., to be returned to active production), or has the potential to be returned to active production (see HFF Planners 2014 for details regarding these classifications). Within the Koolauloa District, which surrounds the proposed Project, approximately 4,265 acres (1,726 hectares) are currently contributing to agricultural production (IAL mapping project maps; City and County of Honolulu, DPP 2015).

3.20.3 Wind Farm Site

3.20.3.1 Agricultural Land Classifications

This section summarizes land within the wind farm site by the agricultural land classifications described in Section 3.20.1. Acreages within each classification by wind farm site parcel are show in Table 3.20-1. Acreages within the surrounding Koolaloa District are provided for comparison.

Land Study Bureau (LSB) Agricultural Productivity Classification

The majority of the soils within the wind farm site are classified as LSB Category B (42 percent), followed by Category E (39 percent), Category C (12 percent), and Categories A and D (3 percent each); approximately 1 percent of wind farm site is unclassified (Table 3.20-1; Figure 30.2-1). The most productive soils (Categories A and B) are located on the Malaekahana Hui West, LLC portion of the wind farm site.

Agricultural Lands of Importance to the State of Hawaii (ALISH)

Approximately 49 percent of the land within the wind farm site is designated as agricultural lands of importance under the ALISH classification system (Table 3.20-1; Figure 3.20-2). This includes approximately 249 acres (101 hectares) of Prime Agricultural Land and 99 acres (40 hectares) of Other Agricultural Land. The majority (228 acres (92 hectares); 89 percent) of land found within the DLNR portion of the wind farm site are not classified under the ALISH system, while the majority (approximately 236 acres [96 hectares]; 52 percent) of lands within the Malaekahana Hui West, LLC portion of the wind farm site are classified as Prime Agricultural Lands (Table 3.20-1; Figure 3.20-2).

Table 3.20-1. Agricultural Land Classifications for the Koolauloa District and Wind Farm Site

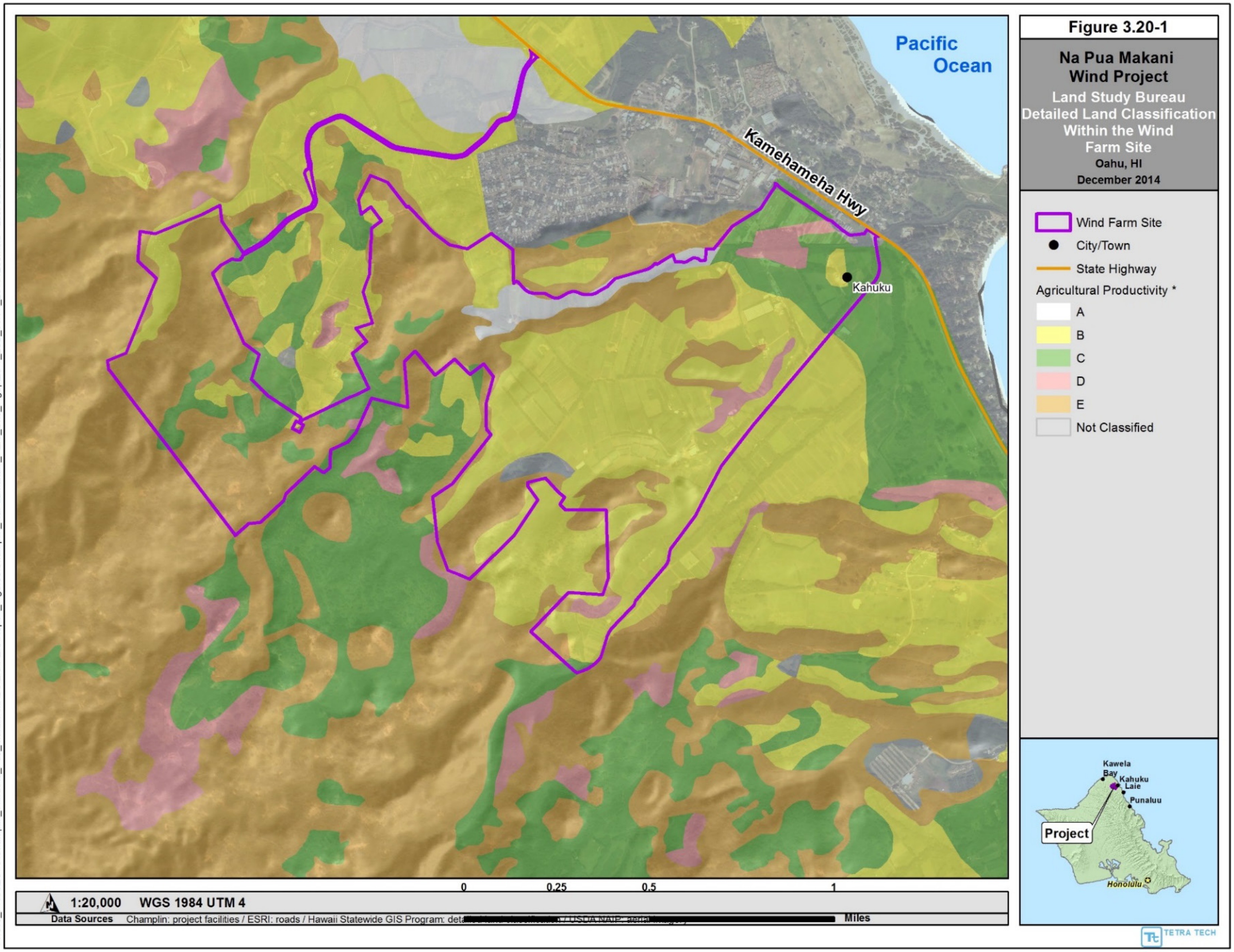
Land Classification	Koolauloa District (Acres)	Wind Farm Site		
		DLNR Parcel (Acres)	Malaekahana Hui West, LLC Parcel (Acres)	Total[1/]
LSB Agricultural Productivity Rating				
No Data	2,886.6	<0.1	8.2	8.2 (1%)
A	645.3	2.0	19.0	21.1 (3%)
B	3,124.7	40.0	253.9	293.9 (42%)
C	2,461.9	41.6	46.8	88.4 (12%)
D	919.9	0.5	22.3	22.8 (3%)
E	27,181.5	170.5	101.7	272.2 (39%)
Total[1/]	**37,220.3**	**254.7**	**451.9**	**706.6**
ALISH Classification				
No Data	28,801.9	227.6	102.1	329.7 (47%)
Other Agricultural Land	5,208.1	13.9	84.9	98.8 (14%)
Unique Agricultural Land	0.0	0.0	0.0	0.0 (0%)
Prime Agricultural Land	2,883.2	13.2	236.1	249.3 (35%)
Unclassified Agricultural Land	327.0	0.0	28.8	28.8 (4%)
Total[1/]	**37,220.3**	**254.7**	**451.9**	**706.6**
No Data	234.7	0.0	2.5	2.5 (<1%)
Class I	0.0	0.0	0.0	0.0 (0%)
Class II	1,413.0	0.6	45.5	46.1 (7%)
Class III	3,614.9	46.5	235.2	281.7 (40%)
Class IV	1,822.9	1.3	18.0	19.3 (3%)
Class V	749.2	0.0	0.0	0.0 (0%)
Class VI	3,575.2	15.4	46.7	62.1 (9%)
Class VII	21,370.3	190.7	71.3	262.0 (37%)
Class VIII	4,440.0	0.1	32.8	32.8 (5%)
Total[1/]	**37,220.3**	**254.7**	**451.9**	**706.6**
Important Agricultural Lands				
Area with 3 Top-rated Criteria	**1,352.4**	**NA[2/]**	**209.3**	**209.3 (30%)**

[1] Column and row totals may not sum exactly due to rounding

[2] State-owned lands in the State Agricultural Land Use District were not included in Phase I of the IAL mapping effort.

NRCS Land Capability Classification

Approximately 7 percent (46 acres; 19 hectares) of the wind farm site is classified under the NRCS Land Capability classification system as being the most conducive to crop production (Class II soils; Table 3.20-1, Figure 3.20-3); there are no Class I soils within the wind farm site. The majority of land (75 percent) within the DLNR portion of the wind farm site is classified unsuitable for cultivation (Class VII), whereas the majority of land (52 percent) on the Malaekahana portion of the wind farm site is classified as having soils with severe limitations that restrict the choice of crops that can be cultivated (Class III).



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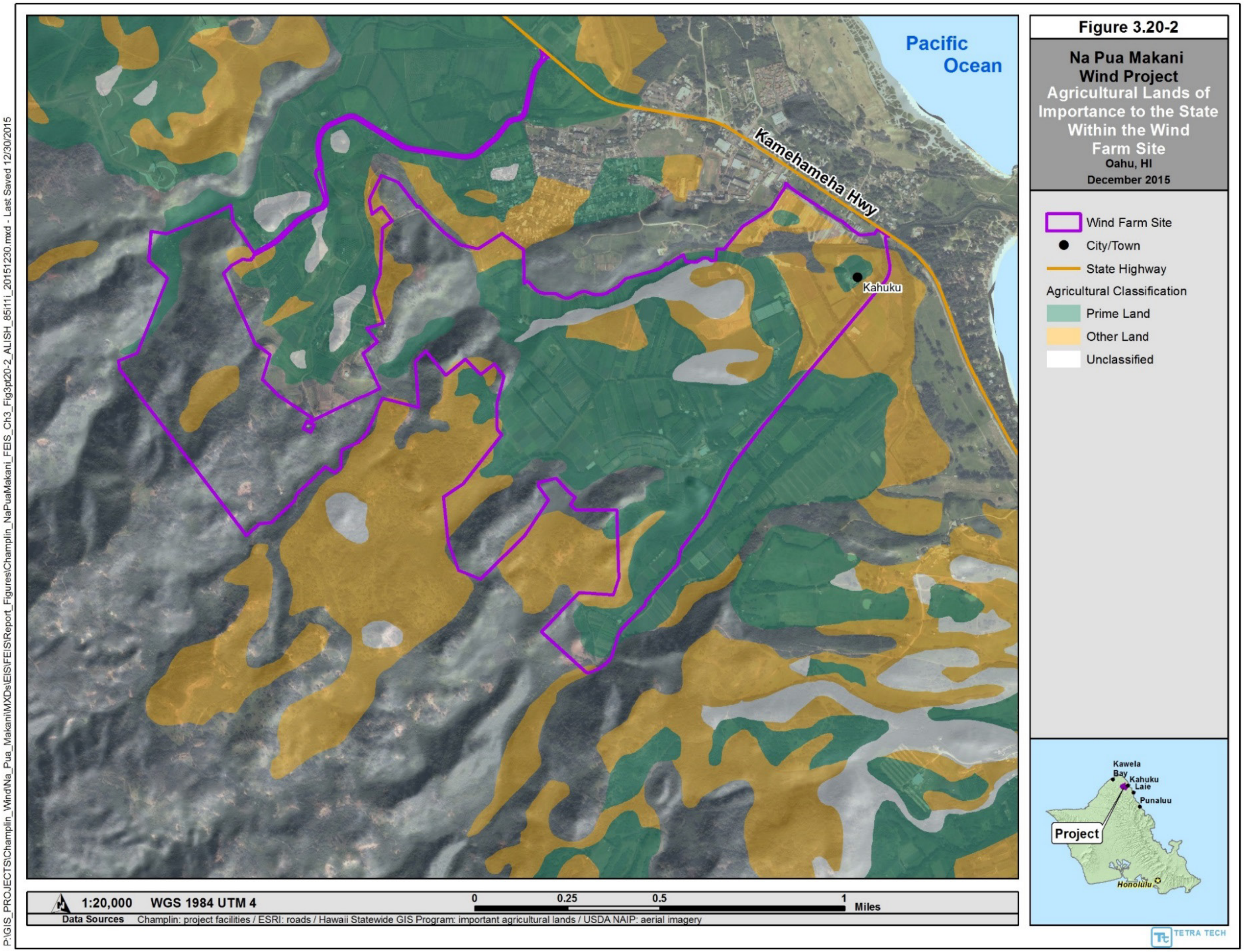
Figure 3.20-2
Na Pua Makani
Wind Project
Agricultural Lands of
Importance to the State
Within the Wind
Farm Site
Oahu, HI
December 2015
Wind Farm Site
City/Town
State Highway
Agricultural Classification
Prime Land
Other Land
Unclassified
Pacific
Ocean
Kamehameha Hwy
Kahuku
Kawela
Bay
Kahuku
Laie
Punaluu
Project
Honolulu
1:20,000 WGS 1984 UTM 4
0 0.25 0.5 1 Miles
Data Sources Champlin: project facilities / ESRI: roads / Hawaii Statewide GIS Program: important agricultural lands / USDA NAIP: aerial imagery
TETRA TECH
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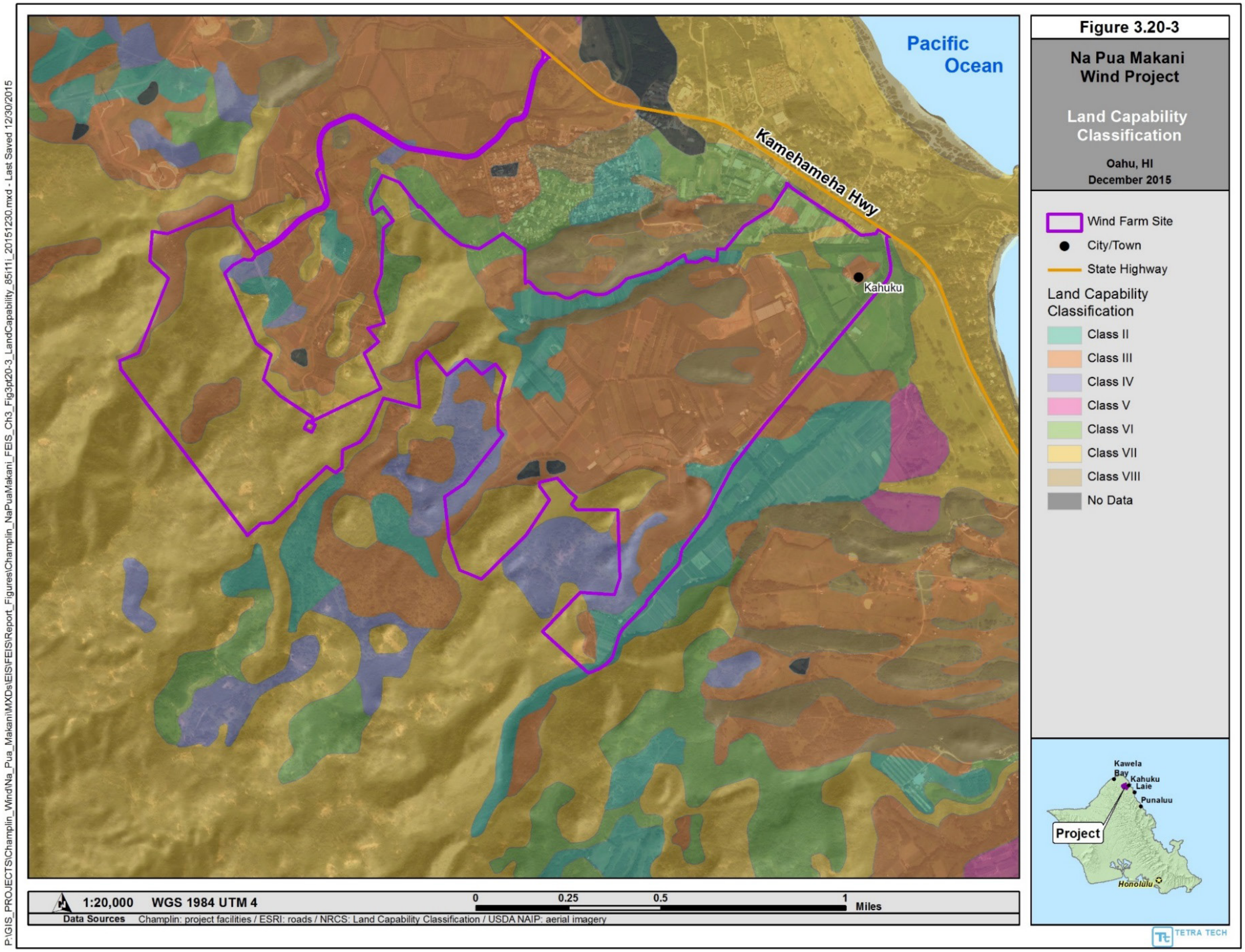


Figure 3.20-3
Na Pua Makani Wind Project
Land Capability Classification
Oahu, HI
December 2015
Pacific Ocean
Kamehameha Hwy
Kahuku
Wind Farm Site
City/Town
State Highway
Land Capability Classification
Class II
Class III
Class IV
Class V
Class VI
Class VII
Class VIII
No Data
Kawela Bay
Kahuku
Laie
Punaluu
Project
Honolulu
1:20,000 WGS 1984 UTM 4
0 0.25 0.5 1 Miles
Data Sources Champlin: project facilities / ESRI: roads / NRCS: Land Capability Classification / USDA NAIP: aerial imagery
TETRA TECH
P:\GIS_PROJECTS\Champlin_Wind\Na_Pua_Makani\MXDs\EIS\FEIS\Report_Figures\Champlin_NaPuaMakani_FEIS_Ch3_Fig3pt20-3_LandCapability_85|11i_20151230.mxd - Last Saved 12/30/2015

Important Agricultural Lands (IAL)

Approximately 30 percent (209 acres; 85 hectares) of the wind farm site is identified as potentially eligible for IAL designation, characterized by meeting all three top-priority rating criteria (Table 3.20-1; City and County of Honolulu, DPP 2015). These are lands with sufficient quantities of water, which are currently used for agricultural production, and possess soil qualities and growing conditions that support agricultural production of food, fiber, or fuel- and energy-producing crops. All potentially eligible lands are located on the Malaekahana Hui West, LLC portion of the wind farm site. The DLNR portion of the wind farm site was not included in the study area for Phase I of the Oahu IAL mapping project because only county-owned and privately-owned lands in the State Agricultural Land Use District were considered during this phase.

3.20.3.2 Existing Agricultural Uses and Activities

Five active farming operations exist on leased land within the Malaekahana Hui West, LLC portion of the wind farm site. All but one of these five leases is a month-to-month lease. Based on Real Property Tax Assessment Reports, approximately 247 acres (100 hectares) of leased land is considered “agricultural use area” and approximately 205 acres (83 hectares) consists of “non-agricultural use area” (e.g., roads, streams, or other areas not currently being used for active agricultural; Table 3.20-2). NPMPP would lease approximately 10 acres from Malaekahana Hui West, LLC for the proposed wind farm.

Based on aerial photo interpretation, approximately 161 acres; 65 hectares (65 percent) of the leased farm lands within the Malaekahana Hui West, LLC portion of the wind farm site is actively farmed land (i.e., cultivated crops; Table 3.20-2). This equates to approximately 23 percent of the wind farm site or 36 percent of the Malaekahana Hui West, LLC parcel. Existing crops include papaya, bananas, taro, ginger, tomatoes, eggplant, cucumbers, and other herbs and vegetables. Farming activities typically occur 7 days a week during daylight hours. Each of the farmers have a variety of agricultural structures on the site including greenhouses, storage sheds, and an agricultural warehouse used for cleaning and packaging of produce.

Table 3.20-2. Leased Agricultural Land and Actively Farmed Areas in the Malaekahana Hui West Parcel of Wind Farm Site

Tenant	Total Leased Area (Acres)1/	Non-Agricultural Use Area (Acres)1/	Agricultural Use Area (Acres)	Actively being Farmed (Acres)2/	Agricultural Use Areas Not Actively being Farmed (Acres)
Farmer A	26.4	15.9	10.5	3.8	6.7
Farmer B	13.4	2.0	11.4	4.2	7.2
Farmer C	14.0	0.0	14.0	4.9	9.0
Farmer D	20.5	0.0	20.5	13.7	6.8
Farmer E	378.4	187.5	190.9	134.4	56.5
Total3/	**452.7**	**205.5**	**247.3**	**161.0**	**86.2**

1/ From Real Property Assessment Tax Forms
2/ Based on GIS delineation of aerial imagery
3/ Column totals may not sum exactly due to rounding

None of the DLNR portion of the wind farm site is actively cultivated agriculture. The immediately adjacent lands surrounding the wind farm site, including the Kahuku Agriculture Park to the north, include both active and fallow agricultural lands.

3.20.3.3 Irrigation, Water Sources, and Road Access

The Hawaii Department of Agriculture, Agricultural Resource Management Division manages five irrigation systems in the state, including one in Kahuku. The Kahuku irrigation system is 3 miles long and serves approximately 445 acres (Agricultural Resource Management Division 2015). This irrigation system could serve the wind farm site on the DLNR lands, however currently no irrigation system is installed, nor anticipated to be needed in the future in this area.

Malaekahana Hui West, LLC has four wells within their property that service the wind farm site on the Malaekahana Hui West lands. These wells supply both potable water and water for irrigation, and are available for existing and expanded agricultural uses (see Section 3.19 – Public Infrastructure for additional details).

Access to the Project is provided through two locations off of Kamehameha Highway; via the existing Malaekahana Road and via the unnamed existing State-owned roads through the Kahuku Agricultural Park. Internal agricultural roads within the wind farm site consist of a mixed of paved, gravel, and compressed dirt roads. Internal agricultural roads within Malaekahana Hui West, LLC lands are sufficient for farmers to access their farm lands. There are no access roads within the DLNR portion of the wind farm site.

3.20.4 Hamakua Marsh (waterbirds)

Hamakua Marsh, located near the western edge of the city of Kailua, is a State-owned waterbird sanctuary administered by the DNLR. There is no existing agricultural production within the Hamakua Marsh mitigation area and the mitigation area is primarily located within the State Urban Land Use District, with a few small areas located within the State Conservation Land Use District; therefore, the Hamakua Marsh mitigation area does not lie within the study area for the Phase I Oahu IAL mapping project. The land within the Hamakua Marsh mitigation area is not classified under the ALISH system and the soils within the mitigation area are unclassified under the LSB system. Under the NRCS land capability classification system, soils within the Hamakua Marsh Mitigation area are classified as Class VI, VII, and VIII and, thus, are not suitable for agricultural production.

3.20.5 Poamoho Ridge (bat)

The Poamoho Ridge mitigation area is located within the Ewa Forest Reserve near the ridgeline of the Koolau Mountain Range. The mitigation areas is owned and managed by the DLNR. There is no existing agricultural production within the Poamoho Ridge mitigation area and the mitigation area is located within the State Conservation Land Use District; therefore, the Poamoho Ridge mitigation area does not lie within the study area for the Phase I Oahu IAL mapping project. The lands within the Poamoho ridge mitigation area are not classified under the ALISH system and the soils are classified as Category E (i.e., least productive soils) under the LSB system. Under the NRCS land capability classification system, soils within the Poamoho Ridge Mitigation area are classified as Class VII and VIII and, thus, are not suitable for agricultural cultivation.

4.0 ENVIRONMENTAL CONSEQUENCES

This chapter provides the scientific and analytic basis for evaluation of the potential effects of each of the alternatives described in Chapter 2 on the physical, biological, and social environments. The resources discussed in this chapter include geology and soils, hydrology and water resources, air quality and climate change, noise, hazardous and regulated materials and wastes, natural hazards, vegetation, wildlife, threatened and endangered species, socioeconomic resources, historic, archaeological and cultural resources, land use, recreation and tourism, visual resources, transportation, public health and safety, environmental justice, public infrastructure and services, military, and agriculture. The discussion for each resource is divided into three primary sections: 1) direct and indirect effects associated with construction and operation of the Project; 2) direct and indirect effects associated with the issuance of the ITP and implementation of the HCP including the implementation of conservation measures, mitigation, and monitoring; and 3) cumulative effects. As discussed in Chapter 2, an evaluation of the Modified Proposed Action Option (Alternative 2a) has been added under each resource subsection.

This evaluation of potential cumulative effects is consistent with the following regulations and guidance:

- CEQ Regulations for Implementing the Procedural Provisions of the NEPA (40 CFR Part 1500-1508, 1978 as amended) (CEQ 2005a);
- EPA Procedures for Implementing the Requirements of the CEQ on the NEPA (40 CFR Part 6 [EPA 2009]);
- CEQ Guidance for Considering Cumulative Effects under the NEPA (January 1997) (CEQ 1997b);
- EPA Guidance for Consideration of Cumulative Impacts in EPA Review of NEPA Documents, EPA 315-R-99-002 (May 1999);
- USFWS NEPA Reference Handbook (550 WL 1.7; 505 WL 1);
- HRS Chapter 343, HAR 11-200; and
- State of Hawaii OEQC Guide to the Implementation and Practice of the Hawaii Environmental Policy (OEQC 2012) and HAR §11-200-10(6)

4.1 Direct and Indirect Effects Analysis

4.1.1 Methods for Determining Level of Impact

Direct impacts would be caused by the action, and would occur at the same time and place as the alternative (40 CFR § 1508.8). These impacts are limited to the Proposed Action and alternatives only. Indirect impacts would also be associated with the action, but would occur later in time or at a more distance location from the action. Indirect impacts "may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems" (40 CFR

§ 1508.8). Direct and indirect impacts could be associated with the construction, operation, maintenance, or decommissioning of the Project, or with implementation of mitigation measures identified in the HCP.

The specific analysis areas that were identified in Chapter 3 for each resource encompass all potential direct and indirect effects to that resource. For some resources, the analysis area is limited to the disturbance footprint of the Project, whereas for others is encompasses a larger geographical area to encompass potential indirect effects.

The direct and indirect impacts for each resource are discussed based on intensity (magnitude), duration, extent, and context of the impact. In addition, impacts may be adverse and beneficial within a resource category. Definitions are provided below.

<u>Intensity (Magnitude)</u>

- **Low**: A change in resource condition is perceptible, but it does not noticeably alter the resource's function in the ecosystem or cultural context.
- **Medium**: A change in a resource condition is measurable or observable, and an alteration to the resource's function in the ecosystem or cultural context is detectable.
- **High**: A change in a resource condition is measurable or observable, and an alteration to the resource's function in the ecosystem or cultural context is clearly and consistently observable.

<u>Duration</u>

- **Temporary**: Impacts would be intermittent, infrequent, or last only a single season or for the duration of a discreet activity, such as construction.
- **Long-term**: Impacts would be frequent, or extend from several years up to the life of the Project.
- **Permanent**: Impacts would cause a permanent change in the resource that would last beyond the life of the Project even if the actions that caused the impacts were to cease.

<u>Extent</u>

- **Local**: Impacts would be limited geographically; impacts would not extend to a broad region or a broad sector of the population.
- **Regional**: Impacts would extend beyond a local area, potentially affecting resources or populations throughout the Island of Oahu.
- **State-wide**: Impacts would extend beyond the wind farm site or region, potentially affecting resources or populations throughout the State.

<u>Context</u>

- **Common**: The affected resource is not rare in the locality and is not protected by legislation. The portion of the resource affected does not fill a unique role within the locality or region.
- **Important**: The affected resource is protected by legislation or is rare either within the locality or the region.

- **Unique**: The affected resource is protected by legislation and the portion of the resource affected fills a unique role within the locality or the region.

Summaries about the overall impacts on the resource synthesize information about intensity, duration, extent, and context, which are all weighed against each other to produce a final assessment. While each summary reflects a judgment call about the relative importance of the various factors involved, the following descriptors provide a general guide for how summaries are reached:

- **Negligible**: A negligible impact would result in no change to a resource, or a change so small it would not be measureable. Negligible impacts are considered less than significant.
- **Minor**: A minor impact would result in a change to a resource, but would be small, localized, and of little consequence. Minor impacts are considered less than significant.
- **Moderate**: A moderate impact would result in a measurable change to a resource, requiring mitigation. Implementation of mitigation would result in the downgrading of impact intensity from moderate to minor or negligible.
- **Major**: A major impact would result in a substantial change to the character of a resource over a large area, and even through mitigation would not be made less than significant.

BMPs and other avoidance and minimization measures associated with construction and operation of the Project are described in the resource-specific discussions below and in Table 2-3 and referenced under the appropriate resource sections. Measures for avoiding and minimizing Project-related impacts to Covered Species that would be implemented under the HCP are listed in Section 2.2.2. Some of these measures also apply to other resources and are identified below.

4.1.2 Incomplete or Unavailable Information

The CEQ guidelines require that:

> When an agency is evaluating reasonably foreseeable significant adverse effects on the human environment in an environmental impact statement and there is incomplete or unavailable information, the agency shall always make clear that such information is lacking (40 CFR § 1502.22).

In the analysis, this EIS identifies those areas where information is unavailable to support a thorough evaluation of environmental consequences of the alternatives. Efforts have been made to obtain all relevant information; however, data gaps still exist at this time for several reasons, such as the costs of obtaining the missing data are exorbitant, the data will take several years to obtain, or the means to obtain the data are unknown.

4.2 Cumulative Effects Analysis

Cumulative effects are defined 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 actions" (40 CFR § 1508.7).

Cumulative impacts pertain to the additive or interactive effects that would result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. If the action has effects that simply contribute to the effects of past, present, and future actions, the impact is additive. Interactive impacts may be either greater or less than the sum of the individual impacts; therefore, the action's contribution to the cumulative case could increase or decrease the net impacts.

Hawaii Administrative Rules (HAR) § 11-200-17(g) requires that an EIS include "specific reference to related projects, public and private, existent or planned in the region … for purposes of examining the possible overall cumulative impacts of such actions." This includes:

- The basis for the assessment, including the regulatory framework, the scope of the analysis, and the cumulative impact analysis area (CIAA) by resource (Section 4.2.1.1); and
- A summary table and brief descriptions of the relevant past, present, and reasonably foreseeable actions that could contribute to a cumulative effect (Section 4.2.1.3).

4.2.1 Methods for Identifying Cumulative Effects

The level of analysis for each resource is commensurate with the intensity of the direct and indirect impacts identified. If the action does not have direct or indirect impacts to a resource, there would be no contribution to cumulative impacts, and the cumulative impact analysis would not be conducted for that resource. Cumulative impacts are identified using the following general approach:

1. Identify the appropriate level of analysis for each resource.
2. Identify resources for which no impacts are expected from the Project. These resources will not be considered further for cumulative impacts.
3. Describe current resource conditions and trends (Chapter 3).
4. List the potential impact producing factors related to construction and operation of the Project, and their potential direct and indirect impacts to specific resources.
5. Identify the potential impacts which each action might contribute to cumulative impacts.
6. Identify past, present, and reasonably foreseeable future actions that could affect resources.
7. Analyze the potential cumulative impacts.

4.2.1.1 Scope of the Analysis

A complete picture of forces already acting upon a particular environmental resource is essential in making reasonable decisions about the management of that resource. If sources of impact exist, whether they are on private or public land, or whether they were taken in the past, are ongoing, or have a reasonable chance of occurring in a future when the impacts of the proposal are also ongoing, their combined impacts give decision-makers and the public a clear idea of the "absolute" impact the resource is experiencing.

Spatial and temporal boundaries are the two critical elements to consider when deciding which past, present, and reasonably foreseeable future actions to include in a cumulative effects analysis. Spatial and temporal boundaries set the limits for selecting those actions that are most likely to contribute to a cumulative effect. The effects of those actions must overlap in space and time with the effects of the alternatives being analyzed for there to be a potential cumulative effect.

The CIAA to be considered in the cumulative effects analysis varies by resource, and consists of the full geographic extent of any direct and indirect impacts as well as any of the reasonably foreseeable future actions. For some resources, the CIAA consists of the analysis area identified in Chapter 3, which includes all impacts associated with the issuance of the ITP and implementation of the HCP, and construction and operation of the Project. However, in several cases, the CIAA for a given resource is substantially larger than the corresponding analysis area in order to consider an area large enough to encompass likely effects from reasonably foreseeable future actions on the same resource (i.e., water resources or air quality). For the purposes of the cumulative effects analysis, the CIAA for Alternative 3 and the Proposed Action are the same. Table 4.2-1 defines the CIAA considered for each resource.

The temporal extent used to identify reasonably foreseeable future projects to be considered in the cumulative effects analysis is the expected physical operational life of this Project and term of the ITP. This is approximately 21 years, which includes site rehabilitation and decommissioning activity if the Project is not repowered.

Table 4.2-1. Cumulative Impact Analysis Area by Resource.

Resource	Definition of Cumulative Impact Analysis Area (CIAA)[1/]	Rationale for Area
Geology and Soils	Wind farm site plus mitigation areas	Impact restricted to immediate areas where ground disturbance would occur.
Hydrology and Water Resources	Oio, Malaekahana, Kaelepulu, Kaukonahua, Poamoho, and Helemano watersheds; Koolauloa aquifer subunit	Watersheds and aquifers intersected by the Project facilities and mitigation areas.
Air Quality and Climate Change	Island of Oahu	Climate change impacts from greenhouse gas emissions and air quality impacts occur on regional and larger scales.
Noise	The area within 5 miles (8 km) of the wind farm site	Areas beyond which no noise from construction at the mitigation sites or construction or operation of Project would be detectable above EPA or Hawaii Community Noise Regulations recommended levels.
Hazardous and Regulated Materials and Wastes	Wind farm site and mitigation areas	Impacts would be limited to areas where construction equipment and vehicles would be used.
Natural Hazards	Island of Oahu	Natural hazards occur on a regional scale.
Vegetation	Project plus 0.25-mile (0.4-km) buffer, plus mitigation areas	Adequately covers the areas where project-related disturbance would occur and area where invasive plant introduction/spread impacts could occur.
Wildlife (Non-listed)	Project plus 0.5-mile (0.8-km) buffer, plus mitigation areas	Reasonable distance beyond which construction or operation of the Proposed Action or other projects is unlikely to disturb nesting birds or other native wildlife.

Table 4.2-1. Cumulative Impact Analysis Area by Resource (continued)

Resource	Definition of Cumulative Impact Analysis Area (CIAA)1/	Rationale for Area
Threatened & Endangered Species (Newell's Shearwater, Hawaiian hoary bat, Hawaiian waterbirds, Hawaiian short-eared owl, Hawaiian goose)	Island of Oahu	Captures impacts of other wind projects on the Oahu populations.
Socioeconomics	Koolauloa District	Corresponds with the socioeconomic and environmental justice analysis area where Project impacts may occur.
Historic, Archaeological, and Cultural Resources	Wind farm site	Includes areas were potential disturbance of cultural or archaeological resources would occur.
Land Use	Koolauloa District	Level at which land use regulations, plans, or authorizations are in effect.
Recreation and Tourism	The area within 5 miles (8 km) of the wind farm site, and within 1 mile (1.6 km) of the bat and waterbird mitigation sites	Includes all recreation and tourism opportunities with the potential to be impacted by the Project.
Visual Resources	Viewshed for Project	Furthest distance within which the Project is visible, given visual attenuation in this landscape.
Transportation	Existing roads used for the Project; the Honolulu Airport; and Kalaeloa Harbor	Where traffic and transportation impacts would occur in association with the Project and HCP.
Public Health and Safety	Areas occupied by people where crossed by Project or from which the Project is visible	Construction and operation of Project may affect the health and safety of people.
Environmental Justice	Koolauloa District	Corresponds with the socioeconomic and environmental justice analysis area.
Public Infrastructure and Services	Wind farm site and the surrounding area serviced by utility providers on Oahu	Coincides with the impacts analysis area for this resource.
Military	Military interests within 5 miles (8 km) of the wind farm site, and within 1 mile (1.6 km) of the respective mitigation areas	Coincides with the military analysis area.
Agriculture	Koolauloa District	Corresponds to larger region in which agricultural activities occur.

1/ Note that for the purposes of the cumulative effects analysis, the Alternative 3 and Proposed Action CIAA is the same.
km = kilometers

4.2.1.2 Past and Present Actions

Past actions are generally not identified individually; rather, this analysis relies on current environmental conditions as a proxy for the impacts of past actions. This is because existing conditions reflect the aggregate impact of all prior human actions and natural events that have affected the environment and might contribute to cumulative impacts. Consequently, this cumulative impacts analysis does not attempt to quantify the impacts of past human actions by adding up all prior actions on an action-by-action basis. Current conditions have been impacted by innumerable actions over the last century, and trying to isolate individual actions that continue to have residual impacts would be nearly impossible. This approach is consistent with a CEQ interpretive memorandum issued on June 24, 2005, regarding analysis of past actions, which states, "agencies can conduct an adequate cumulative effects analysis by focusing on the current aggregate effects of past actions without delving into the historical details of individual past actions" (CEQ 2005b). Past actions are reflected in the baseline information presented in Chapter 3, which provides context for the cumulative impacts analysis.

4.2.1.3 Reasonably Foreseeable Future Actions

This section discusses the reasonably foreseeable future actions that have the potential to overlap spatially and temporally with the Project. As described by the CEQ (2005b), "It is not practical to analyze how the cumulative effects of an action interact with the universe; the analysis of environmental effects must focus on the aggregate effects of past, present, and reasonably foreseeable future actions that are truly meaningful."

Identified reasonably foreseeable future actions were reviewed to determine if they should be considered further in the cumulative impacts analysis. Factors considered when identifying other actions to be included in the cumulative impacts analysis included the following:

- Whether the other action is likely or probable (i.e., reasonably foreseeable), rather than merely possible or speculative.
- Whether the other action and the Project would affect the same resources.
- Whether the other action would create impacts to the same populations at the same time as the Project.
- The current conditions, trends, and vulnerability of resources affected by the other action.
- The duration and intensity of the impacts of the other action, with and without the Project.
- Whether the impacts would likely be truly meaningful, historically significant, or identified previously as a cumulative impact concern.

Table 4.2-2 lists specific projects considered in the cumulative effects analysis and indicates for which resources there are direct or indirect impacts that overlap in space and time with impacts of the reasonably foreseeable future actions.

Table 4.2-2. Projects Considered in the Cumulative Effects Analysis

Location	Project Name/Activity	Project Sponsor	Year Planned	Project Description	Past, Present, or Future	Resource CIAAs Overlapped[1/]
Malaekahana lands	Agricultural operations	Various	Ongoing	Lands within the Malaekahana parcel will continue to be used for agriculture during Project operation.	Present	Vegetation; Hydrology and Water Resources; Land Use; Socioeconomics; Agriculture
Kamehameha Highway from Haleiwa to Kahaluu	Transportation safety improvements[2/]	State Department of Transportation	Anticipated sometime between 2015-2020	On list of potential projects scheduled through 2020. Construct turn lanes, guardrails, signage, crosswalks, etc. to improve safety. Widening of Kamehameha Highway will only be in areas where needed for storage/turn lanes safety improvements (OMPO 2011).	Future	Transportation
Koolauloa District	Residential and commercial development[3/]	Brigham Young University (BYU)	Ongoing (ground breaking in 2011)	Expanded staff and faculty housing in Malaekahana area to accommodate increased enrollment at Brigham Young University from 2,400 to 5,000 students. Also construction of technology park associated with BYU, primarily intended for emerging technology-oriented industries and support services.	Future	Socioeconomics; Transportation; Agriculture
Kahuku Training Area and associated airspace	Ongoing military operations	Department of Defense	Ongoing	Ongoing aviation and ground training, including low level, day, night, and night vision device training.	Present	Military
North end Koolauloa District, Turtle Bay	Turtle Bay Resort Expansion[4/]	Turtle Bay	2015-2025	Expansion of Turtle Bay Resort, including two new full-service hotels, 590 new Resort Residential Units, and 160 Community Housing Units that will be priced to be affordable to residents of the Koolauloa/North Shore region.	Future	Traffic/Transportation, Public Infrastructure and Services
State Department of Agriculture/Malaekahana lands	Existing roads	Numerous	Ongoing	Existing state- and county-owned roads within the TMKs that encompass the Project are used for local access, including the Kahuku Agricultural Park interior roadways. The Project is adjacent to the Kamehameha highways. The Hamakua Marsh is located adjacent to Hamakua Drive. The Poamoho Ridge is accessed via dirt State-owned roads.	Past, Present	Traffic; Noise

Table 4.2-2. Projects Considered in the Cumulative Effects Analysis (continued)

Location	Project Name/Activity	Project Sponsor	Year Planned	Project Description	Past, Present, or Future	Resource CIAAs Overlapped[1/]
Oahu	Existing 138-kV and 46-kv transmission lines	HECO	N/A	Electricity is delivered throughout Oahu through two primary transmission corridors—one in the north and the other in the south. HECO's138-kV transmission lines transport bulk power transmission substations where power is reduced to 46 kV and transported to local area distribution stations.	Past	Wildlife-non-listed wildlife; Newell's shearwater, Hawaiian goose; Natural Hazards; Vegetation
Koolauloa District	Residential solar energy, or photovoltaic (PV), system installation[5/]	Various/HECO	Ongoing	In 2012, HECO ranked 10th among U.S. utilities in watts per customer with a total of 65 MW of new solar capacity, of which approximately 43 MW were residential (SEPA 2013). Currently approximately 5 percent of HECO customers have PV systems. Given high electricity prices and State RPS, PV installation is anticipated to grow.	Present, Future	Socioeconomics
Kahuku	Kahuku Wind Farm	First Wind, LLC	2011-2031	Existing 30-MW wind project located adjacent to Na Pua Makani. Project obtained ITP authorizing incidental take of Newell's shearwater (18 total), Hawaiian petrel (12 total), Hawaiian hoary bat (32 total), Hawaiian duck (pure and hybrids; 24 each), Hawaiian stilt (18 total), Hawaiian coot (17 total), Hawaiian moorehen (20 total), Hawaiian short-eared owl (24 total)	Present	Visual; T&E; Public Infrastructure and Services; Noise; Socioeconomics; Air Quality/Climate Change; Recreation and Tourism; Military; Agriculture
North Shore of Oahu, approximately 5 miles northeast of Haleiwa town	Kawailoa Wind Farm	First Wind, LLC	2011-2031	Existing 69-MW wind project. Project obtained ITP authorizing incidental take of Newell's shearwater (9 total), Hawaiian duck (12 total), Hawaiian stilt (18 total), Hawaiian coot (18 total), Hawaiian moorhen (12 total), Hawaiian short-eared owl (12 total), Hawaiian bat (72 total)	Present	T&E; Air Quality/Climate Change; Military
TBD	Road maintenance	City and County of Honolulu	2014-2017	Various road repaving projects (http://www1.honolulu.gov/ddc/roadrepavingupdate.htm)	Future	Transportation

Table 4.2-2. Projects Considered in the Cumulative Effects Analysis (continued)

Location	Project Name/Activity	Project Sponsor	Year Planned	Project Description	Past, Present, or Future	Resource CIAAs Overlapped[1/]
Malaekahana parcel	Envision Laie Project	Envision Laie	Anticipated before 2019 (20-year planning horizon of Koolauloa Sustainable Communities Plan)	Residential development on 300 acres of Malaekahana land	Future	Socioeconomics, Vegetation, Wildlife, Soils/Topography, Hydrology/Water Resources, Cultural/Archaeology; Agriculture
Kawainui-Hamakua Marsh	Kawainui-Hamakua Marsh master development plan projects[6/]	DOFAW and Hawaii Division of State Parks	Ongoing	Ongoing restoration efforts (wetland expansion, flood control, invasive species control) to enhance the Kawainui-Hamakua marsh complex	Future	T&E (waterbirds)
Ewa Forest Reserve (Poamoho Ridge)	Management activities in Ewa Forest Reserve[7/]	DOFAW	Pending funding	Fencing poamoho parcel and potentially installing fence around two units;	Future	T&E (Hawaiian hoary bat)

1/ Indicates that a past, present, or foreseeable project/activity effect overlaps in space and time with the same type of direct or indirect effect of the proposed Project.
2/ Source: Oahu Regional Transportation Plan (ORTP) 2035 (Oahu Metropolitan Planning Organization 2011)
3/ Source: Koolauloa Sustainable Community Plan (City and County of Honolulu, DPP 1999)
4/ Turtle Bay Expansion Supplemental EIS (Lee Sichter LLC, 2013)
5/ Source: Solar Electric Power Association (2013)
6/ Source: DLNR-DOFAW (2011)
7/ Source: http://manoa.hawaii.edu/hpicesu/DPW/ERMUP/2012_Waimano.pdf)
HECO = Hawaii Electric Company
RPS = Renewable Portfolio Standard
TMK = Tax Map Key
T&E = threatened and endangered
DOFAW = Division of Forestry and Wildlife
ITP = Incidental Take Permit

4.3 Geology and Soils

4.3.1 Impact Criteria

NEPA and CEQ guidelines state that protection of unique geological features, minimization of soil erosion, and the siting of facilities in relation to potential geologic hazards must be considered when evaluating impacts of the Project. Factors considered in determining whether the Project would have a significant impact on geology and soil resources include the extent to which the Project would:

- Damage or prevent access to areas of geologic importance or mineral resources with economic value to the region;
- Increase the exposure of people or structures to geologic hazards;
- Alter drainage patterns through large-scale excavation, filling, or leveling.
- Increase the probability or magnitude of mass soil movement through erosion (e.g., slope failures, slumps);
- Increase soil loss and erosion due to wind erosion or disturbance causing the formation of rills or gullies, and deposition of sediment in down-gradient areas;
- Cause a loss of soil that uniquely supports threatened or endangered plant species or sensitive ecosystems;
- Cause a long-term loss of productivity or vegetative growth from compaction or mixing of soils; and
- Result in loss of prime or unique farmland.

Impact criteria for determining effects on geology and soil resources from the Project are described further in Table 4.3-1 below.

Table 4.3-1. Impact Criteria for Geology and Soil Resources

Type of Effect	Impact Component	Effects Summary		
Changes to geology features and soil characteristics	Magnitude or Intensity	**High:** Acute or obvious changes in geology or soil resources	**Medium:** Noticeable changes in geology or soil resources	**Low:** Changes in geology or soil resources may not be measurable or noticeable
	Duration	**Permanent:** Chronic effects; geology or soil resources would not be anticipated to return to previous levels	**Long-term:** Geology or soil resources would be impacted through the life of the Project and would return to pre-activity levels at some point after completion of the Project	**Temporary:** Geology or soil resources would be impacted infrequently but not longer than the span of the Project construction and would be expected to return to pre-activity levels at the completion of the activity

Table 4.3-1. Impact Criteria for Geology and Soil Resources (continued)

Type of Effect	Impact Component	Effects Summary		
	Geographic Extent	**Extended**: Affects geology or soil resources beyond the region or wind farm site	**Regional**: Affects geology or soil resources beyond a local area, potentially throughout the wind farm site	**Local**: Impacts limited geographically; discrete portions of the wind farm site affected
	Context	**Unique**: Affects unique geology or soil resources or soil resources protected by legislation	**Important**: Affects depleted geology or soil resources within the locality or region or soil resources protected by legislation	**Common**: Affects usual or ordinary geology or soil resources; not depleted or protected by legislation

4.3.2 Alternative 1—No Action

4.3.2.1 Direct and Indirect Effects

Under the No Action Alternative, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Therefore, Alternative 1 would have no effect on geology or soil resources in the analysis area. As such, no mitigation measures would be warranted.

4.3.2.2 Cumulative Effects

Under the No Action Alternative, the Project would not be constructed, the ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Therefore, there would be no effect on geology or soil resources. Thus, Alternative 1 would not contribute to cumulative effects to geology or soil resources.

4.3.2.3 Summary

Alternative 1 would have no effect on geology or soil resources because no action would be undertaken.

4.3.3 Alternative 2—8 to 10 Turbine Project

4.3.3.1 Direct and Indirect Effects of Construction and Operation of the Project

No significant geologic features or mineral resources with economic value are known or expected to occur in the wind farm site, therefore, construction and operation of the Project would not impact these resources. Likewise, earthquake or seismic activity in the wind farm site is not anticipated. Therefore, construction and operation of the Project would not result in increased exposure of people or structures to geological hazards (see Section 4.8 – Natural Hazards). There would be no impact to listed plant species or sensitive ecosystems as none occur at the wind farm site (see Section 4.9 – Vegetation). The effects of the Project during construction and operation would primarily be related to soil disturbance and are described in detail below.

Construction Impacts

Ground-disturbing activities including clearing and grubbing, topsoil stripping, grading, compaction, utility trenching, and placement of aggregate surfacing would occur during the construction of wind turbines and associated foundations and transformers, the electrical collection system and transmission line, met towers, access roads, construction staging areas, O&M building and associated storage yard, and the onsite substation. Grading activities would consist of the removal, storage, and/or disposal of earth, gravel, vegetation, organic matter, loose rock, and debris. Fill material would be utilized from onsite excavations and earthwork. Additional sources of this fill, if needed, include nearby pits or excess material taken from within the property. Construction materials and methods are described in detail in Chapter 2.

Up to approximately 89.0 acres (36.0 hectares) of ground disturbance would occur during construction (Table 2-1). Much of this disturbance would be temporary and subject to restoration activities at the end of Project construction. Up to approximately 59.9 acres (24.2 hectares) of ground disturbance would be long term, lasting through the life of the Project.

Grading and other construction activities have the potential to alter drainage patterns within the wind farm site. During scoping, concern was raised over potential impacts associated with flooding, particularly at the Kahuku football field. During the detailed design phase of the Project, the construction contractor will confirm stormwater runoff requirements and, if necessary, implement stormwater control measures such as seepage pits, drywells, and/or detention basins. New Project access roads would be located to follow natural contours and minimize side hill cuts to the extent possible and would include other BMPs such as ditches and culverts to capture and convey stormwater runoff. Additionally, with the exception of areas where permanent surface recontouring is required, disturbed areas would be restored to pre-existing grades and all disturbed areas where permanent gravel or aggregate is required would be revegetated. These measures would reduce the potential for erosion and adverse effects on drainage patterns. A Preliminary Drainage Study is included in Appendix H of the Final EIS.

Depending on the subsurface conditions, blasting is not expected but may be required to install the trenches. Blasting, if required, would be conducted such that it would minimize the creation of excessive slopes. A design-level geotechnical investigation would be conducted prior to construction to identify geologic conditions that could require additional design consideration or mitigation measures.

Removing vegetation and disturbing the soil for construction of Project facilities may increase wind erosion in areas that contain soil made up of fine sediment. During construction, erosion would be minimized using common dust suppression techniques, such as regularly watering exposed soils, stockpiling soils, and stabilizing soils. Excavation, grading, trenching, and other earth-disturbing activities can expose soils to runoff, potentially causing the formation of rills and gullies.

To minimize impacts associated with soil erosion, NPMPP would prepare a Temporary Erosion and Sediment Control (TESC) Plan that would be implemented by the construction contractor. The TESC Plan would include standard stormwater BMPs including building during the summer months when rainfall potential is low, using silt fences or hay bales to prevent eroded soil from being transported off-site, and contouring to stop drainage from entering the site and to prevent runoff would also be implemented to reduce the risk of erosion. Temporary ditches and culverts used to capture and convey stormwater would be installed in areas of temporary disturbance. Permanent stormwater control structures would be installed to prevent erosion where access roads, buildings, storage areas, and parking areas are constructed. Upon completion of construction, disturbed areas would be revegetated. With implementation of these measures, construction activities would not increase the probability of mass soil movement or wind or water erosion and would not result in long-term loss of soil productivity.

Soils within the Malaekahana Hui portion of the wind farm site are classified under the ALISH system as Prime Agricultural Lands (Hawaii State Department of Agriculture 1977). Up to approximately 26.1 acres (10.6 hectares) of Prime Agricultural Lands would be impacted in association with construction of wind turbines, the substation, O&M building, laydown area, and portions of the underground collector line, transmission line, and access roads. Of this, 12.6 acres (5.1 hectares) would be impacted over the long term, through the life of the Project. This comprises approximately 5 percent of the Prime Agricultural Lands in the wind farm site.

Operation and Maintenance Impacts

During operations, roads, buildings, wind turbines, transmission lines, and electrical collection systems would be maintained in good condition to prevent adverse effects on soil resources. Maintenance vehicles and service trucks would continue to use the access roads for routine maintenance of the wind turbines, met towers, electrical collector cables and transmission line facilities. Access roads would be maintained in good working order by the NPMPP through periodic grading and compacting to minimize naturally occurring erosion. Permanent low-growing vegetation or gravel pads around each wind turbine would be maintained to allow for O&M requirements, which would also minimize erosion. The O&M building and surrounding storage yard and parking areas would undergo routine maintenance and upkeep to minimize erosion and control stormwater runoff and drainage.

Routine servicing of all components of the proposed Project typically would not require heavy equipment such as large cranes but does require service vehicle access. If there were a major component replacement (e.g., blades or generators), heavy equipment similar to that used during construction would be required. Should component replacement be required, BMPs similar to those in place during construction would be followed.

Potential erosion impacts, including mass soil movement, would be less than significant because features designed to control stormwater and minimize erosion would be included in the site design and engineering. Engineering and design features to minimize erosion would include stormwater management features and planting and maintaining vegetative cover.

4.3.3.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP are not expected to affect the geology and soils in the analysis area. There would be some potential for minor movement of soil in conjunction with routine post-construction monitoring efforts associated with surveyors traversing transects beneath the turbines. However, this impact is expected to be negligible.

Impacts of HCP Mitigation Measures

No impacts to geology or soil resources would occur in association with funding provided for Newell's shearwater research and management or short-eared owl research and management. Depending on the measures chosen, minor soil disturbance may occur due to regular visits to the research and management sites to carry out these activities; however, impacts would be negligible.

Installation and maintenance of a partial fence along the northeastern border of the Hamakua Marsh Mitigation Area for waterbird mitigation would have no effect on geological resources or hazards and would not alter drainage patterns or cause slope failure. Lands in the Hamakua Marsh Mitigation Area are not classified by ALISH (Hawaii State Department of Agriculture 1977) or the LSB (University of Hawaii Land Study Bureau 1972); therefore, there would be no impact to prime or other agricultural land or loss of soil productivity associated with waterbird mitigation.

Installation and maintenance of the fence at Hamakua Marsh would result in minor permanent and temporary vegetation clearing and ground disturbance along the fence perimeter, which could increase the potential for soil erosion. The fence would be approximately 1,555 feet (474 meters) long and 4 feet (1.2 meters) high. Permanent disturbance would be restricted to areas where fence poles are located. Proposed design criteria for the fence are outlined in the Project HCP. Therefore, soil loss would be localized and would not affect soil productivity. Maintenance of the fence would include regular walking along the fence line to check for breaches which would result in minor soil disturbance.

Funding for forest restoration and monitoring at the Poamoho Ridge Mitigation Area for bat mitigation would go toward activities such as maintenance of the ungulate-proof fence installed by DLNR, feral pig control and monitoring, and invasive plant removal which are covered under the DLNR's existing exemption from Chapter 343 for the Koolau Forest Watershed Protection Project. Therefore, would have negligible effects to geology and soil resources. Foot traffic and vehicle use associated with fence maintenance, removal and monitoring of non-native ungulates and invasive plant species, and bat monitoring may cause minor disturbances to soils and result in very low level of increased erosion. However, these impacts are expected to be temporary and negligible. Ultimately, forest restoration efforts would have beneficial effects on soil resources within the Poamoho Ridge Mitigation Area by increasing soil stability.

4.3.3.3 Mitigation for Unavoidable Impacts

BMPs listed in Table 2-6, which will be implemented by NPMPP, will minimize impacts to geology and soil resources. These measures include:

- Prepare and implement a TESC Plan, which would help prevent erosion.
- Site Project access roads to follow natural contours and minimize side hill cuts to the extent possible, to minimize the potential for erosion and impacts to site drainage patterns.
- Construct a retention basin at the onsite substation to avoid erosion and eliminate the possibility of degrading downstream waters.
- Use ditches and culverts and other erosion controls to capture and convey stormwater in areas of temporary disturbance.
- Conduct blasting, if required, such that creation of excessive slopes would be minimized.
- Minimize wind erosion during construction through common dust suppression techniques, such as regularly watering exposed soils, stockpiling soils, and stabilizing soils.
- Restore disturbed areas to pre-existing grades and revegetate these areas.
- Install permanent stormwater control structures to prevent erosion where access roads, buildings, storage areas, and parking areas are constructed.
- Prepare and implement a site-specific SWPPP.

No additional avoidance, minimization, or mitigation measures are required.

4.3.3.4 Cumulative Effects

The cumulative effects analysis area for geology and soil resources includes the wind farm site as well as areas that would be disturbed by HCP conservation measures implemented in the mitigation areas. This area encompasses the areas where potential direct and indirect effects to geology and soil resources could occur.

The wind farm site and mitigation areas are not known to contain areas of geologic importance and would not result in significant impacts to geology or geologic hazards. Therefore, the Project would not contribute to cumulative impacts on geology that could result in conjunction with the projects listed in Table 4.2-2.

Past agricultural and associated development activities, as well as urban development and associated infrastructure (i.e., existing HECO transmission lines) have contributed to the overall loss and alteration of soil resources within the wind farm site. Ongoing agricultural operation in Malaekahana area will continue to impact soils in the wind farm site. Human activity and development in the vicinity of the Hamakua Marsh Mitigation Area have also contributed to the overall loss and alteration of soil resources in the area. Although little development has occurred in the Poamoho Ridge Mitigation Area, soils have likely been altered and degraded due to feral pig activity. Removal and control of non-native ungulates in Poamoho Ridge Mitigation Area would improve soil resources in the area.

The only foreseeable project in the cumulative effects analysis area with the potential to impact soil resources is the Envision Laie Project. This project includes residential development on 300 acres of Malaekahana land. It could result in additional permanent and temporary and localized impacts to soils and a temporary, localized increase in erosion. These impacts would be minimized if standard BMPs for minimizing the introduction and spread of invasive plant species would be implemented during construction and operation.

The Proposed Action would result in the disturbance of up to 89.0 acres (36.0 hectares) in association with construction and operation of the Project. Implementation of standard BMPs for soil erosion and restoring disturbed areas to pre-existing grades would minimize these impacts. Therefore, when viewed in conjunction with past, present, and foreseeable future projects in the cumulative effects analysis area, the contribution of Alternative 2 to cumulative effects on geology and soil resources would be minor.

4.3.3.5 Summary

Direct effects on geology and soils from the Proposed Action would include the disturbance of up to 89.0 acres (36.0 hectares), of which 59.9 acres (24.2 hectares) would be disturbed over the long term during Project operation. Soil disturbance would increase the potential for erosion and runoff; however, these effects would be minimized through the implementation of standard BMPs and Project design features. Effects on geology and soil resources under the Proposed Action would be considered minor because while the intensity would be high (obvious change in resource condition), and there would be short-term and long-term changes in the character and loss of soils in areas required for Project facilities, these effects would be localized (limited to a discrete portion of the wind farm site) and a minor amount of unique or important soils (lands classified as prime agricultural lands) would be affected.

4.3.3.6 Alternative 2a - Modified Proposed Action Option

Under Alternative 2a, direct, indirect, and cumulative effects on geology and soil resources would be similar to those described under Alternative 2. However, the Modified Proposed Action Option would result in up to approximately 84.5 acres (34.2 hectares) of ground disturbance, of which 56.7 acres (22.9 hectares) would be long term, lasting the life of the Project. Up to approximately 21.7 acres (8.8 hectares) of Prime Agricultural Lands would be impacted under the Modified Proposed Action Option. Of this, 9.4 acres (3.8 hectares) would be impacted over the long term , through the life of the Project. This comprises approximately 3.8 percent of the Prime Agricultural Lands in the wind farm site. Table 2-1 provides more detail on the disturbance areas associated with each Project component. Implementation of standard BMPs and other mitigation measures, as described under the Proposed Action, would minimize any adverse impacts to geology and soils.

4.3.4 Alternative 3—Larger Generation Facility (up to 12 Turbine Project)

4.3.4.1 Direct and Indirect Effects of Construction and Operation of the Project

Under Alternative 3, direct and indirect effects on geology and soil resources would be similar to those described under Alternative 2. However, with the construction of additional wind turbines and associated access roads (all other Project facilities would be the same; Table 2-1), Alternative 3 would result in up to approximately 98.6 acres (39.9 hectares) of ground disturbance, of which 69.8 acres (28.2 hectares) would be long term, lasting the life of the Project. Up to approximately 35.7 acres (14.5 hectares) of Prime Agricultural Lands would be impacted under Alternative 3 in association with construction of wind turbines, the substation, O&M building, laydown area, and portions of the underground collector line, transmission line, and access roads. Of this, 22.4 acres (9.0 hectares) would be impacted over the long term, through the life of the Project. This comprises approximately 9 percent of the Prime Agricultural Lands in the wind farm site. Table 2-1 provides more detail on the disturbance areas associated with each Project component. Implementation of standard BMPs, as described under the Proposed Action, would minimize any adverse impacts to geology and soils.

4.3.4.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP are not expected to affect the geology and soils in the analysis area. There would be some potential for minor movement of soil in conjunction with routine post-construction monitoring efforts associated with surveyors traversing transects beneath the turbines. However, this effect would be negligible.

Impacts of HCP Mitigation

Impacts of HCP mitigation under Alternative 3 would be the same as described under the Proposed Action. Prior to the construction of the additional turbines proposed under Alternative 3, NPMPP would reopen consultation with the USFWS and DOFAW to assess the potential impacts of the additional turbines to listed species and develop appropriate mitigation measures. The impacts of these mitigation measures to geology and soil resources would be evaluated under a separate environmental analysis at that time.

4.3.4.3 Mitigation for Unavoidable Impacts

Mitigation for unavoidable impacts under Alternative 3 would be the same as described under the Proposed Action (Section 4.3.3.3).

4.3.4.4 Cumulative Effects

The cumulative effects to geology and soil resources under Alternative 3 would be the same as those described under the Proposed Action, with the exception that Alternative 3 would contribute a total of 98.6 acres (39.9 hectares) of disturbance. Therefore, when viewed in conjunction with past, present, and foreseeable future projects in the cumulative effects analysis area, the contribution of Alternative 3 to cumulative effects on geology and soil resources would be minor. Because there will likely be a delay in time of up to 3 years before additional turbines would be built under Alternative 3, new projects and developments in the area will be assessed and reviewed to determine if there are additional cumulative impacts from future unknown projects.

4.3.4.5 Summary

Direct effects on geology and soils from Alternative 3 would include the disturbance of up to 98.6 acres (39.9 hectares), of which 69.8 acres (28.2 hectares) would be affected over the long term during Project operation. Soil disturbance would increase the potential for erosion and runoff; however, these effects would be minimized through the implementation of standard BMPs and Project design features. Effects on geology and soil resources under Alternative 3 would be considered minor because while the intensity would be high (obvious change in resource condition), and there would be short-term and long-term changes in the character and loss of soils in areas required for Project facilities, these effects would be localized (limited to a discrete portion of the wind farm site) and a minor amount of unique or important soils (lands classified as prime agricultural lands would be affected.

4.3.5 Conclusion

Table 4.3-2 summarizes potential impacts to geology and soil resources from the alternatives considered in this analysis.

Table 4.3-2. Summary of Potential Impacts to Geology and Soils

Impact Issues	No Action Alternative	Alternative 2 – Proposed Action	Alternative 2a – Modified Proposed Action Option	Alternative 3
Geologic resources and hazards	No Impact	Negligible	Negligible	Negligible
Drainage patterns and slope failure	No Impact	Minor	Minor	Minor
Erosion	No Impact	Minor	Minor	Minor
Sensitive species or ecosystems	No Impact	Negligible	Negligible	Negligible
Loss of agricultural land or soil productivity	No Impact	Minor	Minor	Minor

4.4 Hydrology and Water Resources

4.4.1 Impact Criteria

Factors considered in determining whether the Project would have a significant impact on hydrology and water resources include:

- Impacts to wetlands and other waters of the United States;
- Alteration of the existing drainage pattern of the site or area that would cause off-site erosion or siltation, adversely affecting adjacent properties;
- Contamination of surface water from erosion or stormwater runoff that would be a violation of Federal or State water quality standards;
- Groundwater quality degradation causing groundwater quality to not meet State or Federal standards; or
- Groundwater depletion or interference with groundwater recharge that adversely affects existing or proposed uses of the aquifers within the Project and mitigation areas.

Impact criteria for determining effects on hydrology and water resources from the Project are described further in Table 4.4-1 below.

Table 4.4-1. Impact Criteria for Hydrology and Water Resources

Type of Effect	Impact Component	Effects Summary		
Changes to Hydrology and Water Resources	Magnitude or Intensity	**High:** Acute or obvious changes in character of hydrology or water resources	**Medium:** Noticeable changes in character of hydrology or water resources.	**Low:** Changes in hydrology or water resources may not be measurable or noticeable.
	Duration	**Permanent:** Chronic effects; hydrology and water resources would not be anticipated to return to previous levels	**Long-term:** Hydrology and water resources would be adversely affected through the life of the Project and would return to pre-activity conditions at some point after completion of the Project.	**Temporary:** Hydrology and water resources would be adversely affected but not longer than the span of the Project construction and would be expected to return to pre-activity conditions at the completion of the activity.
	Geographic Extent	**Extended:** Affects hydrology and water resources beyond the region or wind farm site	**Regional:** Affects hydrology and water resources beyond a local area, potentially throughout the wind farm site	**Local:** Impacts limited geographically; discrete portions of the wind farm site affected.
	Context	**Unique:** Affects unique hydrologic or water resources or resources protected by legislation	**Important:** Affects depleted hydrologic or water resources within the locality or region or resources protected by legislation.	**Common:** Affects usual or ordinary hydrologic or water resources; not depleted or protected by legislation.

4.4.2 Alternative 1—No Action

4.4.2.1 Direct and Indirect Effects

Under the No Action Alternative, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Therefore, Alternative 1 would have no effect on hydrology and water resources. As such, no mitigation measures would be warranted.

4.4.2.2 Cumulative Effects

Under the No Action Alternative, the Project, the ITP would not be issued by the USFWS, and HCP conservation measures would not be implemented. Therefore, there would be no effect on hydrology and water resources. Thus, Alternative 1 would not contribute to cumulative effects on hydrology and water resources.

4.4.2.3 Summary

Alternative 1 would have no direct, indirect, or cumulative impacts to hydrology and water resources because no action would be undertaken.

4.4.3 Alternative 2—8 to 10 Turbine Project

4.4.3.1 Direct and Indirect Effects of Construction and Operation of the Project

Construction Impacts

Surface Water

There are no wetlands within the wind farm site; therefore construction of Alternative 2 would have no direct or indirect impact on wetlands.

Three streams—Malaekahana, Keaaulu, and Ohia—run through the wind farm site. Based on preliminary determination (Hobdy 2013b, SWCA 2015, USACE 2015), all three streams qualify as jurisdictional waters of the U.S. and are subject to jurisdiction under Section 404 of the CWA and Section 10 of the Rivers and Harbors Act (RHA). Additional regulations applicable to waters of the U.S. (including wetlands) and water quality are discussed in Chapter 5. The Project footprint has been designed to avoid jurisdictional features where possible and Proposed Action Project components would not directly impact Malaekahana Stream, Keaaulu Stream, or Ohia Stream.

Project components, including the electrical collector line, transmission line, and internal access roads, would cross Keaaulu Stream in two locations within the wind farm site; however, NPMPP would avoid placing any fill material or project components within the stream's ordinary high water mark (OHWM), thus avoiding the need for a USACE Section 404 CWA permit or Section 10 RHA permit. Under the Proposed Action, the electrical collector line would cross the upper (mauka) portion of Keaaulu Stream near the point where it crosses the boundary between the two leased parcels. Impacts to Keaaulu Stream would be avoided by installing the collector line via an underground directional bore or an overhead distribution line and all ground-disturbing activities would occur outside of the stream's OHWM. Additionally, lower Keaaulu Stream is crossed by the existing Malaekahana road near its intersection with Malaekahana Stream. Improvements to this road may be required at this crossing, which would potentially impact Keaaulu Stream; however, NPMPP would avoid impacts to Keaaulu Stream by installing an aluminum box culvert or bridge-type structure to span the stream channel. Excavation would take place approximately 3 feet outside the OHWM on each side of the feature for installation of the spanning structure's footings. Appropriate BMPs will be installed around each excavation area to avoid sediment runoff into Keaaulu Stream. If during final Project design, it is determined that Keaaulu Stream cannot be avoided the appropriate Federal and State permits would be obtained.

Likewise, ground disturbance associated with the construction of the wind turbine pad located in the northwestern portion of the Project (the wind turbine closest to the adjacent Kahuku Wind Farm) near Ohia Stream are anticipated to occur outside of the OHWM. However, if during final

Project design it is determined that Ohia Stream cannot be avoided the appropriate Federal and State permits would be obtained.

Ground-disturbing activities associated with construction of crossings of Keaaulu Stream or associated with turbine pad construction near Ohia Stream have the potential to directly increase the amount of sediment and other pollutants released into the streams which could adversely affect the water quality in Ohia Stream and Keaaulu Stream as well as downstream into Malaekahana Stream, and potentially near shore waters. Erosion and sediment control measures, including measures in the TESC Plan, would be put in place prior to initiating earth-moving activities to minimize these effects. Permanent stormwater control structures would also be installed to prevent erosion where access roads are constructed.

Ground disturbance during construction of the Project would also increase the potential for sediment and other pollutants present onsite to be conveyed in stormwater runoff into streams within the wind farm site, and potentially into downstream receiving waters. A site-specific Storm Water Pollution Prevention Plan (SWPPP) would be prepared for the Project. The SWPPP would identify BMPs that would be used to minimize or eliminate the potential for sediments and pollutants to reach surface waters through stormwater runoff. Erosion control measures included in the TESC Plan would also prevent water quality degradation from stormwater runoff during the construction phase of the Project. Additional BMPs that will be implemented to reduce erosion during Project construction are described in Section 4.4.3.3 – Mitigation for Unavoidable Impacts.

Alternative 2 would result in up to approximately 10.1 acres (4.1 hectares) of impervious surfaces in the wind farm site, which includes 10.0 acres (4.0 hectares; 99 percent) of gravel surfaces which would be considered semi-pervious.

This increase in impervious surface is less than 0.1 percent of the watersheds within which the Project is located. Additionally, the net increase in stormwater runoff under Alternative 2 was estimated at 11.9 cubic feet per second (cfs) (Belt Collins Hawaii LLC 2016a). With implementation of stormwater control measures, such as seepage pits, drywells, and/or detention basins, this minor increase in impervious surface and increase in the volume of stormwater is expected to have a negligible effect on the volume of stormwater runoff leaving the wind farm site.

Localized topographic alterations resulting from site grading and the construction of building pads and roads would also potentially alter local drainage patterns and stormwater runoff pathways. During scoping, concern was raised over potential impacts associated with flooding, particularly at the Kahuku High School football field and in the Kahuku Agriculture Park, adjacent to the wind farm site. During the detailed design phase of the Project, the construction contractor will confirm net increase in stormwater runoff and, if necessary, implement stormwater control measures such as seepage pits, drywells, and/or detention basins. New Project access roads would be located to follow natural contours and minimize side hill cuts to the extent possible. Additionally, construction of the Project would be designed to minimize changes to naturally existing topography and drainage and to ensure that, during construction, stormwater is directed to the designated drainage systems. These measures, in addition to the low amount of stormwater volume expected to leave the wind farm site, would ensure that the Project would not increase the likelihood of flooding at the Kahuku High School football field and the Kahuku Agriculture Park.

Groundwater

During construction, peak water needs of approximately 10,000 to 15,000 gallons (37,850 to 56,780 liters) per day would be required for dust suppression and emergency fire suppression. Water required during construction would be delivered to the site and stored in an onsite water tank, come from existing wells, or come from a similar source. Therefore, construction of the Project would have no impact on the quantity of available groundwater in the wind farm site.

Construction activities would require the use of hazardous materials such as fuels (e.g., diesel fuel, gasoline), lubricants, cleaning solvents, and paints. If these materials were to enter stormwater, they could reduce groundwater quality. Prior to construction, NPMPP would prepare a project Spill Prevention, Containment, and Countermeasures (SPCC) Plan that would include measures for the safe transport, handling, and storage of these materials. The groundwater in the Koolauloa aquifer is considered to have high vulnerability to contamination; however, with implementation of the SPCC Plan, the potential for localized, temporary adverse impacts to groundwater quality from construction of the Project would be reduced to a negligible level.

As stated above, Alternative 2 would result in only slight increases in impervious surfaces, less than 0.1 percent of the watersheds within which the Project is located. Precipitation falling on these impervious surfaces would likely runoff to adjacent open lands where aquifer recharge would occur, therefore, the slight increase in impervious surfaces is not expected to measurably reduce potential for groundwater recharge.

Operation and Maintenance Impacts

Surface Water

As noted above, Alternative 2 would result in a minor increase in the amount of impervious surfaces in the wind farm site. Operation of the Project under Alternative 2, therefore, would not substantially increase the volume of stormwater runoff that reaches streams and drainages within the wind farm site or downstream of the Project. A Preliminary Drainage Study is provided in Appendix H of the Final EIS.

Alterations to topography resulting from site grading for construction of the permanent Project facilities, including wind turbines and pads and access roads, would have the potential to alter drainage and stormwater runoff patterns onsite during Project operations. However, these alterations would be highly localized, and in compliance with City and County of Honolulu requirements, the Project would be designed to ensure that no net additional changes in stormwater volume and runoff patterns would occur off-site. The presence of new access roads and use of these roads during operations could also increase erosion and sedimentation into streams within the wind farm site. Access roads would be maintained in good working order by the NPMPP through periodic grading and compacting to minimize naturally occurring erosion. Additionally, with the exception of areas where permanent surface recontouring is required, disturbed areas would be restored to pre-existing grades and all disturbed areas where permanent gravel or aggregate is not required would be revegetated. Additionally, permanent stormwater control structures would be installed to prevent erosion where access roads, buildings, storage areas, and parking areas are constructed. With the implementation of the measures described here and listed in Section 4.4.3.3, impacts to surface water during Project operations associated with stormwater runoff and erosion, would be reduced to less than significant. Additional design features and BMPs that will be implemented during O&M of the Project to reduce erosion and soil movement are described in Section 4.3 – Geology and Soils.

Groundwater

The Project would result in a small increase in the amount of new impervious and semi-pervious surfaces in the analysis area (approximately 10.1 acres [4.1 hectares]). Precipitation falling on these new impervious surfaces would drain to adjacent pervious surfaces, and therefore, O&M of the Project would not measurably reduce the potential for groundwater recharge.

During operations, water would be required for use at the O&M building resulting in an average daily demand of up to approximately 200 gallons (757 liters) of water per day, with a maximum daily demand of up to approximately 500 gallons (1,893 liters) and a peak hour demand of 100 gallons (379 liters) per minute. Water for the O&M building would be trucked in and stored in tanks for operations or would be obtained by connecting to existing sources. Therefore, operations of the Project would not measurably reduce the quantity of available groundwater in the analysis area.

4.4.3.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP would not be expected to affect the hydrology and water resources within the analysis area. Although grading for construction of the Project would result in localized, onsite alterations in topography and thus drainage patterns, in accordance with the Project HCP stormwater management employed for the turbine pads and access roads will be designed to minimize the potential for accumulating standing water, which could serve as an attractant to waterbird species.

Impacts of HCP Mitigation

No impacts to hydrology or water resources would occur in association with funding provided for Newell’s shearwater research and management or short-eared owl research and management. Depending on the measures chosen, minor, short-term, localized soil disturbance (and thus the increased potential for soil erosion) could occur due to regular visits to the research and management sites to carry out these activities; however, impacts to water resources would be negligible. No adverse impacts to any wetlands or waters of the U.S. would occur in association with the HCP mitigation measures.

Installation and maintenance of a partial fence along the northeastern border of Hamakua Marsh Mitigation Area for waterbird mitigation would have no direct impact on Hamakua Canal, Hamakua

Marsh, or other wetlands or other waters of the U.S. Additionally, fence construction would result in a negligible increase in impervious surfaces in the mitigation areas. A minor amount of soil disturbance would occur in association with installation of the fence, which would increase the potential for temporary, localized erosion and sedimentation. Construction activities may require the use of hazardous materials such as fuels (e.g., diesel fuel or gasoline for power tools and vehicles), which could reduce ground water quality if they were to enter stormwater. NPMPP would work with USFWS and DOFAW to ensure fence design and construction methods meet mitigation objectives. Standard erosion and sediment control measures, as well as measures for the safe transport, handling, and storage of hazardous materials, would be employed to reduce any temporary, localized impacts to surface and ground water quality to a negligible level.

Funding for forest restoration and monitoring at the Poamoho Ridge Mitigation Area for bat mitigation would go toward activities such as maintenance of the ungulate-proof fence installed by DLNR, feral pig control and monitoring, and invasive plant removal which are covered under the DLNR's existing exemption from Chapter 343 environmental analysis for the Koolau Forest Watershed Protection Project. Therefore, these activities are expected to have negligible effects to hydrology and water resources. Foot traffic and vehicle use associated with fence maintenance, removal and monitoring of non-native ungulates and invasive plant species, and bat monitoring may cause minor, localized disturbances to soils which could result in very low levels of increased erosion that could enter streams and drainages in the watershed. However, these impacts are expected to be temporary and negligible.

Fence maintenance and invasive plant removal may require the use of hazardous materials such as fuels (e.g., diesel fuel or gasoline for power tools and vehicles), which could reduce groundwater quality if they were to enter stormwater. Standard practices for the safe transport, handling, and storage of these materials consistent with DLNR's current practices would be implemented to minimize the potential for impacts to water quality. Likewise, invasive plant control at Poamoho Ridge may include of the application of herbicides. Only appropriate herbicides for the forest will be used, in accordance with labeled instructions to ensure that no significant impacts to water resources are expected from the use of herbicides.

Ultimately, forest restoration efforts would reduce soil disturbance and associated erosion currently being caused by non-native ungulate activity within the Poamoho Ridge Mitigation Area. Therefore, there would likely be an overall beneficial effect on hydrology and water resources within the Poamoho Ridge Mitigation Area through increased soil stability.

4.4.3.3 Mitigation of Unavoidable Impacts

BMPs listed in Table 2-6, which will be implemented by NPMPP, will minimize impacts to hydrology and water resources. These measures include:

- Preparation and implementation of a TESC Plan, which would include standard stormwater BMPs such as building during the summer months when rainfall potential is low, using silt fences or hay bales to prevent eroded soil from being transported off-site, and contouring to minimize impacts to onsite drainage and to prevent runoff from entering surface water.

- Siting Project access roads to follow natural contours and minimize side hill cuts to the extent possible to minimize the potential for erosion and impacts to site drainage patterns.
- Constructing a retention basin at the onsite substation to avoid erosion and eliminate the possibility of degrading downstream waters.
- Using ditches and culverts and other erosion controls to capture and convey stormwater in areas of temporary disturbance.
- Restoring disturbed areas, with the exception of areas where permanent surface recontouring is required, to pre-existing grades and revegetation of these areas.
- Installing permanent stormwater control structures to prevent erosion where access roads, buildings, storage areas, and parking areas are constructed.
- Preparing an SPCC Plan.
- Preparing and implementing a site-specific SWPPP.

No additional avoidance, minimization, or mitigation measures are required.

4.4.3.4 Cumulative Effects

The cumulative effects analysis area for impacts on hydrology and water resources includes the Oio, Malaekahana, Kaelepulu, Kaukonahua, Poamoho, and Helemano watersheds. This area encompasses the areas where cumulative effects to hydrology and water resources would occur.

Past agricultural and associated development activities, as well as urban development and associated infrastructure, and construction of the Kahuku Wind Farm have contributed to the overall loss and alteration of hydrology and water resources in the wind farm site watersheds. Ongoing agricultural operations will continue to impact these resources in the Oio and Malaekahana watersheds. Human activity and development in the vicinity of the Hamakua Marsh Mitigation Area have also contributed to the overall loss and alteration of hydrology and water resources in the Kaelepulu watershed. Although little development has occurred in the Poamoho Ridge Mitigation Area, feral pig activity in the area has resulted in disturbances to soil that has likely had minor impacts to streams and drainages in the Kaukonahua, Poamoho, and Helemano watersheds. Removal and control of non-native ungulates in Poamoho Ridge Mitigation Area would reduce soil disturbances and associated erosion and sedimentation in the area.

The only foreseeable future project in the cumulative effects analysis area with the potential to impact hydrology and water resources is the Envision Laie Project located in the Malaekahana parcel in the vicinity of the wind farm site and ongoing and proposed restoration efforts in the Kawainui-Hamakua Marsh complex (see Table 4.2-2). The Envision Laie Project, which includes residential development on 300 acres of Malaekahana land, has the potential to cause temporary increases in erosion and sedimentation into the streams and drainages of the Oio and Malaekahana watersheds. Increased amounts of impervious surfaces associated with this development could also alter drainage and stormwater runoff patterns. Groundwater within the Koolauloa Aquifer system could be impacted through contamination due to the use of hazardous materials during construction or through water withdrawals, if required. It is assumed that potential impacts to hydrology and water resources would be minimized by the avoidance of wetlands and other waters of the U.S. and through the implementation of standard BMPs for minimizing erosion, stormwater runoff, and contamination (e.g., preparation of SPCC, SWPPP, and TESC plans). Restoration activities in Kawainui-Hamakua Marsh, including wetland expansion, flood control, and invasive species control may have temporary adverse impacts to hydrology and water resources in the Kaelepulu Watershed associated with the implementation of each activity; however, over the long term these activities benefit the hydrology and water resources in the watershed.

The Proposed Action would result in temporary, localized contributions in the effects to hydrology and water resources within the analysis area through erosion and stormwater runoff potentially affecting surface waters including Keaaulu, Malaekahana, and Ohia streams in the wind farm site and waterbodies in the Hamakua Marsh Mitigation Area; no measurable impacts would occur to groundwater quality or quantity. Implementation of mitigation measures described in Section 4.4.3.3 would minimize these impacts. Forest restoration activities at the Poamoho Ridge Mitigation Area would contribute to beneficial effects to hydrology and water resources through increased soil stability. Therefore, when viewed in conjunction with past, present, and foreseeable projects in the analysis area, the contribution of Alternative 2 to cumulative effects on hydrology and water resources would generally be minor.

4.4.3.5 Summary

Direct effects to hydrology and water resource from the Proposed Action will be avoided to the extent feasible. Ground disturbance (associated with construction and operation of the Project and implementation of HCP conservation measures) and the creation of impervious surfaces (permanent Project facilities) would increase the potential for erosion, sedimentation, and stormwater runoff, which could affect surface water quality. These effects would be minimized through the implementation of standard BMPs and design features. Negligible effects to groundwater quality or quantity are anticipated. Effects to hydrology and water resources, including impacts to jurisdictional waters of the U.S., (Keaaulu, Ohia, and Malaekahana streams) under the Proposed Action would be considered negligible to minor because while there would be the potential for impacts to water quality, the intensity would be low (changes to hydrology and water resources not likely to be measurable), disturbance would be temporary and localized, and Project activities would not significantly alter the flow or change the function or character of the streams.

4.4.3.6 Alternative 2a - Modified Proposed Action Option

Direct, indirect, and cumulative effects on hydrology and water resources from the Modified Proposed Action Option would be similar to those described under the Proposed Action. However, the Modified Proposed Action Option would result in up to approximately 9.1 acres (3.7 hectares) of impervious surfaces, which includes 9 acres (3.6 hectares; 99 percent) of gravel surfaces which would be considered semi-pervious. Additionally, the net increase in stormwater runoff under Alternative 2a was estimated at 10.9 cfs (Belt Collins Hawaii LLC 2016a). Table 2-1 provides more detail on the disturbance areas associated with each Project component. Implementation of standard BMPs and other mitigation measures, as described under the Proposed Action, would minimize any adverse impacts to hydrology and water resources.

4.4.4 Alternative 3—Larger Generation Facility (Up to 12 Turbine Project)

4.4.4.1 Direct and Indirect Effects of Construction and Operation of the Project

Construction Impacts

Surface Water

The types of direct and indirect effects on hydrology and water resources from construction of the Project under Alternative 3 would be the same as those described under Alternative 2. There would be no additional direct impacts to wetlands or streams within the wind farm site under Alternative 3 as compared to Alternative 2. Because there would be a lag time of at least 3 years between construction the first 8 to 10 turbines and the additional 2 to 4 turbines under Alternative 3, the time frame of temporary, localized construction-related impacts associated with increases in erosion, sedimentation, and stormwater runoff conveyed into streams and downstream waters would be extended.

Alternative 3 would result in a total of 11.1 acres (4.5 hectares) of impervious surfaces within the wind farm site, approximately 1.0 acres (0.4 hectares) more than under Alternative 2; of this 11 acres [4.4 hectares], approximately 99 percent, are semi-pervious). However, this increase in impervious surfaces amounts to less than 0.1 percent of the watershed within which the Project is located. Additionally, the net increase in stormwater runoff under Alternative 3 was estimated at 13.0 cfs (Belt Collins Hawaii LLC 2016a). With implementation of stormwater control measures, such as seepage pits, drywells, and/or detention basins the increase in impervious surfaces under Alternative 3 would not significantly increase the volume of stormwater runoff leaving the wind farm site. Although stormwater runoff has the potential to adversely affect streams within the wind farm site, with implementation of BMPs and mitigation measures described in Section 4.4.3.3 impacts to surface waters would be minor.

Groundwater

Peak water needs for construction of Alternative 3 would be up to approximately 10,000 to 15,000 gallons (37,850 to 56,780 liters) for dust suppression and emergency fire suppression, as under Alternative 2. Water sources would be the same as those described for Alternative 2. Therefore, construction of Alternative 3 would not measurably reduce the quantity of available groundwater in the wind farm site. Implementation of the SPCC Plan would reduce adverse impacts to groundwater quality from construction of Alternative 3 to a negligible level.

Alternative 3 would result in a minor increase in the amount of impervious surface in the analysis area. Precipitation falling on these impervious surfaces would likely run off to adjacent open lands where aquifer recharge would occur; therefore, the slight increase in impervious surfaces is not expected to measurably reduce the potential for groundwater recharge.

Operation and Maintenance Impacts

Surface Water

Impacts to surface water from O&M activities under Alternative 3 would be as described under Alternative 2. The addition of 2 to 4 additional turbines and 0.7mile (1.1 kilometer) of additional internal access roads would result in additional operational and maintenance needs; however, implementation of BMPs described under Alternative 2 for reducing erosion, sedimentation, and stormwater runoff, which would be implemented under Alternative 3, would minimize impacts to hydrology and water resources during O&M.

Groundwater

Groundwater impacts under Alternative 3 would be the same as those described under Alternative 2.

4.4.4.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP would not be expected to affect the hydrology and water resources within the analysis area.

Impacts of HCP Mitigation

Impacts of the HCP mitigation measures under Alternative 3 would be the same as described under the Proposed Action. Prior to construction of the additional turbines proposed under Alternative 3, NPMPP would reopen consultation with the USFWS and DOFAW to assess the potential impacts of the additional turbines to listed species and develop appropriate mitigation measures. The impacts of these mitigation measures to hydrology and water resources would be evaluated under a separate environmental analysis at that time.

4.4.4.3 Mitigation of Unavoidable Impacts

Mitigation for unavoidable impacts under Alternative 3 would be the same as described under the Proposed Action (Section 4.2.3.3).

4.4.4.4 Cumulative Effects

The cumulative effect analysis area for impacts on hydrology and water resources from HCP conservation measures and construction and operation is as described under Alternative 2. Impacts of past, present, and foreseeable activities within the cumulative effects analysis area for hydrology and water resources would be as described under Alternative 2 (see Section 4.2.3.4). Alternative 3 would result in temporary, localized contributions in the effects to hydrology and water resources within the analysis area through erosion and stormwater runoff potentially affecting surface waters including Keaaulu, Malaekahana, and Ohia streams in the wind farm site and waterbodies in the Hamakua Marsh Mitigation Area; no measurable impacts would occur to groundwater quality or quantity. Implementation of mitigation measures described in Section 4.2.3.3 would minimize these impacts. Forest restoration activities at the Poamoho Ridge Mitigation Area would contribute to beneficial effects to hydrology and water resources through increased soil stability. Therefore, when viewed in conjunction with past, present, and foreseeable projects in the analysis area, the contribution of Alternative 3 to cumulative effects on hydrology and water resources would be minor. As stated above, there would be a lag of at least 3 years between the construction of the first 8 to 10 turbines and the additional 2 to 4 turbines. New projects and developments in the area will be assessed and reviewed to determine if there are additional cumulative impacts to hydrology and water resources from future unknown projects.

4.4.4.5 Summary

Direct effects to hydrology and water resource from the Alternative 3 would be avoided to the extent feasible. Ground disturbance (associated with construction and operation of the Project and implementation of HCP conservation measures) and the creation of impervious surfaces (permanent Project facilities) would increase the potential for erosion, sedimentation, and stormwater runoff which could affect surface water quality. These effects would be minimized through the implementation of standard BMPs and design features. Negligible effects to groundwater quality or quantity are anticipated. Direct and indirect effects to hydrology and water resources under Alternative 3 would be considered negligible to minor because while there would be the potential for impacts to water quality, the intensity would be low (changes to hydrology and water resources not likely to be measurable), disturbance would be temporary and localized, and Project activities would not significantly alter the flow or change the character or function of Keaaulu, Ohia, Malaekahana streams or other streams. .

4.4.5 Conclusion

Table 4.4-2 summarizes potential impacts to hydrology and water resources from the alternatives considered in this analysis.

Table 4.4-2. Summary of Potential Impacts to Hydrology and Water Resources

Impact Issues	No Action Alternative	Alternative 2 – Proposed Action	Alternative 2a – Modified Proposed Action Option	Alternative 3
Impacts to wetlands and other waters of the U.S.	No Impact	Minor	Minor	Minor
Alteration of existing drainage patterns	No Impact	Negligible	Negligible	Negligible
Contamination of surface water quality from increased erosion, sedimentation, stormwater runoff and/or pollutants	No Impact	Minor	Minor	Minor
Alteration of surface water quality resulting in long-term loss or use by humans or aquatic wildlife and plants	No Impact	Minor	Minor	Minor
Decrease in available groundwater or groundwater recharge	No Impact	Negligible	Negligible	Negligible
Degradation of ground water quality	No Impact	Negligible	Negligible	Negligible

4.5 Air Quality and Climate Change

4.5.1 Impact Criteria

The analysis area for the air quality and climate change includes the full extent of the island of Oahu. This analysis area includes the entire Project footprint, the extent of proposed mitigation areas (see Chapter 2 for more details), as well as the full extent of potential Project-related impacts to air quality or climate change. Data used in this analysis comes from air quality monitoring stations (as described below), estimates for traffic levels derived from the Project's Traffic Report (Belt Collins Hawaii LLC 2016b), the EPA's Motor Vehicle Emission Simulator (MOVES) model (EPA 2014a), and the EPA's Non-road Engines Equipment and Vehicles (NONROAD) model (EPS 2014c). The following assumptions were used in the MOVES and NONROAD models:

- 72 percent of vehicles would be heavy trucks used for deliveries, 14 percent would be passenger trucks, and 14 percent would be passenger cars.
- All workers would commute from Honolulu for a round trip of 84 miles per day.
- Emission Factors for each vehicle type (ton/VMT) were derived from the MOVES Model using the most current input files provided by the State of Hawaii.
- To estimate the $C0_2$ equivalent (i.e., CO_{2e}) a multiplier of 25 was applied to CH_4 and a multiplier of 298 was applied to N_2O.

Table 4.5-1 lists the impact criteria considered when determining the level of effect (i.e., negligible, minor, moderate, major) that the Project could have to air quality or climate change. Note that all Project-related impacts to air quality and climate change would affect "important" resources at a "regional" level. Impacts to these resources would, however, vary by magnitude (i.e., high, medium, or low) and duration (i.e., permanent, long term, or temporary), as described in Section 4.1.1.

Table 4.5-1. Impact Criteria for Air Quality and Climate Change

Type of Effect	Impact Component	Effects Summary		
Changes to Air Quality or Climate Change	Magnitude or Intensity	**High:** Acute or obvious changes in resource character considerably above State and Federal ambient air quality standards	**Medium:** Noticeable changes in resource character above or near State and Federal ambient air quality standards	**Low:** Changes in resource character may not be noticeable or are lower than State and Federal ambient air quality standards
	Duration	**Permanent:** Chronic effects; resource would not be anticipated to return to previous levels	**Long-term:** Resource would be reduced through the life of the Project and would return to pre-activity levels at some point after completion of the Project.	**Temporary:** Resource would be reduced infrequently but not longer than the span of the Project construction and would be expected to return to pre-activity levels at the completion of the activity.

Table 4.5-1. Impact Criteria for Air Quality and Climate Change (continued)

Type of Effect		Impact Component	Effects Summary		
		Geographic Extent	**Extended:** Affects resources beyond the Island of Oahu	**Regional:** Affects resources beyond a local area, potentially throughout the Island of Oahu	**Local:** Impacts are limited geographically; may include the extent of the wind farm site.
		Context	**Unique:** Affects rare resources or resources protected by legislation	**Important:** Affects resources regulated by legislation.	**Common:** Affects usual or ordinary resources; not depleted or protected by legislation.

4.5.2 Alternative 1—No Action

4.5.2.1 Direct and Indirect Effects

Under the No Action Alternative, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. As a result, the emissions (including the emission of greenhouse gases) and air quality impacts associated with construction and operation of the Project would not occur. However, if the power that would have been generated by this Project is instead produced through facilities that burn fossil fuels (e.g., coal, gas, or oil burning facilities), then the long-term displacement of green-house-gas emissions associated with generating power via wind instead of burning fossil fuels would not occur. This could potentially result in higher green-house-gas emissions in the long term.

4.5.2.2 Cumulative Effects

Under the No Action Alternative, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Therefore, there would be no adverse or beneficial effects on air quality or climate change. Thus, Alternative 1 would not contribute to cumulative effects on air quality or climate change.

4.5.2.3 Summary

The No Action Alternative would have no direct, indirect, or cumulative effects on air quality or climate change as no action would be undertaken.

4.5.3 Alternative 2—8 to 10 Turbine Project

4.5.3.1 Direct and Indirect Effects of Construction and Operation of the Project

Construction Impacts

Construction of the Project would result in the emission of some pollutants as well as the generation of fugitive dust. Heavy equipment (such as trucks, cranes, and earthmovers) would be required in order to construct this Project. The internal combustion of fuels to power this equipment would generate green-house gases and air pollutants. In addition, soil disrupting activities associated with construction of the Project would result in the generation of fugitive dust (which is measured as PM_{10} and $PM_{2.5}$)[1]. Air pollutant emissions and fugitive dust levels would be highest near the Project's construction sites (where the majority of activities would occur); however, lower levels of emissions and fugitive dust would also occur along travel routes to and from the Project site. Table 4.5-2 lists the estimated levels of air pollutants and fugitive dust that would be generated during the construction of the Project on an annual basis.

As these emissions and increased fugitive dust levels would be temporary (with elevated fugitive dust levels occurring only in a localized area), would occur at relatively low levels compared to the State and Federal ambient air quality standards (see Section 3.3 – Air Quality and Climate Change), and BMPs would be implemented to minimize the effects of these emissions (see Table 2-6), construction of the Project is expected to have a minor effect to air quality. Construction-related emissions would occur at a low enough level that they are expected to have a negligible effect to climate change.

Table 4.5-2. Construction Emissions for Criteria Pollutants under Alternative 2 (tons/year) 1/

Emission Source	Volatile Organic Compounds	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$ 5/	CO_2e 6/
Construction Equipment Emissions 2/	1.20	6.79	14.47	0.02	0.89	0.89	2,905
Fugitive Construction Dust (including unpaved and paved roads)3/	–	–	–	–	101.61	10.18	–
Vehicle Emissions4/	0.15	1.22	0.38	0.00	0.01	0.01	644
Total	**1.35**	**8.01**	**14.85**	**0.02**	**102.51**	**11.08**	**3,549**

1/ Note that ozone is not emitted directly from emission sources (e.g., vehicle exhaust) and instead is a result of chemical reactions near the ground from NOx (i.e., oxides of nitrogen including NO_2 and NO) and volatile organic compounds. Therefore, ozone is not included in this table.

2/ Construction emission factors (EF) were generated from the EPA NONROAD model for the 2015 calendar year.

3/ Fugitive dust based on 89.0 acres of land disturbance and WRAP Fugitive Dust Handbook (WRAP 2006). Paved roadway vehicle dust emissions calculated per AP-42 (EPA 2011) estimation methods for paved roads.

4/ Vehicle mission rates were generated using EPA MOVES Vehicle Emissions Model. Fleet Characterization: 87 light utility vehicles commuting to work, assuming 50% are pickup trucks and 50% passenger cars, and 225 heavy duty diesel trucks. See Traffic Assessment Technical Report for additional details on traffic volumes for the Project.

5/ For construction equipment emissions from combustion sources PM_{10} and $PM_{2.5}$ are conservatively estimated to be equal.

6/ Note that CO_2e includes compounds that are equivalent to CO_2 in regards to their "global warming potentials" (e.g., CH_4 and N_2O)

Operation and Maintenance Impacts

Operation of the Project has the potential to impact air quality. Vehicles used by the Project's employees as well as some heavy equipment, such as cranes that may be required periodically for maintenance or repair of the Project, would produce emission via the internal combustion of fuels. However, operation of the Project is expected to have a negligible adverse effect to air quality because the use of vehicles and equipment during operation is expected to be low (see Chapter 2

[1] PM_{10} is defined as particulate matter that is 10 microns or less in aerodynamic diameter; these particles are typically considered "coarse" particles. $PM_{2.5}$ is defined as particulate matter that is 2.5 microns or less in aerodynamic diameter; these particles are typically considered "fine" particles.

for more details), and estimated emission levels would be low compared to the State and Federal ambient air quality standards (see Section 3.3 – Air Quality and Climate Change).

Recent modeling efforts have shown that extremely large wind facilities can have effects on local climate conditions. For example, a modeling study of a theoretical wind facility consisting of a 100 by 100 array of wind turbines (covering approximately 6,250 square miles) could result in moderate warming and drying of surface air, could slow down the measurable wind speeds at the turbine hub-height level, and could enhance vertical mixing of air thereby affecting the vertical distribution of temperature and humidity, but would have no effect to evapotranspiration (Roy et al. 2004). However, the proposed project consists of 8 to 10 turbines; as a result, the effects described in Roy et al. (2004) are unlikely to occur at wind facilities of the size proposed for this Project. As a result, this Project is expected to have negligible direct effect to local climate conditions.

The Project should have a long-term beneficial indirect effect to air quality and climate conditions. Currently, approximately 75 percent of the electricity generated on Oahu is a result of burning oil; this proposed Project has the potential to offset some of the adverse effects associated with power generating facilities that burn fossil fuels, assuming that the power that would be generated by this wind-facility would have been generated by facilities that burn fossil fuels if this Project is not implemented. As the burning of one barrel of crude oil generates about 0.000196 MW of power, approximately 127,551 barrels of crude oil would need to be burnt annually to generate the up to approximately 25 MW of power that is estimated to be generated by Alternative 2 (ODOE 2014). The EPA estimates that approximately 0.43 metric tons of CO_2 are released by burning one barrel of crude oil (EPA 2014b); therefore, a power facility that burns oil would release about 54,847 metric tons of CO_2 annually in order to generate the amount of energy that would be produced by this wind Project. Comparatively, this Project is estimated to release 66.52 metric tons of CO_2 annually[2], which is a 54,780 reduction in the annual release of CO_2 emissions compared to an oil burning facility of comparable power.[3] Therefore, the potential offset of CO_2 levels that would be generated by this Project compared to an oil-burning facility would have a moderate beneficial impact to air quality (i.e., a reduction in the amount of annual CO_2 emissions).

[2] This value is based on the assumption that three workers would commute from the Honolulu area (42 miles each way) daily, for 365 days per year; and that a mix of equipment would be used on site to conduct operations/maintenance activities (including dozers, backhoes, dump trucks, and loaders, which would range from 175 to 750 horse-power).

[3] This is a conservative estimate, as it does not take into consideration the amount of CO_2 that could be released by fossil fuel burning facilities beyond what would be generated by the burning oil (e.g., the CO_2 released by worker's vehicles or equipment at these fossil fuel burning facilities is not included in the calculation). Therefore, the off-set and benefit of this wind facility may be larger than what is currently estimated.

4.5.3.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP would have no effect on air quality or climate change.

Impacts of HCP Mitigation Measures

Emission of air pollutants as a direct result of the NPMPP's activities under the HCP would be negligible. During implementation of activities associated with funding for forest restoration activities at Poamoho Ridge for bats (maintenance of the ungulate-proof fence, feral pig control and monitoring, invasive plant removal, and bat acoustic monitoring), Newell's shearwater research and management and short-eared owl research and management vehicles may be used on a regular basis to transport staff and equipment to management or research sites which would result in immeasurable exhaust emissions. Installation of the partial fence along the border of Hamakua Marsh Mitigation Area for waterbird mitigation would involve the use of some motor driven equipment, resulting in a temporary elevation in emissions levels and fugitive dust. However, the levels of emissions and fugitive dust generated during the construction of this fence would have negligible effects to air quality and climate change due to the temporary nature of the emissions, the low levels that would be produced by installing a fence, and the existing high air quality of the area.

4.5.3.3 Mitigation of Unavoidable Impacts

NPMPP would implement standard BMPs in order to avoid or minimize impacts to air quality and climate change, as listed in Table 2-6. These include measures to limit fugitive dust generation, limit the risk of wildfires, and requirements to keep all equipment in proper working order. As described above, no anticipated adverse impacts to air quality or climate change rise above a "minor" impact level (as described in Section 4.1.1). In addition, the Project has the potential to have beneficial long-term impacts to air quality and climate change (i.e., offsetting some of the adverse effects associated with power generating facilities that burn fossil fuels). Therefore, no additional mitigation measures would be required.

4.5.3.4 Cumulative Effects

The analysis area for the cumulative effects to air quality and climate change includes the full extent of the island of Oahu. As shown in Table 4.2-2, there are multiple existing and reasonably foreseeable projects on the island of Oahu that could incrementally add to the pollutant and fugitive dust levels on the island; these include existing agricultural operations, multiple road projects, existing wind facilities, as well as proposed development and expansion of resorts and developments. Of these projects, the existing agricultural operations would likely have the greatest impact to fugitive dust levels on the island (due to the continuous soil disturbance associated with agricultural operations), while the existing and proposed roads would likely have the greatest long-term impact to pollutant levels (due to on-going combustion of fuels by vehicles using these roads).

However, due to the low expected levels of air pollutants expected to occur from these projects, the temporary nature of construction related impacts for the reasonable foreseeable project (i.e., those that do not currently exist and would be constructed in the future), the existing high air quality of the region (see Section 3.3 – Air Quality and Climate Change), and the presence of the trade winds which rapidly remove air pollutants from the region, cumulative impacts to air quality and climate change would be minor.

4.5.3.5 Summary

Construction of the Project under Alternative 2 would have a minor effect to air quality because Project-related emissions and increased fugitive dust levels would be temporary in nature, would occur at relatively low levels compared to the State and Federal ambient air quality standards, and BMPs would be implemented to minimize the effects of these emissions. Construction-related emissions would occur at a low enough level that they are expected to have a negligible effect to climate change. Operation of the Project would have a negligible adverse effect to air quality and climate change (due to the low estimated rate of emissions and limited size of the proposed facility), but a potential moderate beneficial impact to climate change (due to the potential offset of CO_2 generated by this Project compared to facilities that burn oil). Likewise, the implementation of HCP conservation measures would have negligible impact on air quality and climate change. For these reasons, the Proposed Action, in conjunction with past, present, and reasonably foreseeable projects, would have a minor adverse cumulative impact on air quality and climate change during construction and a moderate beneficial cumulative impact on air quality and climate change.

4.5.3.6 Alternative 2a - Modified Proposed Action Option

Direct, indirect, and cumulative effects on air quality and climate conditions from the Modified Proposed Action Option would be the same as those described under the Proposed Action. There may be a slightly reduced amount of air pollutant emissions and fugitive dust levels associated with construction under the Modified Proposed Action Option due to the decrease in the number of turbines; however, this reduction would be negligible. Implementation of standard BMPs, as described under the Proposed Action, would minimize any adverse impacts to air quality and climate conditions. In addition, similar to the Proposed Action, the Modified Proposed Action Option has the potential to have beneficial long-term impacts to air quality and climate change (i.e., offsetting some of the adverse effects associated with power generating facilities that burn fossil fuels).

4.5.4 Alternative 3—Larger Generation Facility (Up to 12 Turbine Project)

4.5.4.1 Direct and Indirect Impacts of Construction and Operation of the Project

The impacts to air quality and climate change under Alternative 3 would be similar to those discussed above for Alternative 2. The main difference between the two alternatives in regard to air quality and climate change would be related to the longer construction period for Alternative 3, as well as the offset of CO_2 levels that would be generated by this Project during operation compared to those produced by a facility that burns fossil fuels.

Construction Impacts

As discussed in Chapter 2, Alternative 3 would involve construction of the first 8 to 10 turbines in the first quarter of 2015. There would be a lag of at least 3 years between the construction of the first set of turbines and the additional 2 to 4 turbines proposed under this alternative. Table 4.5-3 lists the additional estimated levels of air pollutants and fugitive dust that would be generated during the construction of the additional turbines under Alternative 3 on an annual basis (total emissions would be those listed in Table 4.5-2 plus those listed in Table 4.5-3).

Table 4.5-3. Additional Construction Emissions for Criteria Pollutants under Alternative 3 (tons/year)[1/]

Emission Source	Volatile Organic Compounds	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$[5/]	CO_2e[6/]
Construction Equipment Emissions[2/]	0.60	3.4	7.24	0.01	0.45	0.45	1,452
Fugitive Construction Dust (including unpaved roads)[3/]					112.42	11.24	
Vehicle Emissions[4/]	0.08	0.67	0.20	0.00	0.005	0.004	340
Total	**0.68**	**4.06**	**7.44**	**0.01**	**112.87**	**11.69**	**1,792**

1/ Note that ozone is not emitted directly from emission sources (e.g., vehicle exhaust) and instead is a result of chemical reactions near the ground from NOx (i.e., oxides of nitrogen including NO_2 and NO) and volatile organic compounds. Therefore, ozone is not included in this table.

2/ Construction emission factors were generated from the EPA NONROAD model for the 2015 calendar year.

3/ Fugitive dust based on 98.6 acres of land disturbance and WRAP Fugitive Dust Handbook (WRAP 2006). Paved roadway vehicle dust emissions calculated per AP-42 (EPA 2011) estimation methods for paved roads.

4/ Vehicle mission rates were generated using EPA MOVES Vehicle Emissions Model. Fleet Characterization: 87 light utility vehicles commuting to work, assuming 50% are pickup trucks and 50% passenger cars, and 225 heavy duty diesel trucks. See Traffic Assessment Technical Report for additional details on traffic volumes for the Project.

5/ For construction equipment emissions from combustion sources PM_{10} and $PM_{2.5}$ are conservatively estimated to be equal.

6/ Note that CO_2e includes compounds that are equivalent to CO_2 in regards to their "global warming potentials" (e.g., CH_4 and N_2O)

As these emissions and increased fugitive dust levels would be temporary (with elevated fugitive dust levels occurring only in a localized area), would occur at relatively low levels compared to the State and Federal ambient air quality standards (see Section 3.3 – Air Quality and Climate Change), and BMPs would be implemented to minimize the effects of these emissions (see Table 2-3), construction of the Project is expected to have a minor effect to air quality. Construction-related emissions would occur at a low enough level that they are expected to have a negligible effect to climate change.

Operation and Maintenance Impacts

As the burning of one barrel of crude oil generates about 0.000196 MW of power, approximately 214,285 barrels of crude oil would need to be burnt annually to generate the up to approximately 42 MW of power that is estimated to be generated by Alternative 3 (ODOE 2014). The EPA estimates that approximately 0.43 metric tons of CO_2 are released by burning one barrel of crude oil (EPA 2014b); therefore, a power facility that burns oil would release about 92,143 metric tons of

CO_2 annually in order to generate the amount of energy that would be produced by this wind Project. Comparatively, this Project is estimated to release 66.52 metric tons of CO_2 annually[4], which is a 92,076 metric ton reduction in the annual release of CO_2 emissions compared to an oil-burning facility of comparable power.[5] Therefore, the potential off-set of CO_2 levels that would be generated by this Project compared to an oil-burning facility would have a moderate beneficial impact to air quality (i.e., a reduction in the amount of annual CO_2 emissions).

4.5.4.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP would have no effect on air quality or climate change.

Impacts of HCP Mitigation Measures

Impacts of HCP mitigation under Alternative 3 would be the same as described under the Proposed Action. Prior to construction of additional turbines proposed under Alternative 3, NPMP would reopen consultation with the USFWS and DOFAW to assess the potential for impacts of the additional turbines to listed species and develop appropriate mitigation measures. The impacts of these mitigation measures to air quality and climate change would be evaluated under a separate environmental analysis at that time.

4.5.4.3 Mitigation of Unavoidable Impacts

The Applicant will implement standard BMPs in order to avoid or minimize impacts to air quality and climate change, as listed in Table 2-6. These include measures to limit fugitive dust generation, limit the risk of wildfires, and requirements to keep all equipment in proper working order. As described above, no anticipated adverse impacts to air quality or climate change rise above a "minor" impact level (as described in Section 4.1.1). In addition, the Project has the potential to have beneficial long-term impacts to air quality and climate change (i.e., offsetting some of the adverse effects associated with power generating facilities that burn fossil fuels). Therefore, no additional mitigation measures would be required under Alternative 3.

4.5.4.4 Cumulative Effects

The analysis area for the cumulative effect analysis includes the full extent of the island of Oahu. As shown in Table 4-2, there multiple existing and reasonably foreseeable projects on the island of

[4] This value is based on the assumption that three workers would commute from the Honolulu area (42 miles each way) daily, for 365 days per year; and that a mix of equipment would be used on site to conduct operations/maintenance activities (including dozers, backhoes, dump trucks, and loaders, which would range from 175 to 750 horse-power).

[5] This is a conservative estimate, as it does not take into consideration the amount of CO_2 that could be released by fossil fuel burning facilities beyond what would be generated by the burning oil (e.g., the CO_2 released by worker's vehicles or equipment at these fossil fuel burning facilities is not included in the calculation). Therefore, the offset and benefit of this wind facility may be larger than what is currently estimated.

Oahu that could incrementally add to the pollutant and fugitive dust levels on the island; these include existing agricultural operations, multiple road projects, existing wind facilities, as well as proposed development and expansion of resorts and developments. Of these projects, the existing agricultural operations would likely have the greatest impact to fugitive dust levels on the island (due to the continuous soil disturbance associated with agricultural operations); while the existing and proposed roads would likely have the greatest long-term impact to pollutant levels (due to on-going combustion of fuels by vehicles using these roads). However, due to the low expected levels of air pollutants expected to occur from these projects, the temporary nature of construction related impacts for the reasonable foreseeable project (i.e., those that do not currently exist and would be constructed in the future), the existing high air quality of the region (see Section 3.3.1.1 of Chapter 3), and the presence of the trade winds which rapidly remove air pollutants from the region, cumulative impacts to air quality and climate change would be minor.

4.5.4.5 Summary

Construction of the Project under Alternative 3 would have a minor effect to air quality because Project related emissions and increased fugitive dust levels would be temporary in nature, would occur at relatively low levels compared to the State and Federal ambient air quality standards, and BMPs would be implemented to minimize the effects of these emissions. Construction-related emissions would occur at a low enough level that they are expected to have a negligible effect to climate change. Operation of the Project would have a negligible adverse effect to air quality and climate change (due to the low estimated rate of emissions and limited size of the proposed facility), but a potential moderate beneficial impact (due to the potential offset of CO_2 generated by this Project compared to facilities that burn oil). The construction of the Project, in conjunction with past, present, and reasonably foreseeable projects, would have a minor adverse cumulative impact on air quality and climate change. The operation of the Project, in conjunction with past, present, and reasonably foreseeable projects, would have a moderate positive cumulative impact on air quality and climate change.

4.5.5 Conclusion

Table 4.5-4 summarizes potential impacts to air quality and climate change from the alternatives considered in this analysis.

Table 4.5-4. Summary of Potential Impacts to Air Quality and Climate Change

Impact Issues	No Action Alternative	Alternative 2 – Proposed Action	Alternative 2a – Modified Proposed Action Option	Alternative 3
Violations of State or Federal air quality standards as a result of construction activity or traffic	No Impact	No Impact	No Impact	No Impact
Greenhouse gas emissions from Project construction	No Impact	Minor	Minor	Minor
Greenhouse gas emissions from Project operation	No Impact	Negligible Adverse/Moderate Beneficial	Negligible Adverse/Moderate Beneficial	Negligible Adverse/Moderate Beneficial

4.6 Noise

Noise during Project construction and operation were assessed. Project construction was assessed in a semi-qualitative manner using information available at this stage of the design process and using representative equipment information where necessary. The operational acoustic assessment was completed using DataKustik GmbH's CadnaA, the computer-aided noise abatement program (v 4.14.145). Details on the prediction approaches used are provided in Appendix C – Noise Impact Assessment.

4.6.1 Impact Criteria

A significant impact on noise would occur if an exceedance of the State noise regulation occurred at a NSR such as a residence. As described in Section 3.4 – Noise, the HAR 11-46 provides daytime and nighttime maximum permissible noise limits according to zoning districts, which are considered the controlling criteria for the Project. The HAR provide the regulatory environment for the State of Hawaii. These criteria are absolute and independent of the existing acoustic environment.

Wind farm site zoning districts are mixed with the Project components themselves located on and adjacent to property classified as Class C (70 dBA day or night limit) zoning districts, see Figure 3.4-1. Nearby, within the acoustic analysis area, are a number of other properties that are classified as Class A zoning (45 dBA night and 55 dBA day limit)or Class B (50 dBA night and 60 dBA day). An exceedance of the HAR 11-46 limit at any of the properties within the acoustic analysis area would be considered a significant impact. Additionally, the magnitude of an increase, if any, from Project received sound levels at a given NSR is used to quantify what the public response may be as a result of the Project.

Scientific research demonstrates that the following general relationships hold between sound level and human perception for two sound levels with the same or very similar frequency characteristics:

- 1 dBA is the practically achievable limit of the accuracy of sound measurement systems and corresponds to an approximate 10 percent variation in sound pressure. A 1 dBA increase or decrease is a non-perceptible change in sound.

- 3 dBA increase or decrease is a doubling (or halving) of acoustic energy and it corresponds to the threshold of perceptibility of change in a laboratory environment. In practice, the average person is not able to distinguish a 3 dBA difference in environmental sound outdoors.
- 5 dBA increase or decrease is described as a perceptible change in sound level and is a discernable change in an outdoor environment.
- 10 dBA increase or decrease is a tenfold increase or decrease in acoustic energy but is perceived as a doubling or halving in sound (i.e., the average person will judge a 10 dBA change in sound level to be twice or half as loud).

Although the Project is only required to demonstrate compliance with HAR 11-46 noise limits, NPMPP elected to also evaluate the potential for impacts from Project-related low frequency noise (LFN) and infrasound (IS). Because there are no Federal, State, or local regulations for LFN and IS from wind energy projects the acoustic analysis implemented other guidelines and standards to assess potential impact conditions, specifically comparisons were made to the American National Standards Institute (ANSI) S12.9 Part 4 guidelines (ANSI 2005) and the United Kingdom Department of Environment, Food & Rural Affairs (DEFRA) guidelines (DEFRA 2005).

The initial LFN/IS impact assessment focusses exceedances of the ANSI S12.9 Part 4 and DEFRA guidelines. ANSI S12.9 Part 4 recommends that project-related sound levels remain below 65 dB for the 16-63 Hz midband frequencies; DEFRA limits are provided in Table 4.6-1 and are based on community response to LFN/IS around Europe. Additionally, a comparison is made to existing monitored LFN and IS to assess the magnitude of change in LFN/IS, if any, from the Project.

Table 4.6-1. DEFRA Equivalent Outdoor dB L_{eq} 1/3-Octave Band Sound Pressure Thresholds

Location	1/3-Octave Band Center Frequency (Hz)												
	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
Non-Steady Outdoor	94	89	86	78	68.5	61	56	51	51	49	47	45	43
Steady Outdoor	99	94	91	83	73.5	66	61	56	56	54	52	50	48
Source: DEFRA 2005; O'Neal et al. 2011													

The assessment of noise impacts is based on magnitude or intensity, duration, geographic extent, and context of the impact. Table 4.6-2 provides descriptions on how these impacts are classified.

Table 4.6-2. Impact Criteria for Noise Impacts

Type of Effect	Impact Component	Effects Summary		
Effects on Noise	Magnitude or Intensity	**High:** Exceedance of HAR 11-46 noise limits from operation or changes in existing noise levels by 10 dBA or more from operation at HAR 11-46 Class A or B Zones.	**Medium:** Exceedance of HAR limits from construction noise. Changes in noise levels of 3 to 5 dBA from operation at HAR 11-46 Class A or B Zones.	**Low:** Changes in construction or operational noise levels of 2 dBA or less at HAR 11-46 Class A or B Zones.
	Duration	**Permanent:** Permanent changes in the acoustic environment that would result even with removal of the Project.	**Long-term:** Operational impacts would last through the life of the Project.	**Temporary:** Construction noise impacts of medium magnitude or intensity.
	Geographic Extent	**Extended:** Noise impacts that extend across Oahu.	**Regional:** Noise affects in areas outside the acoustic analysis area.	**Local:** Affects confined to the acoustic analysis area.
	Context	**Unique:** High magnitude or intensity impacts.	**Important:** Medium magnitude or intensity impacts.	**Common:** Low magnitude or intensity impacts.

4.6.2 Alternative 1—No Action

4.6.2.1 Direct and Indirect Effects

Under the No Action Alternative, the Project would not be constructed, the ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. As a result, Alternative 1 would have no effects related to noise. As such, no mitigation measures would be warranted.

4.6.2.2 Cumulative Effects

Under the No Action Alternative, the Project would not be constructed, an ITP would not be used by the USFWS, and the HCP conservation measures would not be implemented. Therefore, there would be no effects related to noise. Thus, Alternative 1 would not contribute to cumulative effects to noise.

4.6.2.3 Summary

Alternative 1 would have no effects related to noise because no action would be undertaken.

4.6.3 Alternative 2—8 to 10 Turbine Project

4.6.3.1 Direct and Indirect Effects of Construction and Operation of the Project

Temporary construction noise and permanent operational noise from Alternative 2 would result in changes in noise levels in the acoustical analysis area. These effects are described in detail below. A more detailed Noise Impact Assessment is included in Appendix C.

Construction

Construction of Alternative 2 would involve constructing of access roads, excavating and forming wind turbine foundations, work associated with preparing the site for crane-lifting and actual turbine assembly and commissioning. Typically, wind energy projects are constructed in four phases consisting of the following:

- Site Clearing: The initial site mobilization phase includes the establishment of temporary site offices, workshops, stores, and other onsite facilities. Installation of erosion and sedimentation control measures will be completed as well as the preparation of initial haulage routes.
- Excavation: This phase would begin with the excavation and formation of access roads and preparation of laydown areas. Excavation for the concrete turbine foundations would also be completed.
- Foundation Work: Construction of the reinforced concrete turbine foundations would take place in addition to installation of the internal transmission network.
- Wind Turbine Installation: Delivery of the turbine components would occur followed by their installation and commissioning.

Work on these construction activities is expected to overlap. It is likely that the turbines would be erected in small groupings. Each grouping may undergo testing and commissioning prior to commencement of full commercial operation. Other construction activities include those for the supporting infrastructure such as the onsite substation, maintenance building, and the transmission line. The construction of the Project may cause short-term but unavoidable noise impacts depending on the construction activity being performed and the distance to receiver. The sound levels resulting from construction activities vary significantly depending on several factors such as the type and age of equipment, the specific equipment manufacturer and model, the operations being performed, and the overall condition of the equipment and exhaust system mufflers. The construction equipment that may be used on the Project and estimates of near and far sound source levels are presented in Table 4.6-3.

Table 4.6-3. Alternative 2 Estimated L_{max} Sound Pressure Levels from Construction Equipment

Equipment	Estimated Sound Pressure Level at 50 feet (15 meters) (dBA)	Estimated Sound Pressure Level at 2000 feet (610 meters) (dBA)
Forklift	80	48
Backhoe	80	48
Grader	85	53
Man basket	85	53
Dozer	83 - 88	51 - 56
Loader	83 - 88	51 - 56
Scissor Lift	85	53
Truck	84	52
Welder	73	41
Compressor	80	48
Concrete Pump	77	45

Sources: Federal Highway Administration, "Roadway Construction Noise Model User's Guide," Report FHWA-HEP-05-054 / DOT-VNTSC-FHWA-05-01, January 2006. Power Plant Construction Noise Guide, Bolt Beranek and Newman, Inc. 1977. Federal Highway Administration, "Procedures for Abatement of Highway Traffic Noise and Construction Noise." Code of Federal Regulations, Title 23, Part 772, 2010.

Sounds generated by construction activities would likely require a permit, obtained from the HDOH, to allow the operation of construction equipment that result in exceedances of the maximum permissible noise level at property line locations. While the permit and permitting procedures do not limit the sound level generated at the construction site, time restrictions may be placed on time periods when the loudest construction activities are likely to occur, i.e., 7:00 a.m. and 7:00 p.m., Monday through Friday, and between 9:00 a.m. and 6:00 p.m. on Saturday. The HDOH would require reasonable and standard practices be employed to minimize the impact of noise resulting from construction activities. Provisions to conduct noise monitoring and community meetings may also be required, but will likely be deemed unnecessary given the remote location. The Project would proactively work with the community and attempt to resolve any complaints or concerns due to noise from construction by coordinating activities and informing the community of the timing of the expected construction noise at the closest NSRs to avoid conflicts, i.e., if blasting for foundation or removal of ledge or other potentially noisy activities are required during the construction period, nearby residents shall be notified in advance.

Construction activity would generate traffic having potential noise effects, such as trucks travelling to and from the site on public roads. Traffic noise is categorized into two categories: 1) the noise that will occur during the initial temporary traffic movements related to turbine delivery, haulage of components and remaining construction; and 2) maintenance and ongoing traffic from staff and contractors, which is expected to be minor. At the early stage of the construction phase, equipment and materials would be delivered to the site, such as hydraulic excavators and associated spreading and compacting equipment needed to form access roads and foundation platforms for each turbine. Once the access roads are constructed, equipment for lifting the towers and turbine components would arrive. Concrete would be mixed offsite and delivered to the Project site, rather than produced by an onsite concrete batch plant.

Federal laws prohibit State and local governments from regulating off-site sound levels generated by trucks and automobiles operating on a private site or public roadways. This Federal regulatory preemption is specified in the Federal Noise Control Act of 1972 and in the Surface Transportation Assistance Act of 1982, both of which prohibit states and local authorities from regulating the noise emitted by trucks engaged in interstate commerce, i.e., truck deliveries. A Federal OSHA preemption also prohibits local and state governments from regulating safety signals on trucks and construction equipment. Under Alternative 2, construction would be coordinated with individual landowners regarding the operation of trucks, cars and other vehicles on private site access roadways as necessary to prevent the occurrences of unexpected noise resulting from construction and transport related vehicle movements.

Operation

Operational broadband (dBA) sound pressure levels were calculated assuming that all Alternative 2 turbines (a total of 10, two Vestas V110-2.0 and eight Siemens SWT 3.0-113 selected for the purposes of analysis; see Appendix C for additional detail) are operating continuously and concurrently at the highest manufacturer-rated sound level at the given operational condition. Ultimately, the manufacturer of the wind turbines could vary. The sound energy was then summed to determine the equivalent continuous A-weighted downwind sound pressure level at a point of compliance with HAR 11-46, in this case the property or as referred to in Hawaii Tax Map Key (TMK) limit. Calculations were completed using receptor points along each property limit in the acoustic analysis area at a height of 5 feet (1.5 meters) above ground (the approximate height of a standing person's ears). Table 4.6-4 presents the range of sound levels received at each TMK zoning class in the acoustic analysis area. In response to public comments on the Draft EIS, an evaluation of noise impacts based on the C-weighted (dBC) scale is included in Appendix C.

Table 4.6-4. Alternative 2 Predicted Operational Received Sound Pressure Levels (L_{eq}) by Zoning Class

HAR 11-46 Zoning Class	Controlling HAR 11-46 Zoning Limit (dBA L_{eq})	Baseline Sound Level (dBA L_{eq})	Range of Received Sound Levels dBA L_{eq}	Increase over Baseline
Class A	45	42-47	8 - 44	0 - 4
Class A (Day Only)	55	42	31 – 44	2 – 4
Class B	50	42-44	38 – 41	1 – 2
Class C	70	42-47	10 – 58	0 - 15

Acoustic modeling for Alternative 2 was completed for turbine cut-in and full rotational operating conditions, thereby describing sound pressure levels over the full range of future Project operational conditions. The cut-in wind speed at hub height is the lowest wind speed, 3 m/s, at which a turbine begins producing usable power. Though turbines generate less noise under these conditions, oftentimes there is the potential for increased audibility due to the lower ambient levels and reduced masking as compared to sound levels generated under the maximum rotational operation condition and wind speeds. However, baseline monitoring results demonstrate that ambient sound levels are relatively consistent regardless of wind speed with sound levels in calm conditions at or above 41 dBA L_{eq} vs. sound levels at full rotation ranging from 43 to 49 dBA L_{eq}. Wind turbines operating at the highest manufacturer specified sound level, typically coinciding with maximum rotational operation, is the assumed worst-case condition for noise generation by the turbines considered in the analysis for Alternative 2 and was used for comparisons with the applicable regulatory criteria. For time-varying sources such as wind turbines, assessing sound levels generated during these conditions will likely ensure compliance during all other turbine operational conditions. Sound contour isopleths for the maximum rotational operating condition are shown in Figure 4.6-1.

The analysis for Alternative 2 demonstrates compliance with HAR 11-46, although there would be some increases in sound levels at nearby TMKs. As shown in Table 4.6-4 increases at the most sensitive Zone A TMKs are predicted to be no more than 4 dB over existing sound levels. As described in Section 4.6.1 a 3 dBA increase is generally not discernable to the average person, but a 5 dBA increase is; therefore, a 4 dBA increase may be discernable to some people but only considered a minor impact. Class B TMKs are predicted to experience increases in noise over baseline conditions of 1 to 2 dBA, which is not discernable to the average human and therefore considered a negligible impact. Class C TMKs located adjacent to the Project would experience the highest increases in sound levels with some increases predicted to be as high as 15 dBA over baseline conditions. Most of these Class C TMKs have no residences; however, there are some Class C TMKs that have residences and that are predicted to experience increases over baseline conditions in excess of 5 dBA. These include several legal residences on Department of Agriculture land immediately adjacent to the DLRN portion of the wind farm site; however, the majority of receptors on the Class C TMKs are farm structures (storage sheds and warehouses) located within the Malaekahana Hui West, LLC portion of the wind farm site near proposed turbine locations. A 5 dBA increase is considered perceptible to the average human and a 10 dBA increase is perceived as a doubling of sound. While these increases would be perceptible Class C TMKs intentionally allow for higher sound levels to accommodate sound from sources such as tractors for agricultural activities.

The World Health Organization (WHO) has also published guidelines including the Night Noise Guidelines for Europe (WHO 2009) which recommend a nighttime noise level of 40 dBA or below to minimize adverse health effects. Existing noise levels in the vicinity of the wind farm site are already above 40 dBA outside; therefore, the minor increase in noise predicted as a result of the Project would not be expected to result in additional noise effects to people sleeping with the windows open or closed who are already used to the existing level of noise exposure (see Section 4.6.3.3 below for additional discussion indoor versus outdoor noise levels).

Low Frequency Noise and Infrasound

LFN/IS analysis was conducted at the nearest NSRs to the Project's proposed turbines to determine if LFN/IS would exceed the threshold of human hearing, the DEFRA limits, and/or the ANSI S12.9 Part 4 guidelines. The nearest legal residence (on Department of Agriculture land) is located approximately 814 feet (248 meters) from a proposed turbine (see Figure 4.6-2). Received LFN/IS levels are predicted to be 83 dB at 8 Hz and 76 dB at 16 Hz, which are both well below the threshold of human hearing and the DEFRA limits but higher than the ANSI S12.9 Part 4 guideline of 65 dB at 16 Hz. Monitored sound levels in this area would be similar to those monitored at position LT-1, which shows that existing LFN/IS sound levels range from 69 to 76 dB at 8 Hz and 63 to 71 dB at 16 Hz, all below the threshold of human hearing, but at 16 Hz baseline sound levels are on average above the ANSI S12.9 Part 4. The Project would result in an increase in LFN/IS of approximately 2 to 9 dB at 8 Hz and 1 to 7 dB at 16 Hz; however, these increases are from baseline sound levels and project-related sound levels that are all below the threshold of human hearing and therefore are not predicted to result in an impact at the nearest residence. With regard to the 65 dB ANSI S12.9 Part 4 guideline, because the baseline sound levels are already above this threshold, the likelihood of complaints is low given that the LFN/IS would be at least partially masked by existing LFN/IS. Therefore, there is no anticipated LFN/IS impact from Alternative 2. The Noise Impact Assessment in Appendix C provides additional detail for LFN/IS from the Project.

4.6.3.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP are not expected to result in any noise-related effects in the analysis area.

Impacts of HCP Mitigation

No measurable noise impacts would occur in association with Newell's shearwater research and management and short-eared owl research and management, or implementation of activities funded at the Poamoho Ridge Mitigation Area for bat mitigation (forest restoration and monitoring). Depending on the measures chosen, regular visits by vehicles and personnel to the research and management sites may be made to carry out these activities; however noise impacts associated with vehicle use would be negligible, and would negligibly increase existing noise levels in the mitigation areas.

Installation and maintenance of a partial fence along the northeastern border of the Hamakua Marsh Mitigation Area for waterbird mitigation would result in minor increases in noise levels due to the use of vehicles. However, the noise would occur during normal work hours and the mitigation area is located adjacent to existing sound sources such as a parking lot and road where there is already some human sound.

4.6.3.3 Mitigation for Unavoidable Impacts

Operational noise would be in compliance with the HAR 11-46 thresholds under Alternative 2; however, construction noise would exceed the HAR 11-46 sound level limits at some TMKs in the acoustic analysis area resulting in impacts. While there are no operational exceedances of the HAR 11-46 thresholds, increases over ambient sound levels are predicted at some noise sensitive TMKs resulting in medium, long-term, local, and important effects. These increases would be experienced outdoors and only under full rotational conditions. Residents at these homes would realize little to no noise impact from the turbines when inside and with windows closed; therefore, noise impacts such as sleep disturbance are not anticipated, and no mitigation is recommended. However, with windows open, wind turbine noise would be greater in the homes and periodically audible over background sounds. Studies have shown, however, that even with windows open there is attenuation of noise going from outdoor to indoor conditions. For example, the Federal Highways Administration (FHWA) conservatively estimates that noise is reduced by 10 dBA when transitioning from outdoor to indoor conditions with windows open (FHWA, Highway Traffic Noise: Analysis and Abatement Guidance, 2011). Predicted Project sound levels were evaluated at the exterior of each noise-sensitive land use; therefore, interior sound levels would be 10 dBA less assuming windows are open at each of the noise-sensitive structures. If windows are assumed to be closed, the noise reduction going from outside to inside is typically around 20 dBA.

In addition to working with the HDOH to minimize construction noise impacts, additional mitigation measures for construction and operational effects include the following:

- A process shall be established for documenting, investigating, evaluating, and resolving project-related noise complaints.
- All equipment shall be maintained in good working order in accordance with manufacturer specifications. Suitable mufflers and/or air-inlet silencers should be installed on all internal combustion engines and certain compressor components.
- Select equipment with the lowest noise levels available and no prominent discrete tones, when possible.
- All vehicles traveling within and around the wind farm site should operate in accordance with posted speed limits.
- Noisy construction activities should be limited to the least noise-sensitive times of day (daytime only, between 7 a.m. and 7 p.m.) and weekdays.
- Noisy activities should be scheduled to occur at the same time whenever feasible, since additional sources of noise generally do not greatly increase noise levels at the site boundary. Less-frequent but noisy activities would generally be less annoying than lower-level noises occurring more frequently.
- Stationary construction equipment (e.g., compressors or generators) should be located as far as practical from nearby sensitive receptors.

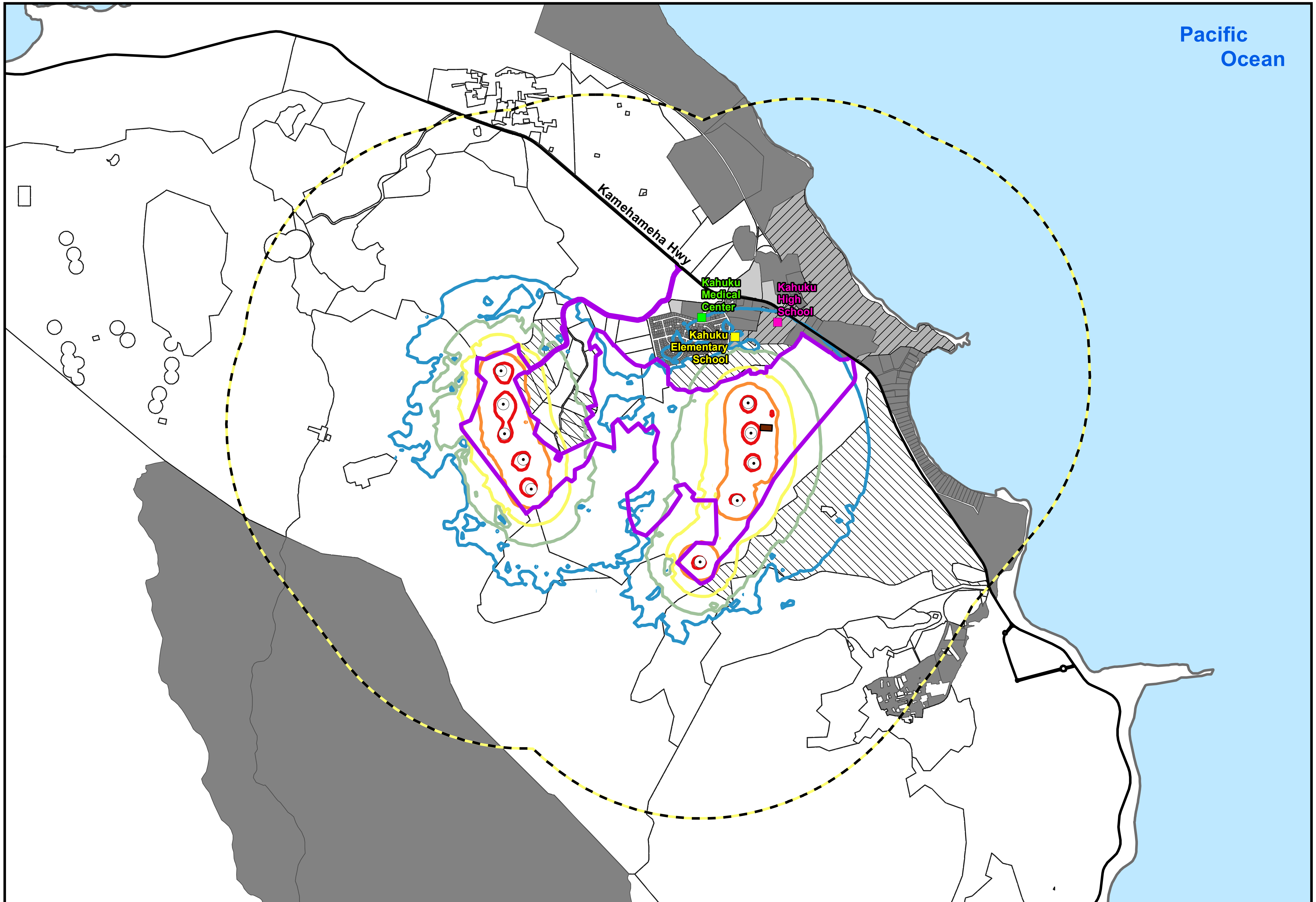
Figure 4.6-1

Na Pua Makani Wind Project

Alternative 2 Operational Sound Level Isopleths

Oahu, HI

December 2015



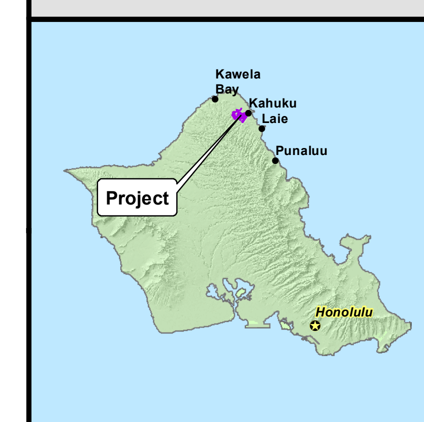
- Wind Farm Site
- Acoustic Study Area
- Collector Substation and Point of Interconnect
- Local Road
- Kahuku Elementary School
- Kahuku High School
- Kahuku Medical Center
- Potential Turbine Location

Hawaii Administrative Rule Zone

- Class A (45 dBA Limit)
- Class A (55 dBA Limit) - Day Use Only
- Class B (50 dBA Limit)
- Class C (70 dBA Limit) - Has Residence
- Class C (70 dBA Limit) - No Residence or Project TMK

Sound Contour Range (dBA)

- 40
- 45
- 50
- 55
- 60



1:32,000 WGS84 UTM 4

0 0.5 1 2 3 4 5 Miles

Data Sources Champlin: project facilities / ESRI: roads / Hawaii Statewide GIS Program: TMK parcels / Tetra Tech: sound contours generated in CadnaA

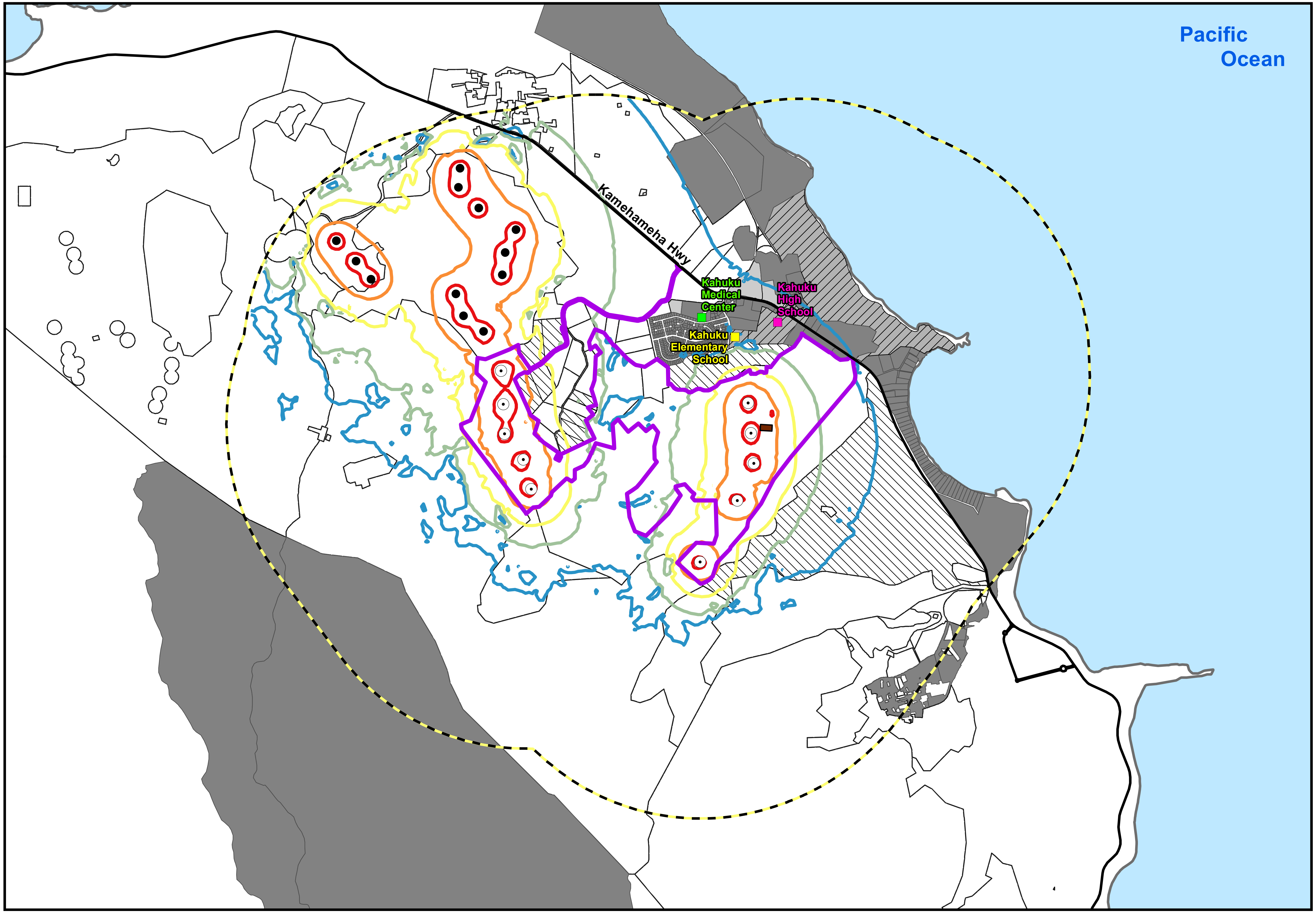
Figure 4.6-2

Na Pua Makani Wind Project

Alternative 2 Cumulative Sound Level Isopleths

Oahu, HI

December 2015



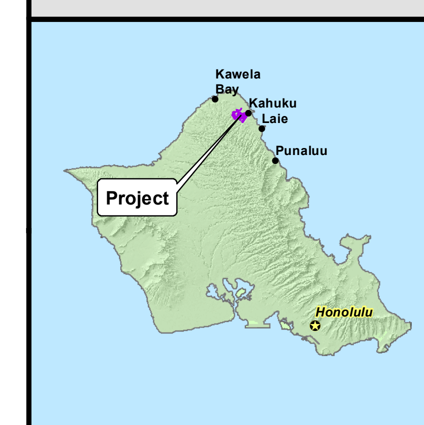
- Wind Farm Site
- Acoustic Study Area
- Collector Substation and Point of Interconnect
- Local Road
- Kahuku Wind Turbine Generator
- Kahuku Elementary School
- Kahuku High School
- Kahuku Medical Center
- Potential Turbine Location

Hawaii Administrative Rule Zone

- Class A (45 dBA Limit)
- Class A (55 dBA Limit) - Day Use Only
- Class B (50 dBA Limit)
- Class C (70 dBA Limit) - Has Residence
- Class C (70 dBA Limit) - No Residence or Project TMK

Sound Contour Range (dBA)

- 40
- 45
- 50
- 55
- 60



1:32,000 WGS84 UTM 4

0 0.5 1 2 3 4 5 Miles

Data Sources Champlin: project facilities / ESRI: roads / Hawaii Statewide GIS Program: TMK parcels / Tetra Tech: sound contours generated in CadnaA

TETRA TECH

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4.6.3.4 Cumulative Effects

Cumulative effects from noise were identified using both quantitative and qualitative analyses. Quantitatively, baseline sound levels were used to ascertain the contribution of the Project to existing sound levels, which include past and present anthropogenic sound sources. Existing anthropogenic sound sources include the Kahuku Wind Farm, Kamehameha Highway, local roadways, air craft overflights, and other developed areas. Note that when baseline sound levels were monitored 11 of the 12 existing wind turbines at the Kahuku Wind Farm, including those closest to the Project, were operating; one turbine was not functioning (assumed to be down for maintenance) during deployment of the monitoring equipment and a different turbine not functioning during retrieval of the monitoring equipment two weeks later. Cumulative sound levels anticipated during Project operation were predicted using the highest acoustic emissions as specified by the turbine manufacturers for turbine models being considered for the Project as well as those operating at the Kahuku Wind Farm; therefore, the cumulative acoustic analysis of operational sound levels represents the highest acoustic emissions anticipated during Project operation. To identify future development that could result in increased sound levels a review of public records was conducted. Potential foreseeable sources of noise would result from expansion of the Turtle Bay resort, residential developments, and widening of the Kamehameha Highway to accommodate a center turn lane. These developments would increase human activity in the area and also result in increased sound levels, although the increase is expected to be in the range of 1 to 3 dB over existing conditions. For example, noise from roadway traffic is not expected to result in substantial increases, or greater than 3 dB, over existing traffic noise conditions because according to the Traffic Assessment Report (Appendix B) Project traffic is predicted to only represent 0.05 percent of the total traffic in the area. For an appreciable increase of at least 3 dB, the Project would need to result in a doubling of traffic area roadways, which is not expected. Received sound levels from the Project at NSRs located close to the highway are low and would be masked by sounds from the highway resulting in no appreciable change with the Project. Cumulative sound levels from wind energy at both the Kahuku Wind Farm and from Alternative 2 were also evaluated and would not exceed HAR 11-46 limits. Figure 4.6-2 provides a map of cumulative wind energy noise levels under the highest operational scenario modeled.

4.6.3.5 Summary

Alternative 2 would result in construction and operational impacts of varying magnitude or intensity, duration, geographic extent, and context. Construction noise would result in, at worst, medium intensity, temporary, local, and common impacts to TMKs sensitive to noise (e.g., Class A) in the acoustic analysis area. Construction impacts would be mitigated by working with the HDOH to obtain a construction permit for the Project that may include stipulations such as use of construction equipment during daytime hours only. Operational noise impacts would be characterized as, at worst, being medium (3 to 15 dBA increases over ambient conditions), local, and important (medium magnitude or intensity impacts), although for the majority of the Project acoustic analysis area increases are predicted to be less than 3 dBA. Note that the predictions of operational noise are intentionally conservative and the likelihood of a 3 to 4 dBA increase at noise-sensitive TMKs (e.g., Class A) would only occur outside under downwind propagation conditions under maximum rotation operational conditions. Because impacts are nonexistent for most TMKs and at worst result in medium 3 to 4 dBA increases over ambient levels at some Class A TMKs, no mitigation measures of operational noise are recommended; therefore, impacts would be considered minor.

4.6.3.6 Alternative 2a - Modified Proposed Action Option

Direct, indirect, and cumulative effects of noise from the Modified Proposed Action Option would be similar as those described under the Proposed Action. Construction noise under Alternative 2a would be almost the same as Alternative 2 with the exception that one less turbine would be constructed. Construction noise, similar to Alternative 2 is likely to exceed HAR 11-46 limits at some TMKs in the Project area and would require a permit from the HDOH under Alternative 2a.

Direct and indirect effects of operational noise from the Modified Proposed Action Option would be similar to those described under the Proposed Action. Impacts from LFN/IS would be the same under Alternative 2a as under Alternative 2 because the nearest legal residence to a proposed wind turbine is the same under both alternatives. Operational broadband (dBA) sound pressure levels for the Modified Proposed Action Option; however, were calculated based on a total of nine Siemens SWT 3.3-130 turbines. Table 4.6-5 presents the range of sound levels received at each TMK zoning class in the acoustic analysis area under Alternative 2a. Similar to the Proposed Action, the operational noise analysis for the Modified Proposed Action Option demonstrates compliance with HAR 11-46, although there would be some increase in sound levels at nearby TMKs (Figure 4.6-3). Increases at the most sensitive Zone A TMKs are predicted to be no more than 3 dBA over existing sound levels. As described in Section 4.6.1 a 3 dBA increase is generally not discernable to the average person. Cumulative sound levels from wind energy at both the Kahuku Wind Farm and from the Modified Proposed Action Option were also evaluated and would not exceed HAR 11-46 limits. Figure 4.6-4 provides a map of cumulative wind energy noise levels under the highest operational scenario modeled. Implementation of mitigation measures, as described under the Proposed Action, would minimize any adverse noise impacts under the Modified Proposed Action Option.

Table 4.6-5. Alternative 2a Predicted Operational Received Sound Pressure Levels (L_{eq}) by Zoning Class

HAR 11-46 Zoning Class	Controlling HAR 11-46 Zoning Limit (dBA L_{eq})	Baseline Sound Level (dBA L_{eq})	Range of Received Sound Levels dBA L_{eq}	Increase over Baseline
Class A	45	42-47	8 – 43	0 - 3
Class A (Day Only)	55	42	27 - 43	2 – 3
Class B	50	42-44	35 - 38	1 – 2
Class C	70	42-47	8 - 56	0 - 11

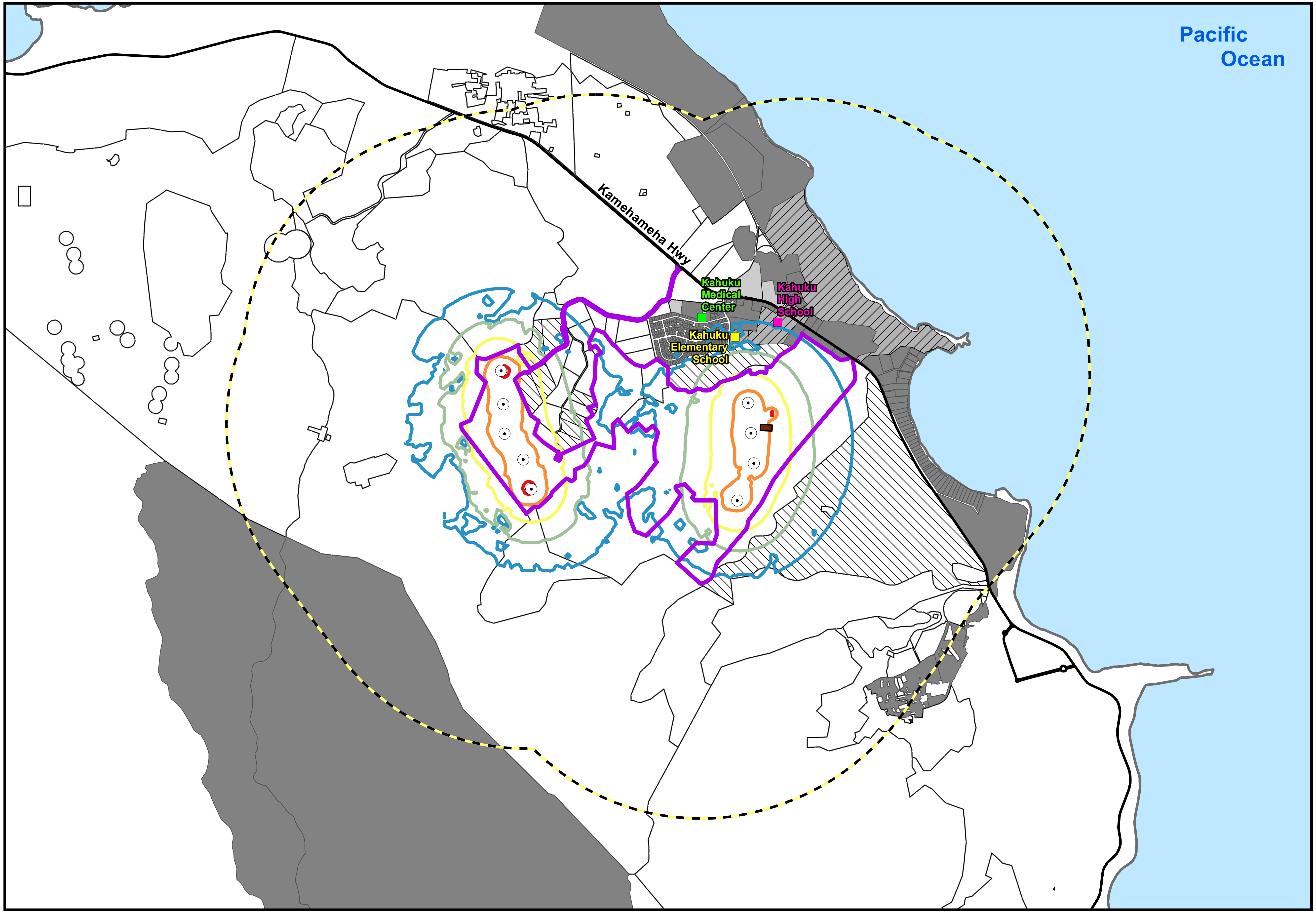
Figure 4.6-3

Na Pua Makani Wind Project

Modified Proposed Action Option (Alternative 2a) Operational Sound Level Isopleths

Oahu, HI

December 2015



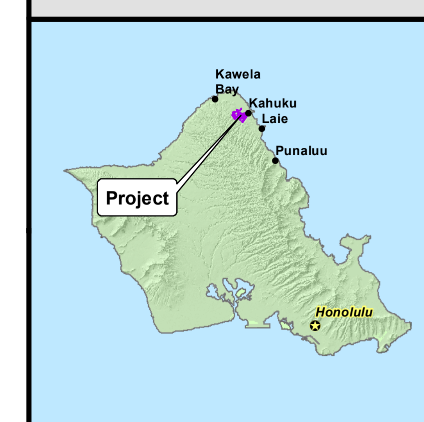
- Wind Farm Site
- Acoustic Study Area
- Collector Substation and Point of Interconnect
- Local Road
- Kahuku Elementary School
- Kahuku High School
- Kahuku Medical Center
- Potential Turbine Location

Hawaii Administrative Rule Zone

- Class A (45 dBA Limit)
- Class A (55 dBA Limit) - Day Use Only
- Class B (50 dBA Limit)
- Class C (70 dBA Limit) - Has Residence
- Class C (70 dBA Limit) - No Residence or Project TMK

Sound Contour Range (dBA)

- 40
- 45
- 50
- 55
- 60



1:32,000 WGS84 UTM 4

0 0.5 1 2 3 4 5 Miles

Data Sources Champlin: project facilities / ESRI: roads / Hawaii Statewide GIS Program: TMK parcels / Tetra Tech: sound contours generated in CadnaA

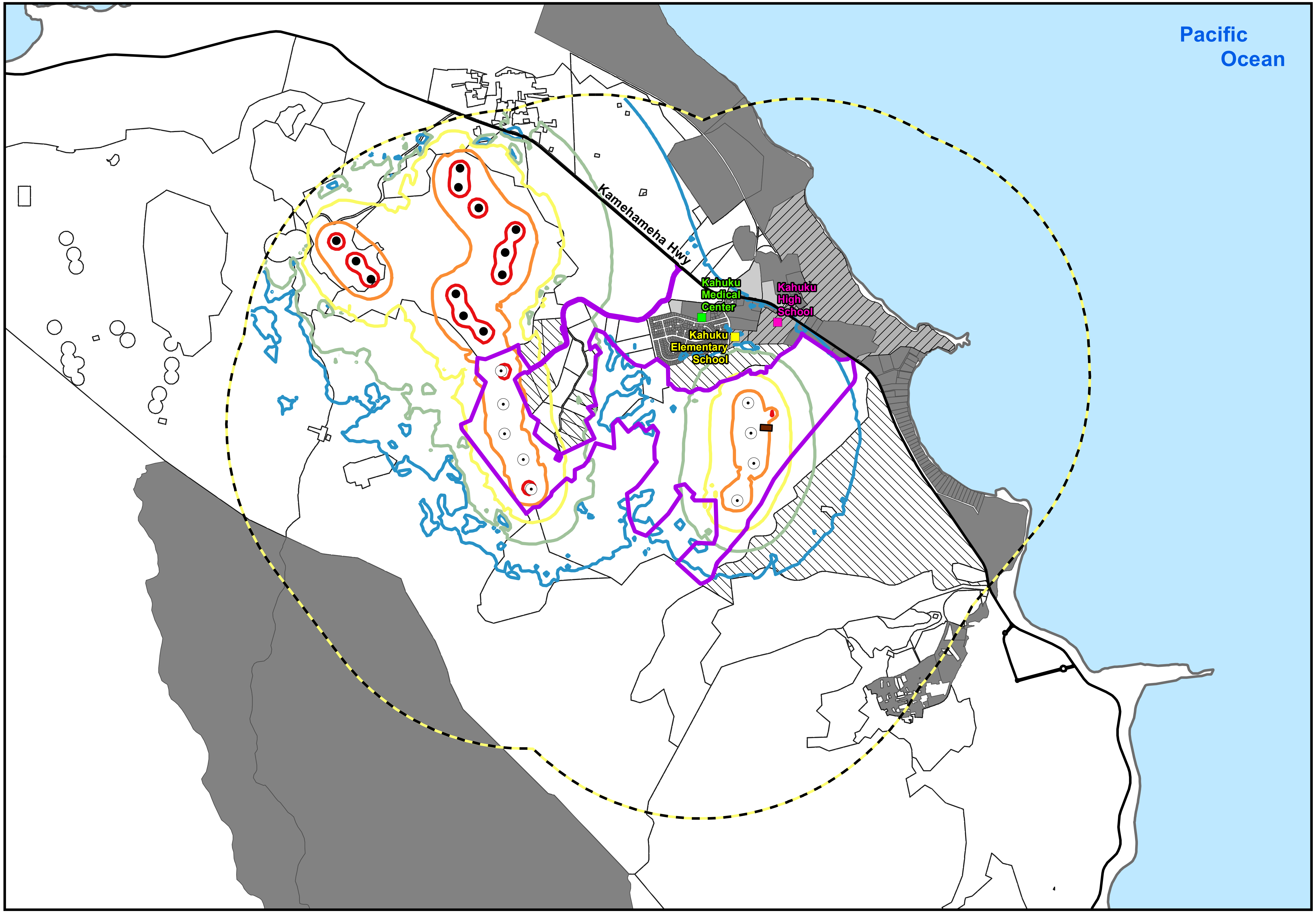
Figure 4.6-4

Na Pua Makani Wind Project

Modified Proposed Action Option (Alternative 2a) Cumulative Sound Level Isopleths

Oahu, HI

December 2015



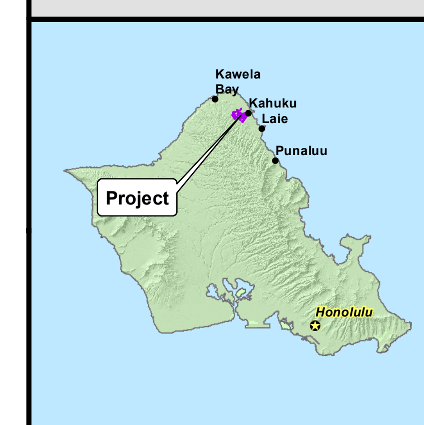
- Wind Farm Site
- Acoustic Study Area
- Collector Substation and Point of Interconnect
- Local Road
- Kahuku Wind Turbine Generator
- Kahuku Elementary School
- Kahuku High School
- Kahuku Medical Center
- Potential Turbine Location

Hawaii Administrative Rule Zone

- Class A (45 dBA Limit)
- Class A (55 dBA Limit) - Day Use Only
- Class B (50 dBA Limit)
- Class C (70 dBA Limit) - Has Residence
- Class C (70 dBA Limit) - No Residence or Project TMK

Sound Contour Range (dBA)

- 40
- 45
- 50
- 55
- 60



1:32,000 WGS84 UTM 4

0 0.5 1 2 3 4 5 Miles

Data Sources Champlin: project facilities / ESRI: roads / Hawaii Statewide GIS Program: TMK parcels / Tetra Tech: sound contours generated in CadnaA

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4.6.4 Alternative 3—Larger Generation Facility (Up to 12 Turbine Project)

4.6.4.1 Direct and Indirect Effects of Construction and Operation of the Project

Temporary construction noise and permanent operational noise from Alternative 3 would result in changes in noise levels in the acoustical analysis area. Alternative 3 is similar to Alternative 2 in that the first portion or phase of Alternative 3 is identical to Alternative 2. Where the alternatives differ is in the second phase of Alternative 3, which includes additional turbines to achieve power generation of up to approximately 42 MW. Therefore, construction and operational noise impacts for the first phase of Alternative 3 are identical to Alternative 2. Because of this, the discussion of Alternative 3 focuses on the sound levels associated with the larger facility inclusive of the second phase of construction of Alternative 3.

Construction

The first phase of construction of Alternative 3 would be identical to Alternative 2 and the second phase of Alternative 3 would use an identical method as that for the first phase of construction. The variation in construction noise between phases one and two of construction are a result of where construction would take place and that construction would occur at least 2 years later for the second phase. Like Alternative 2, construction noise is likely to exceed HAR 11-46 limits at some TMKs in the acoustic analysis area, and therefore, a permit from the HDOH would likely be required. Mitigation of construction noise would be the same for Alternative 3 as that for Alternative 2.

Operation

Alternative 3 includes more turbines that Alternative 2 and therefore operational noise levels from Alternative 3 would cover a larger area. There would be a total of up to 12 turbines, which for this analysis were assumed to be two Vestas V110-2.0 and 10 Siemens SWT 3.0-113. Operational sound levels would not exceed the HAR 11-46 limits at any TMKs. Table 4.6-6 provides the range of predicted sound levels by zoning class for Alternative 3. Figure 4.6-5 provides operational sound contour isopleths for Alternative 3. In response to public comments on the Draft EIS, an evaluation of noise impacts based on the C-weighted (dBC) scale is included in Appendix C.

Table 4.6-6. Alternative 3 Predicted Operational Received Sound Pressure Levels (L_{eq}) by Zoning Class

HAR 11-46 Zoning Class	Controlling HAR 11-46 Zoning Limit (dBA L_{eq})	Baseline Sound Level (dBA L_{eq})	Range of Received Sound Levels dBA L_{eq}	Increase over Baseline
Class A	45	42 - 47	8 – 44	0 – 4
Class B	50	42 - 44	38 – 41	1 – 2
Class A (Day Only)	55	42	31 – 44	2 – 4
Class C	70	42 - 47	10 – 58	0 - 15

The analysis for Alternative 3 demonstrates compliance with HAR 11-46, although there would be some increases in sound levels at nearby TMKs. As shown in Table 4.6-6 received sound levels in Class A TMKs would be no more than 4 dB over existing sound levels. As described in Section 4.6-1, a 3 dBA increase is generally not discernable to the average person, but a 5 dBA increase is; therefore, a 4 dBA increase may be discernable to some people but only considered a minor impact. Class B TMKs are predicted to experience increases in noise over baseline conditions of 1 to 2 dBA, which is not discernable to the average human and therefore considered a negligible impact. Class C TMKs located adjacent to the Project would experience the highest increases in sound levels with some increases predicted to be as high as 15 dBA over baseline conditions. Most of these Class C TMKs have no residences; however, there are some Class C TMKs that have residences and that are predicted to experience increases over baseline conditions in excess of 5 dBA. A 5 dBA increase is considered perceptible to the average human and a 10 dBA increase is perceived as a doubling of sound. While these increases would be perceptible, Class C TMKs intentionally allow for higher sound levels to accommodate sound from sources such as tractors for agricultural activities.

Low Frequency Noise and Infrasound

While sound from more turbines under Alternative 3 would cover a greater area, the worst-case LFN/IS noise levels would be the same under Alternative 3 as they are under Alternative 2 because the nearest legal residence (located on Department of Agriculture land) is also 814 feet (248 meters) from the nearest proposed turbine. Therefore, there are no anticipated impacts from LFN/IS from Alternative 3.

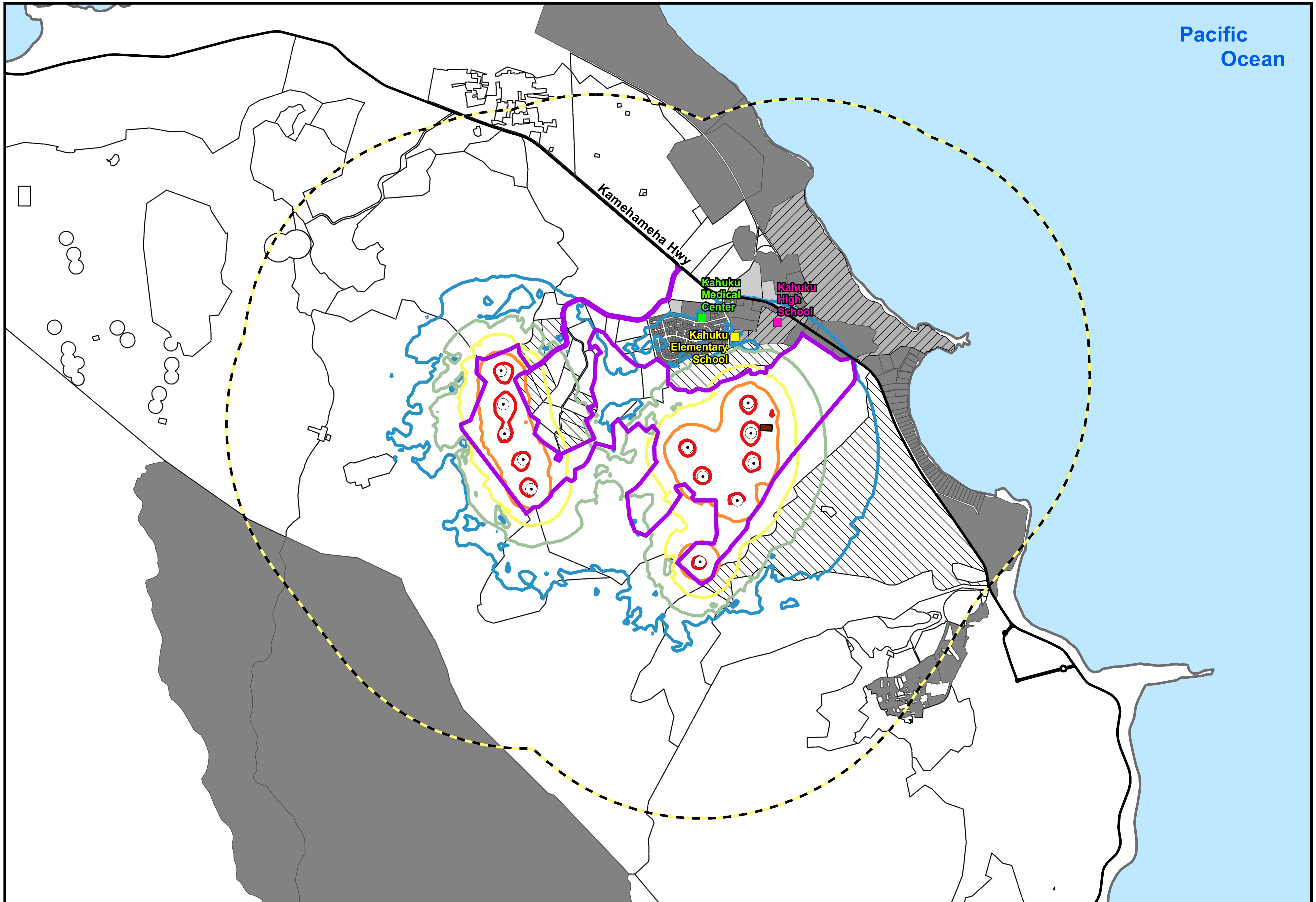
Figure 4.6-5

Na Pua Makani Wind Energy

Alternative 3 Operational Sound Level Isopleths

Oahu, HI

December 2015



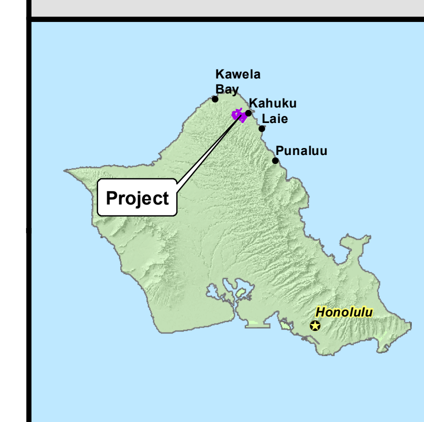
- Wind Farm Site
- Acoustic Study Area
- Collector Substation and Point of Interconnect
- Local Road
- Kahuku Elementary School
- Kahuku High School
- Kahuku Medical Center
- Potential Turbine Location

Hawaii Administrative Rule Zone

- Class A (45 dBA Limit)
- Class A (55 dBA Limit) - Day Use Only
- Class B (50 dBA Limit)
- Class C (70 dBA Limit) - Has Residence
- Class C (70 dBA Limit) - No Residence or Project TMK

Sound Contour Range (dBA)

- 40
- 45
- 50
- 55
- 60



1:32,000 WGS84 UTM 4

0 0.5 1 2 3 4 5 Miles

Data Sources Champlin: project facilities / ESRI: roads / Hawaii Statewide GIS Program: TMK parcels / Tetra Tech: sound contours generated in CadnaA

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4.6.4.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP are not expected to result in any noise-related effects in the analysis area.

Impacts of HCP Mitigation

Impacts of HCP mitigation under Alternative 3 would be the same as described under the Proposed Action. Prior to the construction of the additional turbines proposed under Alternative 3, NPMPP would reopen consultation with the USFWS and DOFAW to assess the potential impacts of the additional turbines to listed species and develop appropriate mitigation measures. The impacts of these mitigation measures related to noise would be evaluated under a separate environmental analysis at that time.

4.6.4.3 Mitigation for Unavoidable Impacts

Operational noise would be in compliance with the HAR 11-46 thresholds under Alternative 3; however, construction noise would exceed the HAR 11-46 sound level limits at some TMKs in the acoustic analysis area resulting in impacts. While there are no operational exceedances of the HAR 11-46 thresholds, increases over ambient sound levels are predicted to at some noise sensitive TMKs that would result in medium, long-term, local, and important effects. These increases would be experienced outdoors and only under full rotational conditions. Residents at these homes would realize little to no noise impact from the turbines when inside and with windows closed; therefore, noise impacts such as sleep disturbance are not anticipated, and no mitigation is recommended. However, with windows open, wind turbine noise would be greater in the homes and periodically audible over background sounds, although even with windows open, there is noise attenuation when transitioning from outdoor to indoors (see Section 4.6.3.3 for discussion). In addition to working with the HDOH to minimize construction noise impacts, additional mitigation measures would be the same as those proposed for Alternative 2.

4.6.4.4 Cumulative Effects

Cumulatively, Alternative 3 would be nearly identical to Alternative 2 with the only difference in cumulative sound levels resulting in areas close to the 2 to 4 additional turbines. Future non-Project related noise would be the same as that under Alternative 2 and the addition of 2 to 4 turbines under Alternative 3 does not change sound levels enough to result in exceedances of the HAR 11-46 limits. Of potential concern to the public are cumulative sound levels from wind turbines at the Kahuku Wind Farm and from Alternative 3; however, no exceedances of the HAR 11-46 limits are predicted cumulatively from wind energy in the area. Figure 4.6-6 provides a map of cumulative wind energy noise levels under the highest operational scenario modeled.

4.6.4.5 Summary

Alternative 3 would result in construction and operational impacts of varying magnitude or intensity, duration, geographic extent, and context. Construction noise would result in, at worst, medium intensity, temporary, local, and common impacts to TMKs (e.g., Class A) sensitive to noise in the acoustic analysis area. Construction impacts would be mitigated by working with the HDOH to obtain a construction permit for the Project that may include stipulations such as use of construction equipment during daytime hours only. Operational noise impacts would be characterized as, at worst, being medium (3 to 15 dB increases over ambient conditions), local, and important (medium magnitude or intensity impacts); although for the majority of the Project acoustic analysis area increases are predicted to be less than 3 dB. Note that the predictions of operational noise are intentionally conservative and the likelihood of a 3 to 4 dB increase at noise-sensitive TMKs (e.g., Class A) would only occur outside under downwind propagation conditions under maximum rotation operational conditions. Because impacts are minimal or nonexistent for most TMKs and, at worst, result in medium 3 to 4 dBA increases over ambient levels at some Class A TMKs, no mitigation measures of operational noise are recommended.

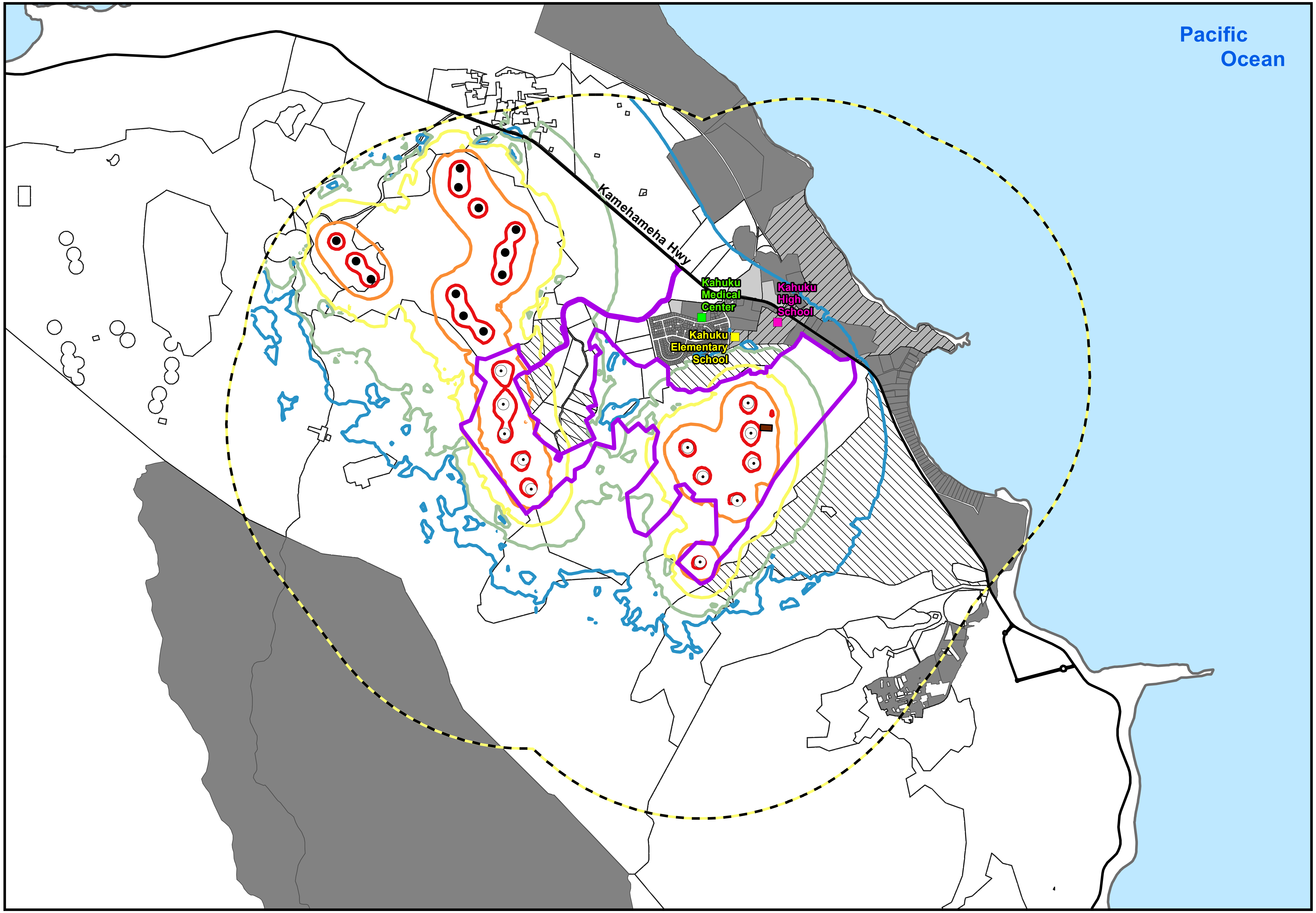


Figure 4.6-6

Na Pua Makani Wind Energy

Alternative 3 Cumulative Sound Level Isopleths

Oahu, HI

December 2015

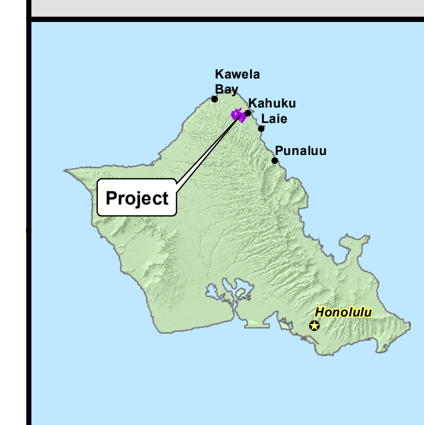
- Wind Farm Site
- Acoustic Study Area
- Collector Substation and Point of Interconnect
- Local Road
- Kahuku Wind Turbine Generator
- Kahuku Elementary School
- Kahuku High School
- Kahuku Medical Center
- Potential Turbine Location

Hawaii Administrative Rule Zone

- Class A (45 dBA Limit)
- Class A (55 dBA Limit) - Day Use Only
- Class B (50 dBA Limit)
- Class C (70 dBA Limit) - Has Residence
- Class C (70 dBA Limit) - No Residence or Project TMK

Sound Contour Range (dBA)

- 40
- 45
- 50
- 55
- 60



1:32,000 WGS84 UTM 4 — 0 0.5 1 2 3 4 5 Miles

Data Sources Champlin: project facilities / ESRI: roads / Hawaii Statewide GIS Program: TMK parcels / Tetra Tech: sound contours generated in CadnaA

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4.6.5 Conclusion

Alternatives 2 and the Modified Proposed Action Option (Alternative 2a) would result in lower overall sound levels than Alternative 3 due to the smaller number of turbines being constructed and operated. Both Alternatives, however, would be able to be constructed in compliance with HAR 11-46, but would require the construction contractor to obtain a noise permit from HDOH. Operationally, the alternatives are not predicted to exceed the HAR 11-46 sound level limits, but are predicted to increase sound levels in the acoustic analysis area by greater than 2 dBA at some Zone A or B TMKs (e.g., the most noise-sensitive TMKs according to HAR 11-46). No mitigation of operational noise is recommended because much of the increase in noise would be masked by existing sound levels; therefore, noise impacts are characterized as being minor. Table 4.6-7 summarizes potential impacts by alternative.

Table 4.6-7. Summary of Potential Noise Impacts

Impact Issues	No Action Alternative	Alternative 2 – Proposed Action	Alternative 2a – Modified Proposed Action Option	Alternative 3
Audible noise	No Impact	Minor	Minor	Minor
Low frequency noise/infrasound	No Impact	Negligible	Negligible	Negligible

4.7 Hazardous and Regulated Materials and Wastes

4.7.1 Impact Criteria

The impacts from the use of hazardous materials, solid waste, and petroleum products were assessed based on whether construction and operation of the Project as well as the implementation of HCP conservation measures could:

- Increase a significant hazard to the public or the environment through routine transport, storage, use, or disposal of hazardous materials;
- Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment;
- Expose workers or the public to hazardous materials at levels in excess of those permitted by OSHA in 29 CFR Part 1910;
- Increase exposure of humans or the environment to potentially hazardous levels of chemicals from the disturbance of existing contamination or from the improper discharge or disposal of hazardous materials; and
- Expose people to significant hazards or structures to loss as a result of intentionally destructive acts (i.e., vandalism).

Impact criteria for determining effects of the use of hazardous materials, solid waste, and petroleum products from the Project are described further in Table 4.7-1 below.

Table 4.7-1. Impact Criteria for Hazardous and Regulated Materials and Wastes

Type of Effect	Impact Component	Effects Summary		
Effects on public and worker health and safety and the environment	Magnitude or Intensity	**High:** Above background conditions and causes effects that are chronic, irreversible, or fatal.	**Medium:** Above background conditions and causes effects that necessitate treatment or medical management and are reversible.	**Low:** Above background conditions but within normal variation of human health and environmental conditions.
	Duration	**Permanent:** Changes in health or environmental indicators persist after actions that caused the impacts to cease.	**Long-term:** Changes in health or environmental indicators extend up to the life of the Project and would return to pre-activity levels sometime after actions causing impacts were to cease.	**Temporary:** Changes in health or environmental indicators last for less than 1 year or the period of Project construction.
	Geographic Extent	**Extended:** Affects communities throughout the region.	**Regional:** Affects 2 or more communities in the region.	**Local:** Affects individuals in a single community

4.7.2 Alternative 1—No Action

4.7.2.1 Direct and Indirect Effects

Under the No Action Alternative, the Project would not be constructed, the ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. The wind farm site would continue to be undeveloped and used for agricultural purposes. No hazardous materials and petroleum products, beyond those currently used for agricultural purposes or activities within the mitigation areas, would be transported, stored, used, or disposed of at the site; therefore, there would be no impacts.

4.7.2.2 Cumulative Effects

Under the No Action alternative, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Therefore there would be no effect related to the use of hazardous materials. Thus, Alternative 1 would not contribute to cumulative effects related to the use of hazardous materials, solid waste, and petroleum products.

4.7.2.3 Summary

There would be no direct, indirect, or cumulative impacts caused by the transport, storage, use and disposal of hazardous materials, solid waste and petroleum products under the No Action Alternative.

4.7.3 Alternative 2—8 to 10 Turbine Project

4.7.3.1 Direct and Indirect Effects of Construction and Operation of the Project

Construction Impacts

Routine Use, Storage and Transport of Hazardous Materials

Construction of the Project involves the routine transport, use, storage, and disposal of hazardous materials. Construction requires the operation of heavy equipment and construction vehicles. Hazardous materials required for construction equipment include antifreeze, diesel fuel, gasoline, hydraulic oil, lube oil, and grease. It would not be practical to remove construction equipment from the wind farm site for refueling and general maintenance such as changing fluids and lubricating parts; therefore, these activities would take place onsite. Other hazardous or regulated materials that would be used during construction include paints, adhesives, curing compounds, concrete, bentonite, and fertilizer. Construction equipment used to mix and pour concrete would be washed onsite because it would not be practical to remove this equipment from the site for washing. There would be waste disposal and collection receptacles and sanitary facilities on site during construction.

NPMPP would prepare and implement a Hazardous Materials and Wastes Management Plan (HMWMP) that details proper procedures for storing and using hazardous materials and storing and disposing of hazardous waste. The plan would contain sufficient detail to address the purpose of the plan and to readily translate into the actions necessary to comply with relevant regulations. The plan would include information about site activities, site contacts, worker training procedures, and a hazardous materials inventory in accordance with Article 80 of the Uniform Fire Code.

A qualified hazardous materials management professional, such as a Certified Hazardous Materials Manager, would prepare and oversee implementation of the plan. The HMWMP would include emergency response procedures. The plan would be provided to local emergency responders so they could properly respond to an emergency at the site. All workers would be trained to understand the established emergency response procedures. Emergency response equipment such as fire extinguishers and first aid kits would be onsite at all times. In addition, water tanks would be onsite for dust suppression and would be available in the event of a fire.

Regulatory requirements and standard industry BMPs for managing the routine transport, use, storage, and disposal of hazardous materials, petroleum products, and solid waste would be implemented. These requirements and BMPs include the following:

- Keep materials in their original containers with the original manufacturer‘s label;
- Seal containers whenever they are not in use;
- Procure and store only the amount of chemicals needed for the job;
- Follow the manufacturer‘s recommendation for proper handling and disposal;
- Store smaller hazardous materials containers in a secure cabinet designed for storage of such materials;

- Conduct routine inspections to ensure that all chemicals are being stored, used, and disposed of appropriately; and
- Place construction debris and trash into a dumpster to prevent it from being wind-blown or left on the ground.

Table 4.7-2 presents a list of pollutants that could be used during construction, a brief description of their storage and use, and a brief description of control measures that would be implemented to ensure they are properly stored. Implementation of these control measures and BMPs would ensure that impacts from routine transport, use, storage, and disposal of hazardous materials would be minor.

Table 4.7-2. Potential Pollutants and Control Measures

Potential Pollutant	Storage or Use	Control Measures
Antifreeze	Vehicles, Equipment	Secure secondary containment; drip pan
Diesel Fuel	Vehicles, Equipment, AST	Secure secondary containment; drip pan
Gasoline	Vehicles, Equipment, AST	Secure secondary containment; drip pan
Hydraulic Oils/Fluids	Vehicles, Equipment	Secure secondary containment; drip pan
Grease	Vehicles, Equipment	Secure secondary containment; drip pan
Sanitary Waste Restrooms	Various	Service provider would secure units to prevent tipping
Trash and Construction Debris	Various	Dumpster
Paints	Contractor	Secure secondary containment; secure, covered storage
Glue, Adhesives, Curing Compounds	Contractor	Secure secondary containment; secure, covered storage
Soil Amendments	Various	Secure secondary containment; secure, covered storage
Landscaping Materials, Fertilizer	Various	Secure secondary containment; secure, covered storage
Concrete Mortar	Mobile Mixer	Secure secondary containment; washout area; secure, covered storage
Concrete	Trucks, Washout	Secure secondary containment; secure, covered storage

Accidental Spills and Releases

There could be accidental releases or spills from the routine transport, use, storage, and disposal of hazardous materials. NPMPP would prepare an SPCC Plan that would be implemented by the construction contractor and operations staff. The SPCC Plan would be reviewed and certified by a Professional Engineer to ensure its adequacy. The Plan would include measures for the safe transport, handling, and storage of hazardous materials and will address security, safety, training, inspections, and spill response. Regulatory requirements and BMPs designed to prevent and respond to spills and releases that would be implemented include:

- Maintain spill containment and cleanup kits in all areas where hazardous materials would be used or stored;
- Fuel and maintain vehicles and equipment in areas protected from releases onto the ground;
- Provide secure secondary containment with a volume of at least 150 percent of the tank volume for all fuel tanks;
- Place drip pans under vehicles to prevent fluids from dripping onto the ground;
- Perform timely maintenance on vehicles and equipment that leaks oil or other fluids;

- Wash equipment and vehicles used for concrete in a designated area where wash water would be properly contained. Pump wash water into trucks and remove it from the site for proper disposal; and
- Construct a sump to contain the waste product of bentonite during drilling operations.

There is the potential for accidental releases or spills from the routine transport, use, storage, and disposal of hazardous materials during construction. Implementation of the control measures and BMPs described above that are designed to prevent and respond to spills and releases would ensure that impacts remain minor.

Worker Exposure to Chemicals Exceeding OSHA Limits

Construction workers could come into contact with hazardous materials in excess of the exposure limits defined by OSHA in 29 CFR Part 1910. To minimize this risk, a Site Safety Handbook would be prepared and implemented in accordance with 29 CFR 1926.65. For more information on the Site Safety Handbook, see Section 4.18 – Public Health and Safety. All persons entering the construction areas would be required to review and adhere to the Site Safety Handbook. NPMPP would implement regulatory requirements and BMPs to prevent harmful exposure of workers, including:

- Have Material Safety Data Sheets available to all workers for all hazardous materials stored and used onsite;
- Ensure that all personnel who handle or could come into contact with hazardous materials are sufficiently trained in the proper way to use and dispose of these materials; and
- Ensure the proper use of personal protective equipment.

The potential for injury to workers from exposure to hazardous materials would be minor with the implementation of the Site Safety Handbook.

Disturbance of Existing Contamination or Improper Disposal

As described in Section 3.5.1, there is no known contamination at the wind farm site; however, there is always some potential that existing contamination such as an illegal dump site could be found during construction. Even though the risk of encountering existing contamination is low, workers would be trained to recognize signs of illegal dumping or subsurface contamination such as odors and soil discoloration. If contamination were discovered, NPMPP would work with the Hawaii Department of Health to take appropriate action, including characterizing the type, extent, and concentration of the contamination and removing contaminated soil.

Construction activities would generate waste including construction debris, concrete wash water, used oil, and other vehicle fluids, and restroom waste. Proper procedures for temporary onsite storage of such wastes would be documented in the HMWMP. All waste, including non-hazardous waste, would be disposed of off-site at an appropriately permitted facility. Facilities where waste may be disposed of and the type of waste each facility accepts are discussed in Section 4.20 – Public Infrastructure and Services. The impacts associated with disturbance of existing contamination or improper handling of waste generated during construction would be minor with implementation of the HMWMP.

Vandalism

Because most construction activities would be in remote areas not readily accessible to or visible by the public, the risk of vandalism would be low. However, onsite project roads would be off limits to public during construction for both security and safety reasons. Site security would be sufficient to prevent vandalism. The wind farm site is currently not fenced. The step-up transformers at the individual turbines would be on access roads that would be physically closed to the public. The transformers would be inside padlocked and wrench-locked vaults to prevent access to the level gauges and valves that would result in oil discharge if tampered with. Security fencing and gates would be installed around the O&M building, it would be locked, and additional security measures such as alarms and security personnel could be used. The onsite substation would also have security fencing. Impacts associated with vandalism would be minor and would be reduced further with the implementation of security measures at the site.

Operations and Maintenance Impacts

Routine Use, Storage and Transport of Hazardous Materials

The amounts of hazardous materials required during O&M would be less than the amounts needed for construction and would be limited to designated storage areas on the wind farm site. The HMWMP would be updated with information about hazardous materials pertaining to the O&M phase, BMPs for managing hazardous materials would be implemented, and appropriate control measures such as secondary containment to contain leaks and spills would be provided.

Hazardous materials would be stored in the O&M building and used at each turbine. Specific hazardous materials inventories, including quantities, would be documented in the HMWMP and updated annually or as required by regulation. Nonhazardous batteries would be stored at the substation. Inspections of each of these facilities for leaks and spills would be done at least monthly. Implementing these measures would ensure that impacts would be minor.

Operations and Maintenance Building

The O&M building would contain hazardous materials needed for routine O&M of the turbines and a backup generator. These materials include mineral oil, hydraulic oil, grease, waste oil, cleaners, degreaser, and diesel fuel. These items would be stored on spill-absorbent materials and inspected routinely. There would likely be 55 gallons or less of each material onsite at any time.

Wind Turbines

Each of the 8 to 10 turbine sites would have a transformer containing mineral oil. A transformer would be mounted on a concrete pad adjacent to the base of each turbine. Pad-mounted transformers themselves have some built in containment in case of failure. Preventive maintenance would help prevent leaks and spills and ensure the proper and continuous functioning of the turbines.

Onsite Substation

The onsite substation would have two transformers that contain mineral oil. The main power transformer would be surrounded by a containment dike. Appropriate control measures to contain leaks and spills for the other transformers are still being determined and would be included in the substation design.

Accidental Spills and Releases

Because hazardous materials would be used at the site, there would be a potential for accidental releases or spills. The SPCC Plan would be updated with information pertaining to the O&M phase. BMPs for spill prevention, response, containment, and reporting would be implemented. When possible, alternatives using fewer amounts of hazardous materials will be used during the O&M phase. For example, manual weed control around the turbines would be preferably used rather than herbicides. Implementation of these measures ensures that impacts would be minor.

Worker Exposure to Chemicals Exceeding OSHA Limits

Because hazardous materials would be used at the site, there would be a potential for worker exposure in excess of the exposure limits specified by OSHA in 29 CFR Part 1910. To minimize this risk, a Site Safety Handbook would be prepared and BMPs for hazardous materials management would be implemented. The HMWMP, updated to address O&M activities, would address proper hazardous materials management and worker training procedures to minimize the risk of worker exposure. The potential for injury to workers from exposure to hazardous materials would be minor with the implementation of the Site Safety Handbook.

Disturbance of Existing Contamination or Improper Disposal

The potential to encounter existing contamination is only relevant to ground-disturbing construction activities; therefore, there would be no impacts during O&M. Used oil from the turbines would be the primary waste generated during the O&M phase. Used oil would temporarily be stored in the O&M building. It would be transported off-site and recycled or disposed of at an appropriately-permitted waste disposal facility. The HMWMP, updated to address O&M activities, would detail proper waste storage and disposal procedures. The impacts associated with disturbance of existing contamination or improper handling of waste generated during construction would be minor with implementation of the updated HMWMP.

Vandalism

The risk of vandalism would be low; however, there would be site security such as fencing, road closures, and locks. These measures are expected to be sufficient to prevent acts of vandalism; however, additional security measures could be implemented such as building alarms and security personnel. Impacts associated with vandalism would be minor and would be reduced further with the implementation of these security measures.

4.7.3.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization

The avoidance and minimization measures proposed under the Project HCP would have no effect related to the transport, storage, use, and disposal of hazardous materials, solid waste, and petroleum products.

Impacts of HCP Mitigation

For waterbird mitigation, NPMPP would be directly involved with the design and installation of a partial fence at Hamakua Marsh. There is a potential for fuel spills during the use of motor driven equipment that may be used during these efforts. However, with the proper use of standard BMPs the use of fuel for motor driven equipment would have negligible impacts.

The remainder of NPMPP's responsibilities under the HCP is to provide funding for existing conservation projects including Newell's shearwater research and management, short-eared owl research and management, or to carry out restoration activities at Poamoho Ridge for bat mitigation. Fuel (diesel or gasoline) would be used to operate vehicles to transport staff and equipment to the management or research sites and may be used to run equipment to carry out mitigation measures. Herbicides may be used as part of vegetation control at Poamoho Ridge. It is assumed that standard BMPs would be implemented for these activities. Therefore the direct and indirect impacts as the result of the transport, storage, use and disposal of hazardous materials, solid waste and petroleum products during NPMPP's implementation of conservation and mitigation measures in the mitigation areas are considered negligible.

4.7.3.3 Mitigation for Unavoidable Impacts

NPMPP will implement standard BMPs in order to avoid or minimize impacts as the result of the transport, storage, use, and disposal of hazardous materials, solid waste and petroleum products, as listed in Table 4.7-2, including the implementation of a Hazardous Materials and Waste Management Plan, SPCC Plan, and measures outlined in the Site Safety Handbook. These include measures to limit the risk of spills and requirements to properly maintain all equipment. As described above, no anticipated adverse impacts as the result of the transport, storage, use, and disposal of hazardous materials, solid waste, and petroleum products rise above a minor impact level. Therefore, no additional mitigation measures would be required.

4.7.3.4 Cumulative Effects

As presented in Table 4.2-1, the cumulative effects analysis area for impacts as the result of the transport, storage, use, and disposal of hazardous materials, solid waste, and petroleum products is the wind farm site and the mitigation areas where construction equipment and vehicles would be used.

The transport, storage, use and disposal of hazardous materials (in particular pesticides), solid waste and petroleum products are associated with past, ongoing and future agricultural activities within the wind farm site. These impacts would be minimized if standard BMPs would be implemented during ongoing and future agricultural operations within the wind farm site. With the implementation of proper BMPs and mitigation measures, the Project as described under Alternative 2 would not cause significant impacts as a result of the transport, storage, use and disposal of hazardous materials, solid waste and petroleum products. Therefore, the Project would not contribute to cumulative impacts that could result in conjunction with the projects listed in Table 4.2-2.

Direct and indirect impacts as a result of the transport, storage, use, and disposal of hazardous materials, solid waste, and petroleum products, with implementation of the mitigation measures described in Section 4.7.3.1, from construction and operation of the Project under Alternative 2 would be minor. Therefore, when viewed in conjunction with past, present, and foreseeable future projects in the cumulative effects analysis area, the contribution of Alternative 2 to cumulative effects is considered to be low.

4.7.3.5 Summary

Construction and operation of the Project and implementation of the HCP conservation measures under Alternative 2 have the potential to have direct and indirect impacts as the result of the transport, storage, use, and disposal of hazardous materials, solid waste, and petroleum products. However, with implementation of mitigation measures described above, these impacts are expected to be minimal and would only result in temporary and localized effects on the public, worker health and safety, and the environment.

4.7.3.6 Alternative 2a - Modified Proposed Action Option

Direct, indirect, and cumulative effects from use of hazardous materials, solid waste, and petroleum projects under the Modified Proposed Action Option would be the same as under the Proposed Action. There may be a reduced amount of hazardous materials, solid waste, or petroleum products generated or used under the Modified Proposed Action Option due to the decrease in the number of turbines; however, this reduction would be negligible. Indirect impacts under the Modified Proposed Action Option would be the same as described above for the Proposed Action. Implementation of standard BMPs and other mitigation measures, as described under the Proposed Action, would minimize any adverse effects from the use of hazardous and regulated materials and wastes.

4.7.4 Alternative 3—Larger Generation Facility (Up to 12 Turbine Project)

4.7.4.1 Direct and Indirect Effects of Construction and Operation of the Project

Construction Impacts

The impacts as the result of the transport, storage, use, and disposal of hazardous materials, solid waste, and petroleum products during the construction period under Alternative 3 would be similar to those discussed earlier for Alternative 2.

The construction period under Alternative 3 would be longer than under Alternative 2 and split into two phases. The longer duration would slightly increase the potential for accidental releases or spills and worker exposure. The construction of additional turbines under Alternative 3 would increase the amount of construction and solid waste generated at the wind farm site. With the implementation of the BMPs described under Alternative 2, the impacts under Alternative 3 would be minor.

Operations and Maintenance Impacts

The impacts as the result of the transport, storage, use, and disposal of hazardous materials, solid waste, and petroleum products during the O&M period under Alternative 3 would be similar to those discussed earlier for Alternative 2. The installation of additional turbines under Alternative 3 would generate more waste oil requiring disposal over the duration of the Project. With the implementation of the BMPs described under Alternative 2, the impacts under Alternative 3 would be minor.

4.7.4.2 Direct and Indirect Effects of the HCP Conservation Measures

The direct and indirect effects of the HCP conservation measures would be the same as under Alternative 2.

4.7.4.3 Mitigation for Unavoidable Impacts

Under Alternative 3, NPMPP will implement standard BMPs to avoid or minimize impacts as the result of the transport, storage, use, and disposal of hazardous materials, solid waste, and petroleum products, as listed in Table 4.7-2. These include measures to limit the risk of spills and requirements to properly maintain all equipment. As described above, no anticipated adverse impacts as the result of the transport, storage, use and disposal of hazardous materials, solid waste, and petroleum products rise above a minor impact level. Therefore, no additional mitigation measures would be required under Alternative 3.

4.7.4.4 Cumulative Effects

The cumulative effects of Alternative 3 related to the transport, storage, use, and disposal of hazardous materials, solid wastes, and petroleum products would be similar to those described for the Proposed Action. However, because of the 3-year lag between construction of the first 8 to 10 turbines and the construction of the additional 2 to 4 turbines (and associated infrastructure) proposed under Alternative 3, there would be a longer period during which there would be the risk of accidental spills or releases of contaminants. It is assumed that agricultural activities within the wind farm site would continue. With the implementation of standard BMPs and mitigation measures during the construction of Alternative 3, and impacts as the result of the transport, storage, use, and disposal of hazardous materials, solid waste, and petroleum products thus minimized, the cumulative effects of Alternative 3, when viewed in conjunction with past, present, and foreseeable future projects, would be minor.

4.7.4.5 Summary

Construction and operation of the Project under Alternative 3 has the potential to have direct and indirect impacts as the result of the transport, storage, use, and disposal of hazardous materials, solid waste, and petroleum products. Alternative 3 would have a slightly larger short-term adverse impact in this respect over a longer construction period than the Proposed Action. In addition, the greater number of turbines in Alternative 3 would generate more waste oil over the course of the Project. However, with implementation of mitigation measures described above, these impacts are expected to be minimal and would only result in temporary and localized effects on the public, worker health and safety, and the environment.

4.7.5 Conclusion

No anticipated adverse impacts as the result of the transport, storage, use and disposal of hazardous materials, solid waste and petroleum products would rise above a minor impact level under Alternatives 2, 2a or 3. Table 4.7-3 provides a summary of the potential impacts as the result of the transport, storage, use, and disposal of hazardous materials, solid waste, and petroleum products.

Table 4.7-3. Summary of Potential Impacts Associated with Hazardous and Regulated Materials and Wastes

Impact Issues	No Action Alternative	Alternative 2 – Proposed Action	Alternative 2a – Modified Proposed Action Option	Alternative 3
Routine use, storage and transport of hazardous materials	No Impact	Minor	Minor	Minor
Accidental spills and releases	No Impact	Minor	Minor	Minor
Worker exposure to chemicals exceeding OSHA limits	No Impact	Minor	Minor	Minor
Disturb existing contamination or improper disposal	No Impact	Minor	Minor	Minor
Vandalism	No Impact	Minor	Minor	Minor

4.8 Natural Hazards

4.8.1 Impact Criteria

Natural hazards, such as hurricanes, tsunamis, or earthquakes, can impact a project and, in some cases, may be a justifiable risk and reason not to build a project in a certain location. While most of the resource topics in this EIS discuss how the Project might impact a specific resource, this section primarily discusses how natural hazards might impact the Project. Therefore, this section does not identify specific impact criteria as is done for the other resources analyzed but rather describes generally the context of impacts.

Impacts from natural hazards were evaluated qualitatively based on known information about natural hazard occurrences on Oahu. Although the occurrence rate on Oahu is low to very low, construction and operation of the Project and HCP conservation measures could be adversely affected by a natural hazard such as a hurricane, tsunami, or earthquake. Depending on the severity of the natural hazard, electrical supply to the HECO grid could be disrupted. Construction and operation of the Project and implementation of HCP conservation measures would increase the potential for wildfires related to the use of vehicles and electrical equipment and increased human presence in the Project and mitigation areas.

4.8.2 Alternative 1—No Action

4.8.2.1 Direct and Indirect Effects

Under the No Action Alternative, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Therefore, Alternative 1 would have no effects related to natural hazards.

4.8.2.2 Cumulative Effects

Under the No Action Alternative, the Project would not be constructed, an ITP would not be issued by the USFWS, and HCP conservation measures would not be implemented; therefore, there would be no effect related to natural hazards. Thus, Alternative 1 would not contribute to cumulative effects related to natural hazards as no action would be undertaken.

4.8.2.3 Summary

There would be no direct, indirect, or cumulative impacts related to natural hazards under the No Action Alternative.

4.8.3 Alternative 2—8 to 10 Turbine Project

4.8.3.1 Direct and Indirect Effects of Construction and Operation of the Project

Construction Impacts

In the event of a hurricane, tropical storm, tsunami, earthquake, flooding, or wildfire, safety procedures in the Site Safety Handbook would be implemented. For more information on the Site Safety Handbook, see Section 4.18 – Public Health and Safety,

Hurricanes and Tropical Storms

No impacts to construction activities resulting from hurricanes or tropical storms are anticipated. In the event that the National Weather Service issues a storm watch or warning, the site construction manager would be responsible for implementing the appropriate procedures in accordance with the Site Safety Handbook to ensure the safety of staff.

Tsunamis

A small portion of the northeastern edge of the wind farm site, near Kamehameha Highway, is within the Civil Defense Tsunami Evacuation Zone (NOAA 2013b). A small segment of proposed access road, the transmission line, and the line tap location lie within the evacuation zone. However, the majority of the wind farm site, including all wind turbine locations, are not within the Civil Defense Tsunami Evacuation Zone. The probability of impacts to the Project resulting from tsunamis during the construction phase is low.

Earthquakes and Seismicity

The entire island of Oahu has a UBC seismic risk zone ranking of 2A (USGS 2001), which indicates a low level of seismic risk. No impacts to the Project from earthquakes and seismicity during construction are anticipated. To reduce the risk of earthquake damage, all structural elements of the proposed Project would meet or exceed current building code requirements for the seismic risk on Oahu. The current design standard is defined by the 2006 UBC. In the event of an earthquake, the site construction safety manager would be responsible for implementing the appropriate procedures in accordance with the Site Safety Handbook to ensure the safety of staff.

Flooding

During scoping, concern was raised over potential impacts associated with flooding, particularly at the Kahuku High School football field. The majority of the wind farm site, including the majority of Project facilities and all proposed wind turbine locations, is located within Flood Zones D and X (Figure 3.6-1). Zone D includes areas where analysis of flood hazards has not been conducted and flood hazards are undetermined, thus flood risks to construction activities in these portions of the wind farm site are unknown. The National Flood Insurance Program does not have any regulations regarding development within Zone D. Areas classified as Zone X are classified as minimal risk areas (FEMA 2013a, 2013b) and include areas determined to be outside of the 0.2-percent-annual-chance (or 500-year) floodplain. The risk of impacts to construction activities from flooding in these portions of the wind farm site is very low.

A small segment of the proposed access road, the transmission line, and the line tap location lie within Flood Zones AE and AEF. These zones are designated as special flood hazard, or high risk, areas (FEMA 2013a, 2013b) and are mapped as lying within the 1-percent-annual-chance (or 100-year) floodplain. Zone AEF include areas along the floodway of a stream in areas that must be kept free of encroachment so that the 1-percent-annual chance flood can be carried without substantial increases in flood heights (FEMA 2013a). The risk of impacts to construction activities due to flooding in these portions of the wind farm site is moderate. During the detailed design phase of the Project, the construction contractor will confirm stormwater runoff requirements and, if necessary, implement stormwater control measures such as seepage pits, drywells, and/or detention basins. The implementation of these measures would minimize the potential for flood events. Moreover, the City and County of Honolulu will require would require the project to be designed such that no net additional drainage would occur off-site.

In the event of a flood event, the site construction safety manager would be responsible for implementing the appropriate procedures in accordance with the Site Safety Handbook to ensure the safety of staff.

Wildfire

Wildfire is one natural hazard that could potentially be created by the Project. Unlike the other natural hazards discussed in this section, the Project could impact the potential for this natural hazard to occur.

The Project could increase the potential for wildfires associated with the use of vehicles and electrical equipment and increased human presence during construction of the Project. Sparks from vehicles and construction equipment, spark producing construction activities such as welding, and improper disposal of matches or cigarettes, for example, could start a fire. There would also be increased presence and use of petroleum products, including oils and lubricants onsite, thereby increasing the potential for fires. Climatic conditions in the vicinity of the wind farm site, including high relative humidity and high precipitation, however, tends to prohibit the production of fires.

A Fire Management Plan (FMP) has been prepared for the proposed Project. The FMP analyzed the available pertinent information including fuel conditions, weather and climate conditions, fire history in the vicinity of the Project, firefighter access, and other factors (see Appendix C of the Final EIS). The FMP concluded that the likelihood of a wildfire ignition during construction of the Project is very low and that no mitigation measures beyond normal construction BMPs would be required to mitigate the threat (see Appendix C of the Final EIS). The impacts to the Project related to wildfires during the construction phase, with the implementation of standard construction BMPs, are anticipated to be very low.

Operation and Maintenance Impacts

Hurricanes and Tropical Storms

Impacts to O&M of the Project from hurricanes or tropical storms are anticipated to be low. The wind turbine models that would be considered for the Project are designed to operate in winds up to approximately 55 miles per hour (25 meters per second). When the wind speed reaches approximately 7.8 miles per hour (3.5 meters per second), the controller automatically “pitches” the blades into the wind and the rotor starts low speed revolutions. At wind speeds in excess of 55 miles per hour (25 meters per second), the controller automatically “pitches” the blades out of the wind and the rotor comes to a complete stop until the wind speeds drop below this threshold. The wind turbine models that would ultimately be selected for the Project would be those designed to withstand wind gusts typical of the region, and would take into account site-specific meteorological data. In the unlikely event that wind speeds are high enough to damage a wind turbine and cause it to fall, the damage would likely be confined to the turbine pad and potentially the areas immediately adjacent. See Section 4.18 – Public Health and Safety for more information on tower collapse and blade throw.

Tsunamis

Impacts from tsunamis during O&M of the Project are the same as those discussed for the construction phase. The probability of impacts to Project O&M resulting from tsunamis during the operation is low and would be restricted to components (i.e., access road, transmission line, and line tap) in a small area in the northern portion of the wind farm site.

Earthquakes and Seismicity

Impacts from earthquakes and seismicity during O&M of the Project are the same as those discussed for the construction phase. No impacts to the Project from earthquakes and seismicity during O&M of the Project are anticipated. As stated above, all structural elements of the proposed Project, including wind turbines, would meet or exceed current building code requirements for the seismic risk on Oahu. In the event of an earthquake, it is possible that electricity fed to the HECO grid could be disrupted.

Flooding

Impacts from flooding during O&M of the Project are the same as those discussed for the construction phase. The risk of impacts to O&M from flooding in portions of the wind farm site designated as Flood Zone D or X is very low. The risk of impacts to O&M due to flooding in portions of the wind farm site designated as Zone AE or AEF is moderate.

Wildfire

Similar to construction of the Project, O&M activities would increase the potential for wildfires associated with the use of vehicles and electrical equipment and increased human presence during O&M. Implementation of the FMP would be required during O&M activities. With implementation of the FMP, the impacts to the Project related to wildfires during the O&M phase are anticipated to be very low. The risk of fire is further minimized by the design features of the wind turbines, such as over-temperature sensors that will shut down the turbine if normal temperature limits are exceeded. In addition, undergrounding of the electrical collection system would reduce the risk of fire.

Water tanks will be maintained onsite for emergency fire suppression during construction. Additional fire suppression measures to be implemented during construction and operation will be developed in coordination with the City and County of Honolulu Fire Department and will be incorporated into a Site Safety Handbook. These measures may include, but are not limited to requiring vehicles to carry fire suppression equipment when onsite such as fire extinguishers, flappers, and shovels, and storing fire suppression tools at designated locations within the wind farm.

4.8.3.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP would have no effect related to natural hazards.

Impacts of HCP Mitigation

No impacts associated with natural hazards (hurricanes, tropical storms, tsunamis, earthquakes and seismicity, flooding, or fire) would occur in association with funding provided for Newell's shearwater research and management or short-eared owl research and management.

No impacts to the Hamakua Marsh Mitigation Area or to waterbird mitigation activities implemented in this mitigation area are anticipated from hurricanes and tropical storms, tsunamis, or earthquakes and seismicity. The Hamakua Marsh Mitigation Area is located within Flood Zones

AE, AEF and X. The risk of flooding in the portions of the mitigation area designated as Flood Zone X, outside of the 0.2-percent-annual-chance (or 500-year) floodplain, is very low. The risk of impacts to the mitigation area and mitigation activities due to flooding in areas designated as Flood Zone AE and AEF is moderate. Conservation and mitigation measures in the Hamakua Marsh Mitigation Area include installation and maintenance of a partial fence along the northeastern border of the mitigation area. The area proposed area for installation of the fence lies within Flood Zone AEF.

Installation and maintenance of fencing in the Hamakua Marsh Mitigation Area would increase the potential for wildfires associated with the use of vehicles and electrical equipment and increased human presence during construction and maintenance of the fence. However, this increased fire risk is anticipated to be very low.

No impacts to the Poamoho Ridge Mitigation Area or to conservation and mitigation activities implemented in this mitigation area are anticipated from hurricanes and tropical storms, tsunamis, earthquakes and seismicity, or flooding. Maintenance of fencing, non-native ungulate removal and monitoring, invasive plant removal and monitoring, and bat acoustic monitoring, in the Poamoho Ridge Mitigation Area would increase the potential for wildfires associated with the use of vehicles and electrical equipment and increased human presence during these activities. However, this increased fire risk is anticipated to be very low.

4.8.3.3 Mitigation of Unavoidable Impacts

The potential for impacts from natural hazards is low. BMPs listed in Table 2-6, which will be implemented by NPMPP, will minimize and reduce risk of impacts from natural hazards. These measures include:

- Implementation of the Project FMP to reduce the potential for fires during construction and operations.
- To reduce the risk of earthquake damage, all structural elements of the Project will meet or exceed current building code requirements for the seismic risk on Oahu. The current design standard is defined by the 2006 UBC.
- A Site Safety Handbook will be prepared for construction and O&M.

4.8.3.4 Cumulative Effects

The cumulative effects analysis area for natural hazards is the island of Oahu because natural hazards take place on a regional scale. The only natural hazard likely to be impacted by the Project is a potential for increased fire risk. The potential for fire risk during construction and operations, especially with implementation of standard construction BMPs and other mitigation measures proposed in the FMP, is very low. Other development projects in the cumulative effects analysis area, such as the Turtle Bay Resort Expansion and the Envision Laie Project (see Table 4.2-2 for additional development projects), as well as ongoing agricultural operations and O&M of existing HECO transmission lines, have the potential to increase fire risks. Assuming similar BMPs and mitigation measures are implemented for these other projects, the Project, in conjunction with other projects would have a low cumulative impact of fire risk.

4.8.3.5 Summary

No impacts to construction or O&M activities are anticipated from hurricanes and tropical storms or earthquakes and seismicity. There is a low potential for impacts from tsunamis, and a low-to-moderate potential for impacts from flooding. The Project itself has a very low potential to create a wildfire impact. The overall potential for impacts from natural hazards during construction and operation of the Project under Alternative 2 is low. Therefore, effects related to natural hazards would be considered negligible to minor.

4.8.3.6 Alternative 2a - Modified Proposed Action Option

Impacts to construction and operation of the Project from natural hazards and the cumulative impact to fire risk under the Modified Proposed Action Option are the same as those described for the Proposed Action. Implementation of standard BMPs and other mitigation measures, as described under the Proposed Action, would minimize and reduce risk of impacts from natural hazards under the Modified Proposed Action Option.

4.8.4 Alternative 3—Larger Generation Facility (Up to 12 Turbine Project)

4.8.4.1 Direct and Indirect Effects of Construction and Operation of the Project

Impacts to construction and operation of the Project from natural hazards under Alternative 3 are the same as those described for Alternative 2. No additional turbines would be located within Flood Zone hazard areas (Figure 3.6-1).

4.8.4.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts associated with avoidance, minimization, and mitigation measures proposed under the Project HCP would be the same as those described for Alternative 2.

4.8.4.3 Mitigation of Unavoidable Impacts

The potential for impacts from natural hazards is low. BMPs listed in Table 2-6, which will be implemented by NPMPP, will minimize impacts from and reduce risk of natural hazards. These measures include:

- Implementation of the Project FMP to reduce the potential for fires during construction and operations.
- To reduce the risk of earthquake damage, all structural elements of the Project will meet or exceed current building code requirements for the seismic risk on Oahu. The current design standard is defined by the 2006 UBC.
- A Site Safety Handbook will be prepared for construction and O&M.

4.8.4.4 Cumulative Effects

Cumulative effects related to natural hazards under Alternative 3 are as described under Alternative 2.

4.8.4.5 Summary

No impacts to construction or O&M activities are anticipated from hurricanes and tropical storms or earthquakes and seismicity. There is a low potential for impacts from tsunamis, and a low-to-moderate potential for impacts from flooding. The Project itself has a very low potential to create a wildfire impact. The overall potential for impacts from natural hazards during construction and operation of the Project under Alternative 3 is negligible to minor.

4.8.5 Conclusion

Impacts related to natural hazards from the alternatives considered in this analysis are summarized in Table 4.8-1.

Table 4.8-1. Summary of Potential Natural Hazards to Impact Project

Impact Issues	No Action Alternative	Alternative 2 – Proposed Action	Alternative 2a – Modified Proposed Action Option	Alternative 3
Hurricanes and tropical storms	No Impact	None expected/negligible	None expected/negligible	None expected/negligible
Tsunamis	No Impact	Negligible	Negligible	Negligible
Earthquakes and seismicity	No Impact	None expected/negligible	None expected/negligible	None expected/negligible
Flooding	No Impact	Minor	Minor	Minor
Wildfire	No Impact	Negligible	Negligible	Negligible

4.9 Vegetation

4.9.1 Impact Criteria

Impacts to vegetation were evaluated by assessing the effects to existing vegetation and vegetation communities from Project construction and O&M activities as well as from implementation of HCP conservation measures within the mitigation areas. Impacts were also evaluated based on the potential for the Project and conservation measures to promote, spread, or expand the range of non-native invasive plants and the potential for the Project and conservation activities to result in an increased fire risk.

A significant impact on vegetation would result if any of the following were to occur as a result of construction or operation of the Project or implementation of conservation measures:

- Loss to a population of plant species that would result in the species being listed or proposed for listing as threatened or endangered;
- Introduction or increased spread of invasive species; or
- Increased fire risk that would impact vegetation resources.

Impacts to threatened and endangered plant species are discussed in Section 4.11 – Threatened and Endangered Species.

Impact criteria for determining effects on vegetation resources from the Project and HCP conservation measures are described further in Table 4.9-1 below.

Table 4.9-1. Impact Criteria for Vegetation

Type of Effect	Impact Component	Effects Summary		
Change to vegetation or vegetation communities	Magnitude or Intensity	**High:** Acute or obvious changes in vegetation and vegetation communities.	**Medium:** Noticeable change in vegetation and vegetation communities.	**Low:** Changes in vegetation or vegetation communities may not be noticeable.
	Duration	**Permanent:** Chronic effects; vegetation and vegetation communities would not be anticipated to return to previous levels.	**Long-term:** Vegetation and vegetation communities would be adversely affected by actions associated with the Project for more than 1 year up to the life of the Project and/or vegetation communities would not return to pre-activity conditions within five years.	**Temporary and Short-term:** Vegetation and vegetation communities would be adversely affected by actions associated with the Project, but not longer than the span of 1 year. Vegetation and Vegetation communities would be expected to return to pre-activity conditions within five years.
	Geographic Extent	**Extended:** Affects vegetation and vegetation communities beyond the region or wind farm site.	**Regional:** Affects vegetation and vegetation communities beyond a local area, potentially throughout the wind farm site.	**Local:** Impacts limited geographically; limited to vicinity of the Project footprint.
	Context	**Unique:** Vegetation and vegetation communities are protected by legislation and the portion of the vegetation or vegetation community affected fills a unique ecosystem role within the locality or region.	**Important:** Affects depleted vegetation or vegetation communities within the locality or region or vegetation and vegetation communities are protected by legislation.	**Common:** Affects usual or ordinary vegetation and vegetation communities in the wind farm site; vegetation and vegetation communities are not depleted in the locality or protected by legislation.

4.9.2 Alternative 1—No Action

4.9.2.1 Direct and Indirect Effects of Construction and Operation of the Project

Under the No Action Alternative, the Project would not be constructed, the ITP would not be issued by USFWS, and HCP conservation measures would not be implemented. Therefore, there would be no effect on vegetation resources under Alternative 1.

4.9.2.2 Cumulative Effects

Under the No Action Alternative, the Project would not be constructed, an ITP would not be issued by USFWS, and the HCP conservation measures would not be implemented. Therefore, there would be no effect on vegetation. Thus, Alternative 1 would not contribute to cumulative effects to vegetation resources because no action would be undertaken.

4.9.2.3 Summary

There would be no direct, indirect, or cumulative impacts to vegetation resources under the No Action Alternative.

4.9.3 Alternative 2—8 to 10 Turbine Project

4.9.3.1 Direct and Indirect Effects of Construction and Operation of the Project

Construction of the Proposed Action would result in permanent ground clearing and vegetation removal for installation of Project facilities including wind turbines and pads, permanent access roads, met towers, substation, an O&M building, and O&M parking and storage areas. Temporary disturbances would occur during construction of the underground electrical collection system and the transmission line, as well as in temporarily cleared areas around wind turbine pads, and construction staging and equipment laydown areas. Gravel pads up to 2 acres (1 hectare) around each turbine would be maintained to allow for O&M requirements. An additional area extending out to 50 percent of the maximum turbine tip height above the ground around each turbine would be maintained to facilitate post-construction mortality monitoring efforts, as practicable (see Appendix A of the HCP).

A total of up to approximately 89.0 acres (36.0 hectares) of vegetation would be impacted for construction and operation under this alternative, including 59.9 acres (24.2 hectares) of long-term impacts. This is conservative in that it includes some previously disturbed areas (e.g., existing road bed and areas of agriculture). Table 2-1 in Section 2.1 – Project Description provides more detail on the disturbance areas associated with each Project component.

Construction Impacts

As stated above, a total of up to approximately 89.0 acres (36.0 hectares) of ground disturbance would be impacted for construction of Alternative 2. Impacts can occur directly or indirectly and can be considered short or long term. Direct impacts include the physical destruction or degradation of vegetation and vegetation communities resulting from construction of Project facilities. Indirect impacts to vegetation communities from Project construction include the introduction and spread of noxious weeds and the potential increased risk of wildfire, both of which can impact and alter vegetation communities within the wind farm site.

Impacts are considered short term if they disturb vegetation but do not prevent the reestablishment of vegetation communities to pre-impact functionality within 5 years. Impacts to herbaceous communities are frequently considered short term because these communities typically recover quickly. Long-term impacts are impacts where a complete change in functionality occurs (e.g., land conversion) or where return to pre-impact conditions takes an extended time to occur, such as in shrub or forested vegetation communities.

Vegetation within the wind farm site is predominantly shrubland and forest; thus, impacts to these vegetation communities from construction of the Project would be considered long term. As described in Section 3.7, however, vegetation within the wind farm site is predominantly non-native shrubland and forest dominated by a mixture of aggressive non-native weedy species, and construction of the Project would generally occur in areas that have been extensively disturbed. Thus, the vegetation impacted is primarily common, and does not include native vegetation communities with the exception of some native species including shrubs such as ulei and akia, and forbs such as uhaloa, and the vine huehue, which would be removed for construction of this alternative, primarily along the ridgetops. Additionally, a few iliahi aloe trees may need to be removed under this alternative.

Due to historic disturbance to vegetation within the wind farm site, there are very few areas free of non-native and invasive plant species. Non-native and invasive plant species infestations are typically greatest near disturbed areas, although non-native species are also commonly found along ridgetops in the wind farm site. Over time, infestations of non-native plant species would continue to spread throughout the area without construction of the Project; however, ground disturbance and movement of construction vehicles and personnel associated with the Project have the potential to result in an increase in spread and colonization of non-native and invasive plant species throughout the wind farm site. Introduction and spread of non-native species have the potential to change the composition, abundance, and diversity of native plants in the wind farm site through competition, by altering the fire regime, or through the alteration of other ecosystem processes (e.g., nitrogen cycling).

The impact of introduction and spread of invasive species from ground disturbance associated with construction and movement of construction equipment and personnel has the potential to noticeably alter vegetation communities long term within the wind farm site; these impacts, however, would be localized and would occur primarily to non-native vegetation communities. With implementation of the BMPs identified in Section 4.9.3.3 below, Alternative 2 is not expected to result in a significant increase in the introduction and spread of invasive species.

There is a slight chance of Project-related fires during construction associated with the presence and use of vehicles and heavy equipment and activities such as welding and grinding that could produce sparks. A Project-related fire could impact vegetation within the wind farm site. Fire has the potential to result in long-term impacts that noticeably alter the impacted vegetation community. However, a Project-related fire is likely to be localized and would impact primarily non-native vegetation communities. Implementation of the Project FMP (see Appendix C of the Final EIS) would further minimize the potential for Project-related fires during construction of this alternative; therefore, this alternative is not expected to result in significant impacts to vegetation resources due to fire.

Operation and Maintenance Impacts

Qualified personnel would routinely monitor, inspect, and maintain the components of the wind farm (e.g., wind turbines, electrical collection system, and communications equipment) and transmission line facilities during Project operations. O&M activities would be accomplished with the use of off-road vehicles and light trucks, which would result in trampling of vegetation if off-road travel is necessary.

Roads used for operation of the Project would include portions of an existing road network which would be widened plus the addition of new roads. It is anticipated that off-road travel during operations would be rare. However, should a major component replacement be necessary for any of these facilities (e.g., blade or transformer), heavy equipment similar to that used during construction would be required, and the access roads, crane pads (for wind turbines only), and staging areas would be used in a similar manner as with the original construction resulting in similar disturbance impacts to vegetation with similar mitigation being required.

Vegetation maintenance (trimming) may be required in areas where vegetation exceeds maximum height limitations in relation to the above ground portions of the electrical collection system and/or transmission line. However, this maintenance is expected to be minimal and existing vegetation in the area predominantly consists of low-growing non-native shrubs and forb species. Additionally, gravel pads up to 2 acres (1 hectare) around each turbine would also be maintained to allow for O&M requirements. An additional area extending out to 50 percent of the maximum turbine tip height above the ground would be maintained (e.g., planting low growing crops or maintaining low growing vegetation) to facilitate post-construction mortality monitoring efforts, as practicable (see Appendix A of the HCP).

O&M activities could result in the introduction and spread of invasive species and a very low increased risk of fire. Prior to the start of O&M activities, standard BMPs to control the spread of invasive species would be implemented (see Section 4.9.3.3). Fire risk associated with transmission line operations is extremely low as it would be primarily underground. Likewise, fire risk associated with wind turbine operations is also very low and would be prevented by the design features and various onsite and off-site control capabilities of the wind turbine model selected. Implementation of the Project FMP (see Appendix C of the Final EIS) during O&M would minimize the already extremely low risk of fire and associated impacts on vegetation in the wind farm site. Effects to vegetation from introduction and spread of invasive species and fire risk associated with O&M activities would be considered minor, because while there may be long-term impacts to vegetation, the intensity would be low, disturbance would be localized, and common, ordinary vegetation resources would be affected.

4.9.3.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP would have no effect on vegetation. There would be some potential for vegetation trampling in conjunction with post-construction monitoring efforts associated with surveyors traversing transects beneath the turbines. However, this impact is expected to be negligible.

Impacts of HCP Mitigation

No impacts to vegetation would occur in association with funding provided for Newell's shearwater research and management and short-eared owl research and management. Depending on measures chosen, some vegetation trampling could occur in association with regular visits made by staff to research or management sites to carry out these activities; however, impacts would be negligible.

Installation and maintenance of a partial fence along the northeastern border of the Hamakua Marsh Mitigation Area would result in ground clearing and disturbance to vegetation. The fence would be approximately 1,555 feet (474 meters) long and 4 feet (1.2 meters) high. Proposed design criteria for the fence are outlined in the Project HCP. Although installation of fencing would result in clearing of vegetation, existing vegetation within the area proposed for fence installation currently consists predominantly of non-native species and areas of bare dirt. Installation and maintenance of the fence has the low potential to increase spread of non-native plant species in the area through construction equipment and movement of personnel. Additionally, the overall benefits of installation of fencing (e.g., controlling access to limit illegal dumping of garbage, and eliminating the use of the marsh as a play area for pets) would result in an overall benefit to vegetation within the Hamakua Marsh Mitigation Area.

Funding for forest restoration activities and monitoring within the Poamoho Ridge Mitigation Area would go toward activities such as maintenance of the ungulate-proof fence installed by DLNR, non-native ungulate removal and monitoring, invasive plant removal and monitoring, and bat acoustic monitoring. Foot traffic and vehicle use associated with removal and monitoring of non-native ungulates and invasive plant species and bat acoustic monitoring may trample existing native vegetation. However, these impacts are expected to be temporary, localized, and negligible.

Movement of equipment and personnel through the area during non-native ungulate and invasive plant removal and monitoring, and bat monitoring activities, have the potential to increase spread of non-native plants within the mitigation area. Although these activities have the potential to increase spread and colonization of non-native species in the area which would impact native communities, potentially long term, the intensity of effects would be low and localized. Standard BMPs for invasive plant management would be implemented to minimize adverse impacts to native vegetation communities at the mitigation area.

Ultimately, forest restoration activities within the Poamoho Ridge Mitigation Area would reduce the spread of non-native plant species and would help foster a vegetative community with a predominance of native plants. Therefore, there would be an overall net benefit to vegetation resources within the Poamoho Ridge Mitigation Area from implementation of conservation and mitigation measures discussed above.

4.9.3.3 Mitigation of Unavoidable Impacts

BMPs listed in Table 2-6, which will be implemented by NPMPP, will minimize impacts to vegetation. These measures include:

- Preparing and implementing a TESC Plan, which would help prevent erosion;

- Revegetating temporarily disturbed areas with non-invasive resident species;
- Inspecting potential off-site sources of materials (gravel, fill, etc.) and prohibiting the import of materials from sites that are known or likely to contain seeds or propagules of invasive species;
- Requiring vehicle operators transporting materials to the Project site from off-site to follow protocols for removing soils and plant material from vehicles and equipment prior to entry onto the site;
- Consulting with the Hawaii Department of Agriculture and Oahu Invasive Species Commission to establish protocols and training orientation methods for screening invasive species introductions during construction; and
- Implementing the Project FMP to reduce the potential for fires during construction and operations.

In addition to the mitigation measures above, the following mitigation measures and BMPs would be implemented to reduce impacts to vegetation resources under Alternative 2:

- Areas temporarily disturbed during construction would be revegetated with non-invasive, resident species immediately following construction. A portion of the turbine pad area would be revegetated through replanting with non-aggressive resident species that are compatible with Project operations in order to minimize erosion.
- Using only certified weed-free seed mixes and mulches for use in revegetation
- At the end of construction, areas impacted by construction would be surveyed to determine if problematic and/or new invasive species had been introduced.
- If new or problematic invasive species are introduced, remedial actions would be implemented to contain or control these target species.

4.9.3.4 Cumulative Effects

The cumulative effects analysis area for impacts on vegetation includes the Project construction footprint, as well as areas that would be disturbed by activities implemented in the mitigation areas plus a 0.25-mile (0.4-kilometer) buffer around these areas. This area encompasses the areas where potential direct and indirect effects to vegetation could occur.

Past agricultural and associated development activities, as well as urban development and associated infrastructure (i.e., existing HECO transmission lines) have contributed to the overall permanent loss and long-term degradation of vegetation and contributed to the spread of non-native invasive plant species within the wind farm site. Ongoing agricultural operations in Malaekahana area would continue to impact vegetation in the wind farm site. These effects would depend on the level of agricultural activity that continues through the life of the Project. Effects from past activities in the vicinity of the wind farm site have resulted in permanent and long-term obvious changes in vegetation and vegetation communities in an extended area that have affected important native vegetation communities.

Human activity and development and associated introduction of non-native plant species, as well as impacts from non-native wildlife species, have also resulted in long-term, obvious degradation of important native vegetation within and in the vicinity of the Hamakua Marsh Mitigation Area. Within the Poamoho Ridge Mitigation Area, vegetation along the ridge is steadily decreasing in quality due to the presence of invasive plant species and feral pigs (pers. com., M. Zoll, Hawaii Department of Land and Natural Resources, 2013). Proposed mitigation activities, including fence installation in Hamakua Marsh and Poamoho Ridge Mitigation Areas, and removal and control of non-native animal and plant species in Poamoho Ridge Mitigation Area, would help foster establishment of native vegetation.

The only foreseeable project in the cumulative effects analysis area with the potential to impact vegetation is the Envision Laie Project located in the Malaekahana parcel in the vicinity of the wind farm site. This project includes residential development on 300 acres (121.4 hectares) of Malaekahana land. It could result in moderate impacts to vegetation due to additional permanent and temporary, localized vegetation removal, which could locally increase the spread of invasive plant species. These impacts would be minimized if standard BMPs for minimizing vegetation removal and controlling introduction and spread of invasive plant species are implemented during construction and operation.

The Proposed Action would contribute 89.0 acres (36.0 hectares) of disturbance, of which 59.9 acres (24.2 hectares) would be long term, to primarily non-native vegetation communities. However, mitigation under the Project HCP would have beneficial effects to vegetation associated with forest restoration activities at Poamoho Ridge Mitigation Area. When viewed in conjunction with past, present, and foreseeable future projects in the cumulative effects analysis area, the contribution of Alternative 2 to cumulative effects on vegetation resources is considered to be low.

4.9.3.5 Summary

Construction and operation of the Project under Alternative 2 has the potential to impact vegetation resources in the Project and mitigation areas directly through vegetation removal and indirectly through the introduction and spread of invasive species. Impacts would be considered minor, because the intensity would be low (changes in vegetation or vegetation communities may not be noticeable), a majority of impacts would be temporary, disturbance would be localized, and common, ordinary vegetation resources would be affected. With implementation of mitigation measures described above, these impacts are expected to be minimal and would result in a less than significant impact to vegetation resources.

4.9.3.6 Alternative 2a - Modified Proposed Action Option

Direct, indirect, and cumulative effects on vegetation resources from the Modified Proposed Action Option would be similar to those described under the Proposed Action. However, the Modified Proposed Action Option would result in up to approximately 84.5 acres (34.2 hectares) of ground disturbance, of which 56.7 acres (22.9 hectares) would be long term, lasting the life of the Project. Table 2-1 provides more detail on the disturbance areas associated with each Project component. Indirect impacts under the Modified Proposed Action Option would be the same as described above for the Proposed Action. Implementation of standard BMPs and other mitigation measures, as described under the Proposed Action, would minimize any adverse impacts to vegetation resources.

4.9.4 Alternative 3—Larger Generation Facility (Up to 12 Turbine Project)

4.9.4.1 Direct and Indirect Effects of Construction and Operation of the Project

Similar to Alternative 2, construction of Alternative 3 would result in permanent ground clearing and vegetation removal for installation of Project facilities including wind turbines and pads, permanent access roads, met towers, substation, transmission line, an O&M building, and O&M parking and storage areas. Temporary construction disturbances would occur in association with the underground electrical collection system and transmission line, temporarily cleared areas around wind turbine pads, and construction staging and equipment laydown areas. Permanent gravel pads up to 2 acres (1 hectare) around each turbine would be maintained to allow for O&M requirements. An additional area extending out to 50 percent of the maximum turbine tip height above ground would be maintained to facilitate post-construction mortality monitoring efforts, as practicable (see Appendix A of the HCP). Approximately 98.6 acres (39.9 hectares) of vegetation would be impacted for construction and operation under Alternative 3, including 69.8 acres (28.2 hectares) of long-term impacts. Table 2-1 in Section 2.1 – Project Description provides more detail on the disturbance areas associated with each Project component.

Construction Impacts

The types of direct and indirect impacts of construction under Alternative 3, as well as the duration of impacts (i.e., short term and long term) are as described under Alternative 2. However, approximately 98.6 acres (39.9 hectares) of impacts, including 69.8 acres (28.2 hectares) of long-term impacts to vegetation, would occur under Alternative 3. The location of the additional turbines and associated infrastructure under Alternative 3 would primarily be in land previously disturbed for agricultural activities (see Section 4.22 - Agriculture for additional discussion). Therefore, the majority of the additional temporary construction impacts under Alternative 3 would result in short-term impacts to vegetation communities. Direct effects on vegetation resources from Alternative 3 are considered low because while there would be permanent removal of vegetation, the intensity would be low, disturbance would be localized, and only common, ordinary vegetation resources would be affected. There would also be temporary removal of vegetation. The intensity of this effect would also be low, the disturbance would be primarily short term and localized, and only common, ordinary vegetation resources would be affected.

Similar to Alternative 2, Alternative 3 has the potential to increase the introduction and spread of noxious weeds and increase the risk of wildfire, both of which can impact and alter vegetation communities within the wind farm site. While the impact of introduction and spread of invasive species from construction of Alternative 3 has the potential to noticeably alter vegetation communities within the wind farm site long term, these impacts would be localized and would occur primarily to non-native vegetation communities. With implementation of BMPs (see Section 4.9.3.3), Alternative 3 is not expected to result in a significant increase in the introduction and spread of invasive species. Additionally, although a Project-related fire under Alternative 3 also has the potential to impact vegetation communities over the long term, the intensity of impacts would likely be low and localized and impacts would occur primarily to non-native vegetation. Implementation of the Project FMP (see Appendix C of the Final EIS) would further minimize the potential for Project-related fires during construction of this alternative; therefore, this alternative is not expected to result in significant impacts to vegetation resources due to fire.

Operation and Maintenance Impacts

The types of direct and indirect impacts of O&M under Alternative 3 are similar to those described under Alternative 2. Direct impacts from routine O&M activities under Alternative 3 are considered low because while there may be some long-term removal of vegetation, the intensity would be low, disturbance would be localized, and common, ordinary vegetation resources would be affected.

With implementation of BMPs described under Alternative 2 and in Section 4.9.3.3, indirect effects to vegetation from introduction and spread of invasive plant species and increased fire risk under Alternative 3 are considered low, because while there may be long-term impacts to vegetation, the intensity would be low, disturbance would be localized, and common, ordinary vegetation resources would be affected.

4.9.4.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP would have no effect on vegetation. There would be some potential for vegetation trampling in conjunction with post-construction monitoring efforts associated with surveyors traversing transects beneath the turbines. However, this is expected to be negligible.

Impacts of HCP Mitigation

Impacts of HCP mitigation under Alternative 3 would be the same as described under the Proposed Action. Prior to the construction of the additional turbines proposed under Alternative 3, NPMPP would reopen consultation with the USFWS and DOFAW to assess the potential impacts of the additional turbines to listed species and develop appropriate mitigation measures. The impacts of these mitigation measures to vegetation resources would be evaluated under a separate environmental analysis at that time.

4.9.4.3 Mitigation of Unavoidable Impacts

Mitigation measures for this alternative are as described under Alternative 2 (Section 4.9.3.3).

4.9.4.4 Cumulative Effects

The cumulative effects to vegetation resources under Alternative 3 would be the same as that described under the Proposed Action, with the exception that Alternative 3 would contribute a total of 98.6 acres (39.9 hectares) of disturbance. Therefore, when viewed in conjunction with past, present, and foreseeable future projects in the cumulative effects analysis area, the contribution of Alternative 3 to cumulative effects on vegetation resources would be minor. Because there would likely be a delay in time of up to 3 years before additional turbines would be built under Alternative 3, new projects and developments in the area will be assessed and reviewed to determine if there are additional cumulative impacts from future unknown projects.

4.9.4.5 Summary

Construction and operation of the Project under Alternative 3 has the potential to impact vegetation resources in the Project and mitigation areas. Similar to Alternative 2, with implementation of mitigation measures as describe in Section 4.9.3.3, these impacts are expected to be minimal and would result in a minor impact to vegetation resources.

4.9.5 Conclusion

Table 4.9-2 summarizes potential impacts to vegetation from the alternative considered in this analysis.

Table 4.9-2. Summary of Potential Impacts to Vegetation

Impact Issues	No Action Alternative	Alternative 2 – Proposed Action	Alternative 2a – Modified Proposed Action Option	Alternative 3
Introduction or spread of noxious weeds	No Impact	Minor	Minor	Minor
Loss to any population of plant species resulting in proposal for listing or listing	No Impact	Negligible	Negligible	Negligible
Loss of native plant communities	No Impact	Minor	Minor	Minor
Fire	No Impact	Minor	Minor	Minor

4.10 Wildlife

4.10.1 Impact Criteria

Impacts to wildlife would occur when individuals are disturbed or killed or when habitat is removed or altered. Effects are discussed both qualitatively (e.g., noise and disturbance) and quantitatively (e.g., acres of habitat impacted), where possible. Effects to State and Federally listed wildlife species are specifically addressed in Section 4.11 – Threatened and Endangered Species.

Table 4.10-1 summarizes the definitions for impact criteria used to evaluate effects of the Project and HCP conservation measures on wildlife resources. Definitions for overall impact conclusion statements—i.e., negligible, minor, moderate, and major—are provided in Section 4.1.1.

Table 4.10-1. Impact Criteria for Wildlife Resources

Type of Effect	Impact Component	Effects Summary		
Behavioral Disturbance	Magnitude or Intensity	**High:** Acute or obvious change in behavior due to Project activity; animals displaced from wind farm site or mitigation areas.	**Medium:** Noticeable change in behavior due to Project activity; animals displaced from the wind farm site or mitigation areas.	**Low:** Changes in behavior due to Project activity may not be noticeable; animals remain in the vicinity of wind farm site or mitigation areas.
	Duration	**Permanent:** Change in behavior patterns would continue even if actions that caused the impacts were to cease; behavior not expected to return to previous patterns.	**Long-term:** Behavior patterns altered for several years and would return to pre-activity levels at some point after actions causing impacts cease.	**Temporary:** Behavior patterns altered infrequently and not longer than the span of Project construction or during maintenance activities and would be expected to return to pre-activity levels after actions causing impacts cease.
	Geographic Extent	**Extended:** Affects wildlife beyond the region (i.e., north shore of Oahu).	**Regional:** Affects wildlife beyond a local area, potentially throughout the analysis area (wind farm site and mitigation areas).	**Local:** Impacts limited geographically; limited to vicinity of the Project footprint or immediate vicinity of HCP mitigation activities.
	Context	**Unique:** Wildlife are protected by legislation and the portion of the resource affected fills a unique ecosystem role within the locality or region.	**Important:** Affects depleted wildlife within the locality or region or wildlife that are protected by legislation.	**Common:** Affects usual or ordinary wildlife; wildlife is not depleted in the locality or protected by legislation.
Collisions/Direct mortality	Magnitude/Intensity	**High:** Potential for direct mortality not reduced through implementation of HCP avoidance and minimization measures.	**Medium:** Moderate potential for direct mortality and reduced through implementation of HCP avoidance and minimization measures.	**Low:** Potential for direct mortality low and reduced through implementation of HCP avoidance and minimization measures.
	Duration	**Permanent:** Potential for direct impacts extends beyond the life of the Project.	**Long-term:** Potential for direct impacts last through the life of the Project.	**Temporary:** Potential for direct impacts last through the construction phase of the Project.
	Geographic Extent	Same as above	Same as above	Same as above
	Context	Same as above	Same as above	Same as above

Table 4.10-1. Impact Criteria for Wildlife Resources (continued)

Type of Effect	Impact Component	Effects Summary		
Habitat Alteration	Magnitude or Intensity	**High:** Acute or obvious changes in habitat character.	**Medium:** Noticeable change in habitat character.	**Low:** Changes in habitat character may not be noticeable.
	Duration	**Permanent:** Chronic effects; habitat would not be anticipated to return to previous levels.	**Long-term:** Habitat would be reduced for up to the life of the Project and would return to pre-activity levels at some point afterward.	**Temporary:** Habitat would be reduced infrequently but not longer than the span of 1 year and would be expected to return to pre-activity levels. Habitat expected to return to pre-activity conditions within five years.
	Geographic Extent	**Extended:** Affects habitat beyond the region or wind farm site.	**Regional:** Affects habitat beyond a local area, potentially throughout the wind farm site and mitigation areas.	**Local:** Impacts limited geographically; limited to vicinity of the Project footprint.
	Context	**Unique:** Habitat is protected by legislation and the portion of the habitat affected fills a unique ecosystem role within the locality or region (e.g., North Shore of Oahu).	**Important:** Affects depleted habitat within the locality or region or habitat is protected by legislation.	**Common:** Affects usual or ordinary habitat in the wind farm site; habitat is not depleted in the locality or protected by legislation.

4.10.2 Alternative 1—No Action

4.10.2.1 Direct and Indirect Effects

Under the No Action Alternative, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Therefore, Alternative 1 would have no adverse effects on any non-listed wildlife species, MBTA-protected species, or other avian species of concern. However, under the No Action Alternative there would be no contribution to forest restoration within the Poamoho Ridge Mitigation Area associated with bat mitigation or protection of waterbirds and their habitat at the Hamakua Marsh Mitigation Area, which would have beneficial effects to other wildlife species. Thus, under the No Action Alternative, current land uses within the wind farm site and mitigation areas would continue without the benefit of habitat protection, invasive species removal, or monitoring associated with HCP conservation measures.

4.10.2.2 Cumulative Effects

Under the No Action Alternative, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Therefore, there would be no effect on wildlife. Thus, Alternative 1 would not directly contribute to cumulative effects to wildlife; however, conditions within the Poamoho Ridge and Hamakua Marsh mitigation areas would continue to degrade without implementation of mitigation activities under the Project

HCP. Beneficial impacts to non-listed wildlife, including MBTA-protected species and other avian species of concern, associated with HCP mitigation activities would not occur.

4.10.2.3 Summary

Under Alternative 1, there would be no direct or indirect adverse or beneficial cumulative impacts to wildlife resources because no action would be undertaken.

4.10.3 Alternative 2—8 to 10 Turbine Project

4.10.3.1 Direct and Indirect Effects of Construction and Operation of the Project

Construction Impacts

Direct effects to wildlife from construction activities include injury or mortality (e.g., collision with construction equipment), habitat removal and alteration, and noise and disturbance. Indirectly, construction activities can also result in the introduction and spread of non-native plant and animal species. The following discusses potential impacts to wildlife, including MBTA-protected and other avian species of concern, from construction of Alternative 2.

Direct Mortality

Wildlife could be killed or injured during by construction equipment or vehicles, particularly in association with grading of roads and turbine pads. However, due to ability of most species to avoid Project construction activities, the potential for direct mortality is expected to be low for avian species, mammal, and invertebrate species. These effects would be localized and temporary, lasting for the duration of construction.

Although there is no habitat within the wind farm site for MBTA-protected shorebirds, seabirds, wading birds, or waterfowl, species from these groups could pass through during migration or in transit to wintering or breeding habitats. Species that fly at night or during times of low visibility would be most susceptible to collisions with construction cranes or turbine towers. Additionally, nighttime lighting has been shown to attract and disorient seabirds. To minimize these risks, NPMPP will maximize the amount of construction activity that can occur in daylight during the seabird breeding season to minimize the use of nighttime lighting that could be an attraction to seabirds. To the extent practicable, NPMPP will avoid nighttime construction during the peak fledging period. Should nighttime construction be required, to minimize the attractiveness of construction lights to wildlife, NPMPP will use shielded lights and non-white lights to the extent practicable and allowable, taking into account safety considerations.

Habitat Removal and Alteration

Construction of the Project under Alternative 2 would disturb up to approximately 89.0 acres (36.0 hectares; Table 2-1). Of this, approximately 59.9 acres (24.2 hectares) would be removed for the life of the Project in association with Project facilities (e.g., turbines, access roads). This comprises approximately 8.5 percent of the wind farm site. These impacts would occur in an area that has been previously disturbed and consists primarily of agriculture in the lower-elevation portions of the wind farm site and vegetation dominated by a mixture of non-native weedy vegetation and common native vegetation at the higher-elevations. Therefore, vegetation removal would not affect any unique or high quality wildlife habitats and no large contiguous blocks of high quality wildlife habitat would be fragmented as a result of the Project. Additionally, with the exception of some avian species and bat (discussed in detail in Section 4.11 – Threatened and Endangered Species), most of the wildlife species likely to breed or forage within the wind farm site are common, non-native, and widespread, and the habitats affected are abundant in the surrounding area. Therefore, vegetation removal would not result in a substantial local loss of wildlife habitat.

The introduction and spread of invasive species can reduce habitat quality both within and adjacent to the wind farm site by replacing native vegetation with exotic plant species that can favor non-native wildlife that compete with or prey on native wildlife. On Oahu, target invasive species include plants, amphibians, and insects. Although most of the wildlife species occurring in the wind farm site are non-native, and much of the available habitat has been disturbed, the implementation of BMPs listed in Table 2-6 for invasive species prevention and control, would help minimize Project-related introduction or spread of invasive species. These include measures for cleaning and inspection of equipment and vehicles and revegetation of newly disturbed areas with non-invasive resident species that are compatible with Project operations. Therefore, construction of the Project would not reduce terrestrial wildlife habitat quality.

There is no breeding or foraging habitat within the wind farm site for any MBTA-protected seabird, shorebirds, waterfowl, or wading bird species. Therefore, construction would not result in terrestrial or aquatic habitat removal or modification for these species, with the exception of the Pacific golden-plover which could use the newly cleared turbine pads and roads for foraging.

Noise and Disturbance

Construction-related activities, including installation of turbines and other infrastructure, as well as construction of access roads, would involve the use of heavy equipment and high levels of human activity around the construction sites. These activities would result in increased onsite noise and human presence that could disturb wildlife using the wind farm site. However, given the temporary nature of the construction period, and the existing level of human activity in the area associated with agriculture operations, construction of the Project would not preclude wildlife from using the wind farm site and at most, temporary displacement of individual animals would be expected. Additionally, due to the temporary and localized nature of construction noise and human activity, no long-term disruption of breeding or foraging activities for MBTA-protected species or other avian species of concern would be expected. Construction activities would have no noise or disturbance-related effects to MBTA-protected shorebirds, seabirds, waterfowl, or wading birds because there is no habitat for these species within the wind farm site.

Operation and Maintenance Impacts

Direct Mortality

Non-listed avian species, including MBTA-protected species and other avian species of concern, that fly through the wind farm site have the potential to collide with turbines or other Project structures. A number of native or migratory birds protected by the MBTA, which may have cultural importance (see Section 4.13 – Historic, Archaeological, and Cultural Resources) have been observed in or near the wind farm site (see Section 3.8 – Wildlife). There have been documented fatalities of MBTA-protected species at the existing Kahuku wind farm adjacent to the Project, and at other Hawaii wind farms (USFWS, pers. comm. 2013). Potential impacts to MBTA-protected species groups are addressed specifically below. The wind farm site does not contain suitable habitat for most MBTA-protected shorebirds, waterfowl, seabirds, or wading birds (see exceptions below) which minimizes the potential for adverse effects to these species.

Shorebirds – There are a number of migratory shorebirds that pass through or overwinter in the Hawaiian Islands. In the vicinity of the Project, the James Campbell NWR provides important wintering habitat for a number of shorebird species. Although shorebirds appear to avoid turbines (they are uncommon fatalities at wind energy facilities), they may be susceptible to collisions with wires, particularly when located near wetlands (Powlesland 2009). Installing a permanent unguyed, lattice met tower, flagging and installing bird flight diverters on the guy wires of the two temporary met towers and the above-ground transmission line, and installing the electrical collection system below ground, would reduce this risk by improving visibility. Additionally, stormwater management on the turbine pads and roads will be designed to minimize the potential for accumulating standing water, which could serve as an attractant to shorebird species.

Of the shorebird species of conservation importance, the Pacific golden-plover is most likely to be at risk of collisions with Project structures. This species has been documented as a fatality at other operational wind facilities in Hawaii and is common in the vicinity of the Project. Additionally, clearing for turbine pads and roads may create habitat for this species, thereby increasing its presence in the wind farm site. However, due to its abundance in the Hawaiian Islands, collisions of individual Pacific golden-plovers with turbines or other project structures are unlikely to have population level effects. The bristle-thighed curlew and wandering tattler are both migrant species on Oahu, and therefore, the potential for collision risk is low.

Waterfowl – There are a number of migratory waterfowl that pass through or overwinter in the Hawaiian Islands. In the vicinity of the Project, the James Campbell NWR provides important wintering habitat for a number of waterfowl species. Migrating waterfowl typically fly at high altitudes, and therefore, the risk of collision with Project turbines is low. Wintering waterfowl passing through the wind farm site between wetland habitats would be most at risk of collision. However, observations at mainland wind farms suggest that the likelihood of waterfowl collisions with wind turbines is extremely low, even in areas with high waterfowl use, and that waterfowl exhibit avoidance of turbines during both daytime and nighttime flights (Koford et al. 2005, Pettersson 2005). Moreover, waterfowl have reduced movement during periods of low visibility and inclement weather; therefore, they are at a lower risk of collision with turbines and other

Project structures than other species groups. Few waterfowl were observed during Project Surveys, and those that were documented were at wetlands outside of the wind farm site. Nighttime lighting of the turbines is not expected to increase the risk of collision by waterfowl (AWWI 2015).

Seabirds – Seabirds are most likely to fly through the wind farm site when in transit. There is the potential for seabirds flying in the vicinity of the Project to become attracted to and disoriented by unshielded white lights on Project facilities. Flashing red lights on the nacelle have been shown to not be attractive to birds and will be used in accordance with FAA requirements. Additionally, onsite lighting at the O&M building and substation will be shielded and/or directed downward, triggered by a motion detector, and fitted with non-white light bulbs to the extent possible. Lighting is expected to be used only when workers are at the site at night. These measures will reduce the potential for seabird attraction to Project lights.

Seabirds are also susceptible to collisions with turbines, although as a group they typically exhibit high avoidance of collisions with structures. To reduce the potential for collisions, the majority of the electrical collection system will be placed below ground. The installation of line-marking devices on any above ground portions, as well as along the above-ground transmission line, will improve their visibility. Additionally, the implementation of turbine low wind speed curtailment from March to November will reduce the risk of seabird collisions (see Section 4.11 – Threatened and Endangered Species for additional discussion). Wedge-tailed shearwaters, Laysan albatross, great-frigatebirds, and white-tailed tropic birds have been observed in the vicinity of the Project and/or documented as fatalities at operating wind energy facilities in Hawaii and were documented during Projects surveys; therefore, there is the potential that these species in particular could be affected by the Project. However none of these species has a large breeding colony on Oahu or in the vicinity of the Project, although a small colony of wedge-tailed shearwaters occurs in the vicinity of the Project, and therefore, it is most likely that individuals would transit though the wind farm site. Therefore, although individual birds could collide with turbines, no population level effects are expected.

Wading birds – Although wading birds are not common wind energy facility fatalities, cattle egrets have been documented as fatalities at operational wind energy facilities in Hawaii. This species is also common in the vicinity of the Project and has the potential to collide with Project wind turbines. Additionally, USFWS has proposed a control rule to allow take of cattle egrets in Hawaii without a permit in order to manage the depredation threat these introduced species pose to listed species in Hawaii (78 FR 65955 – 65959). Due to the abundance of this species, no population-level effects are anticipated. The black-crowned night heron is not common in the immediate vicinity of the Project, but is found commonly at the James Campbell NWR and the wind farm site contains no foraging or breeding habitat for this species; therefore, the likelihood of Project impacts is very low.

Based on the above discussion, with the expected low level of Project-related mortality, no local or regional population-level effects are anticipated for any species, including non-listed MBTA-protect species or other avian species of concern.

Although any impact to an MBTA-protected species is considered a violation of the MBTA, there are currently no “take” permits for MBTA-species available. The USFWS exercises discretionary prosecutorial authority where a wind farm demonstrates a good faith effort to avoid and minimize take of MBTA species. Measures described above and in Section 2.5.1, which are designed to avoid and minimize impacts to the species covered under the Project HCP, would further avoid and minimize impacts to MBTA-protected species and other avian species of concern to the extent possible. The Project has committed to implementing a post-construction monitoring program to assess Project-related impacts to species covered under the Project HCP and would use the results of this monitoring to ensure that impacts to avian species, including MBTA-protected species and other avian species of concern, are avoided and minimized to the extent practicable.

Direct mortality of non-listed mammals during project operation is not anticipated. Invertebrates could be injured or killed during Project operations due to collisions with equipment and vehicles. However, given that onsite traffic would be infrequent and speed limits would be observed, the likelihood of Project-related impacts to invertebrates during O&M would be low.

Habitat Removal and Alteration

No additional terrestrial habitat would be removed during Project operations, and portions of the wind farm site not needed for operations would be revegetated with non-invasive, resident species and restored to approximate their pre-construction condition and function as wildlife habitat. Maintenance activities, such as vegetation clearing or removal around any necessary above ground portions of the transmission line, could remove or reduce the quality of wildlife habitat in these areas. The installation of the turbines would add a new structural element to the landscape and the airspace above the wind farm site. Habitat use within the wind farm site (foraging in and transit through) by birds would be altered locally because they would need to navigate around or through the turbines; however, this impact would be minor due to the small number of turbines proposed and because the Project is not located in between major wintering, breeding, or migratory stopover habitats.

Noise and Disturbance

Low levels of noise and disturbance would occur during operations in association with routine O&M activities at the wind farm site. Given the temporary and localized nature of the noise and disturbance, no long-term impacts to wildlife breeding or foraging activities within the wind farm site would be anticipated during O&M. Disturbance to foraging activities within or transit through the wind farm site associated with the presence of the turbine (and associated noise/motion) in the airspace above the wind farm site is addressed above.

4.10.3.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization

Avoidance and minimization measures proposed under the Project HCP are designed to reduce the risk of incidental take to threatened and endangered species. Many of these measures would also minimize impacts to non-listed wildlife species, including MBTA-protected species or other avian species of concern. Some of these avoidance and minimization measures, including below-ground installation of Project electrical collection system and marking of the above-ground transmission line to the extent possible and revegetation of temporarily disturbed areas, were taken into account in the analysis of impacts to wildlife species.

Impacts of HCP Mitigation

No adverse impacts to non-listed wildlife, including MBTA-species or other avian species of concern, would occur in association with funding provided for Newell's shearwater or Hawaiian short-eared owl research and management. The exception would be where impacts are intentional, such as though predator control which could be funded by Newell's shearwater mitigation and result in impacts to rats, mice, feral cats, and similar species.

Fence installation at Hamakua Marsh would result in a temporary, local disturbance to wildlife due to worker presence and vehicle noise and ground disturbance. This impact is expected to be negligible because the area is currently disturbed and is located in an area with a high level of human activity. Additionally, the resulting fence would reduce human disturbance, reduce the risk of vehicle collisions with waterbirds, and reduce predation by feral and domestic dogs. The overall benefits of installation of fencing (e.g., controlling access to limit illegal dumping of garbage, and eliminating the use of the marsh as a play area for pets) would result in an overall benefit to wildlife, MBTA-protected and other avian species of concern, within the Hamakua Marsh Mitigation Area.

At the Poamoho Ridge Mitigation Area fence maintenance, the removal of feral pigs and invasive plant species, and the conducting of bat acoustic monitoring, could result in a temporary, local disturbance to wildlife caused by worker and equipment noise, helicopter noise, and minor ground disturbance (associated with foot traffic). Adverse impacts due to noise and disturbance associated with these activities are expected to be temporary, localized, and negligible. These activities would not preclude the use of the area by wildlife (except for feral pigs which would be the target of mitigation efforts). However, removal of non-native plant and animal species would result in a beneficial impact to wildlife within the Poamoho Ridge Mitigation Area, including MBTA-protected and other avian species of concern, by enhancing habitat quality.

Overall, adverse impacts from the HCP conservation measures would be considered negligible. These measures would protect and enhance valuable wildlife habitat, and therefore, are expected to provide net benefits to the species covered under the HCP as well as other wildlife in the mitigation areas.

4.10.3.3 Mitigation for Unavoidable Impacts

BMPs listed in Table 2-6, which will be implemented by NPMPP, will minimize impacts to wildlife resources. These measures include:

- Preparing and implementing a TESC Plan, which would help prevent erosion;
- Revegetating temporarily disturbed areas with non-invasive, resident species;
- Inspecting potential off-site sources of materials (gravel, fill, etc.) and prohibiting the import of materials from sites that are known or likely to contain seeds or propagules of invasive species;

- Requiring vehicle operators transporting materials to the Project site off-site to follow protocols for removing soils and plant material from vehicles and equipment prior to entry onto the site; and
- Implementing the Project FMP to reduce the potential for fires during construction and operations.

HCP avoidance and minimization measures are discussed in detail in Section 2.5.1. These measures are designed to avoid and minimize impacts to the species covered under the Project HCP but would do the same for non-listed avian species including MBTA-protected species and other avian species of concern.

4.10.3.4 Cumulative Effects

The cumulative effects analysis area for non-listed wildlife and MBTA-protected species and other avian species of concern is the Proposed Action footprint plus a 0.5-mile (0.8-kilometer) buffer, as well as the mitigation areas. This area encompasses the areas where potential direct and indirect effects to wildlife could occur. Past, present, and reasonably foreseeable actions that overlap in space and time with the impacts of the Project are identified in Table 4.2-2 and described below where appropriate.

Past and ongoing agricultural operations and associated development, as well as urban development and associated infrastructure, including two existing transmission lines (138-kV and 46-kV) in the area have decreased habitat quality with the removal of native vegetation and the introduction of non-native invasive vegetation. The Project would result in a minor contribution to the reduction of habitat for some non-listed wildlife species; however, all of the non-listed wildlife species occurring in the wind farm site are common and widespread, and generally tolerant of development. The only foreseeable project in the cumulative effects analysis area for wildlife is the planned Envision Laie residential development on 300 acres (122 hectares) of Malaekahana land, which could result in injury or mortality during construction and permanent loss of habitat for non-listed wildlife, including MBTA-protected species and other avian species of concern. The Envision Laie development would also likely contribute moderately to noise and disturbance during construction, with lower but ongoing levels of human disturbance after construction is complete and residents have moved to the area.

Mitigation measures proposed under the Project HCP would improve habitat for non-listed wildlife, including MBTA-protected species, by removing invasive plant and animal species, protecting habitat, and restoring native vegetation. Installation of mitigation fencing at Hamakua Marsh would reduce human disturbance, prevent vehicle collisions with waterbirds, and reduce predation by feral and domestic dogs, which would result in an overall benefit to wildlife within the mitigation area. Likewise, mitigation activities at the Poamoho Ridge Mitigation Area for Hawaiian hoary bat mitigation would also provide beneficial effects to wildlife. These activities would contribute to the ongoing restoration and management efforts for wildlife within the mitigation areas.

The existing transmission lines and the existing Kahuku wind farm and associated facilities present a potential collision risk for MBTA-protected species and other avian species. The Project turbines and met tower would contribute to this risk. Post-construction monitoring at the Project site would assess effects to all species. Avoidance and minimization measures under the Project HCP, listed in Section 2.5.1 (e.g., unguyed, free-standing permanent met tower, line marking devices on guy wires of temporary met towers and the transmission line, and installing the majority of the electrical collection system below ground), will minimize risk of collision.

Existing sources of noise and disturbance in the cumulative effects analysis area for wildlife include ongoing agricultural operations and current use of roads, which would be expected to continue during operation of the Project and over the term of the HCP. Implementation of the HCP conservation measures as well as construction and operation of the Project would contribute to short-term and long-term noise levels; however, it would not be expected to preclude non-listed wildlife, including MBTA-protected species or other avian species of concern, from using the area. Therefore, when viewed in combination with past, present, and reasonably foreseeable projects, the contribution of Alternative 2 to cumulative effects on wildlife resources would be considered minor.

4.10.3.5 Summary

Effects to non-listed wildlife, including MBTA-protected species and other avian species of concern, are considered minor under Alternative 2 because the magnitude of the impacts would be low or medium; impacts would be confined to a local area; primarily common, non-native, and widespread species would be impacted; and impacts would not preclude use of the area by these species. The greatest impacts would be temporary. Nevertheless, there is some long-term risk to MBTA-protected species and other avian species of concern from collision with turbines. These groups would, however, benefit from mitigation under the Project HCP; therefore, the impact remains minor.

4.10.3.6 Alternative 2a - Modified Proposed Action Option

Under Alternative 2a, direct, indirect, and cumulative effects on wildlife resources would be similar to those described under Alternative 2. However, the Modified Proposed Action Option would result in less vegetation removal than the Proposed Action. Alternative 2a would disturb up to approximately 84.5 acres (34.2 hectares), of which 56.7 acres (22.9 hectares) would be long term, lasting the life of the Project. Table 2-1 provides more detail on the disturbance areas associated with each Project component. Implementation of standard BMPs, avoidance and minimization, and other mitigation measures, as described under the Proposed Action, would minimize adverse impacts to wildlife resources.

However, the taller wind turbine models proposed under Alternative 2a have longer turbine blades and therefore greater rotor swept areas where birds may be exposed to collision risk compared to the wind turbine models proposed under Alternative 2. However, the data available to date suggest that correlations between wind turbine features and bird collision risk are variable and likely to be species- and site-specific. Several meta-analyses have been conducted, using data from both peer-reviewed and unpublished wind industry reports on bird collisions with wind turbines across the contiguous U.S., to identify factors correlated with bird collision mortality. Loss et al. (2013) found that bird collision mortality increased with increasing turbine hub height, which among the studies considered ranged from 118 to 262 feet (36 to 80 meters) above ground. Turbine hub height was also found to be strongly correlated with total blade tip height and rotor swept area (Loss et al. 2013). Other meta-analyses of wind turbine collision mortality have found no relationship between bird mortality and wind turbine height (Barclay et al., 2007), or a decrease in bird mortality with turbine size for birds (Smallwood, 2013). However, the results of these U.S. mainland analyses are heavily weighted by nocturnal, migrating songbird populations, whose mean flight altitudes are typically higher than turbine hub heights and may not be characteristic of bird species expected to transit through the wind farm site. Moreover, collision risk may decrease through the use of larger turbines because fewer are required to produce the same amount of energy (AWWI 2016). Thus, the taller wind turbines may increase collision risk for some bird species transiting through the wind farm site but this could be counteracted by the reduction in number of wind turbines under Alternative 2a which would reduce the overall rotor swept area by 10 to 20 percent (if 9 or 8 turbines are constructed, respectively).

4.10.4 Alternative 3—Larger Generation Facility (Up to 12 Turbine Project)

4.10.4.1 Direct and Indirect Effects of Construction and Operation of the Project

Direct and indirect impacts associated with the construction and operation of the Project under Alternative 3 would be similar to those for Alternative 2. Project components such as the substation, met towers, and transmission line would be the same as under Alternative 2; however, Alternative 3 would involve the construction and operation of an additional 2 to 4 turbines and associated access road and electrical collection system. The additional turbines and road construction would result in a total of up to 98.6 acres (39.9 hectares) of disturbance, representing a minor increase in habitat removal (9.6 acres [3.9 hectares] above Alternative 2). Alternative 3 would also result in a slight increase in noise and disturbance, and construction-related mortality risk, associated with two separate construction periods. However, because all impacts would be temporary and localized, Alternative 3 would not result in a substantial loss of habitat for any species or preclude any species from using the wind farm site, and the species most likely to be impacted are non-native. The collision risk associated with Project operation would increase due to the additional turbines. However, impacts would be minimized through the implementation of the HCP avoidance and minimization measures described above under Alternative 2 and in Sections 2.5.1 and 2.5.2.

4.10.4.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization

Impacts of HCP avoidance and minimization measures under Alternative 3 would be the same as described under Alternative 2.

Impacts of HCP Mitigation

Impacts of the HCP mitigation measures under Alternative 3 would be the same as described under Alternative 2. Prior to the construction of the additional turbines proposed under Alternative 3, NPMPP would reopen consultation with the USFWS and DOFAW to assess the potential impacts of the additional turbines to listed species and develop appropriate mitigation measures. The impacts of these mitigation measures to wildlife resources would be evaluated under a separate environmental analysis at that time.

4.10.4.3 Mitigation for Unavoidable Impacts

Measures that would be implemented to avoid and minimize impacts under Alternative 3 would be the same as described under Alternative 2.

4.10.4.4 Cumulative Effects

Cumulative effects to wildlife resources under Alternative 3 would be the same as described under Alternative 2, with the exception that Alternative 3 would contribute a total of 98.6 acres (39.9 hectares) of habitat disturbance and alteration of which 69.8 acres (28.2 hectares) would be impacted over the long term (through the life of the Project). This additional disturbance is primarily located in existing agricultural areas that currently provide low-quality habitat for wildlife. Due to the lag time of up to 3 years between construction of the first 8 to 10 turbines and the additional 2 to 4 turbines, there would be no incremental increase in temporary noise disturbance; rather, it would extend the period of noise disturbance contributing to the noise and disturbance within the cumulative effects analysis area. When viewed in conjunction with past, present, and foreseeable future projects in the cumulative effects analysis area, the contribution of Alternative 3 to cumulative effects on non-listed wildlife, including MBTA-protected and other avian species of concern, would be minor. Because there would likely be a delay in time of up to 3 years before additional turbines would be built under Alternative 3, new projects and developments in the area will be assessed and reviewed to determine if there are additional cumulative impacts from future unknown projects.

4.10.4.5 Summary

Effects to wildlife resources are considered minor for Alternative 3. This is because the magnitude of impacts would remain at a low or medium level; impacts would be confined to a local area; and impacts would occur to mostly common, non-native species that would remain in the area. Further, the greatest impacts would be temporary, with some long-term risk to MBTA-protected species and other avian species of concern from collision with turbines. However, these species would benefit from mitigation measures under the Project HCP.

4.10.5 Conclusion

Potential adverse impacts to wildlife resources associated with the Project include minor, localized habitat removal, the potential for collision with Project structures, and temporary noise and disturbance. The Project would represent a minor contribution to cumulative effects to wildlife. As discussed above, Alternative 3 would have slightly greater impacts than Alternative 2 or 2a due to additional turbines and access road construction. For the action alternatives, impacts would be minimized through measures discussed in Chapter 2, and further mitigated through avoidance and minimization and mitigation measures under the Project HCP. HCP actions would benefit wildlife over the long term through protection and enhancement of native habitats. Therefore, direct, indirect, and cumulative effects of the Project, given the avoidance, minimization, and mitigation measures proposed, would be minor for non-listed wildlife, MBTA-protected species, and other avian species of concern. Table 4.10-2 summarizes potential impacts to wildlife resources from the alternatives considered in this analysis.

Table 4.10-2. Summary of Potential Impacts to Wildlife Resources

Impact Issues	No Action Alternative	Alternative 2 – Proposed Action	Alternative 2a – Modified Proposed Action Option	Alternative 3
Habitat removal and alteration	No Impact	Minor adverse/Moderate Beneficial	Minor adverse/Moderate Beneficial	Minor Adverse/Moderate Beneficial
Direct mortality	No Impact	Minor	Minor	Minor
Noise and disturbance	No Impact	Minor	Minor	Minor

4.11 Threatened and Endangered Species

4.11.1 Impact Criteria

Impacts to threatened and endangered species include four components: 1) estimated direct take for the permit term, 2) estimated indirect take for the permit term, 3) estimated combined overall Project take based on conservative assumptions, and 4) an assessment of population-level effects for estimated combined overall Project take. Section 3 of the ESA defines “take” as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct” (16 U.S.C. § 1532 (19)). Similar to the ESA, Hawaiian State statute Section 195D-2 defines “take” as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect endangered or threatened species of aquatic life or wildlife, or to cut, collect, uproot, destroy, injure, or possess endangered or threatened species of aquatic life or land plants, or to attempt to engage in any such conduct.”

The four components are considered for each of the eight State and Federally threatened and endangered species that are known to occur, or have the potential to occur, in the vicinity of the wind farm site (see Section 3.9 for a description of each species). General impacts to wildlife as discussed in Section 4.10 would also be applicable for threatened and endangered species, and are considered in the summary discussion of impacts for each alternative, but will not be repeated in this section specifically. The definitions of impact magnitude, duration, geographic extent, and context described in Table 4.10-1 (Section 4.10) also apply to the terms used in this section for conclusions regarding impacts to threatened and endangered species.

4.11.2 Alternative 1—No Action

4.11.2.1 Direct and Indirect Effects

Under the No Action Alternative, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Therefore, Alternative 1 would have no effect on threatened and endangered species in the analysis area. As such, no mitigation measures would be warranted. However, there would also be no beneficial effect to threatened and endangered species associated with implementation of HCP mitigation.

4.11.2.2 Cumulative Effects

Under the No Action Alternative, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Therefore, there would be no effect on threatened and endangered species. Thus, Alternative 1 would not contribute to cumulative effects to threatened and endangered species.

4.11.2.3 Summary

Alternative 1 would have no direct, indirect, or cumulative effect on threatened and endangered species because no action would be undertaken.

4.11.3 Alternative 2—8 to 10 Turbine Project and Alternative 2a – Modified Proposed Action Option

The discussion of the effects of the Proposed Action and the Modified Proposed Action Option are combined in this section. The Final HCP includes incidental take calculations based on the Modified Proposed Action Option, incorporating 9 turbines with larger dimensions (see the Project HCP and Section 2.2.2 of this EIS for additional detail). However, Project take estimates under the Proposed Action (i.e., included in the Draft HCP and evaluated in the Draft EIS) and Modified Proposed Action Option are comparable and do not result in different levels of requested take for any of the Covered Species. This is due to the uncertainty related to the effect of wind turbine features, such as height, rotor swept area, and blade tip speed, on bird and bat collision fatality risk, described in detail below. Accordingly, the requested take levels for the Covered Species are intentionally conservative (i.e., greater than anticipated take levels) to account for this uncertainty.

The risk of bird and bat collisions with wind turbines is driven by a combination of factors including the characteristics of individual species (morphology, sensorial perception, phenology, behavior or abundance), wind farm site characteristics (landscape, elevation, bird flight paths, food availability, wind regime, and weather) and features of the wind farm (wind turbine type, number, configuration, and lighting; Marques et al. 2014). Taller wind turbines with longer blades have larger rotor swept areas, which could influence collision risk by increasing the area where birds and bats may be exposed to collision compared to smaller turbine models. However, there are conflicting results regarding whether bird or bat fatalities increase with wind turbine size. Several meta-analyses have been conducted that use data from both peer-reviewed and unpublished studies at wind farms across the contiguous U.S. to evaluate correlations between bird and bat mortality and wind turbine features such as blade length, turbine hub height, and total height above the ground. Loss et al. (2013) found that modeled bird mortality increased with increasing turbine hub height. Other meta-analyses found either an increase in mortality with turbine height, but only for bats (Barclay et al., 2007), or a decrease in mortality with turbine size for birds (Smallwood, 2013). No studies to date have found correlations between collision risk and individual turbine features, such as rotor diameter or blade tip speed, independent of turbine height (Barclay and Baerwald 2009, Barclay et al. 2007, Strickland et al. 2011, Arnett and Baerwald 2013, Loss et al. 2013). Moreover, collision risk may decrease through the use of larger turbines because fewer are required to produce the same amount of energy (AWWI 2016). However, these trends may be most apparent at repowered wind farms where older generation lattice tower wind turbines are replaced by modern monopole models. Thus, the taller turbine models proposed under Alternative 2a may increase collision risk for the Covered Species but this effect may be counteracted to some extent through the removal of one to two turbines under Alternative 2a. Because there is no definitive basis for qualitatively assessing the effect of fewer, taller wind turbines on the risk of collision for the Covered Species, assumptions based on the best available information for each species were used to estimate take in the Project HCP. The following discussion summarizes the changes in take estimates for the Covered Species between Draft and Final HCP.

For the Hawaiian hoary bat, minor adjustments were made to take calculation assumptions between the Draft and Final HCP; however, the overall take estimate did not change. Take estimates were based on data from the adjacent Kahuku wind farm, and although some studies have indicated that collision risk for bats increases with wind turbine tower height (Baerwald and Barclay 2009, Barclay et al. 2007, Arnett and Baerwald 2013) there is no evidence to suggest that the operation of fewer, larger turbines would yield a proportionate increase or decrease in bat collision risk. To account for the uncertainty associated with risk to the Hawaiian hoary bat, the requested take authorization for this species is 150 percent of the estimated level of take (see Tables 4.11-1, 2, and 3).

For the Newell’s shearwater and Hawaiian goose, estimated per turbine fatality rates were so low, the net effect of the increased turbine size and removal of one turbine had no influence on the “rounded up” take estimate or the requested take authorization, which was conservatively increased to account for uncertainty (see Tables 4.11-4, 5, 6, 7, 8, and 9). Newell’s shearwaters exhibit high avoidance of tall structures, and there is no evidence to suggest avoidance rates would be less with fewer, taller wind turbines. The decrease in estimated take for the Hawaiian goose between Draft and Final HCP was related to refinements in the population modeling, not a result of changes in turbine dimensions or number.

For the Hawaiian stilt, Hawaiian duck, Hawaiian coot, and Hawaiian moorhen the likelihood of transiting through the wind farm site is extremely low and take estimates were not based on turbine number or dimension; therefore there was no change in take estimates or requested take authorizations between the Draft and Final HCP. Moreover, waterbirds as a group have shown high rates of avoidance to obstacles including wind turbine (Erickson et al. 2002, Jain 2005, Johnson and Erickson 2011), and to date none of these species have been documented as a fatality at an operating wind farm in Hawaii. However, to account for uncertainty related to the risk of collision for these species, the requested take authorizations are four to eight times the estimated level of take (Tables 4.11-10).

Likewise, the Hawaiian short-eared owl has a low likelihood of transiting through the wind farm site, and take estimates were not based on turbine number or dimension. Therefore, no change in requested take authorization occurred between the Draft and Final HCP (Table 4.11-11 and 12).

Thus, although wind turbine features may play an important role in bird and bat collision risk, risk is driven by a complex suite of factors (AWWI 2016, Marques et al. 2014). Therefore, conservative assumptions were used in estimating take of bird and bat species addressed in the Project HCP to account for the uncertainty associated with the influence of turbine size and number on collision risk.

Additionally, the Modified Proposed Action Option does not result in changes to the HCP avoidance, minimization, and mitigation measures. Therefore, the following discussion reflects revisions made to the Draft HCP, based on refinements in the Project design made subsequent to the publication of the Draft EIS (see Chapter 2 for a description), public and agency comments, and new information about the Covered Species (refinement of assumptions used to estimate Project-related take of the Covered Species).

4.11.3.1 Direct and Indirect Effects of Construction and Operation of the Project

As take for some species may vary based on the number and size of turbines comprising the final turbine array selection, within each species discussion below, estimated take is presented based on conservative turbine array design assumptions (see the Project HCP for additional detail). For all species, impacts would be minimized through the avoidance and minimization measures outlined in Section 2.5.1.

Hawaiian Hoary Bat

Direct Take

The most likely potential source of direct bat mortality is a collision or barotrauma associated with an operational turbine, as has been documented at other Oahu wind facilities (Kahuku Wind Power 2013; Kawailoa Wind Power 2013). The Kahuku Wind Project provides the best available data to estimate potential direct take resulting from turbine interactions at the wind farm site for two primary reasons. First, the Kahuku Wind Project is immediately adjacent to the proposed Na Pua Makani site, so the sites have similarities in landscape features (e.g., slope, aspect, elevation). Second, the Kahuku Wind Project has the longest operational history on Oahu, which provides the most comprehensive dataset for these estimates.

Estimates of direct take for the Project were derived by adjusting observed take at the Kahuku Wind Project to the maximum number of turbines at Na Pua Makani and scaling these values for unobserved take. Calculations were based on the Kahuku Wind Project's fatality monitoring data while the Kahuku Wind Project was operational between March 2011 - August 2012 and between August 2013 – July 2015 (note that the Kahuku Wind Project remains operational, but estimates are based on observed fatality data through July 31, 2015). During a portion of this period, the Kahuku Wind Project implemented low wind speed curtailment to reduce the risk of bat fatalities. The Kahuku Wind Project documented three observed bat fatalities during approximately 13 months of operation (March 2011 to April 2012) when operations did not include seasonal low wind speed curtailment, and one observed bat fatality during the approximately 26 months when operations included seasonal low wind speed curtailment. This translates to an observed bat mortality of 0.21 bats per turbine per year when low wind speed curtailment was not implemented and 0.04 bats per turbine per year when turbines were operated using seasonal low wind speed curtailment.

Not all fatalities are expected to be found; to evaluate actual direct take, estimates need to account for undiscovered fatalities. The probability that a carcass is available to be found when the search takes place (i.e., it has not been scavenged prior to the search) and the likelihood that a searcher actually observes an available carcass both have an effect on the proportion of actual fatalities that are discovered by searchers. Post-construction monitoring efforts at the Kahuku Wind Project have been adaptively managed over time with changes including the implementation of scavenger trapping and the training and deployment of canine search teams. Through these changes, the Kahuku Wind Project has increased carcass persistence times and improved searcher efficiency. Based on analyses in the 2014 annual HCP compliance report from the Kahuku Wind Project, approximately one undetected bat fatality may be present for each detected fatality. To conservatively estimate actual take at the Kahuku Wind Project for use in estimating impacts for the Na Pua Makani Project, it is assumed on average two undetected bat fatalities my occur for each observed bat fatality. Table 4.11-1 demonstrates how the observed fatality rates were combined and adjusted for the undetected fatalities to generate an estimate of direct take for the Project assuming no low wind speed curtailment. Adjustments to this estimate to account for uncertainty and proposed implementation of low wind speed curtailment are described in Total Take and Authorized Take Request for ITP and ITL, below.

Table 4.11-1. Direct Take Estimates for Hawaiian Hoary Bat

Component	Value	Rationale
A. Observed fatality rate per turbine at Kahuku under no low wind speed curtailment	0.21 bats/turbine/year	Calculated as (3 fatalities/1.7 years of operation/12 turbines at Kahuku)
B. Observed fatality rate per turbine at Kahuku under low wind speed curtailment adjusted to represent fatality rate without low wind speed curtailment	0.11 bats/turbine/year	Calculated as: 1 fatality/2.17 years of operation/12 turbines at Kahuku/0.35, where dividing by 0.35 scales results under curtailment to their expected value with no curtailment
C. Combined estimated observed fatality rate at Kahuku	0.15 bats/turbine/year	Calculated as A*1.17 years + B*2.17 years/(3.33 years)
D. Estimated unobserved fatality rate (unobserved fatalities/ observed fatality)	2	Based on conservative interpretation of the Kahuku Wind Project's annual compliance report (Kahuku Wind Power 2014)
E. Number of turbines	9	
F. Permit term	21 years	
G. Estimate of direct take	85 bats	Calculated as ([C*E]+[C*D*E])*F

Other potential sources of direct mortality were evaluated but considered negligible. Vehicle collisions are considered negligible given the limited nighttime traffic expected in the wind farm site and low speed limits posted and enforced on Project roads. Mortality through collision with stationary objects (e.g., met tower, construction cranes, transmission line) is considered negligible given the general ability of bats to avoid colliding with stationary objects, and NPMPP's commitment to avoid the use of barbed wire at the Project. Hawaiian hoary bats have been known to become entangled in barbed wire fences (Zimpfer and Bonaccorso 2010).

Indirect Take

The take of a bat during the breeding season may result in the indirect loss or take of dependent offspring. The rationale and values used to estimate indirect take are outlined in Table 4.11-2 and include the proportion of the take that is female, the proportion of the young that are dependent, and the average offspring per pair. Because frameworks for bat mitigation are based on compensation for adult bats, the estimated indirect take of young is converted to an equivalent number of adult bats by adjusting for the estimated number of young that would survive to reproductive age. Together, these calculations result in an indirect take estimate of the equivalent of 10 adult bats over the permit term. Adjustments to this estimate to account for uncertainty, and to account for the benefits of low wind speed curtailment, are described in Total Take and Authorized Take Request for ITP and ITL, below.

Table 4.11-2. Indirect Take Estimates for Hawaiian Hoary Bat

Component	Value	Rationale
A. Proportion of take that is adult	1.00	As a conservative estimate, it was assumed that all take would be of adult bats, despite the potential for newly volant young (i.e., young of the year) to pass through the wind farm site during the fall.
B. Proportion of take that is female	0.50	Hawaiian hoary bats are assumed to have an adult sex ratio of 1:1 and no sex-based differential susceptibility to turbine interactions. Therefore, female bats should comprise 50 percent of total take.
C. Proportion of the year that the young are dependent	0.42 (5 months/12 months)	Adult Hawaiian hoary bats potentially occur at the Project throughout the year. However, as the breeding season only spans April through August (Menard 2001), it is only the loss of adult bats during this 5-month period that may result in the indirect loss of dependent young.
D. Proportion of taken breeding adults with dependent young	1.00	Until weaning, young of the year are completely dependent on the female for survival. Therefore, all female mortality during the breeding season results in the loss of her young.
E. Average offspring/pair	1.83 bats/year	Data are limited, average reproductive success in terms of young/year based on Bogan (1972) and Koehler and Barclay (2000) for mainland hoary bat.
F. Indirect take rate	0.38 dependent young/direct bat take	Calculated as A*B*C*D*E
G. Estimate of direct take	85 bats	From Table 4.11-1
H. Estimate of indirect fatalities of young	33 bats	Calculated as F*G
I. Estimated rate of survival of young to reproductive age	0.30	Data are limited, estimated rate of survival of young to reproductive age based on Humphrey and Cope (1976), Humphrey (1982; based on little brown bat [*Myotis lucifugus*])
J. Equivalent indirect adult fatalities estimated	10 bats	Calculated as H*I

Total Take and Authorized Take Request for ITP and ITL

NPMPP has committed to implementing low wind speed curtailment to reduce the risk to bats, and thus reduce overall potential direct take based on results presented in Arnett et al. (2009, 2010). Arnett et al. (2009, 2010) have conducted studies on the mainland researching the effects of low wind speed curtailment on bat mortality. Their studies indicate that most bat collisions occur at relatively low wind speeds, and consequently, the risk of fatalities may be significantly reduced by curtailing operation on nights when winds are light. Their research shows that bat fatalities were reduced by an average of 82 percent (95 percent CI: 52–93 percent) in 2008 and by 72 percent (95 percent CI: 44–86 percent) in 2009 when cut-in speed was increased to 5 m/s and turbine blades were feathered at lower wind speeds. No significant additional improvement over this level was detected when the cut-in speed was increased to 6.5 m/s (Arnett et al. 2009, 2010).

To reduce take, NPMPP plans to implement low wind speed curtailment by raising the cut-in speed of the turbines to 5 m/s and feathering turbine blades below 5 m/s from sunset to sunrise during the months of March to November, a time period when acoustic bat activity was highest at the Kawailoa and Kahuku wind projects (SWCA 2010, 2011b). Based on Arnett et al. (2009, 2010), NPMPP estimates that this application of low wind speed curtailment would decrease fatalities of bats by 65 percent. Thus, the estimated take is reduced from 95 bats to 34 bats (Table 4.11-3).

To address the uncertainty associated with the prediction of take and estimating actual mortality, NPMPP increased this take estimate to develop the maximum authorized take request and also developed tiers of take. The first tier take limit was established at the estimated take level, and a second tier was established to create a maximum combined limit of 150 percent of estimated take (i.e., the combined take of tiers 1 and 2 would be 150 percent of estimated take). Tier 2 provides a conservative buffer for which additional mitigation would be required (Table 4.11-3). To provide confidence that mitigation for Tier 2 will precede the take that is being mitigated, clear triggers and timing for the initiation of planning and implementation of Tier 2 are described in the Project HCP.

Table 4.11-3. Total Take Estimates for Hawaiian Hoary Bat for 21-year Permit Term

Description	Value	Rationale
A. Estimated direct take	85	Row E from Table 4.11-1
B. Estimated indirect take (equivalent adult bats)	10	Row J from Table 4.11-2 (young that would have survived to reproductive age)
C. Estimated proportional reduction in fatalities due to implementation of low wind speed curtailment	0.65	Arnett et al. (2009, 2010)
D. Estimated take (equivalent adult bats)	34 bats	Calculated as (A+B)*(1-C)
Authorized Take Request and Tiers[1/]		
Tier 1	34	Tier 1 represents estimated take; Tier 2 (authorized take request) represents a conservative buffer at 150 percent of estimated take
Tier 2 (Authorized Take Level)	51	
1/ Each tier represents the total take requested for that tier plus lower level tier; take is not additive among tiers.		

Potential Population-level Effects

Recent population estimates for Hawaiian hoary bat have ranged from several hundred to several thousand, although population studies are ongoing (pers. com., F. Bonaccorso, USGS-BRD, 2013;

Menard 2001). The greatest overall numbers of this species are thought to occur on the islands of Hawaii and Kauai (Menard 2001). Systematic monitoring has not been conducted on Oahu to estimate the size (total, or effective based on genetics) of its local population (pers. com., F. Bonaccorso, USGS-BRD, 2013). Therefore, it is difficult to assess the effect that take of Hawaiian hoary bat resulting from the proposed Project may have on the local population of this species; however, the Hawaiian hoary bat population on Oahu may be larger than previously expected. Potential Project impacts are not anticipated to have statewide population-level impacts because Hawaiian hoary bat numbers appear to be concentrated on Maui, Kauai, and the island of Hawaii (USFWS 1998).

Newell's Shearwater

Direct Take

Direct take of Newell's shearwaters could occur as a result of collision with the turbines or the permanent met tower. Avoidance and minimization measures described in Section 2.5.1 of this EIS are assumed to reduce the potential for take due to nighttime lighting and other Project infrastructure to a negligible level. Direct take is estimated based on observed passage rates and flight heights of potential Newell's shearwaters during three seasons of avian radar surveys, the physical attributes of the turbines, and an estimate of the species' ability to avoid collision. Table 4.11-4 presents the relative contributions of the risk at the turbines to the estimate of direct take, using per-turbine and per-met tower annual fatality based on the analysis presented in Sanzenbacher and Cooper (2013).

Table 4.11-4. Direct Take Estimates for Newell's Shearwaters Based on Radar Surveys

Component Interaction	Value	Rationale
A. Annual direct take—turbines	0.0.093 birds/9 turbines/year	Used methodology presented in Sanzenbacher and Cooper (2013) to estimate risk for an array of 10 turbines with a maximum blade tip height of 512 feet (156 meters) and a rotor diameter of 384 feet (117 meters). Used radar data for shearwater-like targets, assumed 99% avoidance.1/
B. Annual direct take—met tower	0.001 birds/met tower/year	Used methodology presented in Sanzenbacher and Cooper (2013) to estimate risk for an un-guyed lattice met tower 262 ft (80 m) tall. Used radar data for shearwater-like targets, assuming 99% avoidance.
C. Permit Term	21 years	
D. Calculated estimate of direct take	1.95 birds	Calculated as (A + B) * C
E. Estimated direct take	4 birds	Increased to account for uncertainty that is inherent when estimating the frequency and magnitude of a rare event over an extended time period.

1/ The methodology presented in Sanzenbacher and Cooper (2013) uses two risk assessments, one for a frontal approach and one for a side approach. As observed flight paths ranged widely, values here represent the mean of the frontal and side approach exposure risks.

Adjustments to this estimate to account for uncertainty are described in Total Take and Authorized Take Request for ITP and ITL, below.

Use of radar passage rate data for shearwater-like targets is a conservative measure of risk for Newell's shearwaters, and this is supported by the results of the Project radar surveys. Unconfirmed targets meeting the criteria for shearwater-like targets are assumed to be Newell's shearwaters after criteria designed to minimize false negatives are applied (i.e., the mistaken exclusion of a radar target that was a Newell's shearwater). This generates a conservative result because a number of common resident and migrant species would be included as they may meet the criteria for shearwater-like targets, but few Newell's shearwaters would be excluded. During surveys, observers confirmed no Newell's shearwaters but did confirm the identification of 56 individuals of at least 5 species that were not Newell's shearwaters including barn owl and Pacific golden-plover (Sanzenbacher and Cooper 2013 [Appendix B of the Project HCP]). Each of these species was considered a potential mimic of Newell's shearwater flight patterns. Thus, radar surveys are certain to over-count Newell's shearwaters. Shearwater-like targets from Project radar surveys peaked in the spring and were lowest during the summer, contrary to expectations based on life history information (Harris 1966; Ainley et al. 1997; Gray and Hamer 2001), which could be explained by the presence of migrant species in spring and fall that can mimic shearwater radar signatures (Appendix B of the Project HCP). Flight profiles of the shearwater-like radar targets at Na Pua Makani also suggest that some of the shearwater-like targets are not Newell's shearwaters, as flight heights observed at Na Pua Makani varied seasonally (Sanzenbacher and Cooper 2013 [Appendix B of the Project HCP]). Variation in flight height by season is most likely a result of seasonal changes in the composition of species that make up the shearwater-like targets. These observations indicate that the measured passage rate of shearwater-like targets at Na Pua Makani is higher than the passage rate of actual Newell's shearwaters, which ultimately results in a conservative estimate of take.

Pre-construction radar studies at other northern Oahu wind projects support that radar results provide a conservative picture of use in the area, and results from post-construction mortality monitoring efforts at these projects support that the risk to Newell's shearwaters on Oahu is low. No Newell's shearwaters were confirmed during radar surveys at the Kahuku or Kawailoa wind projects, and summer passage rates of shearwater-like targets at the two projects were comparable to the summer passage rate documented at Na Pua Makani (Day and Cooper 2008; Cooper et al. 2009). In each case, fall passage rates were higher than during the expected summer peak period. Fall passage rates at Kawailoa were more than twice the summer rates, and contamination of their fall radar data by non-shearwater mimics was highlighted as a likely cause (Cooper et al. 2009). Post-construction mortality monitoring efforts on Oahu wind projects during one peak breeding season at Kawailoa and two peak breeding seasons at Kahuku have not documented a single Newell's shearwater fatality, nor have any been found at operational wind facilities on Maui, where the species is known to breed (Wood and Bily 2008; A. Nadig, USFWS, pers. com., 2014).

In assessing the risk of interactions with wind energy facilities, the term "avoidance rate" is defined as the probability that an individual bird that nears the airspace of a turbine is able to avoid colliding with it. Behavioral studies of Hawaiian procellariids (shearwaters and petrels) are few. Due to small sample sizes, the similarity of flight characteristics, and similar evolutionary environments, avoidance information for these taxa are best considered as a group. Evidence suggests that Hawaiian petrels and Newell's shearwaters have very high avoidance rates of structures, perhaps greater than 99 percent (Sanzenbacher and Cooper 2013), but collisions with power lines remain a concern especially on Kauai. Swift (2004) documented only one collision of a

Hawaiian petrel with a fence line in 1,539 passes. Although observed avoidance rates are high, collisions with power lines remain a concern on Kauai, which is likely driven by the large population of breeding birds in combination with the parallel orientation of power lines relative to the coast line and the presence of power lines that are in strong relief relative to the surrounding topography and vegetation (Griesemer and Holmes 2011).

Given the strong likelihood that some of the shearwater-like targets are not Newell's shearwaters and evidence that Hawaiian procellariids' avoidance is close to 99 percent, 99 percent avoidance is used to assess risk for Newell's shearwaters at Project turbines (Table 4.11-4). NPMPP has also proposed to implement low wind speed curtailment during March–November to reduce Hawaiian hoary bat fatalities. This minimization measure is not taken into account in the estimate of direct take for Newell's shearwaters, increasing the conservatism of the direct take estimate. Furthermore, this risk analysis assumes that turbines are spinning 24 hours per day year round, which is a highly conservative assumption given that turbines typically produce power approximately 40 percent of the time (pers. com., NPMPP, 2013).

The likelihood for Newell's shearwaters to collide with other Project components is negligible as shearwaters are known to demonstrate a high level of avoidance behavior. These components include construction cranes, the permanent met tower, transmission lines, and vehicles, if driven at night. Construction equipment would be present for relatively short periods and is highly visible. There are no known Newell's shearwater breeding colonies on Oahu and passage rates of potential Newell's shearwaters during Project nocturnal radar surveys were very low. Additionally, although nighttime construction lighting could attract Newell's shearwaters, if present, any potential impact will be minimized by using shielded lights (unless essential for safety reasons). In addition, a biological monitor will be present during any nighttime construction. Vehicles on the Project site would typically avoid times when Newell's shearwaters would be expected to transit the site. Collectively, based on the information above, risk of take associated with these Project activities or collision associated with these Project components is considered negligible.

Indirect Take

The potential for indirect take of Newell's shearwaters exists if birds transit the site while flying to or from an undiscovered nesting colony (i.e., if an adult were to be killed while incubating an egg or rearing a chick). However, not all direct take of adults flying to or from a potential nesting colony would result in the loss of young because not all adults are breeders; during the spring and summer, nonbreeding individuals also attend breeding colonies (Ainley et al. 1997).

In general, indirect take can be estimated by applying average measures of reproductive effort and success to estimates of direct take. Using the approach in Table 4.11-5, the estimated indirect take over the 21-year permit term of the Project is 2 Newell's shearwater chicks/eggs. Adjustments to this estimate to account for uncertainty are described in Total Take and Authorized Take Request for ITP and ITL, below.

Table 4.11-5. Indirect Take Estimates for Newell's Shearwaters

Component	Value	Rationale
A. Direct take of adults	4	Conservatively assume all direct take are birds that could reproduce. From Table 4.11-4.
B. Proportion of birds attending a colony that are part of a breeding pair	0.80	Conservatively assume a high proportion of birds attending a colony breed (Telfer 1986; Ainley et al. 2001; Griesemer and Holmes 2011).
C. Proportion of breeding pairs that fledge young	0.60	Conservatively assume a high rate of breeding success given that any potential colony on Oahu is unmanaged and subject to potential predation (Telfer 1986; Ainley et al. 1995; Griesemer and Holmes 2011).
D. Number of young per pair	1	Ainley et al. 1997
E. Parental contribution	1	Assume both pair members are required to successfully raise young (Ainley et al. 1997).
F. Calculated estimated indirect take (chicks or eggs)	1.92	Calculated as A * B * C * D * E
G. Estimated Indirect Take	2	

Total Take and Authorized Take Request for ITP and ITL

Based on the assumptions and analysis above, the combined estimated direct and indirect take for a 21-year permit term is presented in Table 4.11-6. The calculated estimate is increased in the authorized take request to account for uncertainty in the estimation of take.

Table 4.11-6. Total Take Estimates for Newell's Shearwaters for 21-year Permit Term

Description	Value	Rationale
A. Estimated direct take (adults/fledged young)	1.95	Row D from Table 4.11-4
B. Estimated indirect take (chicks/eggs)	1.92	Row F from Table 4.11-5
Authorized Take Request		
Adults/fledged young	**4**	**Increased to account for uncertainty**
Chicks/eggs	**2**	

Potential Population-level Effects

Should the maximum requested take of 4 adult/fledgling Newell's shearwaters occur, it should not have a population-level impact, as it would represent an increase in the mortality rate of less than 0.01 percent of the population distributed over the 21-year permit term. However, requested take is based on numerous conservative assumptions, and this impact does not take into consideration Project mitigation that should serve to reduce take and, as a result, any population-level impact. Mitigation measures the Project has committed to (Section 2.5.2) will provide a net benefit, and this provides an additional level of assurance that no population level effects should result from Project construction and operation.

Hawaiian Goose

Direct Take

The most likely potential source of direct Hawaiian goose take is collision associated with an operational turbine, as has been documented at operational wind facilities on Maui (pers. com., USFWS, 2013). To assess the potential for direct take, we considered the potential changes in Hawaiian goose populations in the vicinity of the Project over the permit term, potential use of the wind farm site by Hawaiian geese, and the potential for collision of Hawaiian geese with Project turbines.

Although prior to the winter of 2013/2014 Hawaiian geese did not previously occur on Oahu, in March 2014 two translocated adult geese and three goslings were documented at James Campbell NWR, which is less than 1 mile from the wind farm site. The adults settled on Oahu and nested following dispersal after being translocated from Kauai to Hawaii. Two of the three goslings fledged, but the adult male is assumed to have died in 2015 (pers. com., A. Nadig, USFWS, 2015). There is potential for this population to grow through future reproduction and the arrival of additional birds. Plans to continue translocation efforts from Kauai to Maui and the island of Hawaii until 2016, combined with the USFWS's intention to manage a population of Hawaiian geese on Oahu, suggest it is likely that additional Hawaiian geese will be present in future years (pers. com., A. Nadig, USFWS, 2015).

Several assumptions were identified to provide a basis for estimating take of the Hawaiian goose because it is not known whether geese will survive on Oahu and how quickly any such population would grow. These include the assumptions that an adult pair of Hawaiian geese will arrive in both 2015 and 2016 and that two key life history parameters, survival (80 percent annual survival of all age classes) and reproduction (50 percent of adult pairs produce 3 young each year) occur. Assuming that USFWS management efforts on the refuge will control predators, the Hawaiian goose is likely to successfully reproduce, and survival and reproductive rates are based on the species life history information. Using this information, we estimate the combined effect of periodic arrival of translocated birds and on-island reproduction will result in a population of approximately 15 resident Hawaiian geese along the north shore of Oahu during the first 10 years of the permit term. The success of management of this population in the form of predator control around nesting areas will likely determine the long-term trajectory of the population, but assuming ongoing and successful active management and the same life history parameters, we estimate a population of approximately 50 Hawaiian geese could be resident on the north shore of Oahu by the end of the 21-year permit term.

These birds are likely to use James Campbell NWR, surrounding wetland areas, golf courses, and other areas where short grass or vegetation provide opportunities to forage. To facilitate required post-construction monitoring efforts at some operational wind projects, vegetated areas beneath turbines are regularly maintained, and these may attract the Hawaiian goose. Therefore, it is likely that Hawaiian geese in the vicinity will fly through the wind farm site as well as potentially use the post-construction monitoring plots for foraging.

During the first approximately 9 years of operation at the 20-turbine Kaheawa I Wind Project on Maui, 21 Hawaiian goose fatalities were found, or 0.11 fatalities per turbine per year. However, the population of Hawaiian geese is currently much higher on Maui than on Oahu, with a flock of more than 100 currently resident in the vicinity of the Kaheawa I Wind Project (pers. com., A. Nadig, USFWS, 2014). Therefore, take at the Project is likely to be substantially lower than that observed on Maui. Assuming risk of collision is a function of population in the vicinity and assuming the population will grow over time, direct take for the Project would result in increasing per-turbine fatalities per year. Because the estimated population on Oahu, given the conservative assumptions described above, would be approximately 50 Hawaiian geese at the end of the permit term, it is assumed the fatality rate at the end of the permit term would be approximately half that currently found at Kaheawa I Wind Project (Table 4.11-7). Adjustments to this estimate to account for uncertainty are described in Total Take and Authorized Take Request for ITP and ITL, below.

Table 4.11-7. Direct Take Estimates for Hawaiian Goose[1/]

Component Interaction	Value	Rationale
A: Number of turbines	9	
B:Annual per turbine fatality rate at Kaheawa I Wind Project	0.11	Calculated as 21 fatalities/9.33 years/20 turbines
C: Permit Term	21 years	
D: Direct take at turbines (years 1–5)	0.35	Calculated as A*B*(7/100)*5; assumes average population of Hawaiian geese at the Project is 7 for years 1 – 5 compared to a population at Kaheawa Pastures I of 100
E: Direct take at turbines (years 6–10)	0.64	Calculated as A*B*(13/100)*5; assumes average population of Hawaiian geese at the Project is 13 for years 6 – 10 compared to a population at Kaheawa Pastures I of 100
F: Direct take at turbines (years 11–15)	1.09	Calculated as A*B*(22/100)*5; assumes average population of Hawaiian geese at the Project is 22 for years 11 – 15 compared to a population at Kaheawa Pastures I of 100
G: Direct take at turbines (years 16–21)	2.38	Calculated as A*B*(40/100)*6; assumes average population of Hawaiian geese at the Project is 40 for years 16 – 21 compared to a population at Kaheawa Pastures I of 100
H: Estimate of direct take	4.46	Calculated as D + E + F + G
1/ Risk estimates were based on the assumption that risk is proportionate to population size. This estimate assumes that annual fatality per turbine was 0.11 when the population size equals 100 geese locally, as found at Kaheawa Pastures I, and population increases in the vicinity of the Project from the current population of 3 birds to approximately 50 birds over the permit term. Population values represent 5- or 6-year averages of the population model for each period analyzed.		

Indirect Take

Hawaiian goose biology suggests they are not likely to collide with turbines and associated structures when they are breeding, as they are unlikely to fly during this period; therefore, the potential for indirect take of the Hawaiian goose is low. The Hawaiian goose is extremely territorial during the breeding season. Males strongly defend nesting territories while the females are incubating, and both parents attend and defend goslings until they fledge (Banko et al. 1999). Finally, adults molt and are flightless during the last 4 to 6 weeks of the breeding season (USFWS 2004). All of these factors suggest there is a low likelihood that the fatality of an adult Hawaiian goose would result in the indirect take of dependent young or eggs. Nevertheless, take of the Hawaiian goose has occurred during the peak breeding months (October–March) at Kaheawa I Wind Project (pers. com., USFWS, 2013), and it is possible that some of these birds were caring for young.

Hu (1998) found that the average pair of Hawaiian geese produced 0.30 fledglings annually. Applying this information with other assumptions, we present estimates of indirect take for the

Hawaiian goose in Table 4.11-8. Adjustments to this estimate to account for uncertainty are described in Total Take and Authorized Take Request for ITP and ITL, below.

Table 4.11-8. Indirect Take Estimates for Hawaiian Goose

Component Interaction	Value	Rationale
A: Estimate of direct take	4.46	Row H from Table 4.11-7
B:Average number of fledglings per nesting pair	0.30	Hu (1998)
C: Proportion of pairs likely to nest	0.60	Banko (1988)
D: Parental contribution	1	Conservatively assumes both adults are required to fledge young
E: Estimate of indirect take of equivalent fledged young	0.80	Calculated as A*B*C*D

Total Take and Authorized Take Request for ITP and ITL

Based on the assumptions and analysis above, the combined estimated direct and indirect take for a 21-year permit term is presented in Table 4.11-9. Given the numerous conservative assumptions used regarding the establishment and success of a Hawaiian goose population in the Project vicinity and the associated risk of collision, the estimated take is rounded up to determine the Authorized Take Request.

Table 4.11-9. Total Take Estimates for Hawaiian Goose for 21-year Permit Term

Description	Value	Rationale
A: Estimated direct take (adults/fledged young)	4.46	Row H from Table 4.11-7
B: Estimated indirect take (equivalent fledged young)	0.80	Row E from Table 4.11-8
D: Estimated take (equivalent adults/fledged young)	5.26	Calculated as A + B
Authorized Take Request		
Authorized Take Request	**6**	**Rounded up**

Potential Population-level Effects

Should the maximum requested take of 6 Hawaiian geese occur, it should not have a population-level impact, as it would represent an increase in mortality rate of less than 0.3 percent of the population distributed over the 21-year permit term. Furthermore, requested take is based on numerous conservative assumptions. Potential Project impacts should not have population level effects as the state population is growing (USFWS 2004).

Waterbirds (Hawaiian Duck, Hawaiian Stilt, Hawaiian Coot, Hawaiian Moorhen)

Direct Take

Direct take of Hawaiian duck, Hawaiian stilt, Hawaiian coot, and Hawaiian moorhen is anticipated to be low because of the lack of habitat, absence of waterbirds observed during the Project biological surveys, and the ability of the taxa to avoid collisions. Direct take of Hawaiian duck is also anticipated to be low because of the absence of non-hybrid Hawaiian ducks on Oahu; however, plans by DOFAW to reintroduce the species to Oahu could result in the species' presence late in the permit term. Direct take for each of these four waterbird species could occur as a result of collision with the turbines. The potential for take resulting with collision with turbines is described in more detail below.

Overall, waterbirds are expected to have a low frequency of transiting the wind farm site because of their limited presence in the Project vicinity and demonstrated avoidance behavior. Hawaiian stilts, Hawaiian coots, and Hawaiian moorhens were not detected at any time during the 1 year of avian point count surveys in the wind farm site, although they were observed at the nearby James Campbell NWR (Hobdy 2013a; Tetra Tech 2014b). Only Hawaiian duck-mallard hybrids are currently documented on Oahu and were observed during avian point count surveys at the nearby James Campbell NWR (Browne et al. 1993, Fowler et al. 2009, Tetra Tech 2014b). As a group, waterbirds have shown high avoidance of obstacles, including turbines and other objects (Erickson et al. 2002; Jain 2005; Johnson and Erickson 2011), suggesting waterbirds have a low risk of collision with Project turbines. This avoidance behavior is consistent with Hawaiian waterbird behavior, because no Hawaiian ducks (or hybrids), Hawaiian stilts, Hawaiian coots, or Hawaiian moorhens have been detected as fatalities at existing wind facilities in the Hawaiian Islands (USFWS, pers. comm. 2014).

As identified above, due to the low expected frequency of waterbirds transiting the Project and the ability of waterbirds to detect and avoid obstacles, the risk of collision with other Project components is considered negligible. Project components such as construction equipment, the met tower, and the O&M building are stationary or slow-moving, and are more visible and affect a much smaller portion of the airspace in the wind farm site than turbines. Project transmission lines will be marked to increase visibility according to Avian Power Line Interaction Committee standards, which will make any risk of collision with this Project component negligible. Additionally, there is no waterbird habitat in the Project; therefore, the potential for vehicles to kill waterbirds at the Project is negligible.

Taking all of these factors in to consideration, the estimated direct take over the 21-year permit term of the Project is one Hawaiian duck, one Hawaiian stilt, one Hawaiian coot, and one Hawaiian moorhen. Adjustments to this estimate to account for uncertainty are described in Total Take and Authorized Take Request for ITP and ITL, below.

Indirect Take

Indirect take of listed waterbirds could occur if adults with eggs or dependent young occur as a fatality due to the Project. However, such indirect take is unlikely. Hawaiian waterbirds are only likely to move among wetlands after young are independent, from fall to early spring, which are generally non-breeding periods (Nagata 1983; Engilis and Pratt 1993; Reed et al. 1998a; Pratt and Brisbin 2002). All Hawaiian waterbirds are precocial, but dependence on adults for brooding, food, and/or protection ranges from a few weeks to several months, during which the adult providing care is unlikely to move among wetlands. Taking this information into account, the potential for indirect take is considered negligible.

Total Take and Authorized Take Request for ITP and ITL

Based on the assumptions and analysis above, the combined estimated direct and indirect take for a 21-year permit term is presented in Table 4.11-10. In recognition of the uncertainty surrounding the prediction of take and the estimation of actual mortality, take estimates for Hawaiian duck, Hawaiian stilt, Hawaiian coot, and Hawaiian moorhen were increased for the authorized take request. Furthermore, as the estimated benefit of the described mitigation for Hawaiian coot and Hawaiian moorhen are substantially higher for these species than for the Hawaiian duck and Hawaiian stilt, the authorized take request is increased to reflect this difference (Section 4.11.3.2).

Table 4.11-10. Total Take Estimates for Hawaiian Waterbirds for 21-year Permit Term

Description	Species	Adults	Rationale
A: Total estimated take (adults)	Hawaiian duck	1	No current population on Oahu; anticipated low frequency of transit and high avoidance should a population be established; indirect take assumed to be zero
B: Total estimated take (adults)	Hawaiian stilt	1	Low frequency of transit, high avoidance; indirect take assumed to be zero
C: Total estimated take (adults)	Hawaiian coot	1	Low frequency of transit, high avoidance; indirect take assumed to be zero
D: Total estimated take (adults)	Hawaiian moorhen	1	Low frequency of transit, high avoidance; indirect take assumed to be zero
Authorized Take Request			
Authorized Take Request	**Hawaiian duck**	**4**	**Increased to account for uncertainty and expected mitigation benefit**
	Hawaiian stilt	**4**	
	Hawaiian coot	**8**	
	Hawaiian moorhen	**8**	

Potential Population-level Effects

Should the maximum requested take of 4 Hawaiian ducks, 4 Hawaiian stilts, 8 Hawaiian coots, or 8 Hawaiian moorhens take place over the 21-year permit term, it should not have a population-level impact on the respective populations. Assuming the species most likely to have a population-level effect is that with the smallest current population and the largest take, we evaluated the requested take in the context of the Hawaiian moorhen. USFWS (2011e) estimates that DOFAW bi-annual surveys may underestimate Hawaiian moorhen presence by two to three times. Assuming half of the population is missed during surveys, the statewide population is conservatively 600 birds. Thus, the maximum estimated take could represent 1.3 percent of the population distributed over the 21-year permit term. Taking into account the mitigation described in Section 2.5.2, this estimated mortality should not have a population-level effect on the Hawaiian moorhen. Furthermore, given that the Project should have no population-level effect on the Hawaiian moorhen, the more robust populations of Hawaiian duck, Hawaiian stilt, and Hawaiian coot should also not experience population-level effects.

Hawaiian Short-eared Owl

Direct Take

Direct take of Hawaiian short-eared owl could occur as a result of collision with the turbines. However, turbine collision associated fatalities are likely to be low for two reasons. First, Hawaiian short-eared owls are expected to use the wind farm site only as irregular visitors. Second, given the low likelihood of breeding in the area and that high flights are typically used only as pre-breeding display flights, Hawaiian short-eared owls using the area are unlikely to fly within the rotor swept area (Wiggins et al. 2006).

No Hawaiian short-eared owl fatalities have been documented at operational wind farms on Oahu (pers. com., USFWS, 2013). This may be due to the low density of Hawaiian short-eared owls on Oahu, where the subspecies is rare (Klavitter 2009; Pyle and Pyle 2009). Conversely, owl fatalities have occurred at the operational Kaheawa Pastures I Wind Farm on Maui where Hawaiian short-eared owls were detected regularly during preconstruction surveys (Kaheawa Wind Power, LLC 2006), and where the species is much more common than on Oahu (Klavitter 2009; Pyle and Pyle 2009). This information suggests the risk of Hawaiian short-eared owl collision with turbines may be related to owl density and/or breeding activity, which is either very low or does not exist on the Project.

No Hawaiian short-eared owls were detected during Project surveys within or in the vicinity of the wind farm site. However, a single observation from the Kahuku Wind Project during pre-construction radar surveys (Day and Cooper 2008) indicates the species may occur as an irregular visitor to the wind farm site. Based on the rarity of observations of the species during pre-construction survey efforts at the Project and the Kahuku Wind Project (SWCA 2010; Tetra Tech 2014b), it is unlikely that the Hawaiian short-eared owl breeds in the wind farm site. The low frequency of use of the wind farm site by Hawaiian short-eared owls and the low likelihood of the presence of breeding pairs suggest the risk of collision for Hawaiian short-eared owls with turbines is low. In addition, NPMPP has proposed to implement low wind speed curtailment during March–November to reduce Hawaiian hoary bat fatalities. This minimization measure should further reduce the potential for a collision of a Hawaiian short-eared owl because although Hawaiian short-eared owls are largely diurnal they are also sometimes active at night.

The risk of collision with other Project components is considered negligible due to the avoidance and minimization measures proposed, the low potential for the owl to use the wind farm site, and the owl's highly maneuverable flight (Wiggins et al. 2006). A 25 mph (40 kph) speed limit during the day and 10 mph (16 kph) speed limit at night will minimize the risk of Hawaiian short-eared owls colliding with Project vehicles. The selection of an unguyed, free-standing met tower maximizes the ability of owls to detect the structure and avoid collision and the markings of Project transmission lines to increase visibility minimizes the potential for owls to collide with this Project component. The low frequency of use of the area by Hawaiian short-eared owls and their estimated ability to detect and avoid Project components during typical foraging activities makes the risk of collision with Project construction equipment negligible.

Taking all of these factors into consideration, the estimated direct take over the 21-year permit term of the Project is one Hawaiian short-eared owl. Adjustments to this estimate to account for uncertainty are described in Total Take and Authorized Take Request for ITL, below.

Indirect Take

The direct take of a Hawaiian short-eared owl during the breeding season may result in the indirect loss of dependent chick(s) or egg(s). Although results of Project biological surveys and pre-construction survey at the Kahuku Wind Project suggest Hawaiian short-eared owl use the area as irregular visitors rather than residents and local breeders, there is the potential for Hawaiian short-eared owls to breed somewhere in the vicinity of the Project and to occasionally transit the wind farm site or use it for foraging while breeding.

Life history information and the calculation for indirect take for the Hawaiian short-eared owls are presented in Table 4.11-11. Information includes the potential for a Hawaiian short-eared owl to be nesting, the likelihood of nesting failure should a nesting bird be taken, and the number of eggs in a clutch. Conservatively, the calculation assumes that any direct take would be of an adult bird. Adjustments to this estimate to account for uncertainty are described in Total Take and Authorized Take Request for ITL, below.

Table 4.11-11. Indirect Take Estimates for Hawaiian Short-eared Owls

Component	Value	Rationale
A: Direct take of adults	4	Conservatively assume all direct take are adult birds that could reproduce.
B: Proportion of year likely to be caring for young/eggs	0.17	Nest once per year with no peak period and young are dependent for approximately 2 months (Mitchell et al. 2005). Calculated as 2 months/12 months.
C. Average clutch size	5.6	Murray 1976 (for North America). Limited data suggests island populations may have smaller clutches.
D: Parental contribution	1	Assume both pair members are required to successfully raise young. Male provisions female and young and defends nest while female incubates and broods (Wiggins et al. 2006).
E: Total estimated indirect take (chicks or eggs)	3.81	Calculated as A * B * C * D
F. Estimated Indirect Take	4	

Total Take and Authorized Take Request for ITL

Based on the assumptions and analysis above, the combined estimated direct and indirect take for a 21-year permit term is presented in Table 4.11-12. In recognition of the uncertainty surrounding the prediction of take and the estimation of actual mortality, take estimates for Hawaiian short-eared owl were increased for the authorized take request.

Table 4.11-12. Total Take Estimates for Hawaiian Short-eared Owl for 21-year Permit Term

Description	Value	Rationale
A: Estimated direct take (adults/fledged young)	1	Section 4.11.3.1, Hawaiian short-eared owl
B: Estimated indirect take (chicks/eggs)	0.93	Row E from Table 4.11-11
Authorized Take Request		
Adults/fledged young	**4**	**Increased to account for uncertainty**
Chicks/eggs	**4**	

Potential Population-level Effects

No population estimates are available for Hawaiian short-eared owls on Oahu, or even more broadly, in the Hawaiian Islands. Due to the lack of systematic monitoring on Oahu, it is difficult to assess the effect that take of Hawaiian short-eared owls resulting from the Project may have on the local population of this species, but anecdotal observations suggest the Oahu population is low and any take may be of concern. Nevertheless, population-level impacts are not anticipated because the requested take is 4 adult owls and 4 chicks or eggs over 21 years, which is low.

4.11.3.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP are designed to reduce the risk of incidental take to threatened and endangered species. Specific avoidance and minimization measures were taken into account in the analysis of overall estimated take of threatened and endangered species. These are described in detail in Section 2.5 of this EIS. These measures include:

- Below-ground installation of Project electrical collection system;
- Temporal application of low wind speed curtailment;
- The use of a biological monitor for required night time construction;
- Marking the above-ground transmission line to improve visibility and follow Avian Protection Plan Guidelines (APLIC 2012);
- Avoiding use of barbed wire on perimeter fences; and
- Lighting restrictions.

As part of the avoidance and minimization measures, NPMPP will develop post-construction monitoring plots beneath Project wind turbines to facilitate the estimation of fatalities associated with the Project and inform adaptive management practices to adjust Project operations with the goal of minimizing, to the extent practicable, overall Project take (Section 2.5). The low-growing vegetation required in these plots has the potential to attract the Hawaiian goose and increase its risk of collision with Project turbines. However, as described in the avoidance and minimization measures, NPMPP will work with USFWS and DOFAW to minimize this risk through the selection and appropriate management of post-construction monitoring plot vegetation. The effect of this increased risk was accounted for in the estimation of overall take of the Hawaiian goose.

Impacts of HCP Mitigation

As described in Section 2.5.2, under the HCP, mitigation activities are proposed in the Hamakua Marsh and Poamoho Ridge mitigation areas and in the James Campbell NWR, in addition to funding new research and management for the Newell's shearwater and Hawaiian short-eared owl. These activities are intended to directly benefit the Covered Species through research and management or protect and enhance native habitats for the Covered Species, achieving a net benefit and offsetting the effects of estimated overall Project take.

Fence installation at the Hamakua Marsh would result in a temporary local disturbance to waterbirds due to worker and vehicle noise and ground disturbance. This impact is expected to be negligible because the area is currently disturbed by a variety of anthropogenic activities. The resulting fence and associated public outreach would reduce human disturbance to listed waterbirds, listed waterbird deaths resulting from vehicle collisions, and predation/disturbance by dogs.

At Poamoho Ridge, the removal of feral pigs and reduction in invasive plant species could result in a temporary, local disturbance to Hawaiian hoary bats due to worker and equipment noise, helicopter noise, ground disturbance, and removal of invasive trees that could be used by Hawaiian hoary bats roost trees. Impacts associated with disturbance are expected to be negligible. Potential impacts to Hawaiian hoary bat roosting habitat would be minimized through the selection of vegetation control methods and the timing of activities; these measures will be described in the Poamoho Management Plan, the development of which will be funded by as a mitigation measure by NPMPP. Overall, the effects of potentially disturbing activities and potential impacts to Hawaiian hoary bat roosting habitat are designed to achieve improvement to Hawaiian hoary bat habitat and result in a net benefit for the Hawaiian hoary bat from the action.

As discussed in Chapter 2, the environmental effects of fencing for Hawaiian goose mitigation in the James Campbell NWR have been evaluated under the NEPA Environmental Assessment for the James Campbell NWR Comprehensive Conservation Plan (USFWS 2011a). These activities would have no significant adverse impacts on the environmental resources and would ultimately protect, maintain, and enhance habitat for endangered species and resources of concern (USFWS 2011a). Ultimately, mitigation activities would have beneficial effects to the Covered Species as well as numerous species of MBTA-protected waterbird, shorebird, and waterfowl species that occur there.

Overall, HCP conservation measures are expected to provide net benefits to the Covered Species. Any temporary impacts are considered negligible.

4.11.3.3 Mitigation for Unavoidable Impacts

Mitigation for unavoidable impacts to threatened and endangered species is provided under the Project HCP and discussed above and described in Sections 2.5.1 and 2.5.2. These avoidance and minimization measures and species-specific mitigation activities were designed to provide a net benefit to the Covered Species.

Additional BMPs listed in Table 2-6, which will be implemented by NPMPP, will minimize impacts to threatened and endangered species. These measures include:

- Prepare and implement a TESC Plan which would help prevent erosion.
- Restore disturbed areas to pre-existing grades and revegetate these areas with non-invasive resident species.
- Vehicle operators transporting materials to the Project site from off-site will be required to follow protocols for removing soils and plant material from vehicles and equipment prior to entry onto the site.

- An FMP will be implemented during construction and operations.

No additional avoidance, minimization, or mitigation measures are required.

4.11.3.4 Cumulative Effects

The analysis area for cumulative effects for threatened and endangered species encompasses the Island of Oahu to capture other operating wind farms on Oahu that specifically address, and could impact, the same population of species that are the focus of the Na Pua Makani HCP. The following discussion addresses cumulative impacts under Alternative 2 (including the Modified Proposed Action Option) to each Covered Species. Past, present, and reasonably foreseeable actions that overlap in space and time with the impacts of the Project are identified in Table 4.2-2 and described below where appropriate.

At the State level (beyond the extent of the cumulative effects analysis area), the Na Pua Makani Project is one of many projects that have the potential to impact threatened and endangered species on a range-wide basis. In addition to the projects listed in Table 4.2-2, other commercial wind projects in Hawaii include Auwahi (Maui), Kaheawa I and II (Maui), Pakini Nui (Hawaii Island), and Hawi (Hawaii Island); other proposed commercial wind projects include Kauai Wind Power (Kauai). These projects also have the potential to result in incidental take of listed species and are implementing HCPs, developing HCPs, or in consultation with USFWS regarding approaches to managing the risk of incidental take associated with the project. It is anticipated that due to the State's RPS objectives, wind energy development in Hawaii will continue. Further, rapid population growth and real estate development have occurred on the islands of Oahu, Maui, and Kauai, which are expected to continue. Risk of seabirds becoming disoriented by human light sources, loss of nesting or roosting habitat, pesticide use, increased obstacles that could pose collision risks, and increased predation may also result from this development. It is assumed that future development projects will be conducted in compliance with all applicable local, State, and Federal environmental regulations; however, projects involving the development of HCPs are among the few that will implement measures to offset take of listed species.

Hawaiian Hoary Bat

The Hawaiian hoary bat is listed as endangered at the Federal and State level. As described in Section 3.9 and above, there remains much uncertainty related to the distribution, abundance, and range-wide trends of the Hawaiian hoary bat. Therefore, it is difficult to assess the significance of individual projects or cumulative impacts to the Oahu population as a whole. On Oahu, past development and land use have resulted in the loss of roosting habitat through the conversion of forest to agriculture and development. Ongoing impacts such as wildfire and development have the potential to result in further habitat loss.

The Project, existing operational wind farms on Oahu, and two proposed development projects have the potential to result in the incidental take of the Hawaiian hoary bat. The Project may cause the incidental take of this species through collisions or other interactions with wind turbines, which will be mitigated for through a combination of habitat protection/restoration at Poamoho Ridge and research. These restoration and research efforts are designed to result in a net benefit to the Hawaiian hoary bat. Incidental take also has the potential to occur in association with the operational Kahuku and Kawailoa wind projects (collisions) and with the proposed Envision Laie development project and Turtle Bay resort expansion (removal of habitat). The primary component of mitigation under the Kahuku HCP and the Kawailoa HCP are bat habitat restoration and research. Restoration efforts are expected to increase survival and reproductive success of bats commensurate with the authorized take levels such that a net benefit is achieved. Furthermore, it is assumed that the proposed Envision Laie development and Turtle Bay resort expansion would mitigate for any impacts to Hawaiian hoary bat roosting habitat. For these reasons, Alternative 2 (including the Modified Proposed Action Option) in combination with past, present, and reasonably foreseeable projects would not result in significant adverse cumulative effects to the Hawaiian hoary bat.

Newell's Shearwater

Newell's shearwater is listed as threatened at the Federal and State level. As described in Section 3.9, while suitable breeding habitat is present on the island, no Newell's shearwater breeding colonies have been identified to date on Oahu. On Oahu, past development (resulting in light disorientation and collision) and impacts from non-native mammals have likely dramatically reduced or eliminated the population of breeding birds and presence of nesting colonies on the island. Increasing development has the potential to further impact any residual population.

The Project, existing operational wind farms on Oahu, and two proposed development projects have the potential to result in the incidental take of the Newell's shearwater. The Project has the potential to result in the incidental take of this species through collisions with wind turbines, though at a low level. Potential take will be fully mitigated for through contributions to a National Fish and Wildlife Foundation fund, as recommended by the USFWS and DOFAW (Tetra Tech 2014c). Incidental take also has the potential to occur in association with the operational Kahuku and Kawailoa wind projects (collisions) and with the proposed Envision Laie development project and Turtle Bay resort expansion (collisions, light disorientation). The primary component of mitigation under the Kahuku HCP and the Kawailoa HCP are colony management at the Makamaka'ole site on West Maui and predator reduction at a colony on Kauai, respectively. Colony management efforts and predator control efforts are expected to increase survival and reproductive success of Newell's shearwater commensurate with the authorized take levels such that a net benefit is achieved. Furthermore, it is assumed that the proposed Envision Laie development and Turtle Bay resort expansion would mitigate for any impacts to Newell's shearwaters. For these reasons, Alternative 2 (including the Modified Proposed Action Option), in combination with past, present, and reasonably foreseeable projects, would result not result in significant adverse cumulative effects to Newell's shearwater.

Hawaiian Goose

Hawaiian goose is listed as endangered at the Federal and State level. As described in Section 3.9, the Hawaiian goose is a recent arrival on the island, the population level is very low, and the future of the population is uncertain. On Oahu, past development, land use, and impacts from non-native mammals extirpated the original population. Increasing development, ongoing changes in land use, and the effects of non-native mammals have the potential to alter the trajectory of the current incipient population.

The Project, existing operational wind farms on Oahu, and two proposed development projects have the potential to result in the incidental take of the Hawaiian goose. The Project has the potential to result in the incidental take of this species through collisions with wind turbines, though the extent of this risk is a function of how the population changes over time. Potential take will be mitigated for through contributions to fund habitat management at James Campbell NWR, as recommended by the USFWS and DOFAW (Tetra Tech 2014c). Incidental take also has the potential to occur in association with the operational Kahuku and Kawailoa wind projects (collisions) and with the proposed Envision Laie development project and Turtle Bay resort expansion (vehicle collisions, predation). The Kahuku and Kawailoa HCPs do not include mitigation for the potential take of the Hawaiian goose, and the species is not included on their ITPs and ITLs, as the arrival of the species on Oahu was not anticipated at the time of their preparation. It is assumed that the Kahuku and Kawailoa wind projects will work with USFWS and DOFAW to amend their HCPs to provide mitigation measures such that these projects would fully mitigate any permitted incidental take. Furthermore, it is assumed that the proposed Envision Laie development and Turtle Bay resort expansion would mitigate for any impacts to the Hawaiian goose. For these reasons, Alternative 2 (including the Modified Proposed Action Option), in combination with past, present, and reasonably foreseeable projects, would not result in significant adverse cumulative effects to the Hawaiian goose.

Waterbirds (Hawaiian Duck, Hawaiian Stilt, Hawaiian Coot, Hawaiian Moorhen, and Hawaiian Duck)

The Hawaiian duck, Hawaiian stilt, Hawaiian coot, and Hawaiian moorhen are all listed as endangered at the Federal and State level. As described in Section 3.9, significant loss of wetland habitat range-wide has contributed to the decline of all four waterbird species. Introduced predators also continue to be a major ongoing cause of waterbird mortality and nest failure.

The Project, existing operational wind farms on Oahu, and two proposed development projects have the potential to result in the incidental take of endangered Hawaiian waterbirds. The wind farm site does not include suitable habitat for waterbirds and has the potential for a low level of incidental take of this species due to collisions. This will be mitigated for through habitat fencing, public education, and monitoring at the Hamakua Marsh site. Incidental take also has the potential to occur in association with the operational Kahuku and Kawailoa wind projects (collisions) and with the proposed Envision Laie development project and Turtle Bay resort expansion (collisions with powerlines). The primary component of mitigation under the Kahuku HCP and the Kawailoa HCP are predator control/vegetation maintenance at the Kawainui/Hamakua Marsh complex and a combination of predator control, weed control, and monitoring at Ukoa Pond, respectively. It is assumed that if mitigation measures outlined in these HCPs are implemented, they would result in a net benefit to endangered Hawaiian waterbirds. Furthermore, it is assumed that the proposed Envision Laie development and Turtle Bay resort expansion would mitigate for any impacts to

Newell's shearwaters. For these reasons, Alternative 2 (including the Modified Proposed Action Option), in combination with past, present, and reasonably foreseeable projects, would not result in significant adverse cumulative effects to the Hawaiian duck, Hawaiian stilt, Hawaiian coot, or Hawaiian moorhen.

Hawaiian Short-eared Owl

The Oahu population of the Hawaiian short-eared owl is listed as endangered by the State of Hawaii. As discussed in Section 3.9, this species is currently rare on Oahu, and has been and continues to be impacted by loss and degradation of habitat, predation by introduced mammals, pesticide poisoning, disease, food shortages, and vehicle collisions. At the same time, the Hawaiian short-eared owl persists in modified landscapes, suggesting an ability to cope with some human development.

The Project, existing operational wind farms on Oahu, and two proposed development projects have the potential to result in the incidental take of the Hawaiian short-eared owl. The Project has the potential to result in the incidental take of this species through collisions with wind turbines, though at a low level. This will be mitigated for through funding of research and management support. Incidental take also has the potential to occur in association with the operational Kahuku and Kawailoa wind projects (collisions) and with the proposed Envision Laie development project and Turtle Bay resort expansion (conversion of foraging habitat). The primary component of mitigation under the Kahuku HCP and Kawailoa HCPs is funding for research and management. It is assumed that if mitigation measures outlined in these HCPs are implemented, they would result in a net benefit to the Hawaiian short-eared owl. Furthermore, it is assumed that the proposed Envision Laie development and Turtle Bay resort expansion would mitigate for any impacts to Hawaiian short-eared owls. For these reasons, Alternative 2 (including the Modified Proposed Action Option), in combination with past, present, and reasonably foreseeable projects, would not result in a significant adverse cumulative effects to the Hawaiian short-eared owl.

4.11.3.5 Summary

Potential adverse effects to threatened and endangered species associated with Alternative 2 (including the Modified Proposed Action Option) include the potential for collision with Project structures, and temporary disturbance associated with implementation of HCP mitigation. HCP mitigation measures would benefit threatened and endangered species over the long term through the protection (fence installation or maintenance) and/or enhancement (invasive plant species control and feral pig removal) of native ecosystems, reduction in predation pressure (predator control), and/or through research and management. With implementation of the Project HCP, direct, indirect, and cumulative effects of Alternative 2 (including the Modified Proposed Action Option) on Hawaiian hoary bats, Newell's shearwater, Hawaiian goose, Hawaiian duck, Hawaiian stilt, Hawaiian coot, Hawaiian moorhen and Hawaiian short-eared owl would be negligible due to the net benefit provided by the species-specific mitigation measures.

4.11.4 Alternative 3—Larger Generation Facility (Up to 12 Turbine Project)

4.11.4.1 Direct and Indirect Impacts of Construction and Operation of the Project

Under Alternative 3, direct and indirect effects on threatened and endangered species would be similar to those described under Alternative 2. However, Alternative 3 would include the construction and operation of additional wind turbines, and construction and use of associated use of additional access roads and electrical collection lines (all other Project facilities would be the same; Table 2-1), Alternative 3 would result in the construction of up to 12 turbines. Implementation of avoidance and minimization measures and standard BMPs, as described under the Proposed Action, would minimize any adverse impacts to threatened and endangered species.

The additional turbines would result in an increased risk of take from collision. For Newell's shearwater, Hawaiian goose, Hawaiian duck, Hawaiian stilt, Hawaiian coot, Hawaiian moorhen, and Hawaiian short-eared owl, the increase in risk is expected to be low. As discussed above under Alternative 2/2a, these species either have strong avoidance ability, lack of habitat in the wind farm site, or would only transit the wind farm site infrequently. For the Hawaiian hoary bat, the likelihood of take from collisions would increase, and as take of this species is expected to be more frequent than the other Covered Species, the increased associated take with Alternative 3 is expected to be higher than that estimated for other Covered Species.

As the HCP currently applies only to the Proposed Action, Alternative 2/2a, final take requests related to Alternative 3 have not been made for any of the Covered Species. Take requests and associated mitigation would be developed as part of future consultation with the USFWS and DOFAW prior to the construction of additional turbines if Alternative 3 were to move forward.

4.11.4.2 Direct and Indirect Impacts of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under a Project HCP implemented under Alternative 3 would be the same as described under Alternative 2/2a. Any additional avoidance and minimization measures identified during future consultations with USFWS and DOFAW prior to the construction of additional turbines under Alternative 3 would be implemented as appropriate.

Impacts of HCP Mitigation

Impacts of HCP mitigation under Alternative 3 would be the same as described under the Proposed Action/Modified Proposed Action Option. Prior to the construction of the additional turbines proposed under Alternative 3, NPMPP would reopen consultation with the USFWS and DOFAW to assess the potential impacts of the additional turbines to listed species and develop appropriate mitigation measures. The impacts of these mitigation measures, both adverse and beneficial, to threatened and endangered species would be evaluated under a separate environmental analysis at that time.

4.11.4.3 Mitigation for Unavoidable Impacts

Mitigation for unavoidable impacts under Alternative 3 would be the same as described under the Proposed Action/Modified Proposed Action Option (Section 4.11.3.3).

4.11.4.4 Cumulative Effects

Cumulative impacts of Alternative 3 would be the same as under Alternative 2/2a. Take from Alternative 3 would be mitigated for through measures identified in consultation with USFWS and DOFAW, and past, present, and reasonably foreseeable projects are assumed to mitigate for potential impacts to threatened and endangered species. Therefore, Alternative 3 in combination with past, present, and reasonably foreseeable projects would result in negligible cumulative effects to each of the Covered Species. Because there would likely be a delay in time of up to 3 years before additional turbines would be built under Alternative 3, new projects and developments in the area will be assessed and reviewed to determine if there are additional cumulative impacts from future unknown projects during the additional associated environmental review.

4.11.4.5 Summary

Potential adverse effects to threatened and endangered species associated with Alternative 3 include the potential for collision with Project structures and temporary disturbance associated with implementation of HCP mitigation. HCP mitigation measures would benefit threatened and endangered species over the long term through the protection (fence installation or maintenance) and/or enhancement (invasive plant species control and feral pig removal) of native ecosystems, reduction in predation pressure (predator control), and/or through research and management. With implementation of the current Project HCP, direct, indirect, and cumulative effects of construction and operation of the first up to 10 turbines under Alternative 3 on Hawaiian hoary bats, Newell's shearwater, Hawaiian goose, Hawaiian stilt, Hawaiian coot, Hawaiian moorhen, Hawaiian duck, and Hawaiian short-eared owl would be negligible due to the net benefit provided by the species-specific mitigation measures. It is anticipated that effects related to the construction and operation of the additional 2 to 4 turbines would also be negligible, as the associated mitigation would be required to result in a net benefit to the species.

4.11.5 Conclusion

Table 4.11-13 summarizes potential impacts to threatened and endangered species resources from the alternatives considered in this analysis.

Table 4.11-13. Summary of Potential Impacts to Threatened and Endangered Species

Species	Impact Issues	No Action Alternative	Alternative 2 – Proposed Action	Alternative 2a – Modified Proposed Action Option	Alternative 3
Hawaiian hoary bat	Incidental Take	No Impact	Negligible	Negligible	Negligible
	Habitat Impacts	No Impact	Negligible	Negligible	Negligible
Newell's shearwater	Incidental Take	No Impact	Negligible	Negligible	Negligible
	Habitat Impacts	No Impact	No Impact	No Impact	No Impact
Hawaiian goose	Incidental Take	No Impact	Negligible	Negligible	Negligible
	Habitat Impacts	No Impact	Negligible	Negligible	Negligible
Hawaiian duck	Incidental Take	No Impact	Negligible	Negligible	Negligible
	Habitat Impacts	No Impact	No Impact	No Impact	No Impact
Hawaiian stilt	Incidental Take	No Impact	Negligible	Negligible	Negligible
	Habitat Impacts	No Impact	No Impact	No Impact	No Impact
Hawaiian coot	Incidental Take	No Impact	Negligible	Negligible	Negligible
	Habitat Impacts	No Impact	No Impact	No Impact	No Impact
Hawaiian moorhen	Incidental Take	No Impact	Negligible	Negligible	Negligible
	Habitat Impacts	No Impact	No Impact	No Impact	No Impact
Hawaiian short-eared owl	Incidental Take	No Impact	Negligible	Negligible	Negligible
	Habitat Impacts	No Impact	No Impact	No Impact	No Impact

4.12 Socioeconomics

4.12.1 Impact Criteria

The following analysis considers potential impacts to population, employment and income, housing, property values, public services, and tax revenues. The potential socioeconomic impacts of the Project are assessed using data derived from the DOE National Renewable Energy Laboratory's Jobs and Economic Development Impacts (JEDI) Wind model (National Renewable Energy Laboratory 2014). The JEDI Wind model allows the user to identify potential impacts assuming general wind industry averages. Impacts are assessed based on the magnitude or intensity, duration, geographic extent, and context of the potential effect. These general impact criteria are summarized in Table 4.12-1.

Table 4.12-1. Impact Criteria for Socioeconomic Resources

Type of Effect	Impact Component	Effects Summary		
Effects on Socioeconomic Resources	Magnitude or Intensity	**High:** Changes in socioeconomic conditions (such as employment, population, or tourism levels) exceed normal limits and trends or greater than 10% increase or decrease.	**Medium:** Changes in socioeconomic conditions are generally within normal limits and trends, or between 5% to 10% increase or decrease.	**Low:** Changes in socioeconomic conditions are generally below normal limits and trends, or <5% increase or decrease.
	Duration	**Permanent:** Changes in socioeconomic conditions persist after the actions that caused the impacts cease.	**Long-term:** Changes in socioeconomic conditions extend up to the operating life of the Project and would return to pre-activity levels sometime after actions causing impacts were to cease.	**Temporary:** Changes in socioeconomic conditions last less than 1 year or the period of project construction.
	Geographic Extent	**Extended:** Potential impacts extend beyond the region, potentially island- or state-wide.	**Regional:** Potential effects extend to the broader region (Koolauloa District).	**Local:** Potential impacts are primarily limited to communities in the immediate vicinity of the Project.
	Context	**Unique:** Potential impacts are to social and economic resources that are unique to the area.	**Important:** Potential impacts are to social and economic resources that are important to the area.	**Common:** Potential impacts are to social and economic resources that are common to the area,

4.12.2 Impacts Common to All Action Alternatives

A number of comments received during the public scoping period and Draft EIS public comment period for this Project were concerned with potential effects on various socioeconomic conditions. Several of these comments are common to all action alternatives and are addressed in the following sections. Other public comments related to socioeconomics are addressed below by alternative, as appropriate.

4.12.2.1 Property Values

Several comments expressed concern that the proposed Project would negatively affect property values and the salability of homes located near the Project site. These types of concerns are often raised when a new wind facility is proposed. Typical concerns related to the potential impact of wind power facilities on residential property values include scenic vista stigma and nuisance stigma (Hoen et al. 2009). Scenic vista stigma is the concern that a home may be devalued because of the view of a wind energy facility and the potential impact of that view on an otherwise scenic vista. Nuisance stigma refers to the potential impact of other factors, such as sound and shadow flicker on residential property values.

Recent studies addressing the potential impact of wind projects on property values have tended to rely on analysis of property sales data and statistical analysis, rather than surveys of real estate professionals. Most of these studies found no evidence that the presence of an operating wind facility affected residential property values (Canning and Simmons 2010; Carter 2011; Hinman 2010; Laposa and Mueller 2010; Magnusson and Gittell 2012). One large-scale study identified some evidence that post-announcement reductions in price occurred prior to actual construction, but faded following the completion of construction (Hoen et al. 2011). One detailed study (Heintzelman and Tuttle 2012) found overall mixed results, with two of the three wind facilities studied affecting property values, while the other one did not. Where effects did exist, this study found that they tended to increase the closer a property was to the nearest wind turbine. One other study (Sunak and Madlener 2012) also found some support for negative effects in proximity to wind turbines, with effects varying based on relative location. Most of these studies concluded that more research is required to more fully understand the impacts of wind facility development on property values.

Potential visual impacts associated with the Project are assessed in Section 4.16 – Visual Resources. Action alternatives 2, 2a, and 3 are situated on ridge tops above residential communities and have the potential to result in visual impacts to these areas. The visual resources analysis uses a number of representative viewpoints to assess the existing environment and visual impacts of the Project. A number of these viewpoints address impacts to residential viewers in a number of nearby residential locations, including the Kahuku community (Viewpoint 04), Kahuku Sugar Mill Historical Site (KOP 05), and the Kahuku Community Hospital and Medical Center (Viewpoint 17). Viewer sensitivity was generally classified as moderate to high in these locations. Visual impact intensity was rated moderate in these locations, primarily due to the influence of the existing Kahuku Wind Farm (see Section 4.16 – Visual Resources).

Views were also assessed from coastal residences in Laie, near Laie Point (Viewpoint 15), approximately 2.3 miles from the wind farm site. Scenic values in this location are high, but impact intensity from this location was classified as moderate due to the distance from the Project. Other potentially affected residential properties not included in the visual resource assessment include several individual residences located immediately east of proposed turbine on the DLNR side, with the closest residence located approximately 814 feet (248 meters) from the closest proposed turbine location.

4.12.2.2 Homeowners' Insurance Rates

One comment received during scoping asked whether the NPMPP was aware of past wind development projects affecting home insurance rates in nearby communities. NPMPP has indicated that they are not aware of this effect, and Tetra Tech is not aware of studies or other documentation that has identified this as a potential impact.

4.12.2.3 Businesses

Concern was expressed during scoping that the Project would result in a loss of business in the Kahuku area. The comment did not identify a specific business or economic sector, but likely relates to tourism, given the importance of that sector to the local economy. Tourism accounted for 26 percent of the employed labor force in Kahuku in 2012 (Table 3.10-3). Impacts to recreation and tourism are assessed in Section 4.15 – Recreation. The recreation and tourism analysis concluded that the impact of the Project on nearby recreation and tourism resources would be negligible to minor under action alternatives 2, 2a, and 3. Therefore, the Project is not expected to have adverse impacts on tourism-related businesses.

It may also be noted that some local businesses would likely benefit from Project-related construction expenditures, as well as spending by construction workers temporarily relocating to the vicinity of the Project for the duration of their employment. These potential small but positive impacts to local businesses are discussed further by alternative, below.

4.12.2.4 Residential Solar Energy or Photovoltaic System Installation

Several comments expressed concern that the Project would adversely affect the ability of homeowners to install rooftop photovoltaic (PV) systems because the Project use capacity on transmission lines. HECO confirmed in public meetings with the community and a letter to NPMPP dated June 5, 2014, that the construction and operation of the Project is not expected to affect the ability of homeowners to install rooftop PV systems. This is the result of the fact that the existing wind projects on the North Shore of Oahu and this Project connect to HECO's high-voltage transmission lines and system and residential homes connect to HECO's low-voltage distribution lines and system, which are separate from the high-voltage lines. HECO has now adopted the PV Circuit Hosting Capacity Analysis method that identifies distribution circuit capacity to safely and reliably interconnect distributed generation resources. PV Circuit Hosting Capacity provides information to all parties as to the amount of rooftop PV that may be added to each specific distribution circuit (R. Shiro, personal comm., 2015).

4.12.2.5 Electricity Rates

A number of comments on the Draft EIS were made regarding the impact the Project would have directly to electricity rates. Based on the most recent 2014 Renewable Portfolio Standard Status Report, approximately 80 percent of Hawaii's energy is currently derived from fossil fuels, and approximately 20 percent comes from renewable sources (HECO et al. 2014). The cost of electricity for the consumers/residents of Hawaii is the blended average cost of all sources (e.g., oil, wind, solar, etc.) and current rates reflect that high cost from burning oil. Over time, as the proportion of energy coming from renewable sources increases, the average cost of electricity is expected to decrease (HECO 2016).

4.12.3 Alternative 1—No Action

4.12.3.1 Direct and Indirect Effects

Under Alternative 1, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Therefore, Alternative 1 would have no direct or indirect adverse socioeconomic impacts. However, Alternative 1 would also not have the positive socioeconomic impacts associated with employment or tax revenues that would occur during construction and operation of the Project.

4.12.3.2 Cumulative Effects

Under Alternative 1, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Therefore, there would be no effect on socioeconomic resources. Thus, Alternative 1 would not contribute to cumulative effects on socioeconomic resources.

4.12.3.3 Summary

Alternative 1 would have no direct, indirect, or cumulative effects on socioeconomic resources as no action would be undertaken.

4.12.4 Alternative 2—8 to 10 Turbine Project

4.12.4.1 Direct and Indirect Impacts of Construction and Operation of the Project

Construction

Construction of the Project under this alternative is expected to result in total direct employment of 43 full-time equivalent jobs. Full-time equivalent jobs are employment estimates based on 12 months (2,080 hours) employment. These numbers do not translate into individual workers who may be employed for shorter periods. Total construction earnings would be approximately $3 million. These estimates, developed using the JEDI Wind model, is broadly comparable to the estimate developed for the 30-MW Kahuku Wind Power project Environmental Assessment, which anticipated that an average of 15 to 20 people would be employed per day for the duration of construction, with an expected maximum level of 40 employees (U.S. DOE 2010). Construction would involve general construction and more specialized installation of electrical equipment and wind turbine components.

Local workers would be employed where possible, including workers from nearby communities and the greater Honolulu urbanized area, approximately 1 hour's drive from the wind farm site. Other workers would likely temporarily relocate to the analysis area for the duration of their employment. Very few, if any, of the non-local workers employed during the construction phase of the Project would be expected to be accompanied by family members or permanently relocate to the analysis area. A worst case scenario, assuming 90 percent of the peak workforce were to temporarily relocate from elsewhere, would result in a temporary population gain of approximately

38 people, equivalent to 0.2 percent and 1.5 percent of the 2012 populations of the Koolauloa District and Kahuku, respectively (see Table 3.10-1). This is a small share of the total number annual visitors to the region. Additionally, the temporary addition of these workers is not expected to affect the levels of service provided by existing law and fire protection personnel or existing levels of health care and medical services. This impact would be localized and temporary.

Review of the housing resources in the wind farm site suggests that limited housing options exist for construction workers in the vicinity of the Project, with the majority of temporary accommodation oriented towards tourism. More temporary housing options are available further from the site, especially in the urbanized Honolulu area about 1 hour's drive away, and became available with the development of a new hotel near the Polynesian Cultural Center located south of the Project in the Laie community. The temporary relocation of construction workers is not expected to reduce the available supply of temporary housing for other tourists and other visitors.

Alternative 2 would have a minor, positive impact on the local economy during construction through the local procurement of materials and equipment and spending by construction workers. These direct expenditures would generate economic activity in other parts of the economy through what is known as the *multiplier* effect, with direct spending generating indirect and induced economic impacts. Indirect impacts consist of spending on goods and services by industries that produce the items purchased as part of the Project. Induced impacts include expenditures made by the households of workers involved either directly or indirectly in the construction process.

The Project would have a total expected installed cost of approximately $97 million, including equipment costs (turbines, blades, towers), balance of materials (concrete, rebar, transformers, electrical connection equipment), construction labor, and other development costs (engineering, financing, and legal services, easement costs) based on filings made with the Public Utilities Commission. Equipment costs are the largest estimated cost component accounting for about 70 percent of the estimated total. The equipment would all be purchased outside the region and likely imported from outside the state. Local purchases would likely include portions of the balance of materials, including fuel for vehicles and construction equipment, some equipment rentals, and other incidental materials and supplies. Local purchases, employment of local residents, and the temporary relocation of construction workers to the wind farm site would have minor, but positive impacts on local businesses.

The proposed facility would generate general excise tax (GET) and use tax revenues, with the majority of the project components, materials, and construction-related services expected to be subject at the state-level to either GET or use tax of 4 percent, with an additional tax of 0.5 percent levied by Honolulu County. Local purchases by construction workers and others employed directly and indirectly by the Project would also generate GET revenue.

Operation and Maintenance Impacts

Estimates developed using the JEDI Wind model indicate that O&M of the proposed facility would employ two full-time workers; however, the Kahuku Wind Project employs four or five regular full-time employees to operate that facility, which is comparable in size to the Project. There may be four additional full- or part-time employees as a result of requirements to implement the HCP or otherwise (meaning an anticipated total of three to six full-time employees). This estimated change in population would not be expected to affect demand for housing or the provision of community services in the wind farm site. Operation and maintenance of the facility would have a minor positive impact on the local economy through the local procurement of materials and equipment and spending by workers.

Local O&M expenditures would generate state and local GET and use tax revenues. In 2009, the Honolulu City Council created a real property tax exemption for alternative energy improvements, including new wind facilities. As a result, the proposed facility would most likely be exempt from real property taxation for 25 years once a claim for exemption is approved (Revised Order of Honolulu [ROH] Section 8-10-15).

Alternative 2 would provide a clean source of renewable energy to Oahu and assist HECO in meeting its RPS requirements by increasing the portion of Oahu's energy derived from renewable energy sources. Energy generated from the facility would provide power as available and would be used to substitute other energy sources. The population of the analysis area is not expected to increase because of increased energy availability; therefore, Alternative 2 would not be considered growth inducing.

4.12.4.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP would have no effect on socioeconomic resources.

Impacts of HCP Mitigation

Implementation of the proposed HCP conservation measures would have limited, localized impacts in the mitigation areas and would be expected to have negligible to very limited, localized impacts on socioeconomic conditions in the Wahiawa District (associated with activities in the Poamoho Ridge Mitigation Area) and Koolaupoko Districts (associated with activities in the Hamakua Marsh Mitigation Area). These impacts would be in the form of local short- or long-term employment opportunities associated with implementation of mitigation activities. Overall, mitigation measures would have a minor beneficial effect on the socioeconomics within the analysis area.

4.12.4.3 Mitigation for Unavoidable Impacts

No mitigation is proposed to address socioeconomic impacts. NPMPP continues its outreach efforts with affected stakeholders to define its Community Benefits Package. This may include honoring the commitment of the prior developer to pay $10,000 per wind turbine per year over the life of the project to the Kahuku Community. This translates into $80,000 to $100,000 per year over a 20- to 25-year project life or the equivalent of approximately $2,000,000 of direct economic benefits to the Kahuku Community. It is anticipated that Project funds would be administered by a board of local community members who would make decisions as to the use of the proceeds and which activities, programs, groups, and events would be sponsored. Additionally, over the course of the last 12 months, NPMPP has made several revisions to the proposed site plan for the Project eliminating or re-locating five wind turbines that were previously closer to the Kahuku Community.

4.12.4.4 Cumulative Effects

The cumulative effects analysis area for socioeconomic resources is the Koolauloa and Koolaupoko Districts. Ongoing and reasonably foreseeable projects in the analysis area for socioeconomics include the ongoing residential and commercial development associated with BYU, which broke ground in 2011, the proposed Turtle Bay Resort expansion, which is expected to occur sometime between 2015 and 2025, residential development associated with the Envision Laie Project, which is generally anticipated to occur prior to 2019, and ongoing restoration work at the Hamakua Marsh and Poamoho Ridge mitigation areas. In addition, transportation safety improvements for the Kamehameha Highway are anticipated sometime between 2015 and 2020 (see Table 4.2-2).

Construction of one or more of these projects could potentially coincide in time with the Project. Like the Project, these ongoing and reasonably foreseeable projects would employ construction workers. Residential and commercial construction includes more commonly available construction specialties than wind facility development and the share of workers from within the Koolauloa District and elsewhere in Honolulu County would likely be higher for these projects than for the proposed Project. Construction workers accounted for approximately 11 percent of the employed labor force in the Koolauloa District in 2012 and 7 percent in Honolulu County, with about 1,000 construction workers residing in the Koolauloa District and 31,000 county-wide (Table 3.10-3). Additional employment opportunities and funding associated with HCP mitigation would make a very minor short-term contribution to employment associated with ongoing restoration work at the Hamakua Marsh and Poamoho Ridge mitigation areas.

The other ongoing and reasonably foreseeable projects would have positive impacts on the local economy during construction through the local procurement of materials and equipment, as well as spending by construction workers. Procurement and other expenditures would also generate state and county GET and use tax revenues. The contribution of Alternative 2 to cumulative effects to local economic activity during construction is considered minor. This would also be the case during operation of the Project. Direct and indirect effects from Alternative 2 on community services and housing are also expected to be minor, localized, and temporary. Therefore, the contribution of Alternative 2 to cumulative effects on socioeconomic resources would be minor.

4.12.4.5 Summary

Construction of Alternative 2 would likely result in less than 40 workers temporarily relocating to the wind farm site. The impact of this temporary population gain would be minor and would not be expected to affect the availability of temporary housing resources or the provision of community services. Construction-related expenditures and spending by construction workers would result in a minor, beneficial impact to the local economy. These expenditures would also generate GET and use tax revenues. Operation of the Project would have similar, but much smaller impacts.

Implementation of HCP conservation measures may result in a small number of additional employment opportunities, resulting in a minor, beneficial impact to the local economy. Effects to socioeconomic resources would generally be considered minor, to moderate because they would be of low intensity (changes in socioeconomic conditions are generally below normal limits and trends, or less than 5 percent increase or decrease); there would be both temporary and long-term impacts beneficial impacts; and with the exception of tax revenues, impacts would be generally local in nature. However, impacts associated with property values would be expected to vary by location (See Section 4.12.2.1).

4.12.4.6 Alternative 2a - Modified Proposed Action Option

Direct, indirect, and cumulative effects on socioeconomic conditions from the Modified Proposed Action Option would be the same as those described under the Proposed Action. There may be a decrease in the total expected installation cost of the Modified Proposed Action Option due to the fewer number of turbines compared to the Proposed Action, and therefore, a slight reduction in GET and tax revenues for Project components; however, these reductions would be negligible. The Community Benefits Package offered to the Kahuku Community by NPMPP would also be slightly reduced as it would be calculated on a per turbine basis.

4.12.5 Alternative 3 – Larger Generation Facility (Up to 12 Turbine Project)

4.12.5.1 Direct and Indirect Effects of Construction and Operation of the Project

Construction Impacts

As discussed in Chapter 2, Alternative 3 would involve construction of the first 8 to 10 turbines as early as the second quarter of 2016. There would be a lag of at least 3 years between the construction of the first set of turbines and the additional 2 to 4 turbines proposed under this alternative. Effects during the first phase of construction for this alternative would be the same as those described for Alternative 2. The second phase of the alternative, the installation of an additional 2 to 4 turbines, would have similar but proportionately smaller effects than the first phase.

Estimates developed using the JEDI Wind model suggest the second phase of the Project could result in total employment of 34 full-time equivalent jobs, with total construction earnings of $2.4 million. Total estimated installed cost for the second phase would be $34.1 million. Local purchases, employment of local residents, and the temporary relocation of construction workers to the wind farm site would have additional minor but positive impacts on local businesses.

The second phase of Alternative 3 would generate additional GET and use tax revenues, with the majority of the Project components, materials, and construction-related services expected to be subject at the state-level to either GET or use tax of 4 percent, with an additional tax of 0.5 percent levied by Honolulu County. Local purchases by construction workers and others employed directly and indirectly by the Project would also generate additional GET revenue.

Operation and Maintenance Impacts

Impacts to socioeconomic resources from O&M activities would be similar to those described under Alternative 2. The addition of 2 to 4 additional turbines under this alternative would increase the size of the permanent workforce with the addition of one or two additional full-time workers. Operation and maintenance of the facility would have a minor, positive impact on the local economy through the local procurement of materials and equipment and spending by workers.

4.12.5.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP would have no effect on socioeconomic resources.

Impacts of HCP Mitigation

Impacts of the HCP mitigation measures under Alternative 3 would be the same as described under Alternative 2. Prior to the construction of the additional turbines proposed under Alternative 3, NPMPP would reopen consultation with the USFWS and DOFAW to assess the potential impacts of the additional turbines to listed species and develop appropriate mitigation measures. The impacts of these mitigation measures to socioeconomic resources would be evaluated under a separate environmental analysis at that time.

4.12.5.3 Mitigation for Unavoidable Impacts

No mitigation is proposed to address socioeconomic impacts. NPMPP continues its outreach efforts with affected stakeholders to define its Community Benefits Package (see Section 4.12.4.3 for a description).

4.12.5.4 Cumulative Effects

Cumulative effects to socioeconomic resources under Alternative 3 would be similar to those described under Alternative 2. The Project proposed under Alternative 3 would have the potential to coincide with the same ongoing and reasonably foreseeable projects identified for Alternative 2. Therefore, when viewed in conjunction with past, present, and foreseeable projects in the analysis area, the contribution of Alternative 3 to cumulative effects on socioeconomic resources would be minor. Because there will likely be a delay in time of up to 3 years before additional turbines would be built under Alternative 3, new projects and developments in the area will be assessed and reviewed to determine if there are additional cumulative impacts from future unknown projects.

4.12.5.5 Summary

Construction of the first phase of Alternative 3 would have similar effects as Alternative 2, summarized above. Construction of Alternative 3 would likely result in fewer than 40 workers temporarily relocating to the wind farm site during the first phase of construction and up to 34 workers during the second phase. The impact of this temporary population gain would be minor and would not be expected to affect the availability of temporary housing resources or the provision of community services. Construction-related expenditures and spending by construction workers would result in a minor positive impact to the local economy. These expenditures would also generate GET and use tax revenues. These impacts would be minor, temporary, and with the exception of tax revenues, generally local in nature. Operation of the Project would have similar, but much smaller impacts. Effects to socioeconomic resources under Alternative 3 would generally be considered minor because they would be of low intensity (changes in socioeconomic conditions are generally below normal limits and trends, or a less than 5 percent increase or decrease); there would be both temporary and long-term impacts beneficial impacts; and with the exception of tax revenues, impacts would be generally local in nature. However, impacts associated with property values would be expected to vary by location (see Section 4.12.2.1).

4.12.6 Conclusion

Potential socioeconomic concerns raised during scoping included potential adverse impacts to residential property values and potential impacts to the ability of homeowners to install rooftop PV systems. A majority of recent studies suggest that wind facilities do not have adverse impacts on nearby residential property values. In the smaller number of cases where some impact has been identified, impacts have tended to increase the closer a property is to the nearest wind turbine. Impacts also tend to be influenced by the existing landscape, with the presence of other manmade infrastructure like the existing Kahuku wind facility, likely to reduce these potential impacts. Construction and operation of the Project is not expected to affect the ability of homeowners to install rooftop PV systems on their homes.

Construction of the Project and implementation of HCP conservation measures under alternatives 2, 2a, and 3 would result in a small, temporary increase in population that would not be expected to affect the availability of temporary housing resources or the provision of community services. Construction-related expenditures and spending by construction workers under Alternatives 2 (including the Modified Proposed Action Option) and 3 would result in a small, positive impact to the local economy. These expenditures would also generate GET and use tax revenues. Operation of the Project would have similar, but much smaller impacts.

Alternatives 2 (including the Modified Proposed Action Option) and 3 would provide a clean, renewable source of energy to Oahu. In doing so, the Project would contribute to energy self-sufficiency by increasing the ratio of indigenous to imported energy use. As a source of renewable energy, the Project would increase energy security for the State and reduce reliance on fossil-fuel based energy production, thereby reducing greenhouse gas emissions associated with the state's energy supply. The Project would also generate electricity at a cost that is approximately half the cost of generating electricity by burning fossil fuels, and HECO has stated in filings with the Public Utilities Commission that the Project would save the ratepayers millions of dollars over the life of the Project.

Table 4.12-2 summarizes potential impacts to socioeconomic resources from the alternatives considered in this analysis.

Table 4.12-2. Summary of Potential Impacts to Socioeconomic Resources

Impact Issues	No Action Alternative	Alternative 2 – Proposed Action	Alternative 2a – Modified Proposed Action Option	Alternative 3
Property Values	No Impact	Variable	Variable	Variable
Homeowner's Insurance Rates	No Impact	Negligible	Negligible	Negligible
Businesses	No Impact	Minor	Minor	Minor
Residential Solar Energy/ Photovoltaic System Installation	No Impact	Negligible	Negligible	Negligible
Population	No Impact	Minor	Minor	Minor
Demand on Housing	No Impact	Minor	Minor	Minor
Employment/Income	No Impact	Minor	Minor	Minor

4.13 Historic, Archaeological, and Cultural Resources

4.13.1 Impact Criteria

The impacts on historic, archaeological, and cultural resources were assessed by identifying archaeological resources in areas of potential effect (APE) and determining potential direct and indirect impacts on these resources. The significance of impacts on historically significant cultural resources under the National Historic Preservation Act (NHPA) is based on the criteria of adverse effect in Title 36 CFR Part 800, the regulations implementing Section 106 of the NHPA (see Section 3.1.1.1). Assessment of effects involving Native Hawaiian or other traditional community, cultural, or religious practices or resources also requires consultation with the affected group.

Impacts on historic, archaeological, and cultural resources (i.e., historic structures, archeological sites, and traditional cultural practices) are typically considered permanent as these resources are finite and disturbance of them, particularly archaeological sites, cannot be reversed. Impacts to cultural resources that are eligible for listing on the National Register of Historic Places (NRHP) or Hawaii Register of Historic Places (HRHP) would be considered significant under NEPA/HEPA if they result in adverse effects. However, impacts on historic landscapes or the viewsheds of historic or other significant areas can be temporary if projects do not permanently impact associated resources and are removed at a future date.

Impact criteria for determining effects on historic, archaeological, and cultural resources within the APE from the Project are described further in Table 4.13-1 below.

Table 4.13-1. Impact Criteria for Cultural and Archaeological Resource

Type of Effect	Impact Component	Effects of Summary		
Effects on Historic, Cultural and Archaeological Resources	Magnitude or Intensity	**High:** Loss of integrity for eligibility to the NRHP or HRHP.	**Medium:** Measurable impacts to integrity not sufficient to affect National or Hawaii Register eligibility.	**Low:** No detectable changes in integrity.
	Duration	**Permanent:** Chronic effects; resource would not be anticipated to return to previous levels.	**Long-term:** Resource integrity would be reduced but effects could be mitigated with active management.	**Temporary:** Resource integrity would be reduced but short-term mitigation would be expected to restore pre-activity levels.
	Geographic Extent	**Extended:** Affects resources with significance beyond the region or wind farm site. Significance is defined in 36 CFR 79.	**Regional:** Affects resources with significance throughout wind farm site. Significance is defined in 36 CFR 79.	**Local:** Impacts limited geographically to discrete portions of the wind farm site. Significance is defined in 36 CFR 79.
	Context	**Unique:** Affects cultural resources eligible for the National or Hawaii Register and significant at the national or state level.	**Important:** Affects cultural resources eligible for the National or Hawaii Register and significant at the local level.	**Common:** Affects cultural resources not eligible for the National or Hawaii Register, but protected by other laws.

4.13.2 Alternative 1—No Action

4.13.2.1 Direct and Indirect Effects

Under Alternative 1, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Therefore, Alternative 1 would have no effect to historic, archaeological, and cultural resources. As such, no mitigation measures would be required.

4.13.2.2 Cumulative Effects

Under the No Action Alternative, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Therefore, there would be no adverse effects to cultural resources or traditional cultural practices. Thus, Alternative 1 would not contribute to cumulative effects on historic, archaeological, and cultural resources.

4.13.2.3 Summary

Alternative 1 would have no direct, indirect, or cumulative effects on historic, archaeological, and cultural resources because no action would be undertaken.

4.13.3 Alternative 2 – 8 to 10 Turbine Project

4.13.3.1 Direct and Indirect Effects of Construction and Operation of the Project

Direct impacts on historic, archaeological, and cultural resources due to the construction of the Project could result from: vegetation clearing; grading, trenching, excavation for turbine placement or other facilities; and any other earth-moving activity that disturbs historical resources or historic properties, previously undisturbed cultural resources, or cultural resources unevaluated for NRHP or HRHP eligibility. Table 4.13-2 lists the known archaeological resources within the APE and associated significance assessments and recommended treatments.

Indirect impacts to historic, archaeological and cultural resources could result from noise, dust, and vibrations caused by earthmoving and heavy equipment, loss of community access to cultural resources, such as traditional cultural properties. These effects are discussed in detail below in the context of the Project. An Archaeological Inventory Survey (AIS) (approved by the Hawaii State Historic Preservation Division [SHPD] on December 15, 2015) and Cultural Impact Assessment (CIA) evaluating impacts to archaeological and cultural resources are included in Appendices F and G, respectively, the results of which are summarized below.

Archaeological Sites

Of the 14 archaeological sites recorded in the APE, 13 were assessed as significant for their information potential under Criterion D (Table 4.13-2). Each of these sites has either yielded or has the potential to yield information important to state and national history.

Five sites yielded the information they contain during the current AIS investigations and no further work is being recommended. Four of these sites (SIHP Nos. 50-80-02-7845, 50-80-02-7848, 50-80-02-7863, and 50-80-02-7864) are outside of the area of disturbance and would not be affected by Project construction. No further work is recommended for one site (50-80-02-7841) that has the potential to be affected by the Project. Only two (50-80-02-7845 and 50-80-02-7848) are recommended to be eligible for listing on the HRHP, and none are recommended to be eligible for listing on the NRHP.

One site (50-80-02-7844) consists of multiple components of the sugar complex of the historic Kahuku Plantation. Thirty-eight of these components were recorded in the APE. Eleven components and a portion of a twelfth are within the area of disturbance and have the potential to be affected by the Project. Data recovery in the form of historical documentation and analysis of the irrigation network is recommended for the site. A portion of one component (C39) is recommended for preservation (see below). The site is eligible for listing on the HRHP but not on the NRHP.

Table 4.13-2. Archaeological Resources within the APE

SIHP No. 50-80-02-XXXX	Component	Site Type	Site Significance	Feature Des.	Feature Type	Period	Recommendations
7840	-	Complex	Not significant	A	Alignment	Historic/ military	No Further Work
				B	Hearth		No Further Work
7841	-	Marker	D	A	Stone mound	Traditional	No Further Work
7842	-	Habitation	D	A	Platform	Traditional	Preservation
7843	-	Defensive	A, D	A	Bunker	Historic/military	Preservation
				B	Bunker		Preservation
7844	C1	Water transport	A, D	A	Ditch	Historic/sugar	Data Recovery
7844	C2	Water control	A, D	A	Concrete culvert	Historic/sugar	Data Recovery
	C3	Complex	A, D	A	Concrete foundation	Historic/sugar	Data Recovery
				B	Concrete foundation		Data Recovery
				C	Concrete foundation		Data Recovery
				D	Concrete foundation		Data Recovery
				E	Retaining wall		Data Recovery
	C4	Complex	A, D	A	Ditch	Historic/sugar	Data Recovery
				B	Ditch		Data Recovery
				C	Ditch		Data Recovery
				D	Ditch		Data Recovery
	C5	Complex	A, D	A	Valve	Historic/sugar	Data Recovery
				B	Well		Data Recovery
	C6	Complex	A, D	A	Concrete foundation	Historic/sugar	Data Recovery
				B	Concrete ditch		Data Recovery
				C	Iron pipeline		Data Recovery
	C7	Water transport	A, D	A	Pipeline	Historic/sugar	Data Recovery
	C8	Water transport	A, D	A	Soil ditch	Historic/sugar	Data Recovery
	C9	Water transport	A, D	A	Stone/concrete Ditch	Historic/sugar	Data Recovery
	C10	Water transport	A, D	A	Concrete ditch	Historic/sugar	Data Recovery
	C11	Water control	A, D	A	Storage area	Historic/sugar	Data Recovery
				B	Concrete well		Data Recovery
				C	Brick well		Data Recovery
				D	Brick well		Data Recovery
				E	Rock/Concrete wall		Data Recovery
				F	Brick well		Data Recovery
	C12	Water control	A, D	A	Pump house	Historic/sugar	Data Recovery
	C13	Storage	A, D	A	Shed	Historic	Data Recovery
				B	Concrete slab		Data Recovery
	C14	Water transport	A, D	A	Concrete ditch	Historic/sugar	Data Recovery
	C15	Water transport	A, D	A	Stone ditch	Historic/sugar	Data Recovery

Table 4.13-2. Archaeological Resources within the APE (continued)

SIHP No. 50-80-02-XXXX	Component	Site Type	Site Significance	Feature Des.	Feature Type	Period	Recommendations
7844	C16	Roadway	A, D	A	Stone retaining wall	Historic/sugar	Data Recovery
	C17	Water transport	A, D	A	Soil/concrete ditch	Historic/sugar	Data Recovery
	C18	Water transport	A, D	A	Soil ditch	Historic/sugar	Data Recovery
				B	Concrete foundation		Data Recovery
	C19	Water transport	A, D	A	Stone lined ditch	Historic/sugar	Data Recovery
				B	Stone lined ditch		Data Recovery
				C	Stone lined ditch		Data Recovery
	C20	Water transport	A, D	A	Soil ditch	Historic/sugar	Data Recovery
				B	Retaining wall		Data Recovery
				C	Retaining wall		Data Recovery
				D	Concrete ditch		Data Recovery
	C21	Water transport	A, D	A	Soil ditch	Historic/sugar	Data Recovery
				B	Concrete footing		Data Recovery
	C22	Water transport	A, D	A	Concrete ditch	Historic/sugar	Data Recovery
	C23	Water transport	A, C, D	A	Stacked stone ditch	Historic/sugar	Data Recovery
	C24	Water transport	A, D	A	Concrete ditch	Historic/sugar	Data Recovery
	C25	Water transport	A, D	A	Stone alignment	Historic/sugar	Data Recovery
	C27	Water control	A, D	A	Reservoir	Historic/sugar	Data Recovery
	C28	Water transport	A, D	A	Concrete ditch	Historic/sugar	Data Recovery
	C29	Water transport	A, D	A	Concrete ditch	Historic/sugar	Data Recovery
	C30	Water transport	A, D	A	Limestone ditch	Historic/sugar	Data Recovery
	C31	Water transport	A, D	A	Iron pipeline	Historic/sugar	Data Recovery
	C32	Water transport	A, D	A	Concrete ditch	Historic/sugar	Data Recovery
	C34	Water control	A, D	A	Pump house	Historic/sugar	Data Recovery
				B	Tank		Data Recovery
				C	Concrete ditch		Data Recovery
				D	Concrete ditch		Data Recovery
	C36	Water transport	A, D	A	Limestone ditch	Historic/sugar	Data Recovery
	C37	Water transport	A, D	A	Stacked stone ditch	Historic/sugar	Data Recovery
	C38	Water transport	A, D	A	Concrete ditch	Historic/sugar	Data Recovery
	C39	Water transport	A, D	A	Aqueduct	Historic/sugar	Data Recovery
				B	Concrete ditch		Data Recovery
				C	Soil ditch		Data Recovery
				D	Limestone retaining wall		Data Recovery
				E	Concrete ditch		Data Recovery

Table 4.13-2. Archaeological Resources within the APE (continued)

SIHP No. 50-80-02-XXXX	Component	Site Type	Site Significance	Feature Des.	Feature Type	Period	Recommendations
7844	C40	Water transport	A, D	A	Soil ditch	Historic/sugar	Data Recovery
	C41	Water transport	A, D	A	Concrete ditch	Historic/sugar	Data Recovery
7845	-	Agriculture	D	A	Terrace	Historic	No Further Work
7846	-	Agriculture	D	A	Stone terrace	Traditional	Preservation
7847	-	Agriculture	D	A	Terrace	Traditional	Preservation
7848	-	Agriculture	D	A	Terraced soil furrows	Historic	No Further Work
				B	Terrace		No Further Work
				C	Terraced soil furrows		No Further Work
				D	Terraced soil furrows		No Further Work
7863	-		D	A	Modified outcrop	Traditional	No Further Work
7864	-		D	A	Stone terrace	Traditional	No Further Work
7865	-	Agriculture	D	A	Terrace	Traditional	Preservation
				B	Terrace		Preservation
7866	-	Habitation	D	A	Artifact scatter	Historic	Data Recovery
7867	-	Habitation	D	A	Cave	Traditional	Data Recovery

Two additional site (50-80-02-7866 and 50-80-02-7867) still have the potential to yield important information of the history of the area (see below for a description of each). Site 50-80-02-7866 is located outside the area of disturbance, while Site 50-80-02-7867 is located within the area where Project construction will occur. Data recovery excavations have been recommended for these two sites prior to Project construction. Artifact collections and excavations in these sites will provide important information on historic and traditional activities that took place in this area and the chronology of settlement. Once this information has been collected, no additional work will be necessary; however, these site will be eligible for listing on the HRHP.

Six sites (50-80-02-7842, 50-80-02-7843, 50-80-02-7844 (in part), 50-80-02-7846, 50-80-02-7847, and 50-80-02-7865) are recommended for preservation based on their significance (see below for a description of each). These sites appear to be eligible for listing on the HRHP. Site 50-80-02-7843 also appears eligible for listing on the NRHP. All of these sites are outside of the area of disturbance, except Component C39 of Site 50-80-02-7844. Features A (an aqueduct) and B (an adjoining ditch) of this component also are recommended for preservation. Feature A is to be preserved in its entirety, while only the portion of Feature B that is adjacent to Feature A is recommended for preservation.

Two of the 14 archaeological sites within the APE have also been assessed as significant under Criterion A, indicating association with important historical events. The significance of Site 50-80-02-7843 is based on its association with World War II. The significance of Site 50-80-02-7844 is based on its association with the Kahuku Plantation, one of the early sugar plantations in Hawaii and a dominant economic and social force on the north shore of Oahu.

The following provides descriptions of Sites 50-80-02-7844, 50-80-02-7866, and 50-80-02-7867 that are recommended for data recovery. Data recovery is recommended to retrieve important information that will add to the knowledge about chronology, settlement, and use of this portion of the Kahuku area.

- Site 50-80-02-7844: This site is an extensive and discontinuous area containing structural remnants of the Kahuku Sugar Plantation that operated from 1890 to 1971 and was a dominant social, economic, and cultural factor for the North Shore. The site consists of 41 identified components—mostly water transport and control structures. Data recovery is recommended in the form of documentation and analysis of the water transport systems.
- Site 50-80-02-7866: This site is an approximately 2,100-square-foot (200-square-meter) area containing scattered historic artifacts (glass bottles and ceramics). The site appears to represent a dump during the historic period. Data recovery is recommended in the form of surface collection and laboratory analysis of artifacts.
- Site 50-80-02-7867: This site is a cave with a marine shell midden. Excavations previously conducted at the site have identified a subsurface cultural deposit dating between the mid-1600s and 1800s. This site is significant because it gives insight in the area of Kahuku prior to, and likely at the point of, western contact, and provides a glimpse of life before the area was transformed by the sugar plantation. Data recovery is recommended in the form of additional excavation.

The following provides a description of the six sites recommended for preservation:

- Site 50-80-02-7842: This is a traditional pre-Contact stone platform that was probably the foundation of a perishable structure used for habitation by Native Hawaiians. It is recommended for preservation because it is one of the few vestiges of traditional use of this area.
- Site 50-80-02-7843: This site consists of two World War II era concrete bunkers that were a part of the Oahu coastal defense system. They are recommended for preservation because of their association with this period of our Nation's history.
- Site 50-80-02-7844, Component C39 (features A and B): This site consists of a concrete aqueduct and an associated concrete ditch. These features were associated with the Kahuku Sugar Plantation. These features are recommended for preservation because of their construction style and association with the historic activity in the area.
- Site 50-80-02-7846: This site consists of two traditional pre-Contact agricultural features, a stone terrace and a soil terrace, that were used by Native Hawaiians for the cultivation of crops. This site is recommended for preservation because it is one of the few vestiges of traditional use of this area.
- Site 50-80-02-7847: This site consists of a single traditional pre-Contact agricultural feature, a soil terrace that was probably used by Native Hawaiians for the cultivation of crops. This site is recommended for preservation because it is one of the few vestiges of traditional use of this area.
- Site 50-80-02-7865: This site consists of a habitation terrace and a small agricultural terrace constructed and utilized during the pre-Contact period. It is recommended for preservation because of its association with traditional use of this area.

To summarize, construction of the Project has the potential to affect 13 archaeological sites assessed as significant under Criterion D (consisting primarily of features associated with historic sugar plantation activities). Five of the sites have already yielded information and are not recommended to be eligible for listing on the NRHP or HRHP (i.e., no further archaeological work is required). Five additional sites and two features of a sixth site are recommended for preservation and are potentially eligible for listing on the HRHP or NRHP. Three of the sites (50-80-02-7844, 50-80-02-7866, and 50-80-02-7867) are potentially eligible to be listed on the HRHP for their information potential, and data recovery is recommended. If not mitigated with data recovery, this would be considered an adverse effect to historic properties by SHPD. Therefore, treatments have been proposed for these three sites in the form of archaeological data recovery investigations (additional documentation, analysis, collection, and excavations) to mitigate the potential adverse effects caused by development of the Project through retrieval of the significant information. Once retrieved, the demolition of the sites has been mitigated, and there is no longer an adverse effect.

During operation, the presence of new or improved access within the wind farm site has the potential to adversely affect archeological resources by providing increased access to sites that were previously difficult to reach. This could increase the potential for vandalism and theft of resources; however, access to the wind farm site would be controlled for safety reasons, thereby impeding unauthorized access.

Traditional Cultural Uses and Practices

The results of the CIA indicate that the proposed wind farm site and vicinity was heavily disturbed during the Plantation era for sugar cane and pineapple cultivation, which significantly decreases the likelihood of the presence of important cultural resources. Based on the ethnographic interviews conducted as part of the CIA, there does not appear to be a need for traditional access to the wind farm site for the collection of natural resources or for performing traditional cultural practices. No traditional activities associated with gathering natural resources or conducting traditional cultural practices were identified within the APE (see the CIA in Appendix G of the Final EIS for additional information). It appears that community access to this area was not allowed during the plantation era. Given that access to this area does not appear to be needed for traditional cultural uses or practices, NPMPP does not plan to change the current status of mauka/makai access in this area.

Culturally Important Species

The results of the CIA indicate that many species of birds and bats that occur in the vicinity of the Project are recognized as culturally important. The cultural importance of these species is described in Section 3.11, and impacts of the project on these species are described in Section 4.11.3.1. There is the potential for individual birds and bats that are considered culturally important to collide with Project structures. The Project HCP includes measures to avoid, minimize, and mitigate for these impacts (see Chapter 2 for a description). These measures would reduce the risk of Project-related impacts to culturally important species.

4.13.3.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP would have no effect on cultural resources or traditional cultural practices in the analysis area. These measures will benefit culturally important species by reducing the risk of collision with Project-related structures (see Section 4.11.3.2).

Impacts of HCP Mitigation

No impacts to historic, archaeological, and cultural resources would occur in association with funding for Newell's shearwater research and management or short-eared owl research and management. The partial fence along the northeastern border of the Hamakua Marsh Mitigation Area for waterbird mitigation would be designed to avoid known historic, archaeological, and cultural resources within the Kawainui-Hamakua Marsh complex and would be consistent with the DLNR Kawainui Marsh Master Plan (DLNR 1994) and its forthcoming updates (Kawainui-Hamakua Marsh Complex Master Plan; DLNR 2014a). The Kawainui-Hamakua Marsh complex is recognized in part for its importance as a cultural resource. Waterbird mitigation would preclude trespassing into and littering within Hamakua Marsh; therefore, HCP mitigation would have a minor beneficial effect on cultural resources within Hamakua Marsh. Funding for restoration and monitoring at the Poamoho Ridge Mitigation Area for bats would not involve ground-disturbing activities and are covered by DLNR's existing exemption from Chapter 343 environmental analysis for the Koolau Forest Watershed Protection Project (DLNR 2012), and therefore would have negligible effects to historic, archaeological, and cultural resources.

4.13.3.3 Mitigation of Unavoidable Impacts

This section describes measures that NPMPP would implement to minimize and mitigate impacts to archaeological and cultural resources within the APE. These measures are described in detail in the AIS (see Appendix F of the Final EIS) that has been approved by SHPD. A majority (78 percent) of known archaeological sites within the APE do not coincide with proposed Project facilities and therefore would be avoided, and no additional mitigation is required.

NPMPP's design engineers continue to consider construction methods and design modifications that can be implemented to avoid and minimize direct impacts to known archaeological resources that coincide with proposed Project facilities. Some of the archaeological resources that have the potential to be directly affected have been fully documented and will not require any further archeological work; other sites will require further archaeological work in the form of data recovery (mapping and excavation).

Data recovery excavations recommended at sites 50-80-02-7844, 50-80-02-7866, and 50-80-02-7867 will aid in determining the chronology of use of the area as well as provide details about the activities that took place before western contact. Data recovery will consist of further hand excavations with shovels, picks, trowels, and brushes. Soil will be collected in dust pans and all material excavated will be screened through nested 1/4- and 1/8-inch screens; cultural material will be collected and analyzed in a data recovery report. At Site 50-80-02-7867, a backhoe may be used to excavate the filled portion fronting the cave site entrance to aid in access into the cave. Additional test units will be placed in front of the caves exterior to help further clarify the context of the site. NPMPP's contractor Pacific Legacy will prepare a Data Recovery Plan, approved by SHPD, for these sites which will provide additional detail on data recovery methods.

Site 50-80-02-7844 includes two features (an aqueduct and part of a ditch) that are recommended for preservation but are located within a proposed access road. Engineers will work to microsite the Project facilities such that these features can be avoided. If avoidance is not possible, these features will be mitigated as appropriate in coordination with SHPD.

4.13.3.4 Cumulative Effects

The analysis area for cumulative effects to historic, archaeological, and cultural resources is the wind farm site. This area captures direct impacts of the Project, including cultural impacts to the surrounding communities. The Project would not result in adverse impacts to archaeological and cultural resources because standard avoidance and minimization measures have been recommended and incorporated into the Project design, and mitigation for impacted properties has been approved by SHPD. No impacts to archaeological resources or customary or traditional uses by Native Hawaiians would occur as a result of implementing the HCP. None of the projects in Table 4.2-2 overlap with the CIAA for historic, archaeological, and cultural resources; therefore, there would be no cumulative effects.

4.13.3.5 Summary

Construction of the Project under Alternative 2 has the potential for moderate adverse impact to some cultural resources meeting Criterion D (information potential). These impacts would be mitigated through treatments, approved by SHPD, directed toward archaeological resources data recovery from these sites. One site (50-80-02-7844) meeting Criterions A (association with important events), C (high degree of workmanship), and D (information potential) will be preserved and avoided. During operation, access to the wind farm site would be controlled to avoid any indirect impacts to known archaeological resources associated with vandalism or theft. Therefore, effects to historic and archaeological resources would be of low magnitude (no change in integrity anticipated), long-term (lasting the life of the project but mitigated through active management), and localized, and effects to resources eligible for NRHP or HRHP listing would be fully mitigated through data recovery. No effects to traditional cultural uses and practices would occur under the Proposed Action. Therefore, effects to historic, archaeological, and cultural resources under Alternative 2, when avoided, minimized, and mitigated as proposed, would be minor.

4.13.3.6 Alternative 2a - Modified Proposed Action Option

Under Alternative 2a, direct, indirect, and cumulative effects on historic, archaeological, and cultural resources would be the same as those described under Alternative 2. Two archaeological sites (Sites 50-80-02-7846 and 50-80-02-7847) identified and recommended for preservation in the AIS (see Appendix F of the Final EIS) are located in proximity to the turbine and access road that would not be included in the Modified Proposed Action Option. However, both sites are outside the area of disturbance and would not be affected by Project construction under either the Modified Proposed Action Option or the Proposed Action. Implementation of mitigation measures, as described under the Proposed Action, would minimize adverse impacts to historic, archaeological, and cultural resources.

4.13.4 Alternative 3 – Larger Generation Facility (Up to 12 Turbine Project)

4.13.4.1 Direct and Indirect Effects of Construction and Operation of the Project

Archaeological Sites

Impacts to archaeological resources would be the same as described above for Alternative 2. There is one additional component of Site 50-80-02-7844 (C6) located adjacent to the proposed turbines on the Malaekahana parcel that would only be within the construction area under Alternative 3. This site component consists of a concrete foundation, concrete ditch, and iron pipe associated with historic sugar plantation activities and was assessed as significant under Criterion D. These features are part of the historical irrigation network recommended for documentation and analysis as data recovery for Site 50-80-02-7844.

Traditional Uses and Practices

Impacts to traditional uses and practices under Alternative 3 are the same as described under Alternative 2.

Culturally Important Species

Impacts to culturally important species during construction and operation of the Project under Alternative 3 would be the same as described under Alternative 2.

4.13.4.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP would have no effect on historic, archaeological, or cultural resources in the analysis area.

Impacts of HCP Mitigation

Impacts of HCP mitigation under Alternative 3 would be the same as described under the Proposed Action. Prior to construction of the additional turbines proposed under Alternative 3, NPMPP would reopen consultation with the USFWS and DOFAW to assess the potential impacts of the additional turbines to listed species and develop appropriate mitigation measures. The impacts of these mitigation measures to historic, archaeological, and cultural resources would be evaluated under a separate environmental analysis at that time.

4.13.4.3 Mitigation of Unavoidable Impacts

Mitigation for impacts to historic, cultural, and archaeological resources under Alternative 3 would be the same as described under Alternative 2. The additional site that has the potential to be affected under Alternative 3 has been fully documented and requires no further mitigation.

4.13.4.4 Cumulative Effects

Cumulative effects under Alternative 3 would be the same as described above for Alternative 2.

4.13.4.5 Summary

For the reasons described under Alternative 2, the effects to historic and archaeological resources under Alternative 3 would be of low magnitude (no change in integrity anticipated), long term (lasting the life of the project but mitigated through active management), and localized; and effects to resources eligible for NRHP or HRHP listing would be fully mitigated through data recovery. No effects to traditional cultural uses and practices would occur under Alternative 3. Therefore, effects to historic, archaeological, and cultural resources under Alternative 3, when avoided, minimized, and mitigated as proposed, would be minor.

4.13.5 Conclusion

Table 4.13-3 summarizes potential impacts to cultural resources and traditional cultural practices from the alternatives considered in this analysis.

Table 4.13-3. Summary of Potential Impacts to Historic, Archaeological, and Cultural Resources

Impact Issues	No Action Alternative	Alternative 2 – Proposed Action	Alternative 2a – Modified Proposed Action Option	Alternative 3
Archaeological Sites	No Impact	Minor	Minor	Minor
Traditional Cultural Uses and Practices	No Impact	Negligible	Negligible	Negligible

4.14 Land Use

4.14.1 Impact Criteria

Impacts to land use were assessed based on whether the construction and operation of the Project and implementation of HCP conservation measures would be 1) compatible with existing and proposed land uses and 2) consistent with land use plans and regulations. Table 4.14-1 lists the impact criteria considered when determining the level of effect (i.e., negligible, minor, moderate, major) that the Project could have to land use. For consistency with land use plans and policies, effects are determined to be consistent or inconsistent. Based on comments on the Draft EIS that requested an expanded discussion of agriculture, effects to agricultural uses and activities are discussed separately in Section 4.22 – Agriculture.

Table 4.14-1. Impact Criteria for Land Use

Type of Effect	Impact Component	Effects Summary		
Compatibility with existing and planned land uses.	Magnitude or Intensity	**High:** Incompatible with existing and planned uses.	NA	**Low/No Impact:** Compatible with existing and planned uses.
	Duration	**Permanent:** Existing land uses would not be able to return to previous locations and levels following Project decommissioning.	**Long term:** Existing land uses would return to pre-activity locations and levels at some point after completion of the Project.	**Temporary.** Existing land uses will be affected during the Project construction and would be expected to return to pre-activity levels at the completion of the construction.
	Geographic Extent	**Extended:** Affects land use beyond the Koolau Loa Sustainable Communities Plan area.	**Regional:** Affects land use within the Koolau Loa Sustainable Communities Plan area.	**Local:** Affects land use within the wind farm site or immediate vicinity.

Table 4.14-1. Impact Criteria for Land Use (continued)

Type of Effect	Impact Component	Effects Summary		
	Context	**Unique:** The affected lands are protected by legislation and have a unique role within the region.	**Important:** The affected lands are protected by legislation or are rare within the locality or region.	**Common:** The affected lands are not rare in the locality, do not fill a unique role, and are not protected by legislation.
Consistency with the Koolau Loa Sustainable Communities Plan and land use regulations	NA	**Inconsistent:** Project is not consistent with the Koolau Loa Sustainable Communities Plan and land use regulations.		**Consistent/No Impact:** The Project is consistent with the Koolau Loa Sustainable Communities Plan and land use regulations.

4.14.2 Alternative 1—No Action

4.14.2.1 Direct and Indirect Effects

Under the No Action Alternative, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Therefore, Alternative 1 would have no effect on land use. As such, no mitigation measures would be warranted.

4.14.2.2 Cumulative Effects

Under the No Action Alternative, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservations measures would not be implemented. Therefore, there would be no effect on land use. Thus, Alternative 1 would not contribute to cumulative effects on land use.

4.14.2.3 Summary

Alternative 1 would have no direct, indirect or cumulative effects on land use as no action would be undertaken.

4.14.3 Alternative 2—8 to 10 Turbine Project

4.14.3.1 Direct and Indirect Effects of Construction and Operation of the Project

Existing and Planned land Uses

Direct Impacts

Wind energy facilities are widely recognized as being a compatible use of land with active farming. Operations of the Project would continue to allow farming activities within the wind farm site. ALISH Prime Agriculture lands and active farming operations on the Malaekahana Hui West parcel of the wind farm site would be maintained. Nonetheless, direct impacts to land use during construction of the Project would include short-term temporary disruption to existing farming activities on the Malaekahana Hui West, LLC parcel of the wind farm site that are currently being farmed. During the construction period, up to approximately 8.2 acres (3.3 hectares) of active farmed lands would be disrupted. See Section 4.22 – Agriculture for a detailed discussion.

Of this amount, approximately 4.6 acres (1.8 hectares) of existing farmed lands would be used over the long term (for the life of the Project) for the installation of the turbines, access roads, and other Project components. This comprises approximately 3 percent of the existing farmlands within the wind farm site. However, no net loss in agriculture would occur as NPMPP would work with Malaekahana Hui West, LLC to prepare inactive agricultural lands for crop production (see Section 4.22 – Agriculture for additional information).

Upon completion of the planned operational life of the Project (if the Project is not repowered), the Project would be decommissioned and the wind farm site would be rehabilitated, thereby allowing permitted agricultural uses to return to the lands occupied by Project facilities. As a result, direct impacts to land use from Project operations are considered to be long term rather than permanent.

The Project would also be compatible with nearby existing residential, commercial, public, and other land uses, as evidenced by the existing Kahuku Wind Farm that is directly adjacent to the Project to the north. The Kahuku Wind Farm was installed in March 2011 and has co-existed in Kahuku for the past several years. In addition, the wind resources in the Kahuku area, availability of land to lease, and availability of transmission capacity makes the Project location feasible for developing a wind energy facility.

Indirect Impacts

Indirect impacts to land use during the construction of the Project would involve potential disturbance effects to existing land uses in the near vicinity of the Project. Noise from construction activity would be audible in the surrounding area at times during the construction period (noise impacts are discussed in detail in Section 4.6 – Noise). Similarly, Project construction equipment and activities and in-progress Project facilities would be visible to varying degrees within the surrounding area during the construction period (as discussed in Section 4.16 – Visual Resources). Project-related construction activities and traffic would likely cause intermittent delays or access disruptions for land uses served by key access routes in the local area (as discussed in Section 4.17 – Transportation).

The existing roadway system within the wind farm site would be modified or expanded to accommodate the facilities and operations of the Project. During Project construction, it is anticipated that there may be temporary access restrictions along existing roads to ensure the safety of farmers within the wind farm site. A Site Safety Handbook would be developed and implemented during construction which would include measures for notifying farmers of upcoming construction activities, access restrictions, and other measures to ensure safety is maintained during construction. There would be no permanent reduction in access along wind farm site roads; however, during Project operation there may be temporary, localized reductions in access in association with routine maintenance activities to ensure farmer safety. NPMPP would work with Malaekahana Hui West, LLC, to ensure that a notification system is in place to inform farmers of the timing and location of maintenance activities, restrictions in access and alternative access routes, and other important information.. Over the long term, expansion of the road system would result in a beneficial impact to farmers through expanded and improved access along the existing road system. For these reasons, the Project would be compatible with existing and future uses of lands within and surrounding the wind farm site.

Indirect impacts to nearby land uses during the operations phase of the Project would include potential impacts to nearby developed areas of Kahuku Town in relation to air quality, noise, visual, public health, and traffic considerations. For further discussion on applicable direct and indirect impacts, see Sections 4.5 – Air Quality, 4.6 – Noise, 4.16 – Visual, 4.18 – Public Health and Safety, and 4.17 – Transportation, respectively.

Land Use Plans and Regulations

The wind farm site includes lands classified as Prime and with productivity levels rated as A, B, C, D, E, and Unclassified. Under the applicable State land use regulations for Agricultural District (HRS § 205), wind energy facilities are permitted uses on agricultural lands within all of the agricultural productivity rating categories. As such, the Project is consistent with the State land use regulations. See Section 4.22 – Agriculture and Chapter 5 for additional discussion.

The Project is located within the City and County of Honolulu agricultural zoning districts AG-2 General Agricultural (AG-2) and AG-1 Restricted Agricultural (AG-1). Wind energy facilities are a permitted use within these zoning districts as a conditional use that can be approved with the issuance of a Conditional Use Permit Minor. As required, Champlin will submit an application for a Conditional Use Permit Minor to the City and County of Honolulu in compliance with this requirement. As such, the Project would be consistent with existing City and County of Honolulu land use regulations. For additional discussion of Project consistency with land use plans and policies see Chapter 5 of this EIS.

The wind farm site is located within the boundaries of the Koolau Loa planning region of Oahu. The comprehensive plan applicable to this area is the Koolau Loa Sustainable Communities Plan, which designates the wind farm site for agricultural, military, and rural residential use (see Figure 3.12-2; City and County of Honolulu 2012). The location of the Project facilities is within the agricultural designation and permitted as a conditional use according to the agricultural zoning district. The Project is consistent with the policies of the Koolau Loa Sustainable Plan. For further discussion on compliance with the Koolau Loa Sustainable Communities Plan, see Chapter 5 of this EIS.

4.14.3.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP would have a minor effect on land use. As stated above, approximately 4.6 acres (1.8 hectares) of existing farmed lands would be impacted over the long term in association with the turbines, access roads, and other Project components. This includes plots beneath the turbines that would be maintained in low-growing crops or other vegetation to facilitate the post-construction monitoring program.

Impacts of HCP Mitigation Measures

No impacts to direct or indirect effects to land use would occur in association with funding provided for Newell's shearwater research and management and short-eared owl research and management. These activities are not part of any plans for land use development and would be implemented as part of ongoing conservation programs.

Installation of the partial fence at the Hamakua Marsh for waterbird mitigation and funding applied toward forest restoration and monitoring at Poamoho Ridge for bat mitigation would not change existing land uses in the mitigation areas. Mitigation activities would be compatible with, and would contribute to the benefits of, ongoing management and restoration efforts within the mitigation areas and would be consistent with the underlying applicable land use plans and regulations. Thus, mitigation activities would result in a negligible adverse impact on land use over the short term for the installation of the fence at Hamakua Marsh and restoration and monitoring at Poamoho Ridge. Because the waterbird and bat mitigation measures would improve habitat in the mitigation areas (inhibiting trespassing, littering and incidental mortality of waterbirds at Hamakua Marsh and restoration of native forest at Poamoho Ridge), they would be expected to have a minor beneficial impact on land use in these mitigation areas over the long term.

The HCP mitigation measures would have no indirect effect on conditions experienced on lands adjacent to the mitigation areas. The fence at Hamakua Marsh which would be evident along the Kawainui Canal and the adjacent shopping center; however, because it is intended to inhibit trespassing into, and littering within, the mitigation area, it would not adversely affect the existing use of areas adjacent to the mitigation area.

4.14.3.3 Mitigation of Unavoidable Impacts

The Proposed Action would be compatible with the existing land uses within the analysis area and would be consistent with the State and county plans and regulations. Mitigation that applies to land use includes measure such as recontouring and revegetating disturbed areas, invasive species control, measure to avoid fire risk (the Fire Management Plan), and implementation of a Site Safety Handbook. Therefore, the Proposed Action would be expected to result in a minor impact on land use. Therefore, no additional mitigation measures for land use impacts are proposed. See Chapter 5 for additional discussion on the Project's consistency with state and county plans and land use policies.

4.14.3.4 Cumulative Effects

The cumulative effects analysis area for impacts to land use is the Koolau Loa Sustainable Communities Plan area. Reasonably foreseeable future projects within the analysis area are identified in Table 4.2-2.

The Koolau Loa Sustainable Communities Plan identifies future land uses within the Koolau Loa Region. The future projects shown in Table 4.2-2 are included within the Koolau Loa Sustainable Communities Plan as planned future land uses. Any planned or future project will need to comply with applicable land use regulations and policies, and the project evaluation will need to disclose impacts to existing and planned land uses. As a result, future cumulative impacts to land use are anticipated to be negligible or minor because land uses will change over time, but changes will need to be in compliance with the Koolau Loa Sustainable Communities Plan and the existing land use regulations and policies.

4.14.3.5 Summary

Alternative 2 would result in minor direct and indirect impacts to approximately 8.2 acres (3.3 hectares), including long-term displacement to 4.6 acres (1. 8 hectares) of existing farming activities in the wind farm site. However, it should be noted that these impacts would occur on privately owned land, the use of which, whether it be for agriculture, alternative energy development, or other uses, is up to the landowner's discretion. HCP conservation measures would result in a negligible adverse impact and a minor beneficial impact to land use within the mitigation areas. Impacts would be considered minor because although there would be some long-term impacts associated with operation of the Project, they would be of low magnitude (compatible with existing and planned land uses and/or beneficial effects), localized, and would primarily affect land uses that are common (are not rare in the locality, do not fill a unique role, and are not protected by legislation). The Proposed Action would be consistent with the Koolau Loa Sustainable Communities Plan and other land use regulations within the analysis area.

4.14.3.6 Alternative 2a - Modified Proposed Action Option

Under Alternative 2a, direct, indirect, and cumulative effects on land use would be similar to those described under Alternative 2. However, up to approximately 6.0 acres (2.4 hectares) of active farmed lands would be disrupted under the Modified Proposed Action Option, including approximately 2.7 acres (1.1 hectares) that would be disrupted long term, lasting the life of the Project (see Section 4.22 – Agriculture for a detailed discussion). This comprises approximately 2 percent of the existing farmlands within the wind farm site. Implementation of standard BMPs and other mitigation measures, as described under the Proposed Action, would minimize any adverse impacts to land use.

4.14.4 Alternative 3—Larger Generation Facility (Up to 12 Turbine Project)

4.14.4.1 Direct and Indirect Effects of Construction and Operation of the Project

Under Alternative 3, impacts to land use would be similar to those discussed above for Alternative 2. However, Alternative 3 would result in construction of 2 to 4 additional turbines resulting in up to 13.3 acres (5.4 hectares) of disruption to existing farming activities. This includes up to 9.3 acres (3.7 hectares) of long-term displacement of existing farming activities within the wind farm site, which comprises approximately 6 percent of the actively farmed agricultural lands in the wind farm site. Because there would be a lag time of at least 3 years between construction of the first 8 to 10 turbines and the additional 2 to 4 turbines under Alternative 3, the time frame of construction-related impacts associated with disruption to existing farming activities would be extended. The current Project design was modified to minimize impacts to active agriculture.

4.14.4.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP would have minor impact on land use. Under Alternative 3, up to 9.3 acres (3.7 hectares) of existing farmed lands will be permanently displaced for the installation of up to 12 turbines, access roads, and other Project components. This includes plots beneath the turbines that would be maintained in low-growing crops or other vegetation to facilitate the post-construction monitoring program.

Impacts of HCP Mitigation

Impacts of HCP mitigation under Alternative 3 would be the same as described under Alternative 2. Prior to construction of additional turbines proposed under Alternative 3, NPMPP would reopen consultation with the USFWS and DOFAW to assess the potential for impacts of the additional turbines to listed species and develop appropriate mitigation measures. The impacts of these mitigation measures to land use would be evaluated under a separate environmental analysis at that time.

4.14.4.3 Mitigation of Unavoidable Impacts

As discussed under Alternative 2, mitigation measures such as recontouring and revegetating disturbed areas, invasive species control, measure to avoid fire risk (the Fire Management Plan), and implementation of the Site Safety Handbook would minimize impacts to land use. Therefore, no additional mitigation measures for land use impacts are proposed.

4.14.4.4 Cumulative Effects

Cumulative effects to land use under Alternative 3 are the same as described under Alternative 2, with the exception that Alternative 3 would disrupt an additional 5.1 acres (2.0 hectares), which includes an additional 4.7 acres (1.9 hectares) of long-term disruption, to farming activities in the wind farm site. Total impacts to existing farming activities under Alternative 3 would be up to 13.3 acres (5.4 hectares), which includes 9.3 acres (3.7 hectares) of long-term disruption. Relocation of existing farming activities in order to continue farming operations would minimize these impacts. Therefore, when viewed in conjunction with past, present, and foreseeable future projects in the cumulative effects analysis area, the contribution of Alternative 3 to cumulative effects on land use would be minor. Because there would likely be a delay in time of up to 3 years before additional turbines would be built under Alternative 3, new projects and developments in the area will be assessed and reviewed to determine if there are additional cumulative impacts from unknown future projects. Regardless of the time lag, all future projects would need to comply with applicable land use plans, regulations, and policies.

4.14.4.5 Summary

Alternative 3 would result in minor direct and indirect impacts to land use due to displacement of 13.3 acres (5.4 hectares) of existing farming activities in the wind farm site. This includes long-term displacement to 9.3 acres (3.7 hectares) of existing farming activities. HCP conservation measures would result in a negligible adverse impact and a minor beneficial impact to land use within the mitigation areas. Impacts under Alternative 3 would be considered minor because although there would be some long-term impacts associated with construction and operation of the Project, they would be of low magnitude (compatible with existing and planned land uses and/or beneficial effects), localized, and would primarily affect land uses that are common (are not rare in the locality, do not fill a unique role, and are not protected by legislation). Relocation of displaced farming activities to other areas of Malaekahana Hui West's lands would minimize impacts to land use. Alternative 3 would be consistent with the Koolau Loa Sustainable Communities Plan and other land use regulations within the analysis area.

4.14.5 Conclusion

Table 4.14-2 summarizes potential impacts to land use from the alternatives considered in this analysis.

Table 4.14-2. Summary of Impacts to Land Use

Impact Criteria	No Action Alternative	Alternative 2 – Proposed Action	Alternative 2a – Modified Proposed Action Option	Alternative 3
Compatibility with existing and planned land uses.	No Impact	Minor	Minor	Minor
Consistency with the Koolau Loa Sustainable Communities Plan and land use regulations.	No Impact	Consistent/No Impact	Consistent/No Impact	Consistent/No Impact

4.15 Recreation and Tourism

4.15.1 Impact Criteria

Impacts to recreation and tourism resources were assessed based on whether construction and operation of the Project construction as well as the implementation of HCP conservation measures could:

- Result in direct loss of opportunity due to the physical occupation of a recreation resource area by Project infrastructure;
- Indirectly adversely affect a nearby recreation resource due to Project-related traffic (access blocked or otherwise inhibited); or
- Substantially change the environment of a resource such that its function as a recreation resource is impaired or lost (i.e., due to Project-related noise or visual impacts).

Impact criteria for determining effects to recreation resource from the Project are described further in Table 4.15-1 below.

Table 4.15-1. Impact Criteria for Recreation and Tourism

Type of Effect	Impact Component	Effects Summary		
Effects on recreation and tourism resources	Magnitude or Intensity	**High:** Permanent loss of recreational opportunity through displacement; temporary but long-term (1-2 years) loss of opportunity through loss of access; opportunity effectively abandoned during construction period in response to indirect traffic, noise and/or visual impacts; substantial permanent reduction of visitor use in response to indirect traffic, noise and/or visual impacts on the visitor experience.	**Medium:** Temporary short-term (1-2 weeks or more) loss(es) of opportunity through access closure; opportunity effectively abandoned during parts of construction period in response to indirect traffic, noise and/or visual impacts; minor permanent reduction of visitor use in response to indirect traffic, noise and/or visual impacts.	**Low:** Intermittent, brief (1-5 days) loss(es) of opportunity through access closure; substantial reduction of visitor use during parts of construction period in response to indirect traffic, noise and/or visual impacts; some visitors may be annoyed by indirect traffic, noise and/or visual impacts, but effect on recreation experience does not result in measurable long-term reduction of visitor use.
	Duration	**Permanent:** Chronic effects; conditions of recreation and tourism resources would not be anticipated to return to previous levels.	**Long-term:** Effects would persist up to the life of the Project and would return to pre-Project conditions levels after decommissioning.	**Temporary:** Effects would not last longer than the span of one year and would be expected to return to pre-activity levels.
	Geographic Extent	**Extended:** Affects recreation and tourism resources beyond the region, potentially island-wide.	**Regional:** Affects recreation and tourism resources beyond a local area, potentially throughout the region.	**Local:** Impacts limited geographically; limited to vicinity of the Project.
	Context	**Unique:** Affects a recreation resource that is based on inherent natural resource characteristics that could not feasibly be recreated in the same place or at another location.	**Important:** Affects a recreation resource that may be common in region but has unusually high local usage, is a community focal point or is a major component of local economy.	**Common:** Affects a type of recreation resource that is commonly found in the region or based on constructed recreation facilities or infrastructure (such as typical campgrounds and playgrounds) that could feasibly be replaced.

4.15.2 Alternative 1 – No Action

4.15.2.1 Direct and Indirect Effects

Under Alternative 1, the Project would not be constructed, the USFWS would not issue an ITP, and the HCP conservation measures would not be implemented. Therefore, Alternative 1 would have no effect on recreation and tourism resources. As such, no mitigation measures would be required.

4.15.2.2 Cumulative Effects

Under the No Action Alternative, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Therefore, there would be no adverse or beneficial effects on recreation and tourism resources. Thus, Alternative 1 would not contribute to cumulative effects on recreation and tourism resources.

4.15.2.3 Summary

The No Action Alternative would have no direct, indirect, or cumulative effects on recreation or tourism resources as no action would be undertaken.

4.15.3 Alternative 2 – 8 to 10 Turbine Project

4.15.3.1 Direct and Indirect Effects of Construction and Operation of the Project

Construction Impacts

Construction of the Project under Alternative 2 would not cause a direct loss of opportunity to any recreation or tourism resource in the area. No Project infrastructure would be placed within any existing recreation resource area.

Indirect impacts to recreation resources due to Project-related traffic would be would be temporary, occurring primarily during Project construction or decommissioning. All of the recreation resources near the wind farm site are accessed indirectly from the Kamehameha Highway, along which nearly all Project traffic must also travel. Movement of large loads with construction equipment or turbine components would occur at night to minimize or eliminate potential disruptions or delays. Daytime traffic would be limited to commuting traffic of the relatively small workforce and deliveries of some construction materials such as cement for foundations. While visitor travel to some recreation areas may be disrupted or delayed for brief periods, these impacts would be low, intermittent, localized and temporary (disruptions on the order of minutes, with traffic levels returning to normal following construction). Therefore, indirect impacts to recreation resources due to Project-related construction traffic would be negligible to minor.

Construction of the Project would create noise that may affect nearby recreation areas. Table 4.15-2 lists recreation areas that may be exposed to construction noise. The magnitude of the impact associated with construction noise on the closest, most affected receptors (see Section 4.6 – Noise) would be moderate; whereas for most recreation resources in the analysis area, the impact would be minor to negligible. Construction noise is temporary, and periods of particularly loud noise would be intermittent. Sound levels resulting from construction activities vary significantly depending on factors such as the type and age of equipment, the specific equipment manufacturer and model, the operations being performed, and the overall condition of the equipment and exhaust system mufflers. Sounds generated by construction activities exceeding maximum permissible noise levels would likely require a permit to be obtained from the HDOH. While the permits do not limit the sound level generated at the construction site, time restrictions may be placed on when the loudest construction activities may occur (i.e., between 7:00 a.m. and 7:00 p.m. Monday through Friday and between 9:00 a.m. and 6:00 p.m. on Saturday), thereby minimizing impacts to recreation and tourism resources. The HDOH would require reasonable and standard practices be employed to minimize the impact of noise resulting from construction activities.

Operation and Maintenance Impacts

Project O&M activities would generate very low volumes of traffic (see Section 4.17 – Transportation). This additional traffic would result in negligible impacts to recreation and tourism resources in the analysis area.

Sound from the turbines or associated facilities during operation of the Project may be perceived as noise in nearby recreation resource areas (see Section 4.6 – Noise). Operational sound levels from the Project in nearby recreation resource areas are reported below in Table 4.15-2, along with an assessment of significance.

Under Hawaii's Community Noise Control regulation, the maximum allowable noise limit is based on the zoning of the receiving property. The lowest maximum allowable noise level applies to Class A areas, those with residential, conservation, preservation, public space or similar zoning; a higher noise level is allowed for Class B commercial or resort uses; and the highest noise limits apply to Class C agriculturally-zoned parcels (see Table 3.4-2). Of the identified recreation resources near the wind farm site, most are zoned for preservation and/or residential which make them Class A receivers; two private resources are zoned for resort or commercial use which make them Class B receivers, and five have agricultural zoning which make them Class C receivers. No zoning has been applied to the sea bird island sanctuaries; they are therefore assumed to have the most conservative noise limit. Where the zoning is split for a single resource, the lower noise limit is used to assess significance. Applicable zoning and the established noise limit based on the zoning for each resource are listed in Table 4.15-2.

Results of noise modeling indicate that Project operational noise under Alternative 2 would not exceed the State standard at any of the 31 identified recreation and tourism resources within 5 miles of the wind farm site. Operational noise levels would be below 30 dBA, and likely completely inaudible, at 26 of the recreation resources. At the five sites nearest the Project (James Campbell NWR, Malaekahana State Recreation Area, Kahuku District Park, Kahuku Golf Course and Adams Field) operational noise levels would be between 30 and 41 dBA; at this level, Project noise would potentially be noticeable, but would still be well below the most conservative State standard of 45 dBA (see Table 4.15-2). At these five nearest recreation resource areas, the modeled operational noise levels would represent an increase of no more than 3 dBA compared to baseline sound levels; an increase of this amount is considered the threshold of perceptibility, and is likely to be indistinguishable by most people. In most recreational areas, the Project noise would not cause an increase over existing sound levels. Project operational noise impacts to recreation resources would therefore be characterized as negligible, and would not be expected to cause perceptible changes in recreational use or tourism levels.

Table 4.15-2. Potential Impacts of the Proposed Action to Recreation and Tourism Resources in the Wind Farm Site under Alternative 2

GIS ID No.	Recreation Resource Name	Modeled Operational Noise Level (dBA)1/	Receiving Zoning Class and Zoning District	Noise Limit (dBA)2/	Increase over Baseline Noise (dBA)	Potential Visual Impacts
1	James Campbell NWR	<30 to 38	Class A/C (Preservation/ Agriculture)	45/70	0-2	Overall Impact: Moderate. Turbines visible with moderate contrast at 1.0 mile distance. Scenic quality in views toward ocean is high, moderate in views toward Project. Visitor numbers low, with access limited to specific tour seasons/times or by special permission; visitor attention typically focused on bird watching or environmental education activities.
2	Pupukea-Paumalu Forest Reserve	<30	Class A (Preservation)	45	0	Project not visible; no impact
3	Hauula Forest Reserve	<30	Class A (Preservation)	45	0	Overall Impact: Low Potential views of Project largely blocked by vegetation and/or terrain.
4	Kaipapau Forest Reserve	<30	Class A (Preservation)	45	0	Overall Impact: Low Potential views of Project largely blocked by vegetation and/or terrain.
5	Kihewamoku Island Sea Bird Sanctuary	<30	N/A3/	45	0	Overall Impact: Low Unscreened views of Project likely with moderate contrast at 1 mile viewing distance; however, few visitors with attention typically focused on resident seabirds activity rather than shoreward.
6	Mokuauia Island Sea Bird Sanctuary	<30	N/A3/	45	0	Overall Impact: Low Unscreened views of Project likely with moderate contrast at 1 mile viewing distance; however, few visitors with attention typically focused on resident seabirds activity rather than shoreward.
7	Pulemoku Rock Sea Bird Sanctuary	<30	N/A	45	0	Overall Impact: Low Unscreened views of Project likely with moderate contrast at 1 mile viewing distance; however, few visitors with attention typically focused on resident seabirds activity rather than shoreward.

Table 4.15-2. Potential Impacts of the Proposed Action to Recreation and Tourism Resources in the Wind Farm Site under Alternative 2 (continued)

GIS ID No.	Recreation Resource Name	Modeled Operational Noise Level (dBA)1/	Receiving Zoning Class and Zoning District	Noise Limit (dBA)2/	Increase over Baseline Noise (dBA)	Potential Visual Impacts
8	Kukuihoolua Island Sea Bird Sanctuary	<30	N/A	45	0	Overall Impact: Low Unscreened views of Project likely with moderate contrast at 1 mile viewing distance; however, few visitors with attention typically focused on resident seabirds activity rather than shoreward.
9	Mokualai Island Sea Bird Sanctuary	<30	N/A	45	0	Overall Impact: Low Unscreened views of Project likely with moderate contrast at 1 mile viewing distance; however, few visitors with attention typically focused on resident seabirds activity rather than shoreward.
10	Malaekahana State Recreation Area	<30 to 39	Class A (Preservation)	45	0-2	Overall Impact: Moderate Potential views of Project largely screened by vegetation except near entrance. Visitor attention typically focused toward ocean and beach activities rather than inland.
11	Laie Point State Wayside	<30	Class A (Preservation)	45	0	Overall impact: Moderate Unscreened views of Project likely with moderate contrast at over 2 mile viewing distance; Project similar in character to Kahuku wind farm, but more prominent. Few visitors, with attention typically focused seaward, and viewing duration typically short.
12	Laie Beach Park	<30	Class A (Preservation)	45	0	Overall Impact: Moderate Potential views of Project largely screened by vegetation except near entrance; at over 2.6 miles distant Project would be in middleground. Visitor attention typically focused toward ocean and beach activities rather than inland, and viewing duration typically short.
13	Kawela Bay Beach Park	<30	Class A (Preservation)	45	0	Project not visible; no impact

Table 4.15-2. Potential Impacts of the Proposed Action to Recreation and Tourism Resources in the Wind Farm Site under Alternative 2 (continued)

GIS ID No.	Recreation Resource Name	Modeled Operational Noise Level (dBA)[1/]	Receiving Zoning Class and Zoning District	Noise Limit (dBA)[2/]	Increase over Baseline Noise (dBA)	Potential Visual Impacts
14	Kokololio Beach Park	<30	Class A (Preservation/ Residential)	45	0	Overall Impact: Moderate Potential views of Project largely screened by vegetation except near entrance; at 3 miles distant Project would be in middleground. Visitor attention typically focused toward ocean and beach activities rather than inland, and viewing duration typically short.
15	Waialee Beach Park	<30	Class C (Agriculture)	70	0	Project not visible; no impact.
16	Hauula Beach Park	<30	Class A (Preservation)	45	0	Overall Impact: Low-Moderate Potential views of Project partially screened by vegetation and terrain; at 3.8 miles distant Project would be in middleground. Visitor attention typically focused toward ocean and beach activities rather than inland, and viewing duration typically short.
17	Sunset Beach Park	<30	Class A (Preservation)	45	0	Project not visible; no impact.
18	Sunset Point Beach Park	<30	Class A (Preservation)	45	0	Project not visible; no impact.
19	Pupukea Beach Park	<30	Class A (Preservation)	45	0	Project not visible; no impact.
20	Ehukai Beach Park	<30	Class A (Preservation)	45	0	Project not visible; no impact.
21	Kahuku District Park	38 to 41	Class A (Residential)	45	2-3	Overall Impact: Moderate High visibility of Project at close distance, with other manmade features dominating foreground views; high user numbers with attention typically focused toward sports activities on developed fields/courts and activities in community center buildings.
22	Kahuku Golf Course	30 to 38	Class C (Agriculture)	70	0-2	Overall Impact: Moderate Largely unscreened views of Project at middle-ground viewing distance, co-dominated by views of existing wind farm; visitor attention likely typically focused on open panoramic ocean view and golf game.

Table 4.15-2. Potential Impacts of the Proposed Action to Recreation and Tourism Resources in the Wind Farm Site under Alternative 2 (continued)

GIS ID No.	Recreation Resource Name	Modeled Operational Noise Level (dBA)[1/]	Receiving Zoning Class and Zoning District	Noise Limit (dBA)[2/]	Increase over Baseline Noise (dBA)	Potential Visual Impacts
23	Adams Field	36 to 37	Class A (Preservation)	45	1	Overall Impact: Low-Moderate Partially screened views of Project at close distance co-dominated by views of existing wind farm; visitor numbers likely low and primarily local residents at this undeveloped property
24	Laie Park	<30	Class A (Preservation)	45	0	Overall Impact: Low-Moderate Potential views of Project partially screened by vegetation and structures, with other manmade features dominating foreground views; at 1.4 miles Project would be in middleground. Visitor attention typically focused toward sports activities on developed fields/courts.
25	Hauula Community Park	<30	Class A (Preservation/ Residential)	45	0	Overall Impact: Moderate Potential views of Project partially screened by vegetation and structures; at over 4.25 miles Project would be in background. Visitor attention typically focused toward sports activities on developed fields/courts.
26	Sunset Beach Neighborhood Park	<30	Class A (Preservation)	45	0	Project not visible; no impact.
27	Koolau Summit Trail	<30	Class A (Preservation)	45	0	Overall Impact: Low-Moderate Potential intermittent views of Project from ridgeline at minimum 2.5 miles distance; views largely screened by overgrown vegetation; low contrast due to viewing angle; low hiker numbers with attention typically focused on route finding.

Table 4.15-2. Potential Impacts of the Proposed Action to Recreation and Tourism Resources in the Wind Farm Site under Alternative 2 (continued)

GIS ID No.	Recreation Resource Name	Modeled Operational Noise Level (dBA)1/	Receiving Zoning Class and Zoning District	Noise Limit (dBA)2/	Increase over Baseline Noise (dBA)	Potential Visual Impacts
28	Hukilau Beach Park	<30	Class A (Preservation)	45	0	Overall Impact: Low-Moderate Potential views of Project largely screened by vegetation; at 1.3 miles distant Project would be in middleground. Visitor attention typically focused toward ocean and beach activities rather than inland, and viewing duration typically short.
29	Turtle Bay Resort, Palmer and Fazio golf courses	<30	Class B/C (Resort/ Agriculture)	50/ 70	0	Overall Impact: Moderate Potential Project views partially screened by vegetation and terrain; high viewer numbers but visitor attention typically focused on golf and other resort activities.
30	Polynesian Cultural Center	<30	Class B (Community Business)	50	0	Overall Impact: Low to None Low potential Project visibility at 2.5 miles distant, with views likely blocked by vegetation and manmade features; visitor attention focused on PCC activities rather than distant views.
31	Kahuku Motocross Course	<30	Class C (Agriculture)	70	0	Project not visible; no impact.

1/ Reported noise levels are the loudest generated by the turbine models being considered for the Project. Actual sounds levels would likely be lower due to the combination of turbine models that may be selected.
2/ Noise limits as defined in HAR 11-46; these are the most conservative nighttime limits.
3/ No zoning has been applied to the sea bird island sanctuaries; they are therefore assumed to have the most conservative noise limit, equivalent to Class A receivers.

Visual impacts are primarily related to views of the turbines, but may also include visual changes due to other Project infrastructure including new and improved access roads, the substation, O&M building, or electrical collector or transmission lines. Section 4.16 – Visual Resources includes a visual impact analysis based on visual simulations of the proposed turbines. Many of the recreation resources were addressed as representative viewpoints in Section 4.16; where a recreation resource is not directly analyzed in Section 4.16, visual impact assessment results of nearby viewpoints were used to assess visual impacts at nearby recreation sites. Potential visual impacts of the Project under Alternative 2 on nearby recreation resource areas are summarized above in Table 4.15-2.

Visual analysis indicates that the Project would not be visible from 9 of the 31 recreation and tourism resources in the area. Based on screening by vegetation and/or structures, low visitor numbers, and the likely focus of users' attention drawn away from potential Project views, the overall visual impact of the Project is characterized as low to moderate at 19 of the nearby recreation areas. Based on these results, it is unlikely that the visual impact of the Project would affect recreational use or tourism at 28 of the identified resources. Only in 4 of the closest resource areas (James Campbell NWR, Kahuku District Park, Kahuku Golf Course, and Laie Point State Wayside) would the Project result in a moderate overall visual impact. However, a moderate visual impact by itself does not necessarily translate to a significant adverse impact on those resources as recreation or tourism sites; the question is whether the visual impact, in conjunction with other factors, would cause a significant change in user numbers.

At the James Campbell NWR, a visitor is likely to have views of the Project turbines, co-dominated by views of the Kahuku Wind Farm and other manmade features. However, access to the refuge is very limited so visitor numbers are already low at around 600 visitor per year, about two-thirds of whom are students in environmental education classes (USFWS 2011a), indicating that the refuge is not a significant driver of tourism in the area. In addition, the primary focus of visitors to the refuge is for bird watching, effectively reducing the importance of changes to the surrounding scenery. The Project would not adversely affect biological resources within the refuge (see Section 4.10 – Wildlife for additional discussion). Moreover, HCP mitigation (see below) would have a beneficial effect on Hawaiian geese and other birds within the refuge, thereby potentially improving opportunities for bird watching. Considering the negligible noise and traffic impacts at this location, beneficial effects associated with HCP mitigation, and the predominant nature of visitors and their activities, it is unlikely that development of the Project would affect recreational or tourism use of the James Campbell NWR.

The focus of users' attention also plays heavily in assessing likely impacts to recreational use at the Kahuku District Park and Kahuku Golf Course. At both of these locations, visitors are likely to have views of the turbines at relatively close range (see Section 4.16 – Visual Resources); views would be co-dominated by the existing Kahuku Wind Farm and by vegetation and manmade structures and other features in the foreground. However, despite a view of the turbines, users' attention is likely to be focused elsewhere. At the golf course, users' attention would likely be on the game and the open panoramic views of the ocean and shoreline. At the Kahuku District Park, the focus would be on organized sports activities occurring on the baseball field or tennis and basketball courts, or on a wide variety of activities sponsored by the adjacent Kahuku Community Center. Views of the turbines would not interfere with either a golf game or with participating in or watching activities at the district park. Both sites appear to be well-used; the golf course is one of a small number of public courses on Oahu and draws both local residents and tourists, while the district park and community center are heavily used by area residents. Considering the negligible noise and traffic impacts at these locations, the focus of users' attention, and the existing strong demand for these resources, it is unlikely that development of the Project would affect recreational use levels at either the Kahuku Golf Course or the Kahuku District Park.

4.15.3.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP are not expected to affect recreation and tourism resources. They would not result in the direct loss of a recreation or tourism opportunity or reduce the ability of a recreation resource or tourism opportunity to function as such.

Impacts of HCP Mitigation

Impacts to recreation and tourism resources as a result of the implementing mitigation under the Project HCP would negligible. The mitigation measures would not cause a direct loss of any recreation resource area. Additionally, none of the mitigation measures would cause a noticeable increase in traffic in the vicinity of, thereby inhibiting access to, recreation or tourism resources in the analysis area (see Section 4.17 – Transportation).

With the exception of the work at Hamakua Marsh for waterbird mitigation, the mitigation measures would not cause a noise or visual impact to recreation or tourism resources in the analysis area. At Hamakua Marsh, the installation of mitigation fences would have a minor, localized noise impact during their construction, but no ongoing noise impact. The fence and signage at Hamakua Marsh would have a minor, localized visual impact, but would be designed to be as visually unobtrusive as practicable while still fulfilling its intended role of keeping waterbirds out of commercial parking lots. In terms of impacts to nearby recreation areas, however, the fences would have virtually no visual impact because it is unlikely to be visible from any site except the mitigation areas themselves. In addition, the fence and signage at Hamakua Marsh would be seen against the backdrop of existing commercial uses. Therefore, impacts to recreation and tourism resources associated with HCP mitigation would be negligible.

4.15.3.3 Mitigation for Unavoidable Impacts

NPMPP and its construction contractor would implement a number of mitigation measures to reduce or eliminate adverse impacts to recreation resources in the vicinity of the wind farm site. Traffic impacts would be addressed through the development and implementation of a construction traffic management plan to minimize disruptions for people traveling to recreation sites near the

Project. One of the primary elements of the plan would be that most construction equipment and materials, including all turbine components and other oversize loads, would be moved from the harbor to the wind farm site at night; this would avoid conflicts with daytime resident and tourist traffic. If necessary, traffic controls would be implemented to maintain traffic safety while accommodating Project, resident, and tourist traffic during the daytime. This is likely to occur only during the short time period when the Project access road is being improved at its intersection with the Kamehameha Highway; traffic levels and types during other periods are unlikely to warrant special traffic management actions. With implementation of these measures, potential impacts to recreation and tourism resources would be less than significant.

Mitigation measures listed in Table 2-6 and described in Section 4.6 – Noise to minimize noise impacts include limiting noisy activities to daytime weekdays, scheduling of construction activities to conduct noisy activities at similar times to reduce the overall frequency of those periods, using equipment with properly functioning mufflers or noise suppressors, and establishing a complaint resolution system. The implementation of these measures would minimize any potential noise-related impacts to recreation and tourism resources. Due to the nature of the Project, views of the turbines and the resulting visual impacts are difficult to mitigate, though a few specific design standards will be implemented to reduce visual impacts to the extent practicable. Turbines and towers will be painted a uniform matte white or off-white as recommended by the FAA; the use of a matte finish would inhibit reflections or glare. No signs, writing, or advertising would be permitted on the turbines. The turbines would not be lighted with the exception of synchronized red flashing lights on turbines as required to satisfy FAA marking and lighting requirements. Where lighting may be necessary elsewhere on the Project, such as at the substation or O&M building, lights would be shielded and directed downward and inward toward the facilities to prevent offsite glare. Necessary lighting would be controlled with motion sensors, timers, or similar features such that the lights are on only when needed. The implementation of these measures would minimize the potential impacts to recreation and tourism resources associated with Project visibility.

4.15.3.4 Cumulative Effects

The analysis area for cumulative effects on recreation and tourism resources includes the area within 5 miles of the wind farm site, and within 1 mile of the bat and waterbird mitigation sites. Since the Project would not directly impact any recreation resource area, the cumulative effects analysis focuses on indirect traffic, noise, and visual effects.

Project traffic is a concern only during construction, when dozens of truck trips may occur daily; operational traffic levels would be negligible. Project construction is proposed to begin in as early as the second quarter of 2016, with commercial operation commencing in 2017. There are a number of other large construction projects in the vicinity that may also be occurring in that time period that may contribute to cumulative traffic impacts (see Table 4.2-2). These include the planned expansion of Turtle Bay Resort and ongoing construction of staff and faculty housing in the Malaekahana area to accommodate a growing BYU enrollment, construction of a technology park associated with BYU, and the construction of transportation safety improvements along Kamehameha Highway. These projects, along with growth in background traffic levels from incoming residents and increased tourism, would individually have some impacts to traffic levels; however, it is unlikely that cumulative adverse effects to recreation resources would occur.

Cumulative traffic impacts from separate projects are limited in magnitude and extent by a number of factors, such as that construction traffic is inherently temporary and the potential for major disruptions to traffic flow is intermittent. The effects of a major non-road construction project on traffic flow are generally highly localized, occurring primarily at the entrance to a project site and possibly at a few nearby intersections. In addition, major construction projects must be permitted through Honolulu County, and would require a traffic management plan to be implemented such that the effect of each project would be at most minor. Permitting through a single agency is likely to improve coordination between separate projects and help to minimize cumulative adverse impacts to recreation and tourism resources.

Cumulative noise effects would occur only at those few closest recreation resources that experience audible noise from the Project as well as from other nearby uses, in particular the adjacent Kahuku Wind Farm. However, based on the results of baseline noise monitoring (which includes the existing noise of the Kahuku Wind Farm) and operational noise modeling, the Project would contribute no more than a 3 dBA increase over existing noise levels at any recreation or tourism resource. This increase is considered the threshold of perception, and is likely to be indistinguishable by most people. Other likely future development are not considered substantial noise generators, and are unlikely to further contribute to long-term cumulative noise impacts to recreation resources in the area.

Cumulative visual effects also occur primarily at the few closest recreation resource areas that would experience views of the Project as well as other developments, in particular the Kahuku Wind Farm. However, based on existing visual conditions, screening, user numbers, and the focus of users' attention being drawn away from views of the Project or other developments by recreational activities, it is unlikely that a cumulative visual impact would result in a perceptible reduction in recreational or tourism use rates. Rather, the additional housing, commercial and resort development is likely to increase recreation and tourism use rates throughout the area.

When viewed in conjunction with past, present, and foreseeable future projects in the cumulative effects analysis area, the contribution of Alternative 2 to cumulative effects on recreation and tourism resources is considered to be negligible for most resources to, at most, moderate for a few of the closest recreation resource areas. However, the cumulative effects remain unlikely to result in a perceptible reduction in recreational or tourism use of these resources.

4.15.3.5 Summary

The Proposed Action would not directly impact any recreation or tourism resource in the vicinity. Potential indirect impacts, under this alternative, due to traffic would be negligible to minor, and would be temporary with conditions returning to normal following construction of the Project. The results of the noise analysis indicate that the effect of noise from the Proposed Action would be minor; Project operational noise would not exceed established State noise limits at any recreation resource area and would cause a barely perceptible increase in existing noise levels at only a few resource areas. Construction noise may temporarily exceed the noise limits at the closest sites, pursuant to a HDOH permit. The results of the visual analyses indicate that the construction and operation of the Proposed Action would result in a moderate visual impact to three of the nearest sites and, at most, low to moderate visual impact at all other resource areas. However, based on the minor noise and traffic impacts, existing screening and presence of other manmade features in view, and the nature of visitors and the activities at each of these sites, it is unlikely that the overall impacts of the Project would result in a perceptible change in recreational or tourism use at any recreation resource area. Implementation of HCP conservation measures would negligible effects on recreation resources. Overall, effects on recreation and tourism resources under Alternative 2 would be considered negligible because although there would be some long-term noise and visual impacts, the intensity would be at most low (no direct or indirect loss of a recreation opportunity, moderate visual impacts but no likely change to recreation or tourism use rates), the effects would be localized, and recreation resources potentially affected are common to the area.

4.15.3.6 Alternative 2a - Modified Proposed Action Option

Under Alternative 2a, direct, indirect, and cumulative effects on recreation and tourism would be similar as those described under Alternative 2. No loss of recreation opportunities would occur and there are no anticipated changes in recreation or tourism rates due to noise, traffic, or visual effects. Table 15 of the supplemental technical analysis in Appendix A summarizes impacts to recreation and tourism resources in the vicinity of the wind farm site. Noise levels would be lower under the Modified Proposed Action Option than under the Prosed Action (see Section 4.6 – Noise). Traffic levels (average daily and maximum daily traffic rates) under the Modified Proposed Action Option would be the same as the Proposed Action (see Section 4.17 – Transportation). While the taller turbines proposed under Alternative 2a may individually result in greater visual contrast, the degree of increased contrast would not be sufficient to result in a change to the overall visual impact of the Project at any of the recreation sites compared to the Proposed Action. Under both the Proposed Action and the Modified Proposed Action Option the visual impacts would result in the same number of recreation sites where the Project would not be visible, sites where the Project would result in low to low-moderate visual impacts, and sites where the Project would result in moderate to moderate-high visual impacts (Appendix A, Table 17). Implementation of mitigation measures, as described under the Proposed Action, would minimize adverse impacts to recreation and tourism resources under the Modified Proposed Action Option.

4.15.4 Alternative 3 – Larger Generation Facility (Up to 12 Turbine Project)

4.15.4.1 Direct and Indirect Effects of Construction and Operation of the Project

Construction Impacts

As with Alternative 2, Alternative 3 would not result in a direct loss of opportunity impact to any recreation or tourism resource in the analysis area. No Project infrastructure would be placed within any existing recreation resource area.

Similar to Alternative 2, impacts to recreation resources due to construction traffic under Alternative 3 would be considered negligible to minor. Most turbine components and construction equipment would be moved to the wind farm site at night, limiting daytime traffic conflicts, and a traffic management plan would be implemented to address remaining potential traffic issues. If any traffic disruptions or delays were to occur, they would be short term, localized, and intermittent, and traffic would return to normal once construction is completed. Under Alternative 3, there would be two periods of construction activity and therefore construction-related traffic, separated by several years, rather than one construction period as under Alternative 2. The amount of traffic associated with the construction of the first 8 to 10 turbines under Alternative 3 would be similar to that produced by Alternative 2, with additional traffic associated with the installation of the additional 2 to 4 turbines.

Impacts of construction noise on recreation and tourism resources under Alternative 3 would be similar to those described under Alternative 2. The amount of noise associated with the construction of the first 8 to 10 turbines under Alternative 3 would be similar to that produced by Alternative 2; however, additional short-term, localized construction noise would occur with the installation of the additional 2 to 4 turbines.

Operation and Maintenance Impacts

O&M of the Project under Alternative 3 would generate very low volumes of traffic that would result in negligible impacts to nearby recreation and tourism resources.

Indirect impacts from operational noise and visual impacts under Alternative 3 are similar to those for Alternative 2. Section 4.6 – Noise provides a predicted operational noise levels under Alternative 3, and the loudest modeled sound levels at recreation resources in the analysis area are reported in Table 4.15-3. The results of the noise modeling indicate that there are no recreation sites in which operational noise from Alternative 3 would exceed the State standard. Operational noise levels at 26 of the 31 identified recreation and tourism resources within 5 miles of the wind farm site would be below 30 dBA and virtually inaudible. Operational noise levels at the five sites nearest the Project (James Campbell NWR, Malaekahana State Recreation Area, Kahuku District Park, Kahuku Golf Course and Adams Field) would be between 30 and 42 dBA, potentially noticeable but still below the most conservative State limit of 45 dBA. The modeled operational noise levels would represent an increase of no more than 3 dBA compared to baseline sound levels in all of these areas, so would be characterized as a negligible impact; in most recreational areas the Project noise would represent no increase over existing levels. Noise from Project construction may result in temporary exceedence of the State noise limits at some of the nearest recreation areas; these would be addressed through a HDOH noise permit. Potential visual impacts of Alternative 3 on nearby recreation resource areas are also reported below in Table 4.15-3. Despite the greater number of turbines, the overall visual impacts of Alternative 3 are essentially identical to those for Alternative 2; this is because the impacts are based largely on characteristics of the recreation resource site and intervening lands rather than on the Project. Visual impact analysis indicates that the Project would not be visible from 9 of the 31 recreation and tourism resources in the area.

Table 4.15-3. Potential Impacts of Alternative 3 to Recreation and Tourism Resources in the Wind Farm Site

GIS ID No.	Recreation Resource Name	Modeled Operational Noise Level (dBA)1/	Receiving Zoning Class and Zoning District	Increase over Baseline Noise (dBA)	Potential Visual Impacts
1	James Campbell NWR	<30 to 39	Class A/C (Preservation/ Agriculture)	0-2	Overall Impact: Moderate Turbines highly visible with strong contrast at 1.0 mile distance. Scenic quality in views toward the ocean is high and moderate in views toward the Project. Visitor numbers low, with access limited to specific tour seasons/times or by special permission; visitor attention typically focused on bird watching or environmental education activities.
2	Pupukea-Paumalu Forest Reserve	<30	Class A (Preservation)	0	Project not visible; no impact
3	Hauula Forest Reserve	<30	Class A (Preservation)	0	Overall Impact: Low Potential views of Project largely blocked by vegetation and/or terrain.
4	Kaipapau Forest Reserve	<30	Class A (Preservation)	0	Overall Impact: Low Potential views of Project largely blocked by vegetation and/or terrain.
5	Kihewamoku Island Sea Bird Sanctuary	30 to 31	N/A	0	Overall Impact: Low Unscreened views of Project likely with moderate contrast at 1 mile viewing distance; however, few visitors with attention typically focused on resident seabirds activity rather than shoreward.
6	Mokuauia Island Sea Bird Sanctuary	<30	N/A	0	Overall Impact: Low Unscreened views of Project likely with moderate contrast at 1 mile viewing distance; however, few visitors with attention typically focused on resident seabirds activity rather than shoreward.
7	Pulemoku Rock Sea Bird Sanctuary	<30	N/A	0	Overall Impact: Low Unscreened views of Project likely with moderate contrast at 1 mile viewing distance; however, few visitors with attention typically focused on resident seabirds activity rather than shoreward.
8	Kukuihoolua Island Sea Bird Sanctuary	<30	N/A	0	Overall Impact: Low Unscreened views of Project likely with moderate contrast at 1 mile viewing distance; however, few visitors with attention typically focused on resident seabirds activity rather than shoreward.

Table 4.15-3. Potential Impacts of Alternative 3 to Recreation and Tourism Resources in the Wind Farm Site (continued)

GIS ID No.	Recreation Resource Name	Modeled Operational Noise Level (dBA)1/	Receiving Zoning Class and Zoning District	Increase over Baseline Noise (dBA)	Potential Visual Impacts
9	Mokualai Island Sea Bird Sanctuary	<30	N/A	0	Overall Impact: Low Unscreened views of Project likely with moderate contrast at 1 mile viewing distance; however, few visitors with attention typically focused on resident seabirds activity rather than shoreward.
10	Malaekahana State Recreation Area	<30 to 40	Class A (Preservation)	0-2	Overall Impact: Moderate Potential views of Project largely screened by vegetation except near entrance. Visitor attention typically focused toward ocean and beach activities rather than inland.
11	Laie Point State Wayside	<30	Class A (Preservation)	0	Overall impact: Moderate Unscreened views of Project likely with moderate contrast at over 2 mile viewing distance; Project similar in character to Kahuku wind farm. Few visitors, with attention typically focused seaward, and viewing duration typically short.
12	Laie Beach Park	<30	Class A (Preservation)	0	Overall Impact: Moderate Potential views of Project largely screened by vegetation except near entrance; at over 2.6 miles distant Project would be in middleground. Visitor attention typically focused toward ocean and beach activities rather than inland, and viewing duration typically short.
13	Kawela Bay Beach Park	<30	Class A (Preservation)	0	Project not visible; no impact
14	Kokololio Beach Park	<30	Class A (Preservation/ Residential)	0	Overall Impact: Moderate Potential views of Project largely screened by vegetation except near entrance; at 3 miles distant Project would be in middleground. Visitor attention typically focused toward ocean and beach activities rather than inland, and viewing duration typically short.
15	Waialee Beach Park	<30	Class C (Agriculture)	0	Project not visible; no impact.
16	Hauula Beach Park	<30	Class A (Preservation)	0	Overall Impact: Low-Moderate Potential views of Project partially screened by vegetation and terrain; at 3.8 miles distant Project would be in middleground. Visitor attention typically focused toward ocean and beach activities rather than inland, and viewing duration typically short.

Table 4.15-3. Potential Impacts of Alternative 3 to Recreation and Tourism Resources in the Wind Farm Site (continued)

GIS ID No.	Recreation Resource Name	Modeled Operational Noise Level (dBA)1/	Receiving Zoning Class and Zoning District	Increase over Baseline Noise (dBA)	Potential Visual Impacts
17	Sunset Beach Park	<30	Class A (Preservation)	0	Project not visible; no impact.
18	Sunset Point Beach Park	<30	Class A (Preservation)	0	Project not visible; no impact.
19	Pupukea Beach Park	<30	Class A (Preservation)	0	Project not visible; no impact.
20	Ehukai Beach Park	<30	Class A (Preservation)	0	Project not visible; no impact.
21	Kahuku District Park	39 to 42	Class A (Residential)	2-3	Overall Impact: Moderate High visibility of Project at close distance, with other manmade features dominating foreground views; high user numbers with attention typically focused toward sports activities on developed fields/courts and activities in community center buildings.
22	Kahuku Golf Course	31 to 39	Class C (Agriculture)	0-2	Overall Impact: Moderate Largely unscreened views of Project in middleground distance, co-dominated by views of existing wind farm; visitor attention likely typically focused on open panoramic ocean view and golf game.
23	Adams Field	37 to 38	Class A (Preservation)	1-2	Overall Impact: Low-Moderate Partially screened views of Project at close distance co-dominated by views of existing wind farm; visitor numbers likely low and primarily local residents at this undeveloped property
24	Laie Park	<30	Class A (Preservation)	0	Overall Impact: Low-Moderate Potential views of Project partially screened by vegetation and structures, with other manmade features dominating foreground views; at 1.4 miles Project would be in middleground. Visitor attention typically focused toward sports activities on developed fields/courts.
25	Hauula Community Park	<30	Class A (Preservation/ Residential)	0	Overall Impact: Moderate Potential views of Project partially screened by vegetation and structures; at over 4.25 miles Project would be in background. Visitor attention typically focused toward sports activities on developed fields/courts.

Table 4.15-3. Potential Impacts of Alternative 3 to Recreation and Tourism Resources in the Wind Farm Site (continued)

GIS ID No.	Recreation Resource Name	Modeled Operational Noise Level (dBA)1/	Receiving Zoning Class and Zoning District	Increase over Baseline Noise (dBA)	Potential Visual Impacts
26	Sunset Beach Neighborhood Park	<30	Class A (Preservation)	0	Project not visible; no impact.
27	Koolau Summit Trail	<30	Class A (Preservation)	0	Overall Impact: Low-Moderate Potential intermittent views of Project from ridgeline at minimum 2.5 miles distance; views largely screened by overgrown vegetation; low contrast due to viewing angle; low hiker numbers with attention typically focused on route finding.
28	Hukilau Beach Park	<30	Class A (Preservation)	0	Overall Impact: Low-Moderate Potential views of Project largely screened by vegetation; at 1.3 miles distant Project would be in middleground. Visitor attention typically focused toward ocean and beach activities rather than inland, and viewing duration typically short.
29	Turtle Bay Resort, Palmer and Fazio golf courses	<30	Class B/C (Resort/ Agriculture)	0	Overall Impact: Moderate Potential Project views partially screened by vegetation and terrain; high viewer numbers but visitor attention typically focused on golf and other resort activities.
30	Polynesian Cultural Center	<30	Class B (Community Business)	0	Overall Impact: Low to None Low potential Project visibility at 2.5 miles distant, with views likely blocked by vegetation and manmade features; visitor attention focused on PCC activities rather than distant views.
31	Kahuku Motocross Course	<30	Class C (Agriculture)	0	Project not visible; no impact.

1/ Reported noise levels are the loudest generated by the turbine models being considered for the Project. Actual sound levels would likely be lower due to the combination of turbine models that may be selected.

Based on screening by vegetation and/or structures, low visitor numbers, and the likely focus of users' attention drawn away from potential Project views, the overall visual impact of the Project is characterized as low to moderate at 19 of the nearby recreation areas. Only in 3 of the closest resource areas (James Campbell NWR, Kahuku District Park, and Kahuku Golf Course) would the Project result in a moderate overall visual impact. However, considered together with the negligible noise and traffic impacts, existing screening and presence of other manmade features in view, and the nature of visitors and the activities at each of these sites, it is unlikely that views of the Project would result in a perceptible change in recreational or tourism use at any recreation resource area.

4.15.4.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP are not expected to affect recreation and tourism resources. They would not result in the direct loss of a recreation or tourism opportunity or reduce the ability of a recreation resource or tourism opportunity to function as such.

Impacts of HCP Mitigation

Impacts to recreation and tourism resources as a result of the implementing mitigation under the Project HCP under Alternative 3 would be the same as described under Alternative 2. Prior to construction of additional turbines proposed under Alternative 3, NPMPP would reopen consultation with the USFWS and DOFAW to assess the potential for impacts of the additional turbines to listed species and develop appropriate mitigation measures. The impacts of these mitigation measures to recreation and tourism resources would be evaluated under a separate environmental analysis at that time.

4.15.4.3 Mitigation for Unavoidable Impacts

Mitigation measures for reducing impacts to recreation and tourism resources associated with traffic, noise, and Project visibility under Alternative 3 are essentially identical to those that would be implemented for Alternative 2. The key difference is that mitigation measures to be implemented during construction would occur twice, once during the each construction phase of the Project.

4.15.4.4 Cumulative Effects

The cumulative effects to recreation and tourism resources under Alternative 3 would be similar in nature to those of Alternative 2, but would be somewhat greater in magnitude for noise and visual impacts. Cumulative traffic impacts would differ primarily in that there would be two periods of Project construction, separated by a few years. The cumulative traffic effects on recreation resources for each phase of construction would be minor for a few resource areas and negligible for most. While some disruptions to access of recreation resource areas may occur during construction of the Project and other nearby developments, they would be temporary and intermittent, highly localized, and would tend to be on the order of a few minutes at most.

Cumulative noise effects would occur only at those few closest recreation resources that experience audible noise from the Project as well as from other nearby industrial developments, in particular the adjacent Kahuku Wind Farm. However, based on the results of baseline noise monitoring (which includes the existing noise of the Kahuku Wind Farm) and operational noise modeling, the Project would contribute no more than a 3 dBA increase over existing noise levels at any recreation or tourism resource. This increase is considered the threshold of perception, and is likely to be indistinguishable by most people. Other likely future development are not considered substantial noise generators, and are unlikely to further contribute to long-term cumulative noise impacts to recreation resources in the area. Cumulative visual effects also occur primarily at the few closest recreation resource areas that would experience views of the Project as well as other developments, in particular the Kahuku Wind Farm. However, based on existing visual conditions, screening, user numbers, and the focus of users' attention being drawn away from views of the Project or other developments by recreational activities, it is unlikely that a cumulative visual impact would result in a perceptible reduction in recreational or tourism use rates. Rather, the additional housing, commercial and resort development is likely to increase recreation and tourism use rates throughout the area.

Because there would be a delay in time of up to 3 years before additional turbines would be built under Alternative 3, new projects and developments in the area will be assessed and reviewed to determine if there are additional cumulative impacts to recreation and tourism resources from future unknown projects.

4.15.4.5 Summary

Alternative 3 would not directly impact any recreation or tourism resource in the vicinity of the Project. Potential indirect impacts due to traffic would be negligible to minor, and would be temporary with conditions returning to normal following construction of each phase of the Project. The results of the noise analysis indicate that the effect of Alternative 3 operational noise on recreation resources would be negligible; Project operational noise would not exceed established State noise limits at any nearby recreation resource area and would cause a barely perceptible increase in existing noise levels at only a few of the nearest resource areas. The results of the visual analyses indicate that the construction and operation of Alternative 3 would result in a moderate visual impact to three of the nearest sites and, at most, low to moderate visual impact at all other resource areas. However, based on the minor noise and traffic impacts, existing screening and presence of other manmade features in view, and the nature of visitors and the activities at each of these sites, it is unlikely that the overall impacts of the Project would result in a perceptible change in recreational or tourism use at any recreation resource area. Implementation of HCP conservation measures would have at most a minor impact on recreation resources near each site; in most cases there would be no impact. Overall, effects on recreation and tourism resources under Alternative 3 would be considered negligible because although there would be some long-term noise and visual impacts at individual recreation resources, the intensity would be, at most, low (no direct or indirect loss of a recreation opportunity, negligible traffic or noise impact, moderate visual impacts, and no likely change to recreation or tourism use rates), the effects would be localized, and common recreation resources would be affected.

4.15.5 Conclusion

Table 4.15-4 summarizes potential impacts to recreation and tourism resources from the alternatives considered in this analysis.

Table 4.15-4. Summary of Potential Impacts to Recreation

Impact Issues	No Action Alternative	Alternative 2 – Proposed Action	Alternative 2a – Modified Proposed Action Option	Alternative 3
Direct loss of recreation or tourism opportunity	No Impact	No Impact	No Impact	No Impact
Indirect loss of recreation or tourism opportunity due to traffic, noise, or visual impacts	No Impact	Negligible	Negligible	Negligible
Predicted impact to recreation and tourism use rates	No Impact	Negligible	Negligible	Negligible

4.16 Visual Resources

Impacts to visual resources were assessed based on the proposed Project's potential visibility and how the Project would be viewed from particular locations. Section 4.16.1 discusses the methodology and impact criteria used to assess the visual impacts. The remainder of this section addresses direct and indirect impacts, mitigation measures, and cumulative effects for the alternatives evaluated in detail.

4.16.1 Methodology

A review of plans applicable to the lands within and near the wind farm site indicated there are no formal guidelines for managing visual resources on those lands. Therefore, commonly used visual resource assessment concepts were applied to characterize the current visual environment, identify the expected change to the landscape resulting from the introduction of Project elements, and assess the level of visual impact based on expected viewer response to those changes. The following discussion summarizes the approach used in the respective steps of the visual assessment process.

4.16.1.1 Define Analysis Area

The analysis area for visual resources was defined as the area within 10 miles from the wind farm site (Figure 4.16-1). Some degree of detail would be evident where Project components are viewed at distances up to about 5 miles. Viewers more distant than about 5 miles would be able to discern overall Project shape and mass, but not individual details. Project components might be visible to some degree beyond 10 miles, but their prominence would be sufficiently reduced that the impact would likely be minor or negligible. Therefore, the impact assessment was focused on the area within 10 miles of the Project.

4.16.1.2 Conduct Viewshed Analysis

A viewshed analysis was completed to identify locations within the analysis area from which the Project would potentially be visible (Figures 4.16-2, 4.16-3, 4.16-4 and 4.16-5). Viewshed analysis for the Project was run using the preliminary Project layout and a U.S. Geological Survey digital elevation model dataset. The analysis results identify all points on the terrain surface with a direct line of sight to the tip elevation of one or more Project turbines. Because the turbines are the tallest

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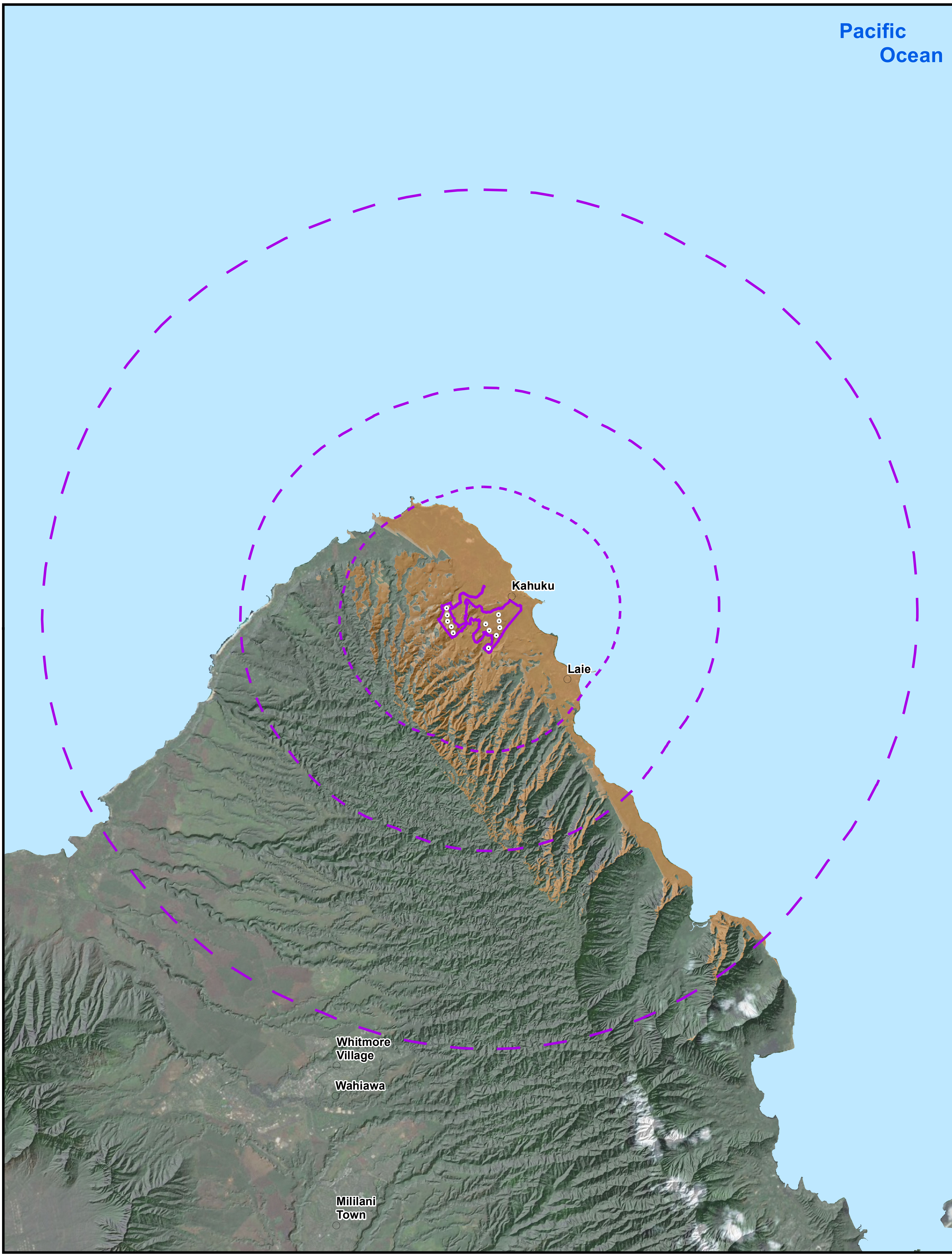


Figure 4.16-1

1:150,000 WGS84 UTM 4

0 0.5 1 2 3 4 Miles

Na Pua Makani Wind Project

Visual Resource Analysis Area

Oahu, HI

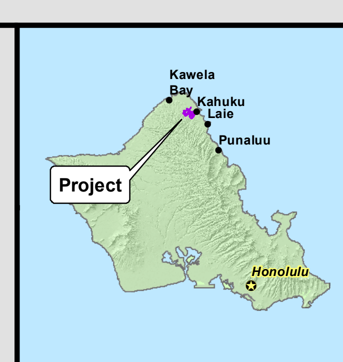
January 2016

Wind Farm Site
Potential Turbine Location

Distance Zones
2.5 miles
5 miles
10 miles
City/Town

Zones of Visual Influence *
High
Low

*Zones of visual influence calculated using a viewing height of 6 feet (1.8 meters) and a 100% maximum blade tip height of up to 512 feet (156 meters)



Data Sources Champlin: project facilities / ESRI: roads, cities, aerial imagery / Tetra Tech: zones of visual influence

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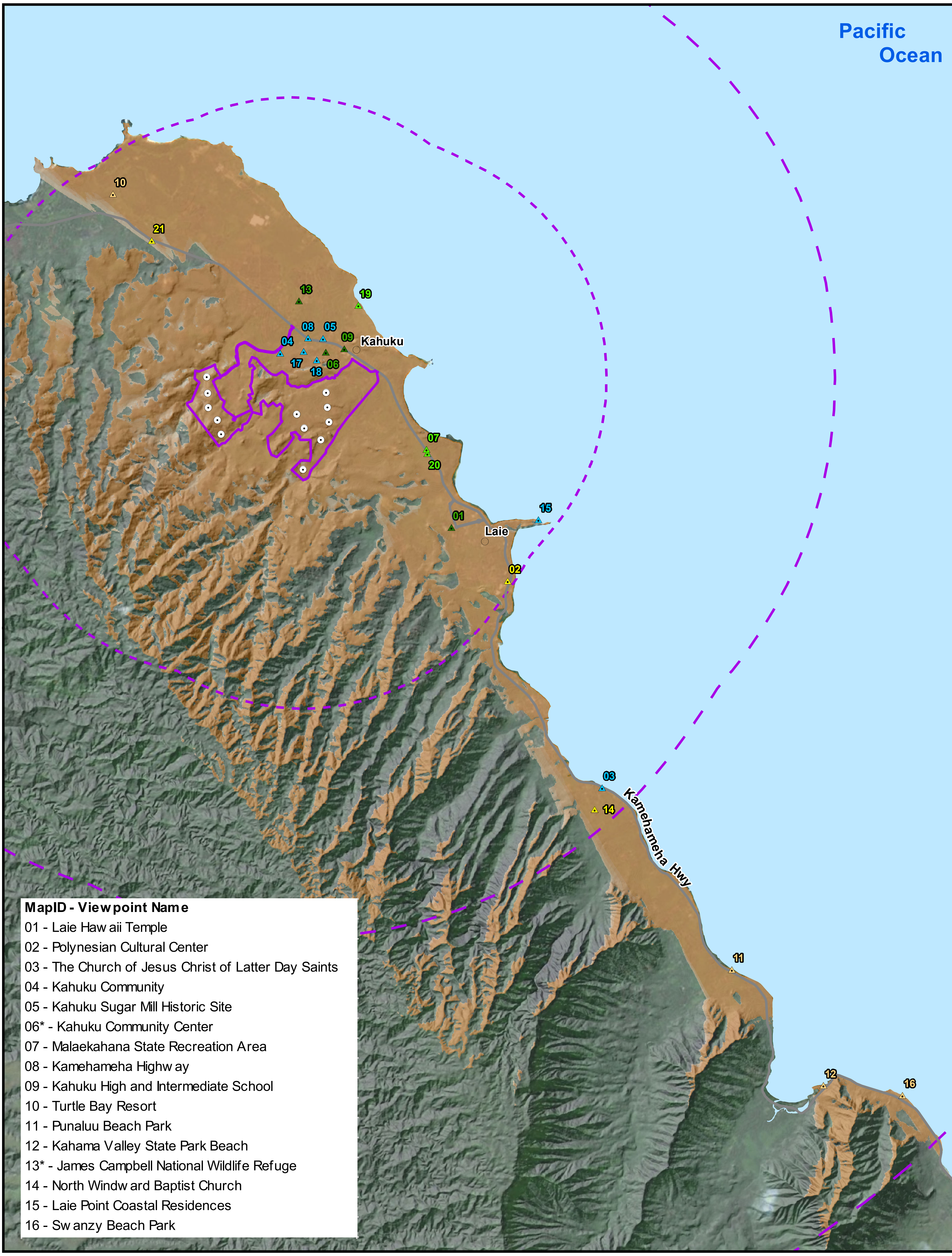


Figure 4.16-2

1:65,000 WGS84 UTM 4

0 0.5 1 2 3 4 Miles

Na Pua Makani Wind Project

Visual Resource Viewpoint Selection

Oahu, HI

January 2016

Wind Farm Site

Potential Turbine Location

Turbine Visibility Potential

Distance Zones

2.5 miles

5 miles

10 miles

City/Town

Secondary Road

Zones of Visual Influence *

High

Low

Confirmed Yes

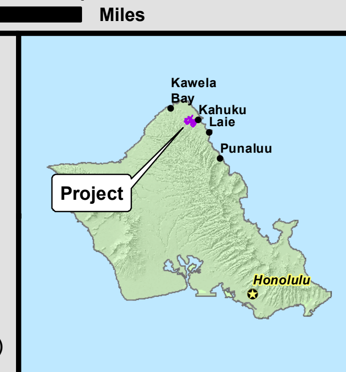
Yes

Likely

Possible

Low

*Zones of visual influence calculated using a viewing height of 6 feet (1.8 meters) and a 100% maximum blade tip height of up to 512 feet (156 meters)



Data Sources Champlin: project facilities / ESRI: roads, cities, aerial imagery / Tetra Tech: zones of visual influence

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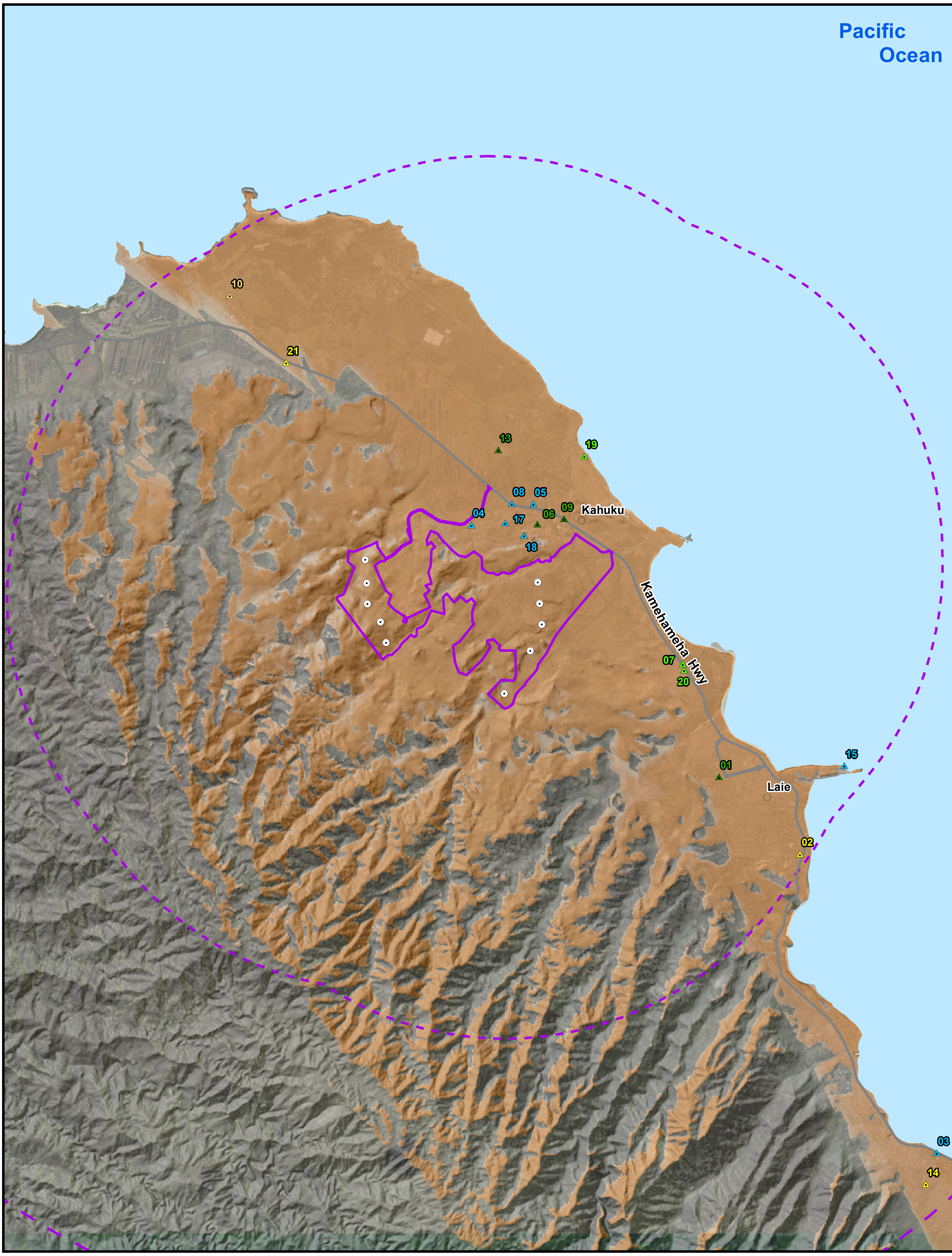


Figure 4.16-3

1:45,000 WGS84 UTM 4

0 0.25 0.5 1 1.5 2 Miles

Na Pua Makani Wind Project

Visual Resource Viewpoints within 2.5 miles of the Project Alternative 2

Oahu, HI

January 2016

Wind Farm Site

Potential Turbine Location

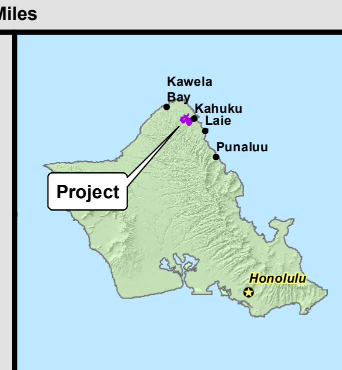
Distance Zones
- 2.5 miles
- 5 miles
- 10 miles

City/Town

Secondary Road

Zones of Visual Influence *
- High
- Low

Turbine Visibility Potential
- Confirmed Yes
- Yes
- Likely
- Possible
- Low



*Zones of visual influence calculated using a viewing height of 6 feet (1.8 meters) and a 100% maximum blade tip height of up to 512 feet (156 meters)

Data Sources Champlin: project facilities / ESRI: roads, cities, aerial imagery / Tetra Tech: zones of visual influence

TETRA TECH

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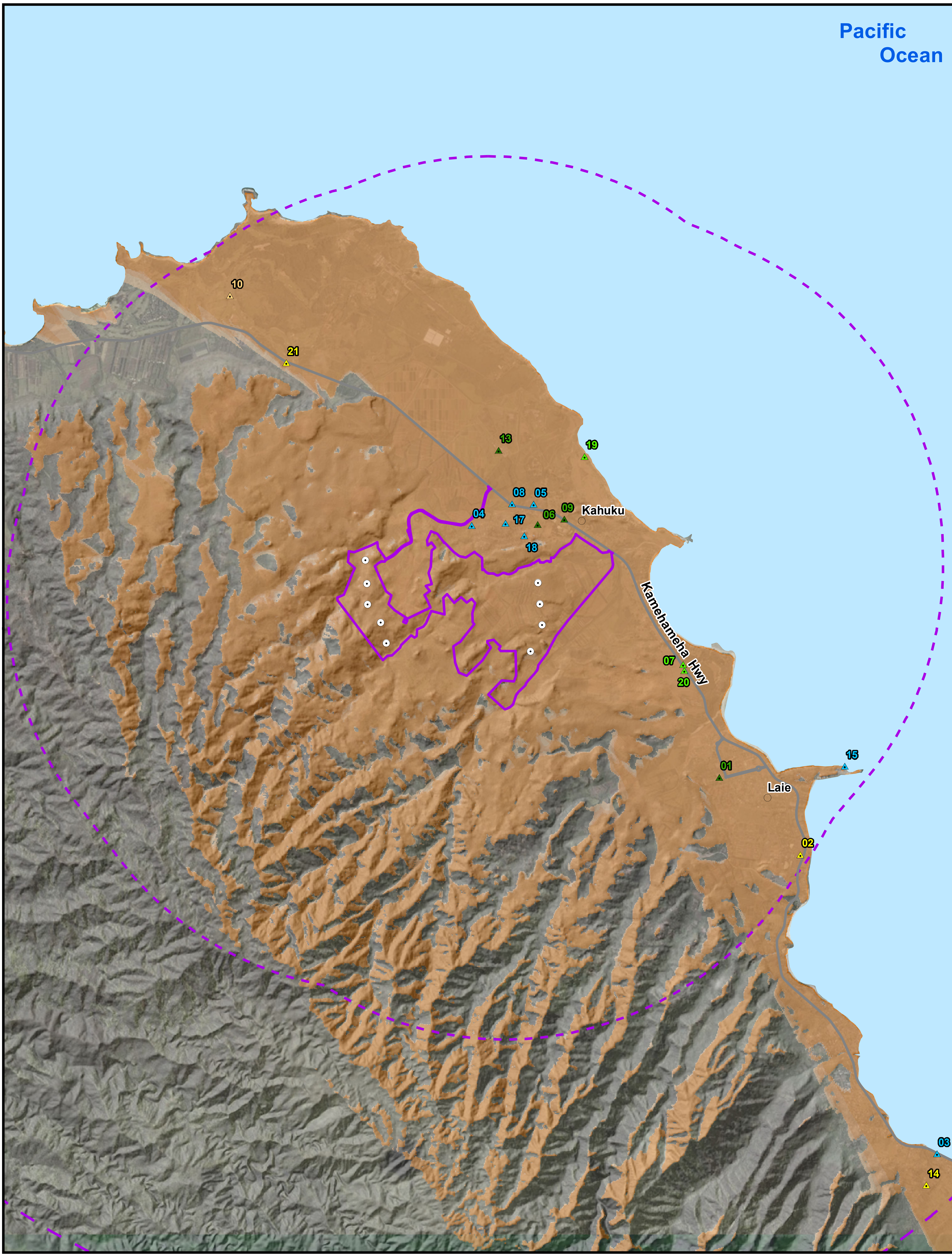


Figure 4.16-4

1:45,000 WGS84 UTM 4

0 0.25 0.5 1 1.5 2 Miles

Na Pua Makani Wind Project

Visual Resource Viewpoints within 2.5 miles of the Project Alternative 2a

Oahu, HI

January 2016

Wind Farm Site

Potential Turbine Location

Distance Zones

- 2.5 miles
- 5 miles
- 10 miles

City/Town

Secondary Road

Zones of Visual Influence *

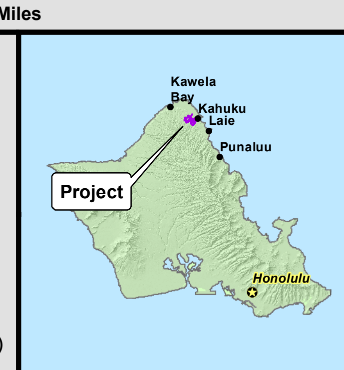
High

Low

Turbine Visibility Potential

- Confirmed Yes
- Yes
- Likely
- Possible
- Low

*Zones of visual influence calculated using a viewing height of 6 feet (1.8 meters) and a 100% maximum blade tip height of up to 656 feet (200 meters)



Data Sources Champlin: project facilities / ESRI: roads, cities, aerial imagery / Tetra Tech: zones of visual influence

TETRA TECH

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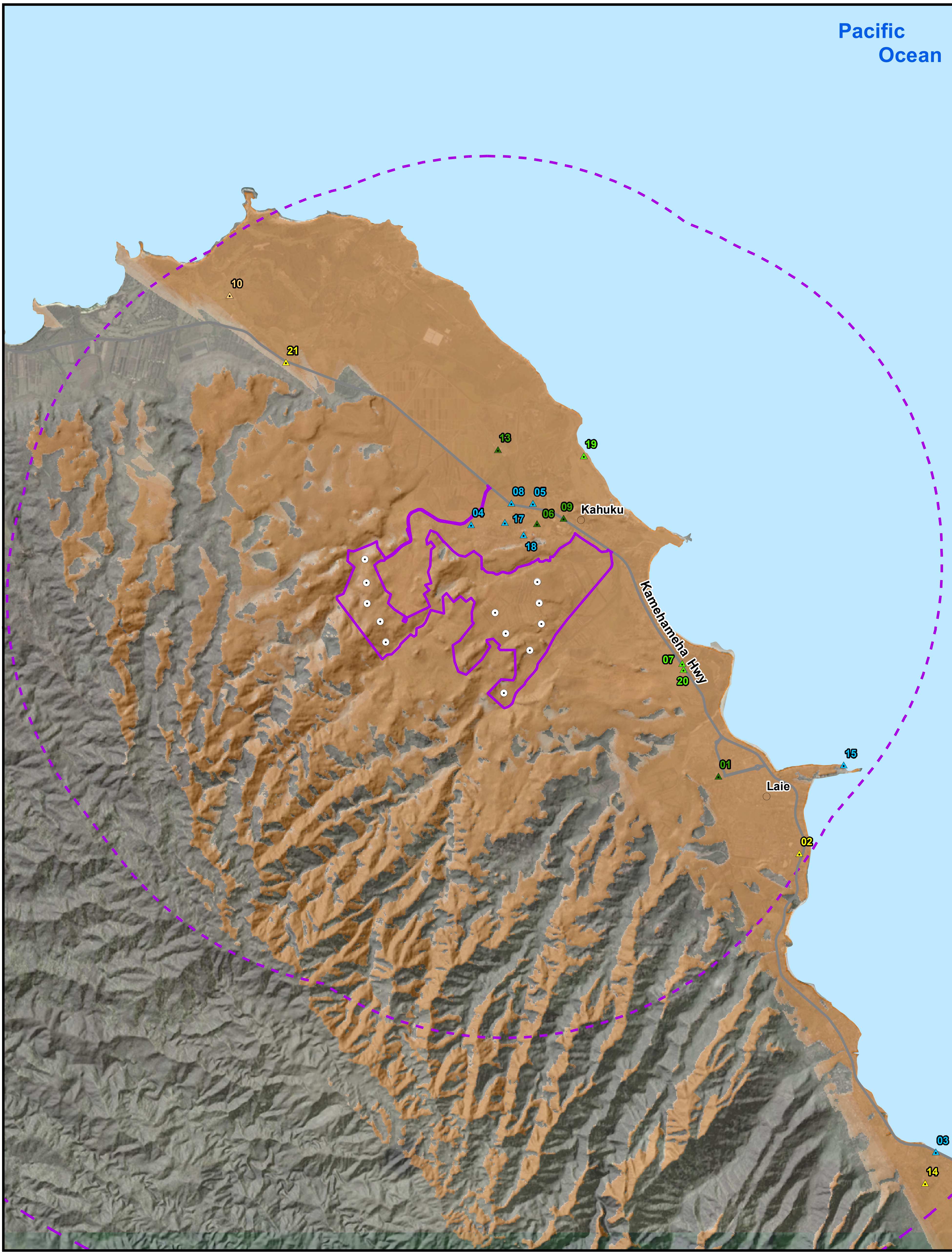


Figure 4.16-5

1:45,000 WGS84 UTM 4

0 0.25 0.5 1 1.5 2 Miles

Na Pua Makani Wind Project

Visual Resource Viewpoints within 2.5 miles of the Project Alternative 3

Oahu, HI

January 2016

Wind Farm Site

Potential Turbine Location

Turbine Visibility Potential

Distance Zones

- 2.5 miles
- 5 miles
- 10 miles

City/Town

Secondary Road

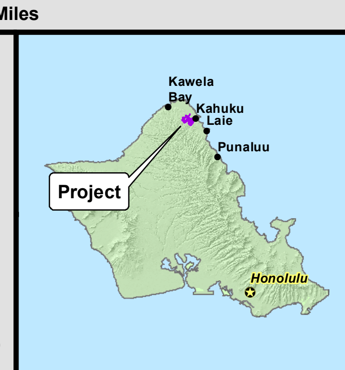
Zones of Visual Influence *

High

Low

- Confirmed Yes
- Yes
- Likely
- Possible
- Low

*Zones of visual influence calculated using a viewing height of 6 feet (1.8 meters) and a 100% maximum blade tip height of up to 512 feet (156 meters)



Data Sources Champlin: project facilities / ESRI: roads, cities, aerial imagery / Tetra Tech: zones of visual influence

TETRA TECH

P:\GIS_PROJECTS\Champlin_Wind\Na_Pua_Makani\MXDs\EIS\FEIS\Report_Figures\Champlin_NaPuaMakani_FEIS_Ch4_Fig4pt16-4_Alt3Zoom_17i11i_20160113.mxd - Last Saved 1/13/2016 structures of the proposed Project and are typically sited along ridges to maximize the wind resource, the turbines are generally the most prominent Project facilities and the most likely to be visible.

It should be noted that the viewshed analysis results are a conservative representation of potential Project visibility. The analysis represents line-of-sight conditions based only on topography; it does not account for factors that might obscure or block visibility from a specific location or at certain times, such as weather conditions, existing structures, or vegetation.

4.16.1.3 Select Viewpoints

A desktop study was performed to assist with the identification of viewpoints. The study consisted of reviewing aerial photographs, land use and resource plans, land use data, and the public scoping comments for the Project. The viewshed analysis was also reviewed to identify locations with potential views of the Project that would be suitable for use as viewpoints in the visual assessment. Field review of the visual resource analysis area was conducted during April 2013 and April 2014 to verify the characterization of existing visual conditions based on desktop analysis. The field review included photo-documentation of conditions at 21 specific viewpoints within the analysis area. Locations of those viewpoints are indicated in Figure 4.16-2. Table 4.16-3 summarizes information about viewpoint location, the viewer groups represented, and the distance to the Project.

Four of those 21 viewpoints were selected for the development of visual simulations of with-Project conditions, as a key element of the visual impact assessment. The four viewpoints are the Kahuku Community Center, James Campbell National Wildlife Refuge, Kahuku Golf Course and Malaekahana Bike and Pedestrian Path (see Appendix J of the Final EIS).

4.16.1.4 Assess Existing Scenic Quality

The existing visual resources of an area are defined by landscape character and scenic quality. Scenic quality is a measure of the visual appeal of a particular location. Landscape character is a descriptive means by which humans assess a landscape. When evaluating scenic quality, both natural and man-made components of the visual environment are considered as they either add to or detract from the overall landscape character within a specific setting. Scenic quality levels were established by evaluating the distinctiveness and diversity of a particular landscape setting in relation to the following scenic quality factors (BLM 1986):

- Landform
- Vegetation
- Water
- Color
- Effects of adjacent scenery
- Scarcity of the landscape
- Cultural modifications

Scenic quality levels of High, Moderate or Low were assigned to each viewpoint, based on evaluation of the existing conditions as viewed from each location. Descriptions for the respective scenic quality levels are as follows:

- *High* – Distinct visually appealing landscapes with a high degree of variety and uniqueness where landscape elements have high visual appeal.
- *Moderate* – Moderately appealing landscape with common features that may contain built features, but they are not dominant
- *Low* – Landscape is less appealing and is dominated by built features

4.16.1.5 Assess Contrast

Contrast in the landscape is determined by the differences in form, line, color, texture, scale, and landscape juxtaposition between the existing conditions and the expected conditions with a proposed action. In the context of the proposed Project, visual contrast would result from 1) landform modifications that are necessary to prepare the proposed Project site for construction, 2) the removal of vegetation to construct and maintain the wind turbines, roads, and ancillary facilities, 3) the construction of temporary and permanent access roads required to erect and maintain the wind turbines and ancillary facilities, and 4) the introduction of wind turbines and ancillary facilities into the landscape setting. Contrast levels of None, Weak, Moderate and Strong were assigned to the Project as it would likely be seen from each viewpoint based on the definitions listed below (BLM 1986):

- *None* – The contrast is not visible or is not perceived.
- *Weak* – The contrast can be seen but does not attract attention.
- *Moderate* – The contrast begins to attract attention and begins to dominate the characteristic landscape.
- *Strong* – The contrast demands attention and is dominant in the landscape.

Several environmental factors can influence the amount of visual contrast introduced by a proposed action. These environmental factors listed below are based on the U.S. Bureau of Land Management (BLM) Visual Resource Management Manual; however, the list does not include season of use, because the weather in Hawaii stays relatively the same and it does not snow (BLM 1986).

- Distance – The contrast created by a project usually is less as viewing distance increases.
- Angle of Observation – Viewing the project from different angles can greatly affect the apparent size of a project and the resulting level of visual contrast.
- Length of Time in View – The longer an action is in view, the greater the level of visual contrast.
- Relative Size or Scale – The level of visual contrast created by a project is directly related to its size and scale compared to the surrounding landscape.
- Lighting Conditions – The direction and angle of the sun affects the color, intensity, shadow, reflection, form, and texture of visual aspects of proposed project components.

- Motion – Movement from features, such as wind turbines, will draw attention to the project.
- Atmospheric Conditions – The contrast created by the project is reduced by clouds, fog or smog, and precipitation.
- Spatial Relationships – The arrangement of features on the landscape and how they blend into the landscape can reduce the contrast.
- Recovery time – The amount of time successful revegetation/reclamation is expected to have.

Contrast rating sheets were completed for each viewpoint, based on careful review of the basic design elements of form, line, color, and texture of the Project facilities expected to be visible at each location relative to the existing landscape character (see Appendix J of the Final EIS). Simulations prepared for four viewpoints provided the direct basis for evaluating contrast at those locations, and were interpreted to inform the assessment of contrast levels at the other viewpoints.

4.16.1.6 Assess Visual Quality Change

The expected change in visual quality with the Project was determined by evaluating the contrast associated with the proposed Project relative to the existing landscape conditions (scenic quality). As discussed above, the existing landscape conditions were assessed using the basic design elements of form, line, color, and texture of the existing landforms, vegetation, and man-made elements. The expected change in visual quality at each viewpoint was rated as High, Moderate, or Low. For example, a case of Strong contrast and High existing scenic quality would represent a High change in scenic quality. A Strong contrast rating at a viewpoint with Low existing scenic quality was considered a Moderate change in scenic quality.

4.16.1.7 Assess Viewer Response

The expected viewer response to the change in visual quality was assessed based on the combination of viewer expectations or sensitivity, duration of view, and use volume applicable to the viewers present at each viewpoint. Viewer expectations or sensitivity tend to vary among viewer groups based on the characteristics of the viewers and the nature of their activity; residential and recreational viewers are typically considered to be highly sensitive to change in visual quality, while potential viewers engaged in agricultural or commercial activity are focused primarily on their work and generally have low sensitivity to change in visual quality. Overall viewer response levels were rated as High, Moderate, or Low for each viewpoint. Viewpoints rated as having a High overall viewer response generally have viewers assumed to have high sensitivity, relatively long view durations, and at least a medium volume of use. A viewpoint along a highway would likely have a relatively high use volume, short view duration and moderate viewer sensitivity, and the overall viewer response would consequently be rated as Moderate.

4.16.1.8 Assess Impact Levels

Overall impact levels for visual resources were assessed by applying the impact criteria outlined in Table 4.16-1, which address the impact dimensions of magnitude or intensity, duration, geographic extent, and context, and interpreting the results on a Project-wide basis.

Ratings for impact magnitude or intensity were determined by considering the expected change in visual quality and the overall viewer response for each viewpoint. Table 4.16-2 is a matrix indicating the visual impact intensity levels based on the visual quality change and viewer response components. For example, if a viewpoint has a High rating for change in scenic quality, meaning the landscape has a uniqueness and variety, and Low rating for viewer response, than visual impact intensity would be moderate.

As discussed below in Section 4.16.3, the resulting impact intensity levels vary among the individual viewpoints, based on variability in existing scenic quality, Project visibility and contrast, and overall viewer response. The duration, extent and context characteristics are appropriately considered on a broader basis across all of the viewpoints, or at least for groups of viewpoints. As a result, the significance of the visual impacts identified was assessed on a Project-wide basis, considering the four components addressed in Table 4.16-1, rather than defining significance levels for each viewpoint.

Table 4.16-1. Impact Criteria for Visual Resources

Type of Effect	Impact Component	Effects Summary		
Changes to Visual Resource Character	Magnitude or Intensity	**High:** A high reduction of scenic quality and a high level of viewer response to visual change, or a similar scenic quality/viewer response outcome	**Moderate:** Moderate reduction of scenic quality with moderate viewer response to visual change, or a similar scenic quality/viewer response outcome	**Low:** Low reduction of scenic quality with low viewer response to change in the visual environment, or a similar scenic quality/viewer response outcome
	Duration	**Permanent:** Chronic effects; reduction in scenic quality and viewer response to the change would continue throughout the operation of the Project	**Long-term:** Reduction in scenic quality would continue beyond the construction period of the Project, but would be substantially mitigated within 5-10 years after completion of the Project and restoration/ reclamation activities	**Temporary:** Scenic quality would be noticeably reduced for a period no longer than the span of the Project construction; visual conditions would be expected to approximate pre-Project conditions at the completion of the activity
	Geographic Extent	**Extended:** Reduction of scenic quality would be experienced beyond the region, potentially island-wide	**Regional:** Reduction of scenic quality would be experienced beyond the local area (the wind farm site and adjacent community), potentially throughout northeastern Oahu	**Local:** Reduction of scenic quality would be limited to the local area (the wind farm site and adjacent community)
	Context	**Unique:** Affects scenic resources that are unique or are protected by specific legislation	**Important:** Affects scenic resources that may be common in region but have unusually strong local attachment or focus within the local community	**Common:** Affects scenic resources that are common to the region and the island, and are not protected by legislation

Table 4.16-2. Visual Impact Intensity Levels

Visual Quality Change	Overall Viewer Response		
	High	**Moderate**	**Low**
High	High	Moderate-High	Moderate
Moderate	Moderate-High	Moderate	Moderate-Low
Low	Moderate	Moderate-Low	Low
None	No Impact	No Impact	No Impact

4.16.2 Alternative 1 – No Action

4.16.2.1 Direct and Indirect Effects

Under the No Action Alternative, USFWS would not issue an ITP and the Project would not be developed and the HCP conservation measures would not be implemented. The No Action Alternative would therefore have no visual impacts. No mitigation measures would be required.

If the No Action Alternative is implemented, the demand for a wind energy facility, as described in Chapter 2, would not be met with this Project and electricity providers would need to turn to other proposals to meet energy demands. Under the No Action Alternative, visual impacts similar to those described for the proposed Porject might occur due to development of new wind energy facilities or other energy related projects built to meet the increasing demand. Regardless of any actions that might be taken to increase energy supply, new sources of visual change in the landscape could also occur as a result of new or ongoing land uses.

4.16.2.2 Cumulative Effects

As indicated above, under the No Action Alternative there would be no visual impact associated with the Project. Thus, Alternative 1 would not contribute to cumulative effects to visual resources.

4.16.2.3 Summary

Alternative 1 would have no effect on visual resources because no action would be undertaken.

4.16.3 Alternative 2 –8 to 10 Turbine Project

Alternative 2 would consist of constructing and operating up to 10 wind turbines, each with a nameplate capacity of up to 3.3-MW turbines and associated infrastructure; see Chapter 2 for a detailed description.

4.16.3.1 Direct and Indirect Effects

Construction Impacts

Large trucks, cranes, mount towers, wind turbine components (i.e., nacelle, rotor, tower, and blades), and other large-scale construction equipment would be present on the Project site during construction. Specific activities would include clearing, grading, and surfacing of the sites for Project facilities; improving existing access roads and constructing new roads; constructing the turbine foundations and ancillary structures; assembling the wind turbines; trenching to bury electrical distribution lines; and stockpiling materials and equipment in staging and parking areas. These construction elements would introduce forms, lines, colors and textures that would create contrast with the existing landscape and result in short-term impacts to visual resources. These construction activities would include the implementation of mitigation measures (e.g., dust abatement, phased construction) intended to minimize impacts to the aesthetic environment.

Operation and Maintenance Impacts

The turbines, with heights of up to 512 feet (156 meters), would be the primary source of long-term visual impact from the Project. The turbines would be much taller than existing structures in or immediately adjacent to the wind farm site. Given the height of the wind turbines, their placement on ridgelines, and the rural nature of the Project site, the turbines would be highly visible from certain viewpoints. Views of the wind turbines could not be avoided because of their size and exposed location. Visibility of the wind turbines would be blocked or partially obscured by topography in some locations, however, and could be diminished in other locations because of factors such as distance from viewers, the angle of observation, atmospheric conditions, and the presence of vegetation and/or structures. The viewshed analysis identifies the areas from which at least a portion of one or more wind turbines would potentially be visible, based on line-of-sight conditions determined by topography.

In addition to the size, form, and color of the turbines, another source of visual contrast from the operation of the Project would be the introduction of motion into a static landscape. The oscillating motion of wind turbine blades often draws the eye of potential viewers and creates more contrast than does a static structure of similar size and form.

Other Project features that would have relatively limited visual impact would be access roads, electrical collection and communication networks, substation and one permanent meteorological tower. These features would be much smaller and would generally create much less visual contrast than the turbines.

At nighttime, the substation and the turbines would be minimally lit. This would create a new light source in the wind farm site. Much like the motion of the blades during daytime operations, the blinking safety lights can draw the attention of a casual observer.

Summary of Impact Assessment for Viewpoints

Table 4.16-3 summarizes the potential visual impact of the Project for each viewpoint. The table is followed by a brief summary of the existing visual conditions and impact considerations for each viewpoint. As a result of public comments on the Draft EIS related to visual impacts, the viewpoint-specific summary has been edited for clarity and to provide more detailed explanation for the factors that were incorporated into the impact evaluation. Visual quality and contrast ratings have also been updated to reflect the current turbine layout (see Chapter 2 for discussion of Project changes between the Draft and Final EIS). Visual simulations of the Project as it would appear from selected viewpoints can be found in Figures 4.16-6a, 6b, 7a, 7b, 8a, 8b, 9a, 9b, and 9c. Visual impact rating sheets are found in Appendix J of the Final EIS.

Table 4.16-3. Alternative 2: Visual Impact Intensity for Viewpoints

Viewpoint	Viewpoint Name	Distance from Closest Wind Turbine (miles)	Viewer Group(s) Represented	Existing Scenic Quality	Contrast Rating	Change in Visual Quality	Overall Viewer Response	Impact Intensity
01	Laie Hawaii Temple	1.7	Recreational, Institutional	High	None	None	Moderate	None
02	Polynesian Cultural Center	2.5	Recreational	Moderate	None	None	Moderate	None
03	The Church of Jesus Christ of Latter Day Saints	4.8	Institutional	High	None	None	Moderate	None
04	Kahuku Residential Community	0.7	Residential	Low	Weak	Low	High	Moderate
05	Kahuku Sugar Mill Site	0.6	Commercial	Low	Weak	Low	Low-Moderate	Low
06[1/]	Kahuku Community Center	0.5	Recreational	Moderate	Moderate	Moderate	Moderate	Moderate
07	Malaekahana State Recreation Area	1.3	Recreational	Moderate	Moderate	Moderate	Moderate	Moderate
08	Kamehameha Highway near Kahuku	0.4	Highway travelers	Low	Moderate	Low	Moderate	Low-Moderate
09	Kahuku High and Intermediate School	0.5	Institutional	Low	Weak	Low	Moderate	Low-Moderate
10	Turtle Bay Resort Golf Course	2.6	Recreational	Moderate	Weak	Low	Moderate	Low-Moderate
11	Punaluu Beach Park	7.3	Recreational	High	None	None	Moderate	None
12	Ahupua'a 'o Kahama Valley State Park Beach	8.8	Recreational	High	None	None	Moderate	None
13[1/]	James Campbell National Wildlife Refuge	1.0	Recreational	Moderate	Moderate	Moderate	Moderate	Moderate
14	North Windward Baptist Church	4.9	Institutional	Moderate	None	None	Moderate	None

Table 4.16-3. Alternative 2: Visual Impact Intensity for Viewpoints (continued)

Viewpoint	Viewpoint Name	Distance from Project (miles)	Viewer Group(s) Represented	Existing Scenic Quality	Contrast Rating	Change in Visual Quality	Overall Viewer Response	Impact Intensity
15	Laie Point Coastal Residences	2.5	Residential	High	Moderate	Moderate-High	Moderate-High	Moderate-High
16	Swanzy Beach Park	9.6	Recreational	High	None	None	Moderate	None
17	Kahuku Hospital and Medical Center	0.5	Institutional	Low	Weak	Low	Moderate	Low-Moderate
18	Kahuku Elementary School	0.3	Institutional	Low	Weak	Low	Moderate	Low-Moderate
19[1/]	Kahuku Golf Course	0.7	Recreational	Moderate	Moderate	Moderate	Moderate	Moderate
20[1/,2/]	Malaekahana Bike and Pedestrian Path	1.2	Recreational	Moderate	Moderate	Moderate	Moderate	Moderate
21	Kamehameha Highway near Turtle Bay	1.2	Highway Travelers	Low	Moderate	Low	Moderate	Low-Moderate

Key:
1/ A visual simulation has been completed for the viewpoint.
2/ A nighttime visual simulation has been complete for viewpoint

Viewpoint 01 Laie Hawaii Temple. The Laie Hawaii Temple was established in 1850 as a temple of The Church of Jesus Christ of Latter-day Saints. The temple is built on a small hill on a property of 11 acres, and is located about one quarter of a mile west from the Pacific Ocean. Only church members may enter the temple and participate in sacred ceremonies, but non-Mormon visitors (generally tourists) can take public tours of the grounds and visitor center. The visitor center reportedly attracts over 100,000 people annually. The grounds contain statues, architectural columns and walkways, tropical gardens, and reflecting pools, which contribute to the aesthetic appeal of the site. External views from the compound are largely blocked by structures or screened by landscape components located on the grounds. The existing scenic quality for this viewpoint was rated as high.

The Project is located 1.7 miles to the northwest from Viewpoint 01. The viewshed analysis indicates the Project would be visible from the Laie Hawaii Temple. Onsite review indicated that most views toward the Project would be screened by vegetation or blocked by structures. Further desktop analysis indicated that portions of some turbines could be barely visible through intervening tree foliage. As a result, it is expected that the Project would not be noticeable to the casual viewer at this location. Therefore, the visual contrast was rated as none and there would be no visual impact at Viewpoint 01.

Viewpoint 02 Polynesian Cultural Center. The Polynesian Cultural Center is a “living” museum located on 42 acres of land on Palekana Street in Laie, where actors depict the everyday life and culture of tropical villages from Polynesia. The facility is owned by The Church of Jesus Christ of Latter-day Saints. The grounds are arranged as different villages where visitors can learn crafts, partake in traditional sports, and learn to cook the Polynesian way. Because views from within the facility are enclosed, the cultural center parking lot is the specific photo location for Viewpoint 02. Views from this location include the paved parking lot surface, light standards, and vehicles within the immediate foreground, and adjacent structures and street features beyond. Views beyond the foreground are effectively screened by vegetation. The scenic quality is rated as moderate, based on the enclosed views and the numerous man-made features on the landscape.

The Project is located 2.5 miles to the northwest from Viewpoint 02. The viewshed analysis indicates the Project would potentially be visible from the Polynesian Cultural Center. Onsite review indicated that views to the northwest are effectively screened by vegetation. As a result, the Project would not be visible at this location and there would be no visual impact at Viewpoint 02.

Viewpoint 03 The Church of Jesus Christ of Latter-Day Saints. Viewpoint 03 is at the Church of Jesus Christ of Latter-day Saints located in Hauula, off of Kamehameha Highway, and approximately 4.8 miles to the southeast of the Project. The entry to the church property from the highway provides panoramic views to the west, north and east that include the Pacific Ocean; although the highway, adjacent utility poles and wires, and residences along the beach are plainly visible, they do not dominate the view. Therefore, the existing scenic quality of the view from the highway is rated as high.

The viewshed analysis indicates the Project would likely be visible from Viewpoint 03. Onsite review and photography indicated that the existing Kahuku turbines, which are on essentially the same line of sight from Viewpoint 03 as is the Project, are not evident from this viewpoint. This condition suggests that views of the Project turbines might also be blocked by terrain and/or screened by vegetation, and that visibility (if any) would be limited to turbine blades. As a result, the Project would not be noticeable to the casual viewer, the contrast with the Project is rated as none, and no visual impact is expected at Viewpoint 03.

Viewpoint 04 Kahuku Residential Community. Kahuku is a community of approximately 2,600 residents located 0.7 mile from the wind farm site. Viewpoint 04 is located in a residential area in the northwestern part of the community. The predominant visual character of the foreground views at this location is that of an urban streetscape consisting of constructed features including homes and ancillary structures, paved streets and driveways, parked vehicles, and utility poles supporting numerous overhead lines. Hilly, vegetated terrain rising above the homes is visible to the west and southwest. The upper portions of some existing wind turbines in the Kahuku Wind farm are visible above and among structures and landscaping trees, but they are not prominent. The existing scenic quality is rated as low, because relatively little of the natural landscape is seen and the constructed features dominate the view.

Viewpoint 04 represents residential viewers in the community, who are considered to have high sensitivity to visual change. The viewpoint is approximately 0.8 mile from the closest turbines in the proposed Project, resulting in high visibility. The contrast is rated as weak, however, because the Project turbines would be viewed within the context of a modified landscape that is dominated by existing constructed features that include many vertical elements. The change in visual quality would therefore be low. Viewer numbers are moderate and the views would occur for long durations; therefore, the overall viewer response is high. Based on low visual quality change and high viewer response, the visual impact intensity is considered moderate.

Viewpoint 05 Kahuku Sugar Mill Site. The Kahuku Sugar Mill was built in 1890 and produced sugar until it closed in 1971. The site of the former mill is just north of the Kamehameha Highway in Kahuku. The main mill building was demolished in 2004, and the site is now a small commercial center that includes a bank, gas station, restaurants, and medical offices. Foreground views include the commercial structures, roadways and parking lot features on the site, plus utility poles and lines and other structures adjacent to the highway. There are distant views of rolling vegetated terrain to the southwest, and the upper portions of two wind turbines in the existing Kahuku Wind Farm are visible among trees to the west. The scenic quality is considered low because the constructed features dominate the view.

Viewers at Viewpoint 05 are at the site primarily for commercial purposes, and have relatively low sensitivity to visual change. The viewpoint is approximately 0.3 mile from the proposed Project and 0.6 mile from the closest turbine, resulting in high visibility. The turbines would create weak contrast, because they would be seen within the context of an urbanized landscape that has been substantially modified. Based on the low existing scenic quality and weak contrast, the level of visual quality change is considered low. Viewer numbers are considered moderate and the view duration is relatively brief. With an overall viewer response of low to moderate, the overall visual impact intensity is low.

Viewpoint 06 Kahuku Community Center (Figure 4.16-6a). The Kahuku Community Center, located on the south side of Kamehameha Highway, is a meeting facility and sports club adjacent to the entrance to Kahuku District Park. The park contains two baseball diamonds, a soccer field, tennis and basketball courts, playground equipment and additional open space. The immediate foreground view from the community center is open to the flat, green grass fields and associated facilities of the park, including tall light standards for the sports fields. The structures of the Kahuku Elementary School (Viewpoint 18) are just beyond the park fields to the south, and the Kahuku High and Intermediate School (Viewpoint 09) complex is adjacent to the east side of the park. Residential structures frame the foreground views to the southwest and west. Rolling vegetated hills in the middleground rise above the school facilities and residential areas, with more distant mountains visible beyond. Two wind turbines in the existing Kahuku Wind Farm are visible above rooftops to the west. The existing scenic quality is rated as moderate overall; although the numerous manmade features are prominent throughout the view, their influence is balanced by the green expanse of the sports fields and the hillsides beyond the developed features.

Viewers at viewpoint 06 are primarily recreational. The Project boundary is approximately 0.3 mile from the viewpoint and the turbines would be highly visible, with the closest turbine just beyond the foreground at 0.6 mile. The Project would create a moderate degree of contrast because it would be seen in the context of numerous constructed features including large buildings, utility poles, street lights, tall fencing and parking lots in the foreground, and turbines of an existing wind project in the middleground. In particular, the tall metal light standards around the sports field provide a strong vertical element that would moderate the contrast introduced by the height and form of the Project turbines. Viewer numbers are moderate and most viewers would have relatively brief, intermittent views because they would be focused on active recreation. The overall viewer response is moderate. Based on moderate contrast and visual quality change and moderate viewer response, the visual impact intensity is considered moderate.

Viewpoint 07 Malaekahana State Recreation Area. The Malaekahana State Recreation Area is a public recreation resource situated on the east side of Kamehameha Highway between Laie and Kahuku. The recreation area is predominantly wooded and provides developed beach access. Visitors can swim, bodysurf, fish, picnic and camp in the park. Views at the entrance to the park include Kamehameha Highway, fencing along the highway, and open rolling terrain to the west with a few existing wind turbines. Views within the interior of the park are enclosed and largely screened by vegetation, particularly in the more heavily used areas along and near the beach. The existing scenic quality at the park entrance is moderate because of the presence of manmade features, while scenic quality in the interior of the park ranges from moderate to high.

Viewpoint 07 represents recreational viewers, who are considered to have a high sensitivity to visual change. The contrast as seen from the entrance area is rated as moderate because the Project would be seen behind landscape modifications in the highway corridor and adjacent to the existing Kahuku Wind Farm, and would not dominate the view. The change in visual quality at this viewing location would therefore be moderate. Viewer numbers are moderate and the views would occur for brief durations; therefore, the overall viewer response is moderate. Based on moderate visual quality change and moderate viewer response, the visual impact intensity at the park entrance is considered moderate. The Project would likely be screened from view at the beach and other interior areas of the park.

Viewpoint 08 Kamehameha Highway near Kahuku. Kamehameha Highway is a State-designated scenic highway (Route 83) that is located along the Pacific shoreline in several sections, exhibiting highly acclaimed ocean, coastal, and Koolau views (City and County of Honolulu 2012). Two viewpoints were investigated to document representative views along the highway at points northwest and north of the Project. Viewpoint 08 is located near the western edge of Kahuku approximately 0.4 mile north of the eastern portion of the Project. (Viewpoint 21, located 1.2 miles northwest of the Project near Turtle Bay, is discussed below.) Views to the south from Viewpoint 08 toward the Project are mostly enclosed by urbanized development and landscaping in Kahuku that occupies the foreground. Views to the southwest and west are partially screened by trees and shrubs near the highway, with the upper parts of some structures visible above the roadside vegetation and rolling vegetated landscape beyond. Manmade features include structures in Kahuku, fences, sweeping conductor lines, utility poles and guardrails and associated highway features; portions of several turbines from the existing Kahuku Wind Farm are visible above the roadside vegetation to the west.

The scenic quality for Viewpoint 08 is considered low because the constructed features in the surrounding views are very prominent.

Viewpoint 08 represents travelers on Kamehameha Highway. The travelers may be local residents taking short trips or tourists taking scenic drives and touring around the island. With a moderate level of sensitivity, high viewer volume, and views occurring over short durations, the overall viewer response is expected to be moderate. Although the Project turbines would be noticeable in the near middleground, the contrast is rated as moderate because the lower parts of the turbines would be blocked from view, and the upper portions would be seen within the context of a landscape that has been substantially modified by urbanized development with numerous types of constructed features, including an existing wind farm. The change in visual quality would therefore be low. Overall visual impact intensity would be moderate at most, due to moderate viewer response and low change in visual quality.

Viewpoint 09 Kahuku High and Intermediate School. Kahuku High and Intermediate School, located in Kahuku south of Kamehameha Highway, provides schooling for over 1,800 students from grades 7 to 12. The school has multiple-use recreation fields and numerous buildings on site. The visual character of the landscape surrounding the school consists primarily of manmade features, including institutional, residential and commercial buildings; roads, parking lots, and associated signage; a large, red-and-white painted communications tower; numerous utility poles with multiple sets of lines; and light standards in Kahuku District Park. Views to the distant landscape beyond the foreground are largely blocked by buildings or screened by trees in the community, although the tops of rolling vegetated hills and silhouettes of mountains can be seen in part of the background. The scenic quality is low due to the degree of landscape modification resulting from the numerous constructed features that are present throughout the view.

Institutional viewers at Viewpoint 09 include faculty and students who are considered to be moderately sensitive to visual change. The visual contrast associated with the Project was rated as weak because the partial views of Project turbines would be subordinate to the many existing constructed features. Based on the low scenic quality and weak contrast, the level of visual quality change is considered low. Viewer numbers are high and views would occur intermittently and for short durations. Therefore, the overall viewer response would be moderate and the visual impact intensity would be low to moderate.

Viewpoint 10 Turtle Bay Resort Golf Course. The Turtle Bay Resort is located on the north shore of Oahu, approximately 4 miles from Kahuku and more than 2 miles from the Project. The resort includes two golf courses, two practice facilities, restaurants, a hotel, beach cottages, villas, and miles of coast line to recreate along. The visual character of the landscape includes panoramic views from the north side of the resort to the Pacific Ocean. Views to the south and southeast from much of the resort are enclosed by forest cover, although views to the distant landscape from the golf course are more open and only partially screened by trees. Therefore, a location on the resort's Fazio Golf Course was used to represent Viewpoint 10. Views to the southeast from this location include rolling vegetated hills beyond the flat terrain of the golf course. Several vertical wind turbines in the existing Kahuku Wind Farm are partially visible rising above a low ridge. The scenic quality of the view toward the Project from Viewpoint 10 is considered to be moderate.

Guests at Turtle Bay Resort are primarily involved in recreation, including active uses such as swimming, water sports and golf and more passive uses such as sunbathing and beachcombing. Although recreational users are typically considered to have high sensitivity to visual change, the most sensitive viewers at Turtle Bay would be those along and near the beach areas where views toward the Project are enclosed. Viewers at Viewpoint 10 are primarily focused on their golf activity and are in a more developed setting, and therefore considered to be moderately sensitive to the surrounding scenery. The views from the golf course toward the Project site are partially enclosed by vegetation. The visual contrast associated with the Project was rated as weak, because the Project turbines 2.6 miles distant would be partially screened and would be seen beyond the Kahuku Wind Farm. Based on the moderate scenic quality and weak contrast, the level of visual quality change is considered low. Viewer numbers are considered moderate and the view duration is relatively brief for golfers at Viewpoint 10, and the overall viewer response is considered moderate. With a low visual quality change and moderate viewer response, the visual impact intensity would be at low to moderate.

Viewpoint 11 Punaluu Beach Park. Punaluu Beach Park is located south of Punaluu on the windward coast of Oahu, approximately 7 miles from Kahuku. The beach is narrow and flanked by wooded vegetation, and restrooms, picnic tables, and roadside parking are provided for beach users. There are open and panoramic views to the Pacific Ocean to the north and east. Views to the northwest along the curving shoreline include homes and trees along the beach and rolling vegetated mountains in the foreground and the middleground. More distant views up the coast include nearshore waters and low terrain with some development evident. The existing scenic quality at Viewpoint 11 is high.

The Project is located 7.3 miles from Viewpoint 11. The viewshed analysis indicates the Project would possibly be visible from Punaluu Beach. Onsite review indicated that views in that direction are screened by vegetation and/or blocked by terrain. Based on the observed conditions and the viewing distance, the Project would not be visible or would not be noticeable to the casual observer at this location. Therefore, there would be no visual impact at Viewpoint 11.

Viewpoint 12 Ahupua'a 'O Kahana State Park Beach. The beach area in Ahupua'a 'O Kahana State Park is adjacent to Makalil Point on Kahana Bay. There are two hiking trails that visitors can take into the forest from the beach. The beach has scattered rocks near the shoreline and is surrounded by wooded vegetation, with picnic tables for visitors. Views are predominately enclosed due to the bay being located in a cove and flanked by wooded slopes. Along the far eastern part of the beach, however, there are open northwesterly views to beachfront homes on a wooded point in the middleground, and more distant views across ocean waters to some low terrain in the background. The existing scenic quality at Viewpoint 12 is considered to be high.

The Project is located 8.8 miles from Viewpoint 12. The viewshed analysis indicates the Project would possibly be visible from the State Park beach. Onsite review indicated that views in that direction are screened by vegetation and/or blocked by terrain. (Viewing conditions at Viewpoint 12 are very similar to those for Viewpoint 11.) Based on the observed conditions and the viewing distance, the Project would not be visible or would not be noticeable to the casual observer at this location. Therefore, there would be no visual impact at Viewpoint 12.

Viewpoint 13 James Campbell NWR (Figure 4.16-7a). The James Campbell National Wildlife Refuge (NWR), located just north of Kahuku, has scattered wetland habitat for endangered Hawaiian birds, migratory shorebirds, waterfowl and seabirds. The refuge is closed to general public access, but limited guided tours are conducted during specific seasons and times. The NWR extends from the Kamehameha Highway northeast to the Pacific Ocean. Landscape views on the refuge are generally open and panoramic to the surrounding areas. The foreground views from the primary refuge access point include a flat, open lawn area, a gravel road and parking area, a stone wall, some utility poles, and shrub and long-grass vegetation beyond a woven-wire fence around the compound. Views beyond the compound are enclosed by dense mixed vegetation to the southeast, but are relatively open in other directions. Utility poles along the highway and the tops of buildings in Kahuku can be seen to the south, with low, rolling hills and mountains beyond. Middleground views to the west include a commercial facility and agricultural buildings along the highway and all of the turbines in the existing Kahuku Wind Farm. The existing scenic quality is considered moderate overall.

Viewers at Viewpoint 13 are predominately passive recreationists, with high sensitivity to visual change. User volume is considered low, because of limited public use due to sensitive wildlife concerns, and view duration is moderate. Therefore, overall viewer response is rated as moderate. With generally open views and only partial screening from vegetation, the Project would be visible at Viewpoint 13. The contrast is rated as moderate, because the Project turbines would be co-dominant with the existing wind farm. Based on moderate scenic quality and contrast, the overall change in visual quality is considered moderate. The overall visual impact intensity would also be moderate, based on the moderate viewer response and moderate change in visual quality.

Viewpoint 14 North Windward Baptist Church. The North Windward Baptist Church is located near Hauula and adjacent to the Hauula Elementary School off the Kamehameha Highway. The grounds are comprised of multiple buildings, though some of the visible buildings may be associated with the elementary school. Views are limited to the immediate foreground by vegetation and structures. The scenic quality is considered to be moderate.

The Project is located 4.4 miles from Viewpoint 14. The viewshed analysis indicates the Project would have a low potential visibility from the North Windward Baptist Church. Onsite review indicated that views are screened by vegetation or blocked by buildings. As a result, the Project would not be visible at this location and there would be no visual impact at Viewpoint 14.

Viewpoint 15 Laie Point Coastal Residences. Viewpoint 15 represents residences near Laie Point. Residences on the north side of Laie Point have an expansive, uninterrupted view to the northwest that includes the coastline and the Pacific Ocean. The terrestrial landscape includes flat, light-colored sandy beaches and dark rock faces along the ocean, with forested rolling hills beyond the beach zone. Visible modifications to the natural landscape are relatively limited, including homes along the shoreline of the point and in Laie. The upper portions (primarily blades) of six turbines in the existing Kahuku Wind Farm are visible rising above a vegetated hill about 4 miles in the distance, but are not prominent. The overall existing scenic quality at Viewpoint 15 is considered high.

Residential viewers at Laie Point are considered to have a high sensitivity to visual change. Views to the northwest from Viewpoint 15 are open and panoramic to the Pacific Ocean and the mountains, and the Project turbines would be visible in the middleground with relatively little screening. The visual contrast associated with the Project was rated as moderate. Although vegetation and terrain would provide partial screening and the Project turbines would be visually similar to the existing wind turbines, the Project would be noticeably more prominent because all of the turbines would be visible and they would appear larger than the existing turbines. Therefore the visual quality change would be moderate to high. Viewer numbers are moderate or low, viewer sensitivity is high, and the views would occur for long durations; therefore, the overall viewer response is considered moderate to high. Based on moderate to high visual quality change and moderate to high viewer response, the visual impact intensity is considered moderate to high.

Viewpoint 16 Swanzy Beach Park. Swanzy Beach Park is a small public park facility located adjacent to Kamehameha Highway in Kaaawa on the windward side of Oahu. It is approximately 1 mile to the southeast along the coast from Kahana Valley State Park (Viewpoint 12) and has a similar view orientation toward the Project. Park features include a large grassy area, a basketball court, a pavilion with picnic tables, and nine campsites. Camping is permitted Friday through Monday only. There is a concrete walkway with a masonry wall along the inland edge of the beach, which provides limited ocean access for users to fish and swim due to the rocky substrate present. There are open and panoramic northwest views to the ocean and steep mountains, with silhouettes of rolling vegetated terrain further in the distance. Although landscape modifications are evident, including the paved walkway and homes adjacent to the park and along the shoreline, the existing visual quality is considered high overall.

The Project is located 9 miles from Viewpoint 16. The viewshed analysis indicates the Project would potentially be visible from Swanzy Beach Park. Parts of five or six turbines in the existing Kahuku Wind farm can be detected in photos taken at Viewpoint 16 if the photos are enlarged substantially, but are not evident when the photos are viewed normally. It appears that some of the Project turbines would be blocked from view by a mountain ridge, while there would be a line of sight to several turbines located in the eastern part of the Project and somewhat closer to the viewer than the existing Kahuku turbines. Based on review of the existing conditions, it is expected that the Project turbines would not be noticed by the casual observer at Swanzy Beach Park. As a result, the visual contrast, visual quality change and visual impact intensity at Viewpoint 16 are all rated as none.

Viewpoint 17 Kahuku Community Hospital and Medical Center. The Kahuku Hospital and Medical Center is located in the northwestern part of Kahuka, a short distance to the west of Kahuku High School and Kahuku District Park. The medical center faces a residential neighborhood with numerous homes and other buildings. Other constructed features evident in outward views include fences, vertical utility poles with horizontal wires, and vehicles. In addition, the upper portions of several wind turbines in the existing Kahuku Wind farm are visible above trees and roofs to the west. The scenic quality is considered low because the manmade features dominate the views.

Viewpoint 17 represents institutional viewers including workers, patients, and visitors at the hospital, who are considered to have a moderate sensitivity to visual change. The viewpoint is approximately 0.5 mile from the proposed Project, resulting in potentially high visibility. The contrast is rated weak because views would be partially screened by vegetation and/or blocked by structures, and the visible Project turbines would be seen within a modified urban landscape. Based on the low scenic quality and weak contrast, the level of visual quality change is considered low. Viewer numbers are considered moderate, the view duration is relatively brief, and viewers have a primary viewer focus on medical center business. Therefore, the overall viewer response is considered moderate, and the visual impact intensity is low to moderate.

Viewpoint 18 Kahuku Elementary School. The Kahuku Elementary School is located near the center of Kahuku, immediately south of Kahuku District Park and west of the Kahuku High and Intermediate School. The fenced facility includes two main buildings, a playground and courtyard, and a parking lot. Views to the surrounding landscape are dominated by constructed features including houses, streets and vehicles, fencing, and utility poles with sweeping conductor lines. Views to the southeast and south are enclosed by terrain, vegetation and structures in the foreground, while views to the southwest include rolling vegetated hills and the upper part of an existing wind turbine in the distance. The existing scenic quality is considered low due to the dominance of the constructed features.

Viewpoint 18 represents institutional viewers, specifically faculty, staff and students, who are considered to have a moderate sensitivity to visual change. Although the closest Project turbine would be approximately 0.3 mile distant, the turbines would not dominate the scene because the views would be partially screened by vegetation and/or blocked by structures; because the angle of observation is inferior, the viewer would need to look above the roof tops to see the Project. The contrast is rated as weak, based on these viewing conditions and the existing degree of landscape modification. The change in visual quality would therefore be low. Viewer numbers are high and the views would occur for short durations; therefore, the overall viewer response is moderate. Based on low visual quality change and moderate viewer response, the visual impact intensity is considered low to moderate.

Viewpoint 19 Kahuku Golf Course (Figure 4.16-8a)**.** Viewpoint 19 is located at the north end of the Kahuku Golf Course, a nine-hole municipal golf course located on the northeast side of Kahuku. The course itself is generally open, with panoramic views to the Pacific Ocean to the east. On-course views to the south and southwest include golf course features in the foreground and rolling vegetated hills backed by mountains in the middeground, while the turbines of the existing Kahuku Wind Farm are partially screened in views to the west. Landscape modifications visible from Viewpoint 19 are relatively limited, including a tall, red-and-white-painted communications tower, the wind turbines, and a mostly-screened view of some of the development in Kahuku. Based on the constructed features visible from on the course, the existing scenic quality at Viewpoint 19 is considered moderate for viewers that are facing the Project. The landscape modifications evident at this location are considerably less than what golf course users experience at the parking lot on the west edge of the course, however, which provides an elevated view of the developed uses in Kahuku and full exposure of the Kahuku Wind Farm turbines.

Viewpoint 19 represents recreational users, who are typically considered to have high sensitivity to visual change. Viewers at Viewpoint 19 are primarily focused on their golf activity and are in a more developed setting, and therefore considered to be moderately sensitive to the surrounding scenery. The visual contrast associated with the Project at this location was rated as moderate, because the Project turbines would be co-dominant with an existing wind facility. (If the contrast rating were based on the view from the parking lot, however, the contrast would be rated as weak because of the extensive landscape modification evident in that view.) Based on the moderate scenic quality and moderate contrast, the level of visual quality change is considered moderate. Viewer numbers are considered moderate and the view duration is relatively brief. The overall impact intensity is moderate, based on the moderate viewer response and visual quality change.

Viewpoint 20 Malaekahana Bike and Pedestrian Path (Figures 4.16-9a and 4.16-9c)**.** The Malaekahana Bike and Pedestrian Path is a 1.2-mile trail that connects Laie with Kahuku and is located along the west side of Kamehameha Highway. The trail passes through a mostly rural landscape. Views to the west toward the Project site are open and panoramic, with flat grassland and scattered trees in the foreground and rolling vegetated terrain backed by mountains in the middleground. Constructed features that are visible include fencing along the path and in the adjacent fields, a few scattered homes and associated outbuildings, the paved path and highway, dual rows of utility poles and lines on each side of the highway, and three turbines of the existing

Kahuku Wind Farm that are largely screened by vegetation. The overall scenic quality of the view toward the Project is considered moderate.

Viewpoint 20 represents active recreational viewers, who are considered to have a high sensitivity to visual change. Viewers at this viewpoint would have a high degree of Project visibility because the turbines would be seen in the middleground with only partial screening by vegetation. The visual contrast for this viewpoint was rated as moderate, because the Project turbines would be seen within the context of the existing wind turbines and the substantially modified setting of the immediate highway corridor (not shown in the Figure 4.18-8a, but within the field of view). Viewer numbers are moderate or low and the views would occur for relatively short durations; therefore, the overall viewer response is moderate. Based on moderate visual quality change and moderate viewer response, the visual impact intensity is considered moderate.

Viewpoint 21 Kamehameha Highway near Turtle Bay. Kamehameha Highway is a State-designated scenic highway (Route 83) that is located along the Pacific shoreline in several sections, exhibiting amazing ocean, coastal, and Koolau views (City and County of Honolulu 2012). Viewpoint 21 is 1.2 miles northwest of the Project, near Turtle Bay Resort. Views to the south and southeast at this location are largely enclosed by a low ridge in the foreground and are also partially screened by vegetation. Several turbines from the existing Kahuku Wind Farm are prominent in the middle ground, rising above a low, rounded hill. Other constructed features are also noticeable, including multiple sets of utility poles and wires, a fence along the edge of the highway right-of-way, and a large, agricultural or industrial structure along the top of the ridge. The scenic quality for Viewpoint 21 is low due to the number of manmade features and the scale of the existing wind turbines dominating the view.

Travelers at Viewpoint 21 would have a moderate overall viewer response, similar to those at Viewpoint 08. The contrast is rated as moderate because the low ridge in the foreground would partially or largely block the views of the Project turbines, and the Project turbines would be seen along with turbines in an existing wind project and other landscape modifications. Based on moderate contrast and low scenic quality, the change in visual quality is low. Based on low visual quality change and moderate viewer response, the visual impact intensity is considered low to moderate.

4.16.3.2 Direct and Indirect Effects of HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP are not expected to affect the visual resources. Some avoidance and minimization measures will reduce impacts to visual resources, including below-ground installation of Project collection lines and revegetation of temporarily disturbed areas. There may be some potential for visual disturbance due to researchers and biologist moving to conduct post-construction monitoring efforts; however the disturbance would be temporary and the impact would not be significant.

Impacts of HCP Mitigation Measures

No direct or indirect impacts to visual resources would occur in association with funding provided for Newell's shearwater research and management and short-eared owl research. Depending on the measures employed, there may be minor disturbance to land due to regular visits by researchers.

Installation and maintenance of the fence at Hamakua Marsh would result in minor permanent and temporary vegetation clearing and ground disturbance along the fence perimeter. The fence would be approximately 1,555 feet (474 meters) long and 4 feet (1.2 meters) high. Proposed design criteria for the fence are outlined in the Project HCP. The fence would have a minor, localized visual impact, but would be designed to be as visually unobtrusive as practicable while still fulfilling its intended role of keeping waterbirds out of commercial parking lots.

Funding for forest restoration and monitoring at the Poamoho Ridge Mitigation Area for bat mitigation would go toward activities such as maintenance of the ungulate-proof fence installed by DLNR, feral pig control and monitoring, and invasive plant removal. Foot traffic and vehicle use associated with fence maintenance, removal and monitoring of non-native ungulates and invasive plant species, and bat monitoring may cause minor visual disturbances due to the motion and presence of humans. However, these impacts are expected to be temporary and not significant. Ultimately, forest restoration efforts would have beneficial effects on visual resources within the Poamoho Ridge Mitigation Area by increasing the diversity of the forest. No impacts to visual resources would occur in association with funding for forest restoration and monitoring at the Poamoho Ridge Mitigation Area for bat mitigation.

4.16.3.3 Mitigation for Unavoidable Impacts

To the extent possible, the Project layout will be integrated with the surrounding landscape through the use of non-reflective paints, and positioning of turbines, and collector lines and road corridors in linear routes that follow the natural contours of the landscape. Restoration efforts will be made in areas that support temporary construction. The following mitigation measures are recommended for both action alternatives to reduce the visual impact rating, based on Table 4.16-3.

- The collector lines that run between turbines and the onsite substation would be placed underground along access roads;
- Project buildings to be grouped together as much as possible;
- Project buildings that have a high level of visual intrusion should be screened by vegetation;
- Signage related to the Project should be confined to entrance gates;
- Keep construction time to a minimum;
- Remove construction debris;
- Locate construction staging and storage areas away from adjacent roads;
- Comply with all required setbacks from roads and residences;
- Use a low-reflectivity finish on project buildings to minimize visibility; and
- Navigational lights on the wind turbines should be fitted with shields so the lights are not visible from below.

There are no additional measures that could reasonably be implemented to further reduce the potential visual impacts due to the large scale of wind turbines; a certain degree of impacts is unavoidable.

4.16.3.4 Cumulative Effects

Visual impacts of the Project would occur within the context of landscape modifications associated with past, current, and expected future uses on and near the wind farm site. The area for cumulative effects analysis is the same as the analysis area for visual resources, which includes the area within 10 miles of the wind farm site as well as areas that would be disturbed by HCP conservation measures implemented in the mitigation areas. This area encompasses the areas where potential direct and indirect effects to visual resources could occur.

The Project would have an incremental effect within the context of other ongoing and foreseeable wind energy developments within the surrounding region. When construction begins on the Project, the surrounding regional landscape would already be modified by the development of other wind energy projects, including Kahuku Wind and Kawailoa Wind Farm. These three wind energy projects would result in the presence of 52 large wind turbines. In addition to the wind projects, other landscape modifications contributing to the cumulative effects associated with visual resources include existing transmission lines, telecommunications towers, tall buildings, development areas, and other tall structures. There are utility distribution lines located along the Kamehameha Highway and throughout Kahuku town, Malaekahana, and other urbanized areas. The nearest known line to the wind farm site extends along the unnamed road running southwest near the Project access road, into the Malaekahana valley. There are five registered microwave towers in the vicinity of the wind farm site. One is located in Kahuku town at the Kahuku Police Station. Two are located atop Mt. Kawela within the Army's Kahuku Training Area, approximately 3.45 miles west of Kahuku. Two privately owned towers are located near Turtle Bay Resort, about 0.5 mile from Kamehameha Highway. Other facilities with large buildings include the Kahuku Medical Center and the Kahuku Wastewater Treatment Plant.

Based upon the findings above, some cumulative impacts may be realized by the Project in conjunction with other projects. The impacts would be incremental due to their location. Therefore, the Project in combination with features associated with other actions would not result in significant cumulative visual impacts.

4.16.3.5 Summary

The Project would be most visible at viewpoints close to the wind farm site (within about 1 mile), including the Kahuku Community Center, Kahuku High and Intermediate School, Kahuku Elementary School, Kahuku Golf Course, Kahuku Hospital and Medical Center, Malaekahana Bike and Pedestrian Path near the Malaekahana State Recreation Area, along Kamehameha Highway near the entrance of the Malaekahana State Recreation Area, and James Campbell National Wildlife Refuge. Individuals most likely to experience visual impacts include recreation users, residents, and travelers on the highway. The Project would be located on ridge tops, above residential communities and recreational areas where the turbines would incrementally increase the vertical element in the landscape. The Project would not dominate, however, because there is already a substantial degree of landscape modification in most views, including an existing windfarm adjacent to the proposed Project. The Project, in relation to existing developments (residential and commercial), would co-exist on the landscape and not dominate the landscape character. Based on consideration of the existing scenic quality, the contrast created by the Project, and the expected viewer response, the visual impact magnitude or intensity was rated as moderate or less for virtually all of the respective viewpoints evaluated. The visual impact intensity was rated as moderate-high for one location, Viewpoint 15 Laie Point Coastal Residences, because the Project would create moderate contrast in a setting with high existing visual quality. The duration of impact would be permanent, as defined in Table 4.16-1. The geographic extent of the most noticeable visual impacts would be local, although the Project would be visible beyond the local area. The Project would affect common visual resources that are not rare, unique, or protected by specific legislation. Based on collective consideration of these impact components, the visual assessment indicates that the potential visual impacts from the Project would be Moderate for Alternative 2.

4.16.3.6 Alternative 2a - Modified Proposed Action Option

Under Alternative 2a, direct, indirect, and cumulative effects on visual resources would be similar to those described under Alternative 2. The turbine layout under the Modified Proposed Action Option, however, would include nine Siemens SWT 3.3-130 turbines, with heights up 656 feet (200 meters). Although the larger turbines would create slightly more contrast at each viewpoint, the viewing context would remain the same and would continue to be a key factor in the contrast ratings assigned to the Project. The degree of increased contrast would not be sufficient to cause the Project to dominate the scene at any of the viewpoints evaluated, and would not result in a change to the contrast rating at any of the viewpoints. Implementation of mitigation measures, as described under the Proposed Action, would minimize adverse impacts to visual resources under the Modified Proposed Action Option. Visual simulations of Alternative 2a are provided in Appendix A.

4.16.4 Alternative 3 – Larger Generation Facility (Up to 12 Turbine Project)

Alternative 3 would involve the construction and operation of a larger generation facility of up 42-MW consisting of up to 12 3.3-MW turbines and associated infrastructure.

4.16.4.1 Direct and Indirect Effects

Under Alternative 3, direct and indirect effects on visual resources would be similar to those described under Alternative 2. However, with the construction of additional wind turbines and associated access roads, Alternative 3 would potentially have 2 to 4 additional turbines compared to Alternative 2. All viewpoints were determined to have the same visual impact ratings for Alternative 3 as for Alternative 2. Although there would be an additional 2 to 4 turbines, two of the turbines would be located within a turbine corridor planned for Alternative 2 where the visual impacts would not increase but would co-exist with Alternative 2. Two turbines would potentially be located outside the existing turbine corridor and to the west; however, these turbines would not increase the overall Project impact rating of moderate. Visual simulations for Alternative 3 were created for the Kahuku Community Center, James Campbell NWR, Kahuku Golf Course, and Malaekahana Bike and Pedestrian Path (Figures 4.16-6b, 4.16-7b, 4.16-8b, 4.16-9b and 4.16-9d, respectively).

Impacts of Avoidance and Minimization Measures

As discussed for Alternative 2, the avoidance and minimization measures proposed under the Project HCP are not expected to affect visual resources in the analysis area.

Impacts of HCP Mitigation

Impacts of HCP mitigation under Alternative 3 would be the same as described under Alternative 2.

4.16.4.2 Mitigation for Unavoidable Impacts

Mitigation for unavoidable impacts under Alternative 3 would be the same as described under Alternative 2 (Section 4.16.3.3).

4.16.4.3 Cumulative Effects

While Alternative 3 would involve an additional 2 to 4 turbines, this change would not result in an identifiable difference to the cumulative effects to visual resources as described for Alternative 2.

4.16.4.4 Summary

The Project would be most visible at viewpoints close to the wind farm site (within about 1 mile), including the Kahuku Community Center, Kahuku High and Intermediate School, Kahuku Elementary School, Kahuku Golf Course, Kahuku Hospital and Medical Center, Malaekahana Bike and Pedestrian Path near the Malaekahana State Recreation Area, along Kamehameha Highway near the entrance of the Malaekahana State Recreation Area, and James Campbell National Wildlife Refuge. Individuals most likely to experience visual impacts include recreation users, residents, and travelers on the highway. The Project would be located on ridge tops, above residential communities and recreational areas where the turbines would incrementally increase the vertical element in the landscape. The Project would not dominate, however, because there is already a substantial degree of landscape modification in most views, including an existing wind farm adjacent to the proposed Project. The Project in relation to existing developments (residential and commercial) would co-exist on the landscape and not dominate the landscape character. Based on consideration of the existing scenic quality, the contrast created by the Project, and the expected viewer response, the visual impact magnitude or intensity was rated as moderate or less for virtually all of the respective viewpoints evaluated. The visual impact intensity was rated as moderate-high for one location, Viewpoint 15 Laie Point Coastal Residences, because the Project would create moderate contrast in a setting with high existing visual quality. The duration of impact would be permanent, as defined in Table 4.16-1. The geographic extent of the most noticeable visual impacts would be local, although the Project would be visible beyond the local area. The Project would affect common visual resources that are not rare, unique, or protected by specific legislation. Based on consideration of these impact components, the visual assessment indicates that the potential visual impacts from the Project would be moderate for Alternative 3.

Figure 4.16-6a: Proposed Action

Na Pua Makani
Wind Project

Visual Simulation
Kahuku Community Center

January 2016 Oahu, HI

Looking southwest from the Kahuku Community Center

Figure 4.16-6b: Alternative 3

Na Pua Makani Wind Project

Visual Simulation Kahuku Community Center

January 2016 **Oahu, HI**

Looking southwest from the Kahuku Community Center

Figure 4.16-7a: Proposed Action

Na Pua Makani Wind Project

Visual Simulation
James Campbell National Wildlife Refuge

January 2016 Oahu, HI

Looking southwest from the James Campbell National Wildlife Refuge

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Figure 4.16-7b: Alternative 3

Na Pua Makani
Wind Project

Visual Simulation
James Campbell National Wildlife Refuge

January 2016 Oahu, HI

Looking southwest from the James Campbell National Wildlife Refuge

Figure 4.16-8a: Proposed Action

Na Pua Makani Wind Project

Visual Simulation Kahuku Golf Course

January 2016 Oahu, HI

Looking southwest from the eastern edge of the Kahuku Golf Course

Figure 4.16-8b: Alternative 3

Na Pua Makani Wind Project

Visual Simulation Kahuku Golf Course

January 2016 | Oahu, HI

Looking southwest from the eastern edge of the Kahuku Golf Course

Figure 4.16-9a: Proposed Action

Na Pua Makani Wind Project

Visual Simulation Kahuku Walking Trail

January 2016 Oahu, HI

Looking northwest from the walking path on the west side of Kamehameha highway, approximately 1/2 mile south of Kahuku

Figure 4.16-9b: Alternative 3

**Na Pua Makani
Wind Project**

**Visual Simulation
Kahuku Walking Trail**

January 2015 **Oahu, HI**

Looking northwest from the walking path on the west side of Kamehameha highway, approximately 1/2 mile south of Kahuku

Existing Conditions

Simulated Conditions: Proposed Action

Figure 4.16-9c: Proposed Action

**Na Pua Makani
Wind Project**

**Night Time Visual Simulation
Kahuku Walking Trail**

January 2016 Oahu, HI

Looking northwest from the walking path on the west side of Kamehameha highway, approximately 1/2 mile south of Kahuku

Figure 4.16-9d: Alternative 3

Na Pua Makani
Wind Project

Night Time Visual Simulation
Kahuku Walking Trail

January 2016 | Oahu, HI

Looking northwest from the walking path on the west side of Kamehameha highway, approximately 1/2 mile south of Kahuku

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4.16.5 Conclusion

Table 4.16-4 summarizes potential impacts to visual resources from the alternatives considered in this analysis.

Table 4.16-4. Summary of Potential Impacts to Visual Resources

Impact Issues	No Action Alternative	Alternative 2 – Proposed Action	Alternative 2a – Modified Proposed Action Option	Alternative 3
Changes to Visual Resource Character	No Impact	Moderate	Moderate	Moderate

4.17 Transportation

4.17.1 Impact Criteria

This section analyzes potential effects on transportation infrastructure, including harbors, airports, highways, and roadways. Impacts to transportation infrastructure were evaluated by assessing the effects of Project construction and operations and maintenance activities that utilize the construction access routes as described in Section 2.4.6, and the mitigation areas.

The methods used to determine whether a Project alternative would have a significant impact on transportation infrastructure included:

- Reviewing and evaluating baseline conditions for transportation infrastructure that could potentially be affected by the Project.
- Reviewing and evaluating the Project alternatives to identify the actions' potential to effect transportation infrastructure specifically the following potential effects:
  - An increase traffic of more than 100 new peak hour trips or 500 daily trips on Kamehameha Highway;
  - Long traffic delays for substantial number of motorists;
  - Changes to traffic patterns that create hazardous situations for motorist, pedestrians, or bicyclists; and/or
  - Changes to air or marine traffic patterns that would cause substantial safety hazards.
- Impacts to the transportation infrastructure from the HCP mitigation actions were assessed based on whether the mitigation actions would increase traffic to affect traffic patterns to and from the mitigation areas. The mitigation areas include the Hamakua Marsh for water birds and the Poamoho Ridge for the Hawaiian hoary bat.

Table 4.17-1 lists the impact criteria considered when determining the level of effect (i.e., negligible, minor, moderate, major) that the Project could have to transportation. A Traffic Assessment Report conducted by Belt Collins forms the basis of analysis presented below (Belt Collins Hawaii LLC 2016b). The Traffic Assessment Report is included as Appendix B.

Table 4.17-1. Impact Criteria for Transportation

Type of Effect	Impact Component	Effects Summary		
Increase or changes in traffic volumes, traffic patterns, or safety.	Magnitude or Intensity	**High:** Increase traffic exceeding 100 new peak hour trips or 500 daily trips on Kamehameha Highway; road closures for motorist over 30 minutes; hazardous situations for motorist, pedestrians, or bicyclist; hazardous situations for air or marine traffic; substantial affect to traffic patterns to the mitigation areas.	**Medium:** Increase traffic up to 100 new peak hour trips or 500 daily trips on Kamehameha Highway; road closures for 15 minutes; effects to transportation infrastructure that require traffic solution; minimal affect to traffic patterns to the mitigation areas .	**Low:** Traffic would not increase; no road closures but traffic delays due to construction; no changes to traffic patterns that crease hazardous situations; no affect to traffic patterns to the mitigation areas.
	Duration	**Permanent:** Chronic effects; changed conditions of transportation infrastructure that would persist beyond Project decommissioning.	**Long-term:** Effects would persist up to the life of the Project, with a return to pre-Project baseline conditions after decommissioning.	**Temporary:** Effects are generally associated with construction and would not last longer than approximately 1 year, with a subsequent return to pre-activity levels.
	Geographic Extent	**Extended:** Affects transportation infrastructure for the entire island.	**Regional:** Affects transportation infrastructure to and from the wind farm site and mitigation areas.	**Local:** Impacts limited to the immediate vicinity.
	Context	**Unique:** Affects transportation infrastructure that could not feasibly be recreated in the same place or at another location.	**Important:** Affects transportation infrastructure that may be common in region but is critical to providing services locally.	**Common:** Affects transportation infrastructure that could readily be improved in the same location.

4.17.2 Alternative 1—No Action

4.17.2.1 Direct and Indirect Effects

Under Alternative 1, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Alternative 1 would therefore have no adverse impacts to transportation.

4.17.2.2 Cumulative Effects

Under Alternative 1, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Therefore, there would be no adverse or beneficial effects on transportation. Thus, the No Action Alternative would not contribute to cumulative effects on transportation.

4.17.2.3 Summary

The No Action Alternative would have no direct, indirect, or cumulative effects on transportation as no action would be undertaken.

4.17.3 Alternative 2—8 to 10 Turbine Project

4.17.3.1 Direct and Indirect Effects of Construction and Operation of the Project

Construction Impacts

Construction related traffic to build the Project would include transporting the major turbine components, hauling in cement and aggregate, miscellaneous deliveries, and construction worker traffic. As outlined in Section 2.4.6, the major turbine components, including the blade, tower, and nacelles, will be off-loaded at Kalaeloa Harbor and transported to the Project site using three proposed routes. NPMPP is required to coordinate with the Hawaii Department of Transportation, and to comply with applicable HDOT regulations regarding the transport of turbines to the project site. Due to the size and weight of these components, permits to transport these oversized and overweight loads would need to be obtained from State of Hawaii Department of Transportation (HDOT) and the City and County of Honolulu. The following are anticipated requirements of these permits:

- The roundtrips must be performed Monday through Saturday between the hours of 9:00 p.m. and 5:00 a.m.
- No oversized loads are allowed to be transported on Sundays or holidays.
- A minimum of four police escorts per load are required to help the oversized load navigate turns.
- Police escorts and/or flagpersons must provide traffic direction at the entrance to the Project Site on Kamehameha Highway during construction.

It is anticipated that up to 100 nighttime roundtrips of oversized loads would be needed extending over approximately 20 days during the construction of the Project.

Transport of the oversized components would require tree trimming, temporary traffic signal and roadway sign relocation, temporary guardrail relocation, overhead utility line adjustments, and temporary asphalt curb removal. The Traffic Assessment Report identifies potential tree trimming to a clearance height of 16.5 feet (5 meters) along Kalaeloa Boulevard, Kauhi Road, Ka Uka Boulevard, and Kamehameha Highway. Temporary traffic signal, roadway sign, guardrail, and asphalt curb removal and relocation would be required; however, these would be improved back to their existing condition after transport of the oversized loads. Additionally, the left turn onto Kamehameha Highway at Kamananui Road, the left turn onto Wilikina Drive, and the right turn at Ka Uka Boulevard would require police escorts to control traffic in order for the oversize loads to make the turns.

The Paumalu Bridge, along Kamehameha Highway near Sunset Beach, has been derated by HDOT and currently no oversized loads are permitted (see the Traffic Assessment Report in Appendix B for additional detail). Per HDOT, use of a longer truck with more axels to spread the load when transporting turbine components to the site or a structural analysis on the bridge will be needed for further use of the bridge. HDOT began conducting repair work on Paumalu Bridge in May 2016, and anticipates lifting the weight restrictions once repairs are complete. NPMPP and/or its contractors will coordinate with HDOT regarding special transportation requirements associated with use of the Paumalu Bridge to ensure all requirements are met.

Other construction-related trips include cement, aggregate, and miscellaneous deliveries as well as construction worker trips. Deliveries are anticipated to occur outside of the morning and afternoon peak hour traffic times, and construction workers are expected to work between the hours of 7:00 a.m. and 3:30 p.m. Tables 4.17-2 and 4.17-3 reflect the anticipated average and maximum daytime trips during construction.

Table 4.17-2. Anticipated Average Daytime Trips

Construction Trips	Average Number of Round Trips Per Day	Morning Peak Hour Trips (7:00 a.m. to 8:00 a.m.)	Afternoon Peak Hour Trips (3:45 p.m. to 4:45 p.m.)
Cement	50	5	5
Aggregate	50	5	5
Substation	1	0	0
Building Components	2	1	0
Miscellaneous Deliveries	1	0	0
Construction Workers	40	4	4
TOTAL TRIPS	**144**	**15**	**14**
Note: Assumed 10 percent of the daytime trips would occur during the peak hours.			

Table 4.17-3. Anticipated Maximum Daytime Trips

Construction Trips	Average Number of Round Trips Per Day	Morning Peak Hour Trips (7:00 a.m. to 8:00 a.m.)	Afternoon Peak Hour Trips (3:45 p.m. to 4:45 p.m.)
Cement	50	5	5
Aggregate	50	5	5
Substation	1	0	0
Building Components	2	1	0
Miscellaneous Deliveries	1	0	0
Construction Workers	100	10	10
TOTAL TRIPS	**154**	**21**	**20**
Note: Assumed 10 percent of the daytime trips would occur during the peak hours.			

Table 4.17-4 provides a comparison of the anticipated volumes to the baseline traffic volumes in the morning and afternoon peak hours for a 24 hour period during construction.

Table 4.17-4. Percentage of Peak Project Construction Trips to Baseline Traffic

Time	Percentage
Morning Peak Hour (7:00 a.m. to 8:00 a.m.)	1.8
Afternoon Peak Hour (3:45 p.m. to 4:45 p.m.)	1.9
24 Hour	2.4

Based upon the HDOT's Best Practices for Traffic Impact Reports, a typical trigger for preparing a Traffic Impact Report is 100 or more new peak hour trips or 500 new daily trips. This trigger assumes that this threshold could potentially adversely affect transportation infrastructure. Based upon the anticipated construction traffic trips along the existing traffic volumes on Kamehameha Highway, the mitigation measures for transport of the oversized loads, and the trigger for preparation of a Traffic Impact Report, the construction of the Project is expected to have a temporary and minor impact on transportation.

Components for five wind turbine would be transported along the Department of Agriculture Kahuku Agricultural Park interior roadway, to the DLNR-owned portion of the wind farm site. It is anticipated that 70 truckloads would be needed to transport the turbine components (e.g., base, nacelle, hub, blades, and other components). In total, including regular truck loads delivering turbine foundation equipment, construction equipment, and concrete; trucks delivering/taking away the crane, and wire trucks for the electrical collection system, 150 to 250 vehicle trips are anticipated along this road during a two to four month period. Superloads carrying turbine components would require traffic control on Kamehameha Highway at the entrance to, and along, the Kahuku Agricultural Park interior roadway. During these wind turbine component deliveries, the road may be blocked momentarily until turbine component passes through. All other traffic would be standard traffic and should not impede passing traffic or use of the Kahuku Agricultural Park interior roadway.

In regard to air and marine transportation, the delivery of materials for the Project is not anticipated to affect air and marine transportation. Materials delivered via air freight would be minimal as the cost of delivery would be expensive relative to other delivery modes. When it would be necessary, air freight forwarders are able to accommodate delivery of materials without any impacts to their operations and air infrastructure. Materials delivered via marine freight would use freight forwarders that are equipped to provide ocean delivery services. The Kalaeloa Barbers Point Harbor is able to accommodate shipping of the oversized turbine components as evidence by the past wind farms constructed in Oahu.

Operations and Maintenance Impacts

During operations and maintenance of the Project, there will be approximately three to six full-time employees on site with typical work hours of 7:00 a.m. to 5:00 p.m. and would result in six roundtrips per day. This represents an increase of less than 0.6 percent in traffic volume along Kamehameha Highway during morning and afternoon peak hours. At this low level of increase, the Project related long-term traffic is not expected to have a significant impact to transportation.

The Department of Agriculture access road into the wind farm site, the Kahuku Agricultural Park interior roadway, would be used for routine maintenance activities. It is anticipated that on average this use would be approximately 10 trucks trips per month, or one to two trips per week, and potentially up to approximately 50 truck trips per month if significant maintenance is occurring on an individual turbine. Vehicles used during operation would be pickup trucks; however, if major maintenance for a turbine is required a crane would be needed. Additional truck trips, anticipated to be approximately two truck trips per week, would also occur in association with the wildlife post-construction mortality monitoring program. Given the low amount of routine traffic anticipated, no road closure or limits to access by Department of Agriculture lessees would be anticipated unless the use of a crane were required, in which case access would be limited to allow the crane to access the wind farm site.

4.17.3.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization

The avoidance and minimization measures proposed under the Project HCP would have no effect on transportation because they would not result in an additional increase in traffic volume or affect roadways or access.

Impacts of the HCP Mitigation Measures

Funding provided for management and research activities for the Newell's shearwater, Hawaiian short-eared owl, and Hawaiian goose would have no effect on transportation. Because of the limited nature of the physical actions and the location of the mitigation sites, the installation of the partial fence at the Hamakua Marsh Mitigation Area for waterbirds and implementation of forest restoration and monitoring activities at the Poamoho Ridge Mitigation Area for bats are also expected to have negligible effects on transportation. The vehicles and vehicular trips required for implementation of mitigation measures at the mitigation areas would involve too few vehicle trips on an infrequent basis (at most on a weekly to monthly basis) to measurably affect transportation and traffic.

4.17.3.3 Mitigation for Unavoidable Impacts

The anticipated permit requirements of the HDOT and City and County of Honolulu oversized and overweight loads would minimize the potential impacts of the Project on transportation during the construction period, as shown below. These measures will be incorporated in to a traffic management plan.

- The roundtrips must be performed Monday through Saturday between the hours of 9:00 p.m. and 5:00 a.m.
- No oversized loads are allowed to be transported on Sundays or holidays.
- A minimum of four police escorts per load are required to help the oversized load navigate turns.
- Police escorts and/or flagmen must provide traffic direction at the entrance to the Project Site on Kamehameha Highway during construction.
- Prior to transport of the oversized components, a "high pole" survey will be conducted to confirm and identify any new trees or wires that need to be trimmed or raised, respectively, that were not identified in the Traffic Assessment Report.

In addition, NPMPP has agreed to provide the community with public radio announcements and community flyers on the transport schedule of the oversized loads in order for community members to plan their transportation routes and schedule.

4.17.3.4 Cumulative Effects

The cumulative effects analysis area for impacts to transportation infrastructure is the construction access route and, in particular, Kamehameha Highway. Reasonably foreseeable future projects within the analysis area are identified in Table 4.2-2.

The Koolau Loa Sustainable Communities Plan identifies future land uses within the Koolau Loa Region. The future projects shown in Table 4.2-2 are included within the Koolau Loa Sustainable Communities Plan as planned future land uses. According to the Traffic Assessment Report (Appendix B), the average regional traffic for Kahuku is expected to increase 1.23 percent annually. Table 4.17-5 reflects the future baseline traffic volume at the Malaekahana Bridge at the time of completion for Alternative 2 (2017) without the Project.

Table 4.17-5. Future Baseline Traffic Volume without the Project

Time	Future Traffic Volume (Both Directions)
Morning Peak Hour (7:00 a.m. to 8:00 a.m.)	1,150
Afternoon Peak Hour (3:45 p.m. to 4:45 p.m.)	1,063
24 Hour	12,797

It is anticipated that the regional traffic will increase by 55 trips in the morning peak hour, 51 trips in the afternoon peak hour, and 610 trips in a 24-hour period in 2017 from the existing 2013 levels. This low volume of traffic is expected to have a minor impact to Kamehameha Highway when viewed in conjunction with past, present, and foreseeable projects in the Koolau Loa Region. The contribution of six roundtrips on the transportation infrastructure would be minor to negligible impact to the already low volume of anticipated regional traffic in 2017.

4.17.3.5 Summary

The effects of Alternative 2, the Proposed Action, on transportation infrastructure would have a low level of magnitude (minor), localized and largely temporary using existing transportation infrastructure. Direct impacts during the transport of the oversize loads such as disruption to traffic flow and temporary relocation of guardrails and traffic signals are temporary until the transport of the oversized loads are completed. These direct impacts would be limited with the mitigation measures that would be required in the oversized load permits and notification to the community of transport schedule. The HCP conservation measures would also not have an effect on transportation infrastructure. Cumulative impacts are negligible as regional traffic is anticipated to increase by a low amount.

4.17.3.6 Alternative 2a - Modified Proposed Action Option

Under Alternative 2a, direct, indirect, and cumulative effects on transportation would be the same as those described under Alternative 2. It is assumed that if the largest turbine model under consideration were selected tree trimming, temporary traffic signal and traffic sign relocation, temporary guardrail relocation, overhead utility line adjustments, and temporary asphalt curb removal along the transportation route would be comparable as those identified under Alternative

2. Implementation of mitigation measures, as described under the Proposed Action, would minimize adverse impacts to transportation under the Modified Proposed Action Option.

4.17.4 Alternative 3 – Larger Generation Facility (Up to 12 Turbine Project)

4.17.4.1 Direct and Indirect Effects of Construction and Operation of the Project

Construction Impacts

In general, construction of Alternative 3 would have similar impacts as Alternative 2. Construction of an additional 2 to 4 turbines would not adversely affect existing transportation infrastructure. Prior to the construction of the additional turbines, NPMPP would need to obtain a new oversized and overweight permit from HDOT and City and County of Honolulu to transport these additional turbines and, likely, the permit requirements would be similar to Alternative 2. Namely, the turbines would need to be transported during the nighttime off-peak hours.

It is anticipated that up to 40 nighttime roundtrips of oversized loads would be needed extending over approximately 8 days during the construction of the additional turbines. The construction of the first 8 to 10 turbines would require up to 100 nighttime roundtrips of oversized loads over approximately 20 days (same as Alternative 2).

Transport of the oversized components would again require tree trimming, temporary traffic signal and traffic sign relocation, temporary guardrail relocation, overhead utility line adjustments, and temporary asphalt curb removal along the same areas as identified in Alternative 2. Also, similar to Alternative 2, the left turn onto Kamehameha Highway at Kamananui Road, the left turn onto Wilikina Drive, and the right turn at Ka Uka Boulevard would require police escorts to control traffic in order for the oversize loads to make the turns.

Other construction-related trips includes cement, aggregate, and miscellaneous deliveries as well as construction worker trips would be similar to Alternative 2. Tables 4.17-3 and 4.17-4 above reflect the same anticipated average and maximum daytime trips during construction.

Table 4.17-6 provides a comparison of the anticipated volumes to the baseline traffic volumes in the morning and afternoon peak hours for a 24-hour period during construction of these additional turbines (in 2019).

Table 4.17-6. Percentages of Peak Project Construction Trips to Baseline Traffic

Time	Percentage
Morning Peak Hour (7:00 a.m. to 8:00 a.m.)	1.8
Afternoon Peak Hour (3:45 p.m. to 4:45 p.m.)	1.8
24 Hour	2.3

At this traffic level, the construction of the additional turbines is expected to have a temporary and minor impact on transportation infrastructure. Similar to Alternative 2, the delivery of materials for the additional turbines is not anticipated to effect air and marine transportation infrastructure.

Operations and Maintenance Impacts

The operation of the Project under Alternative 3 would require the three full-time employees needed for Alternative 2, plus potentially one to two additional full-time employees to handle the additional turbines. And as such, the installation of additional turbines would not impact transportation during long-term operations and maintenance for Alterative 3.

4.17.4.2 Direct and Indirect Impacts of the HCP Conservation Measures

The avoidance and minimization measures proposed under the Project's HCP would have no effect on transportation because they would not result in an additional increase in traffic volume or affect roadways or access.

4.17.4.3 Mitigation for Unavoidable Impacts

Mitigation measures to be implemented for Alternative 3 would be the same as described for Alternative 2. These include delivering the oversized loads during nighttime off-peak hours, utilizing police escorts to direct traffic, and notifying the community of delivery schedules.

4.17.4.4 Cumulative Effects

According the Traffic Assessment Report (Appendix B), the average regional traffic for Kahuku is expected to increase 1.23 percent annually. Table 4.17-7 reflects the future baseline traffic volume without the Project in 2019 when the additional turbines are anticipated to be constructed.

Table 4.17-7. Future Baseline Traffic Volume without the Project in 2019

Time	Future Traffic Volume (Both Directions)
Morning Peak Hour (7:00 a.m. to 8:00 a.m.)	1,178
Afternoon Peak Hour (3:45 p.m. to 4:45 p.m.)	1,089
24 Hour	13,114

It is anticipated that the regional traffic will increase by 927 trips in 2019 from the existing 2013 levels for a 24 hour period. This level of increase in traffic may trigger HDOT to request that a Traffic Impact Report be conducted prior to the construction of the additional turbines to determine the level of impact on a cumulative basis. However, the Project would not contribute to additional long-term trips as the three to six full-time employees would already be employed and their traffic trips would already be accounted for. As a result, the additional turbines would not contribute to cumulative effects on transportation to Kamehameha Highway when viewed in conjunction with past, present, and foreseeable projects in the Koolau Loa Region.

4.17.4.5 Summary

As with Alternative 2, the Proposed Action, the effects of Alternative 3 on transportation would be, at most, minor, localized, and largely temporary using already existing transportation infrastructure. However, construction of the additional 2 to 4 turbines would not occur until 2019 due to required HECO transmission line upgrades. Therefore, the effects associated with the additional 2 to 4 turbines in Alternative 3 would occur at a different time period than the effects from constructing the first 8 to 10 turbines. Direct impacts during the transport of the oversize loads such as disruption to traffic flow and temporary relocation of guardrails and traffic signals and signs are temporary until the transport of the oversized loads are completed. These direct impacts would be limited with the mitigation measures that would be required in the oversized load permits and notification to the community of the transport schedule. The HCP conservation measures would also not have an effect on transportation infrastructure. Cumulative impacts are not anticipated because no traffic trips would be added.

4.17.5 Conclusion

No anticipated adverse impacts to transportation would rise above a minor impact level under Alternatives 1, 2 (including the Modified Proposed Action Option), or 3. Table 4.17-8 summarizes potential impacts to transportation from the alternatives considered in this analysis.

Table 4.17-8. Summary of Potential Impacts to Transportation

Impact Criteria	No Action Alternative	Alternative 2 – Proposed Action	Alternative 2a - Modified Proposed Action Option	Alternative 3
Increase traffic exceeding a 100 new peak hour trips or 500 daily trips on Kamehameha Highway	No Impact	Negligible	Negligible	Minor
Long term traffic delays for a substantial number of motorist	No Impact	Minor	Minor	Minor
Changes to traffic patterns that create hazardous situations for motorist, pedestrians, or bicyclists	No Impact	Minor	Minor	Minor
Changes to air or marine traffic patterns that would cause substantial safety hazards	No Impact	Negligible	Negligible	Negligible
Increase traffic to affect traffic patterns to and from the mitigation areas	No Impact	Negligible	Negligible	Negligible

4.18 Public Health and Safety

4.18.1 Impact Criteria

The public health and safety analysis was based on an evaluation of whether NPMPP has committed to measures to be taken during the design, construction, and operation phases of the Project including:

- Designing all aspects of the Project in accordance with applicable Federal, State, and industry codes to minimize the potential for wind or fire to affect public health and safety;
- Preparing and implementing a spill prevention, control and containment plan; notification protocols; immediate spill response procedures; hazardous material handling; and fire management plans during construction and operation; and
- Preparing and implementing plans covering routine and emergency measures to govern Project operations.

Table 4.18-1 lists the impact criteria considered when determining the level of effect (i.e., negligible, minor, moderate, major) that the Project could have to public health and safety.

Table 4.18-1. Impact Criteria for Public Health and Safety

Type of Effect	Impact Component	Effects Summary		
Effects on Public Health and Safety	Magnitude or Intensity	**High:** Above background conditions, non-compliance with or exceedence of industry standards or recommended thresholds (e.g., shadow flicker >30 hours per year).	**Medium:** Above background conditions with change noticeable but in compliance with industry standards and at levels at or below recommended thresholds.	**Low:** No change in background conditions; in compliance with all industry standards and recommended thresholds.
	Duration	**Permanent:** Potential for impacts extends beyond the lifespan of the Project.	**Long-term:** Potential for impacts lasts through the operational period of the Project.	**Temporary:** Potential impacts last for less than 1 year or the period of Project construction.
	Geographic Extent	**Extended:** Affects communities throughout the region.	**Regional:** Affects 2 or more communities in the region.	**Local:** Affects individuals in a single community.
	Context	**Unique:** Type of effect specific to alternative energy development and currently not present in the analysis area.	**Important:** Type of effect specific to alternative energy development, but already present in analysis area.	**Common:** Type of effect not specific to alternative energy development.

4.18.2 Alternative 1—No Action

4.18.2.1 Direct and Indirect Effects

Under the No Action Alternative, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Conditions affecting public health and safety would remain as they are under existing conditions. Therefore, no effects to public health and safety would occur under the No Action Alternative. As such, no mitigation measures would be warranted.

4.18.2.2 Cumulative Effects

Under the No Action Alternative, the Project would not be constructed, the USFWS would not issue an ITP, and the HCP conservation measures would not be implemented. Therefore, there would be no effect on public health and safety. Thus, Alternative 1 would not contribute to cumulative effects to public health and safety.

4.18.2.3 Summary

Alternative 1 would have no direct, indirect, or cumulative effects to public health and safety because no action would be undertaken.

4.18.3 Alternative 2—8 to 10 Turbine Project

4.18.3.1 Direct and Indirect Effects of Construction and Operation of the Project

Construction Impacts

Potential safety issues during construction are associated with public access to the wind farm site and accidents or injuries of construction workers. Workers and the general public could be injured from the movement of construction vehicles, equipment, and materials. A Site Safety Handbook would be prepared and implemented prior to the start of construction, which would outline measures such as establishing safety zones or setbacks from construction work areas and would identify requirements for temporary fencing around staging areas, storage yards, and excavations during construction to control and restrict public access to the construction area, as well as outline worker safety practices. All persons entering the construction areas would be required to review and adhere to the Site Safety Handbook. Safety of farmers that lease land from Malaekahana Hui West, LLC is addressed specifically in Section 4.22 – Agriculture.

Construction of the Project would result in an increased fire risk. Sparks from vehicles and construction equipment, spark-producing construction activities such as welding, and improper disposal of matches or cigarettes, for example, could start a fire. There would also be increased presence and use of petroleum products, including oils and lubricants onsite, thereby increasing the potential for fire or other medical emergency. To mitigate the risk of fire posed by the Project, NPMPP would implement a Project Fire Management Plan (FMP) during construction and operation. The FMP identifies potential fire hazards and provides pre-suppression actions that include ignition prevention, firebreaks, fuel breaks, and fuels management. A copy of the FMP is provided in Appendix C of the Final EIS. Water tanks will be maintained onsite for emergency fire suppression during construction. Additional fire suppression measures to be implemented during construction will be developed in coordination with the City and County of Honolulu Fire Department and will be incorporated into a Site Safety Handbook. These measures may include, but are not limited to requiring vehicles to carry fire suppression equipment when onsite such as fire extinguishers, flappers, and shovels, and storing fire suppression tools at designated locations within the wind farm.

To reduce risk posed by the presence of hazardous and flammable materials, a SPCC Plan would also be developed and implemented to minimize risks to public safety during Project construction. Designated storage areas for various types of materials would be provided and would include dry containment cabinets for secured storage of hazardous and flammable materials, a containment berm for large vessels containing petroleum products, and secondary fuel containment. See Section 4.7 – Hazardous and Regulated Materials and Wastes for more information. With these measures in place, minor impacts to public health and safety in association with fire during Project construction would be expected.

Operation and Maintenance Impacts

Turbine Collapse and Blade Throw

As noted in Section 3.16, while possible and potentially dangerous, tower collapse and blade throw are very rare occurrences and often are linked to improper assembly or exceedance of design limits (AWEA 2008). Such incidents have been largely eliminated due to technological improvements and mandatory safety standards during turbine design, manufacturing, and installation. All turbines are designed with several levels of built-in safety and comply with the codes set forth by OSHA and ANSI standards. The wind turbines would also be equipped with sophisticated computer control systems to monitor variables such as wind speed and direction, air and machine temperatures, electrical voltages, currents, vibrations, blade pitch, and yaw angles. Each turbine would be connected to a central data control system. The system would allow for remote control and monitoring of individual turbines and the wind farm as a whole from both the central host computer or from a remote computer. This system would enable the emergency halting of the rotors at any time.

A concern raised during scoping and during the Draft EIS public comment period was the likelihood of turbine collapse or blade throw as a result of high winds associated with tropical storms or hurricanes. Modern utility-scale turbines are certified according to International Electrotechnical Commission (IEC) standards (IEC 61400-1; see Section 3.16 for additional discussion), which include ratings for withstanding different levels of hurricane-strength winds and other criteria. Historical records show that on average four to five tropical storm systems develop in the central Pacific region each year and hurricanes have occurred in Hawaii in the past although infrequently (two in the last 50 years; NOAA 2013a), with most storm systems passing south of the Hawaiian Islands. The island of Oahu has never been directly hit by a hurricane (NOAA 2013a). Thus, the occurrence of hurricane-force winds is rare. Nonetheless, final selection of the turbine models for the Project would take into account Project-specific meteorological data and historic weather patterns to ensure selection of models with IEC ratings appropriate for site-specific wind conditions.

Commercial scale wind turbines are designed to standards IEC 61400. Selection of a particular model takes into account site-specific wind conditions. The wind turbine models being considered for the Project are designed to operation in wind speeds of up to 55 miles per hour and withstand 50-year occurrence gusts of 94 miles per hour. They have a built-in cut-out speed, such that when wind speeds exceed 55 miles per hour, the wind turbine stops operating. Under extreme conditions, the rotor pitch can also be changed to a neutral position (facing into the wind with blades coming to a stop). As noted above, these adjustments are made by the wind turbine controller (a computer system that runs self-diagnostic tests, starts and stops the turbine, and makes adjustments as wind speeds vary); however a built-in SCADA system allows 24 hours, 7 days per week remote control of the facility.

Implementing the measures outlined in the Site Safety Handbook and constructing and operating the turbines per industry specifications and standards would minimize the potential for tower collapse and blade throw. Additionally, members of the public would not have access to the wind farm site, and signs would be used to discourage unauthorized access, thereby minimizing onsite safety risks. Safety of farmers leasing land from Malaekahana Hui West, LLC who would continue farming operations during Project operation is addressed specifically in Section 4.22 – Agriculture. Project wind turbines would be setback a minimum of 1,611 feet (491 meters) from the nearest residential areas (i.e., zoned residential parcels), and 814 feet (248 meters) from the nearest legal residence on Department of Agriculture land. This meets the required county setback for the tallest wind turbine model under consideration (the distance equal to the height of the turbine). For these reasons, there is a negligible risk of impacts to public health and safety in association with turbine collapse and blade throw that would be expected.

Shadow Flicker

Shadow flicker is defined as moving blades passing between the sun and a receptor, creating alternating changes in light intensity of shadows. The spatial relationship between a wind turbine and a receptor, along with weather characteristics such as wind direction and sunshine probability, are key factors related to shadow flicker impacts. Shadow flicker becomes much less noticeable at distances beyond approximately 1,000 feet (305 meters), except at sunrise and sunset when shadows are long (NRC 2007).

As discussed in Section 3.16, there is no state or national standard that exist for frequency or duration of shadow flicker from wind turbines. However, a threshold of 30 hours per year has been widely used in the industry as a target value in the absence of formal guidelines. However, predicted shadow flicker greater than this threshold does not necessarily create a nuisance and is still well below concerns for impacts to health such as triggering epileptic seizures (Epilepsy Action 2008; see Section 3.16).

To assess potential Project shadow flicker impacts, a computerized simulation using the WindPro software package was used to determine exposure to shadows cast by the moving turbine blades for all sensitive receptors located within 1.6 miles (2.5 kilometers) of proposed wind turbine locations. A follow-up site visit was conducted in April 2013, and again in September 2015, to confirm site-specific conditions. A total of 737 receptor locations were identified within 1.6 miles (2.5 kilometers) of proposed Project turbines and are included in the analysis. These included temporary and permanent residences, outbuildings used by farmers, the Kahuku elementary school and high school, and the Kahuku medical center. For each receptor, the annual hours and minutes of shadow impact were calculated. The analysis was based on worst case conditions for shadow flicker (full sunlight and blades perpendicular to incoming sunlight) to conservatively estimate the potential amount of shadow impact hours for a year (see Appendix D for more detail on the assumptions of the shadow flicker analysis).

WindPro predicts that shadow flicker impacts would be greatest at locations within the wind farm site boundary nearer to the wind turbines. Seventeen of the 737 receptors modeled had expected shadow flicker impacts of more than 30 hours per year (Table 4.18-2; see the shadow flicker analysis in Appendix D). The maximum predicted shadow flicker impact at any receptor is 244 hours and 9 minutes per year (Receptor 647), which is approximately 5.5 percent of the potential available daylight hours. Collectively, receptors with predicted shadow flicker of more than 30 hours per year would experience shadow for 2 to 8 months of the year (theoretical maximum of 47-

248 days with shadow per year), with maximum shadow flicker times per day ranging from 17 minutes to 2 hours and 20 minutes (Table 4.18-3).

Public comments on the Draft EIS requested additional information on the location and types of receptors that are predicted to have more than 30 hours of shadow flicker. This information has been added to Tables 1, 2, and 3 in the shadow flicker analysis in Appendix D and is summarized here. Receptors 647, 609, 607, 608, 610, 743, 648, 450, 645, and 452 are agricultural structures (storage sheds and a warehouse) located within the wind farm site on land owned and leased by Malaekahana Hui West, LLC, for the wind farm. These structures are used by farmers who are leasing land from Malaekahana Hui West, LLC for agricultural crop production and who would continue to conduct day-to-day farming activities within the wind farm site during Project operation (see Section 4.22 – Agriculture for additional detail). These receptors would experience shadow flicker during 2 to 8 months of the year (theoretical maximum of 47 to 234 days with shadow per year), depending on the receptor (Table 4.18-3). The theoretical maximum shadow flicker time per day at these receptors would range from 17 minutes to 2 hours and 20 minutes per day and would occur primarily in the morning (i.e., prior to 10 a.m.) or late afternoon (i.e., after 4:30 p.m.). Therefore, shadow flicker has the potential to occur during a very small portion of an individual farmer's work day, and would not be expected to hinder farming activities.

Receptors 595, 600, 599, 602, 594, 593, and 601 are located adjacent to the wind farm site on land owned by the Department of Agriculture. These are legal residences on agriculturally zoned parcels. These receptors would experience shadow flicker during 3 to 9 months of the year (theoretical maximum of 95 to 256 days of shadow per year), depending on the receptor (Table 4.18-3). The theoretical maximum shadow flicker time per day would range from 40 minutes to 1 hour and 27 minutes per day and would occur in the mid- to late-afternoon (i.e., primarily between 4:30 p.m. to 6:00 p.m.).

It should be noted that actual exposure would depend on weather and the presence of screening, such as trees or buildings and therefore the analysis is very conservative in that it assumes that the receptors all have a direct in-line view of the incoming shadow flicker sunlight. These results indicate that the potential for shadow flicker would be almost entirely contained within the wind farm site and the amount of potential flicker extending onto adjacent areas would be relatively short in duration. Moreover, under Alternative 2, there would be no shadow flicker impacts at the Kahuku elementary school, Kahuku high school, and Kahuku medical center (zero hours of shadow flicker time). Therefore, the Proposed Action would have moderate impacts associated with shadow flicker, with minimal impacts outside of the wind farm site boundary.

Table 4.18-2. Summary of Shadow Flicker Impacts for Alternative 2

Cumulative Shadow Flicker Time (expected on an annual basis)	Number of Receptors
0 Hours	490
> 0 Hours < 10 Hours	162
≥ 10 Hours < 20 Hours	60
≥ 20 Hours < 30 Hours	8
≥ 30 Hours	17
Total	**737**

Table 4.18-3. Predicted Shadow Flicker Impacts by Sensitive Receptor for Alternative 2

Receptor[1/]	Expected Shadow Hours Per Year (hours:minutes)	Maximum Number of Days with Shadow[2/]	Maximum Shadow Hours per Day (hours:minutes)[2/]
647	244:09	234	2:20
609	123:24	248	1:03
595	122:38	230	1:07
607	121:50	148	2:07
608	107:01	167	1:33
610	90:55	181	1:01
600	85:43	256	0:49
599	69:28	172	0:57
602	61:38	213	0:40
594	57:43	104	1:12
743	55:58	186	0:59
593	52:00	95	1:27
601	51:56	140	0:48
648	49:05	95	1:01
450	46:26	67	0:28
645	43:48	83	1:27
452	32:58	47	0:17

[1/] Receptors for which more than 30 hours of shadow per year is predicted.
[2/] Representative of theoretical worst case; does not take into account factors that reduce or eliminate shadow flicker impacts such as estimated Project wind turbine operational time and orientation including wind speed and direction (based on site-specific wind data) and sunshine "availability" (percent of total hours available).

Fire and Fuels

During operation, potential causes of fire include lightning strike, short circuit of electrical equipment, the mechanical failure or malfunction of equipment, and the storage and use of flammable materials and equipment at the operations and maintenance building. The risk of fire associated with operation of the wind turbines is relatively low and minimized by the design features of the turbines, such as over-temperature sensors that will shut down the turbine if normal temperature limits are exceeded. In addition, undergrounding of the electrical collection system would reduce the risk of fire.

Overall, risk to public safety during a fire event would be very low due to the distance between the turbines and private property and residences. Implementation of the Project FMP and SPCC Plan, discussed above, would minimize fire risk and risk posed by presence of hazardous and flammable materials during operation of the Project. With these measures in place, in addition to regular maintenance of Project facilities, minor impacts to public health and safety would be expected during operation in association with fire and fuels. Additionally, as noted above, additional fire suppression measures to be implemented during operation will be developed in coordination with the City and County of Honolulu Fire Department and will be incorporated into a Site Safety Handbook. These measures may include, but are not limited to requiring vehicles to carry fire suppression equipment when onsite such as fire extinguishers, flappers, and shovels, and storing fire suppression tools at designated locations within the wind farm.

Noise and Vibration

The normal operation of a wind turbine produces sound and vibration, which has resulted in concern about potential health implications associated with exposure to increased audible noise levels or to airborne vibration associated with infrasound. In an effort to determine the validity of reports of wind turbine-related health effects, 17 separate independent scientific reviews have been conducted both nationally and internationally to evaluate the best available science on this subject (Pedersen and Halmstad 2003; Leventhall 2004; Jakobsen 2005; NRC 2007; Chatham-Kent Public Health Unit 2008; Colby et al. 2009; McCunney et al. 2014; Minnesota Department of Health 2009; UK Health Protection Agency 2010a, b; CMOH 2010; NHMRC 2010; Knopper and Ollsen 2010; Bolin ant al. 2011; Fiumicelli 2011; MassDEP and MDPH 2012; OHA 2013).

To date, no scientific peer-reviewed study has demonstrated a direct causal link between people living in proximity to modern wind turbines, and the noise they emit (audible and inaudible sounds), and resulting physiological health effects (Harding and Wilkins 2008; Keith et al. 2008; Leventhall 2006; O'Neal et al. 2011; Pedersen et al. 2007, 2009, 2010; Pedersen and Larsman 2008; Pedersen and Persson 2004; Pedersen and Waye 2007, 2008; Pederson 2011; Salt and Hullar 2010; Shepherd et al. 2011; Smedley et al. 2010; van den Berg 2003). A limited number of epidemiological studies have shown that audible noise from wind turbines can be annoying to some people and associated with some reported health effects (e.g., sleep disturbance), especially when found at sound pressure levels greater than 40 dBA at night (Pedersen et al. 2009; Pedersen 2011; Pedersen and Waye 2007; Shepherd et al. 2011). However, research has shown that this annoyance appears to be more strongly related to visual cues, noise sensitivity, and attitude about the wind turbines rather than to noise itself (Knopper and Ollson 2011). That is, the level of annoyance or disturbance experienced by people hearing wind turbine noise is influenced by individuals' perceptions of other aspects of wind energy facilities, such as turbine visibility, trust, fairness and equity, and the level of community engagement during the planning process (OHA 2013). No studies have identified positive associations between wind turbine noise and long-term health impacts such as hypertension, cardiovascular disease, high blood pressure, tinnitus, headache/migraine, hearing impairment or other diseases; however, these long-term health effects may result from or be exacerbated by sleep disturbance from night-time wind turbine sound (MDEP 2012; OHA 2013). However, scientists and medical experts from around the world continue to publish on these topics and due to the inherent limitations of available studies for drawing definitive conclusions about health-related concerns, additional research is needed to address current data gaps (McCunney et al. 2014).

Although there is a vast amount of information available in the form of popular literature and on the internet (e.g., Pierpont 2009; Nissenbaum 2010; Krogh et al. 2011) which suggests a causal link between the infrasound created by wind turbines and effects to the body's vestibular system (those that maintain a person's sense of balance and the stabilization of visual images) and to the internal organs associated with vibration (referred to as "wind turbine syndrome"), these claims have not been supported by verifiable scientific evidence (Colby et al. 2009; Knopper and Ollson 2011; Ellenbogen et al. 2012). Such studies are based on self-reported data, rely on a limited number of participants, and have not involved the actual measurement of sound pressure levels; they also appear to lack objectivity as authors are also known advocates who oppose wind turbine developments (Knopper and Ollson 2011). In summary, research shows that people have complained of annoyance resulting from wind turbine sound, and there is reason to be careful in turbine siting; however, there is no evidence of any direct relationship between wind turbine sound and adverse physiological health impacts.

At the nearest noise-sensitive receptors (most residences, hospitals, schools), predicted Project operational noise levels dissipate to less than 43 dBA (see Section 4.6 – Noise for additional discussion). Additionally, based on monitored sound levels, there is no anticipated low frequency noise/infrasound impact associated with Alternative 2 (see Section 4.6 – Noise for detailed discussion). Given the current scientific evidence, the minor increase over existing noise levels may result in a noticeable change to some noise-sensitive individuals working in or living adjacent to the wind farm site; however, predicted sound levels are not expected to result in annoyance, sleep disturbance, or other health effects in the general population, and therefore would have minor adverse effects to public health.

Comments on the Draft EIS requested additional discussion of the health impacts of wind turbines on people with autism or sensory integration issues. Hypersensitivity to sound is frequently reported in many autistic patients (Kellerman et al. 2005); however, there is a lack of research into health effects on different population groups, including those with autism, living near sources of noise from power facilities such as wind turbines (Howell et al. 2015). Despite this lack of research, the Project is not expected to have disproportionate effects to people with autism or others with noise sensitivity because the project increase in audible noise associated with Project operation would be very minor, and in most cases imperceptible. As discussed in Section 4.6.3, increases in audible sound levels at the nearest noise-sensitive receptors (most residences, hospitals, schools) are predicted to be no more than 4 dB over existing sound levels. A 3-dBA increase is generally not discernable to the average person but a 5-dBA increase is; therefore, a 4-dBA increase may be discernable to some people, but is not anticipated to be more than a minor impact. Additionally, the predictions of operational noise are intentionally conservative and the likelihood of a 3- to 4-dB increase at nearest noise-sensitive receptors would only occur outside under downwind propagation conditions and under maximum rotation operational conditions. Moving inside a structure with open or closed windows results in substantial noise attenuation not accounted for in the noise analysis (see Section 4.6 for additional discussion). Additionally, as described Section 4.6.3, low frequency noise and infrasound levels predicted under Alternative 2 are well below the threshold of human hearing and the DEFRA limits. Although predicted operational LFN/IS are higher than the ANSI S12.9 Part 4 guidelines, existing sound levels in the area are already above this threshold; therefore, as stated above, there is no anticipated low frequency noise/infrasound impact associated with Alternative 2. Therefore, no effects to people with autism or others with noise sensitivity are anticipated.

Electromagnetic Fields

Components of wind energy projects (transmission lines and wind turbines), like the energized components of electrical motors, home wiring, lighting, and all electrical appliances, produce electric and magnetic fields, commonly referred to as EMF. The EMF produced by the alternating current electrical power system in the United States has a frequency of 60 Hz, meaning that the intensity and orientation of the field changes 60 times per second. Power line fields of 60 Hz are considered to be extremely low frequency. Measurements of EMF recorded in wind farm sites have shown very low magnetic fields at the base of a wind turbine, and no detectable magnetic field at 25 feet (7.6 meters) (Windrush 2004).

The potential EMF produced by the generation and export of electricity from the wind turbines would have negligible effects on the health and safety of the public or the workers at the wind farm site. The electrical collection system would be constructed primarily underground. Aboveground portions of the electrical collection system and the transmission line would adhere to industry standards minimizing EMF exposure.

NPMPP has consulted with Comsearch, a company that identifies the potential impact of wind turbines on licensed non-Federal government microwave systems. Comsearch has developed and maintains comprehensive technical databases containing information on licensed microwave networks throughout the United States. Microwave bands that may be affected by the installation of wind turbine facilities operate over a wide frequency range (900 MHz to 23 gigahertz) and include systems that are the telecommunication backbone of the country, providing long-distance and local telephone service, backhaul for cellular and personal communication service, data interconnects for mainframe computers and the Internet, network controls for utilities and railroads, and various video services (Comsearch 2011). The Project would avoid any impacts identified by Comsearch.

Stray Voltage

When electrical systems are grounded some current flows through the earth and a small voltage develops at each point where the system is grounded. Stray voltage can occur if unbalanced neutral currents flow in the earth through ground rods, pipes, or other conducting objects in a facility (AWEA 2008). Stray voltage may come from damaged or poorly connected wiring systems, corrosion on either end of the wires, or weak or damaged insulation materials on the “hot” wire. Construction of the above ground portions of the transmission line would follow standard industry procedures including structure assembly and erection, ground wire, and conductor stringing. Operation activities would include routine monitoring, inspection, and maintenance by qualified personnel. Therefore, negligible effects to public health and safety from stray voltage are expected in association with the Proposed Action.

4.18.3.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP would have no effect on public health or safety. Project biologists or personnel onsite conducting post-construction fatality monitoring are exposed to hazards such as tower collapse, blade throw, stray voltage, and fire (described in detail above). All personnel involved in post-construction fatality monitoring or other elements of the HCP mitigation strategy would receive safety training prior to commencing work within the wind farm site and would be required to follow the Site Safety Handbook.

Impacts of HCP Mitigation

None of the HCP mitigation measures pose a risk to public health and safety. Therefore, negligible impacts to public health and safety would be expected in association with implementation of HCP mitigation.

4.18.3.3 Mitigation for Unavoidable Impacts

Unavoidable adverse impacts to public health and safety are anticipated to be minimal. The following measures will help avoid and minimize the potential impacts to public health and safety during Project construction and operation.

- To mitigate for shadow flicker impacts, NPMPP will offer home owners for which shadow flicker is predicted to be greater than 30 hours per year reimbursement for costs up to $800 for adding awnings or blinds to windows facing the wind farm and/or landscaping/trees to block shadow flicker.
- Development and implementation of an FMP in coordination with the Honolulu County Fire Marshall and appropriate agencies. The FMP is included in Appendix C of the Final EIS.
- Preparation, prior to commencement of any construction work, and implementation of a Site Safety Plan that would apply to all contractor and subcontractor personnel and farmers working at the site. The plan would be designed to ensure compliance with all laws, ordinances, regulations, and standards concerning health and safety. The contractor would assign a safety manager with the authority to issue a “stop work” notice when health and safety issues arise.
- Preparation and implementation of an SPCC Plan. The SPCC Plan would apply to both construction and operation if hazardous materials were stored onsite in quantities sufficient to trigger the plan requirement.
- Preparation and implementation of Hazardous Waste Management Plans, one for construction and one for operation, that comply with State and Federal hazardous waste management laws for handling, storage, and disposal.
- Compliance with all applicable local, State, and Federal safety, health, and environmental laws, ordinances, regulations, and standards for construction and operation of a wind project.

4.18.3.4 Cumulative Effects

The cumulative effects analysis area for impacts to public health and safety includes areas occupied by people where crossed by Proposed Action footprint or from which the Project is visible. The Proposed Action has been designed to incorporate measures that address the potential for wind turbine failure, minimize the risk of fire and exposure to hazardous materials, and address access-related safety issues. Many of these risks to public health and safety would be the same for any large construction project, and, therefore, would be negligible with the implementation of proper safety measures. The Project would contribute to existing levels of noise within the analysis area associated with the highway, ongoing agricultural operations, and the natural sources (e.g., the ocean). Construction projects in the analysis area would contribute short-term, localized noise. However, none of these sources of noise would produce noise and vibration that would cause health and safety impacts. Shadow flicker resulting from the Project may contribute to the effects associated with the Kahuku wind projects if both projects are visible to individual motorists driving along the highway. Implementation of the HCP avoidance and minimization and mitigation measures would not result in adverse impacts to public health and safety, and therefore would not contribute to cumulative effects. Therefore, the direct and indirect effects of the Proposed Action in combination with past, ongoing, and reasonably foreseeable actions would not result in significant adverse cumulative impacts to public health and safety in association with noise and shadow flicker.

4.18.3.5 Summary

Under Alternative 2, effects associated with turbine collapse and blade throw, fire and fuels, EMF, and stray voltage would be minimized by implementation of mitigation measures, including adherence to industry design standards and implementation of the Site Safety Handbook and other Project plans as proposed. Effects on public health and safety associated with noise would be considered minor because although the magnitude would be medium (above background conditions with change noticeable but in compliance with industry standards) and long term (lasting the life of the Project), effects would be localized and would not comprise a new type of effect into the analysis area. Effects on public health and safety associated with shadow flicker under Alternative 2 would be considered moderate because there would be high (more than 30 hours of shadow flicker per year, above the industry recommended threshold), long-term (lasting through the life of the Project) impacts at individual receptors, but impacts would be localized (to individual receptors and limited to the wind farm site), with a majority (approximately 98 percent) of receptors predicted to experience less than 30 hours per year.

Public health and safety are common topics brought up in relation to proposed wind energy Projects. As discussed above, seventeen separate independent scientific reviews have been conducted both nationally and internationally to examine the relationship between wind turbines and possible human health effects associated with audible (the "whooshing" sound created by the rotating blades) and inaudible noise, vibration, shadow flicker, and EMF. To date, no scientific peer-reviewed study has demonstrated a direct link between people living in proximity to modern wind turbines and resulting physiological health effects. However, as noted above, further research is needed to fully draw conclusions about health-related concerns. The following are a sample of conclusions drawn from these peer-reviewed scientific studies and research syntheses which summarize the best available science to date regarding public health and safety:

- "After careful consideration and deliberation of the body of evidence, [the National Health and Medical Research Council] concludes that there is currently no consistent evidence that wind farms cause adverse health effects in humans." (NHMRC 2015)
- "Cross-sectional studies, despite their inherent limitations in assessing causal links, however, have consistently shown that some people living near wind turbines are more likely to report annoyance than those living farther away. These same studies have also shown that a person's likelihood of reporting annoyance is strongly related to their attitudes toward wind turbines, the visual aspect of the turbines, and whether they obtain

economic benefit from the turbines. Our review suggests that these other risk factors play a more significant role than noise from wind turbines in people reporting annoyance." (McCunney et al. 2014)

- "while some people living near wind turbines report symptoms such as dizziness, headaches, and sleep disturbance, the scientific evidence available to date does not demonstrate a direct causal link between wind turbine noise and adverse health effects. The sound level from wind turbines at common residential setbacks is not sufficient to cause hearing impairment or other direct health effects, although some people may find it annoying." (UK Health Protection Agency 2010)
- "There is no evidence that the audible or sub-audible sounds emitted by wind turbines have any direct adverse physiological effects."(Colby 2009)
- "None of the... evidence reviewed suggests an association between noise from wind turbines and pain and stiffness, diabetes, high blood pressure, tinnitus, hearing impairment, cardiovascular disease, and headache/migraine." (MassDEP and MDPH 2012)
- "Although opposition to wind farms on aesthetic grounds is a legitimate point of view, opposition to wind farms on the basis of potential adverse health consequences is not justified by the evidence." (Chatham-Kent Public Health Unit 2011)
- "The electromagnetic fields produced by the generation and export of electricity from a wind farm do not pose a threat to public health..."(NHMRC 2010)

4.18.3.6 Alternative 2a - Modified Proposed Action Option

Under Alternative 2a, direct, indirect, and cumulative effects would be the same as those described under Alternative 2, with the exception of slightly greater shadow flicker effects at some receptors. Analysis of potential shadow flicker impacts for the Modified Proposed Action Option were calculated based on an array of nine larger-dimension turbines (see Appendix D). Results of the WindPro shadow flicker analysis indicated that 25 of the 737 receptors modeled had expected shadow flicker impacts of more than 30 hours per year under Alternative 2a (Table 4.18-4; see the shadow flicker analysis in Appendix D). This includes the 17 receptors discussed above under the Proposed Action plus two additional receptors on the Malaekahana Hui West, LLC portion of the wind farm site (farm structures; receptors 606 and 431), one additional receptor outside of the wind farm site on Department of Agriculture land (legal residences; receptor 592), and five additional receptors within the Kahuku Agriculture Park (legal residences; receptors 528, 529, 530, 531, and 532). The latter five have a predicted shadow flicker time of between 30 and 31 hours per year (Table 4.18-5).

The maximum predicted shadow flicker impact at any receptor under the Modified Proposed Action Option is 258 hours 19 minutes per year (Receptor 647), which is approximately 5.8 percent of the potential available daylight hours. The receptors with predicted shadow flicker of 30 hours or more would experience shadow flicker during 3 to 9 months of the year (theoretical maximum of 90 to 267 days with shadow per year), depending on the receptor (Table 4.18-5). The theoretical maximum shadow flicker time per day at any of these receptor would range from 36 minutes to 2 hours and 13 minutes per day and would occur primarily in the morning (i.e., prior to 10 a.m.) or late afternoon (i.e., after 4:30 p.m.). The results of the shadow flicker analysis indicate that, like for the Proposed Action, the potential for shadow flicker associated with the Modified Proposed Action Option would be almost entirely contained within the wind farm site and the amount of potential flicker extending onto adjacent areas would be relatively short in duration. Therefore, the Modified Proposed Action Option would have moderate localized impacts associated with shadow flicker, with minimal impacts outside of the wind farm site boundary.

Table 4.18-4. Summary of Shadow Flicker impacts for Alternative 2a

Cumulative Shadow Flicker Time (expected on an annual basis)	Number of Receptors
0 Hours	537
> 0 Hours < 10 Hours	70
≥ 10 Hours < 20 Hours	75
≥ 20 Hours < 30 Hours	30
≥ 30 Hours	25
Total	**737**

Table 4.18-5. Predicted Shadow Flicker Impacts by Sensitive Receptor for Alternative 2a

Receptor1/	Expected Shadow Hours Per Year (hours:minutes)	Maximum Number of Days with Shadow2	Maximum Shadow Hours per Day (hours:minutes)2/
647	258:19	260	2:13
595	174:46	267	1:26
607	147:47	178	2:06
609	146:26	260	1:11
608	105:37	151	1:36
610	104:51	189	1:09
600	101:30	261	0:54
599	95:00	207	1:02
594	85:08	127	1:26
593	84:35	117	1:55
602	82:04	232	0:48
601	79:24	182	0:57
648	78:06	165	1:08
743	65:53	188	1:08
450	63:49	147	0:57
452	59:12	104	1:30
606	49:14	125	1:03
645	39:58	90	1:10
592	35:29	156	0:36
431	34:41	119	0:38
530	30:55	116	0:42
531	30:46	117	0:41
529	30:41	113	0:43
532	30:27	118	0:40
528	30:10	110	0:43

1/ Receptors for which more than 30 hours of shadow per year is predicted.
2/ Representative of theoretical worst case; does not take into account factors that reduce or eliminate shadow flicker impacts such as estimated Project wind turbine operational time and orientation including wind speed and direction (based on site-specific wind data) and sunshine “availability” (percent of total hours available).

All other impacts associated with turbine collapse and blade throw, fire and fuels, noise and vibration, electromagnetic fields, and stray voltage under the Modified Proposed Action Option would be comparable to the Proposed Action. Implementation of standard BMPs and other mitigation measures, as described under the Proposed Action, would minimize any adverse impacts to public health and safety from the Modified Proposed Action Option.

4.18.4 Alternative 3 – Larger Generation Facility (Up to 12 Turbine Project)

4.18.4.1 Direct and Indirect Effects of Construction and Operation of the Project

Impacts associated with construction and operation of the Project under Alternative 3 related to public health and safety would be the same as under the Proposed Action with respect to turbine collapse and blade throw, fire risk and hazardous materials exposure, EMF, and stray voltage.

Predicted operational noise levels under Alternative 3 would fall below 44 dBA at the nearest noise-sensitive receptors (most residences, hospitals, schools) (see Section 4.6 – Noise for additional discussion). Given the current scientific evidence, the minor predicted increase over existing noise levels may result in a noticeable change to some noise-sensitive individuals working in or living adjacent to the wind farm site; however, predicted sound levels are not expected to result in annoyance, sleep disturbance or other health effects in the general population. As discussed above under Alternative 2, comments on the Draft EIS requested additional discussion on the health impacts of wind turbines on people with autism. Using conservative estimates, increases in sound levels at the nearest noise-sensitive receptors (most residences, hospitals, schools) under Alternative 3 are predicted to be no more than 4 dB over existing sound levels. This low level of increase in sound levels is not anticipated to be more than a minor impact and would not be expected to have a disproportionate effect to noise-sensitive people.

Additionally, based on monitored sound levels, there is no anticipated low-frequency noise/infrasound impact associated with Alternative 3 (see Section 4.6 – Noise for detailed discussion). Therefore, Alternative 3 would have minor effects to public health related to noise (see discussion above under the Proposed Action).

WindPro predicts that shadow flicker impacts would be greatest at locations nearer to the wind turbines. Nineteen of the 737 receptors modeled had expected shadow flicker impacts of more than 30 hours per year (Table 4.18-6). This includes the 17 receptors discussed above under the Proposed Action plus two additional receptors on the Malaekahana Hui West, LLC portion of the wind farm site (farm structures; receptors 646 and 431). The maximum predicted shadow flicker impact at these receptors is 393 hours 10 minutes per year (Receptor 647), which is approximately 8.9 percent of the potential available daylight hours. These receptors would experience shadow flicker during 3 to 12 months of the year (theoretical maximum of 74 to 365 days with shadow per year), depending on the receptor (Table 4.18-7). The theoretical maximum shadow flicker time per day at any of these receptor would range from 36 minutes to 2 hours and 13 minutes per day and would occur primarily in the morning (i.e., prior to 10 a.m.) or late afternoon (i.e., after 4:30 p.m.). The results of the shadow flicker analysis indicate that, like for the Proposed Action, the potential for shadow flicker associated with the Alternative 3 would be almost entirely contained within the wind farm site and the amount of potential flicker extending onto adjacent areas would be relatively short in duration. Therefore, Alternative 3 would have moderate, localized impacts associated with shadow flicker.

Table 4.18-6. Summary of Shadow Flicker Impacts for Alternative 3

Cumulative Shadow Flicker Time (expected on an annual basis)	Number of Receptors
0 Hours	89
> 0 Hours < 10 Hours	162
≥ 10 Hours < 20 Hours	60
≥ 20 Hours < 30 Hours	7
≥ 30 Hours	19
Total	**737**

Table 4.18-7. Predicted Shadow Flicker Impacts by Sensitive Receptor for Alternative 3

Receptor[1/]	Expected Shadow Hours Per Year (hours:minutes)	Maximum Number of Days with Shadow[2/]	Maximum Shadow Hours per Day (hours:minutes)[2/]
647	393:10	365	3:03
648	286:46	340	3:16
607	160:05	196	2:37
608	135:29	211	2:11
609	130:46	248	1:21
595	127:13	230	1:18
645	108:39	169	1:58
610	104:16	229	1:12
600	95:38	293	1:03
599	77:03	190	1:02
602	68:30	213	0:59
646	64:56	108	1:12
594	60:34	114	1:12
743	55:58	186	0:59
450	55:19	163	0:52
593	52:00	95	1:27
601	51:57	140	0:48
452	32:39	74	1:12
431	31:35	132	0:34

[1/] Receptors for which more than 30 hours of shadow per year is predicted.
[2/] Representative of theoretical worst case; does not take into account factors that reduce or eliminate shadow flicker impacts such as estimated Project wind turbine operational time and orientation including wind speed and direction (based on site-specific wind data) and sunshine "availability" (percent of total hours available).

4.18.4.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP would have no effect on public health and safety.

Impacts of HCP Mitigation Measures

Impacts of HCP mitigation measures under Alternative 3 would be the same as under the Proposed Action. Prior to construction of additional turbines proposed under Alternative 3, NPMPP would reopen consultation with the USFWS and DOFAW to assess the potential for impacts of the additional turbines to listed species and develop appropriate mitigation measures. The impacts of these mitigation measures to public health and safety would be evaluated under a separate environmental analysis at that time.

4.18.4.3 Mitigation for Unavoidable Impacts

Unavoidable adverse impacts to public health and safety in association with Alternative 3 are anticipated to be minimal. Under Alternative 3, the same mitigation measures described for the Proposed Action would be implemented to avoid and minimize potential impacts to public health and safety.

4.18.4.4 Cumulative Effects

Cumulative effects under Alternative 3 would be the same as under the Proposed Action. Alternative 3 would have negligible effects related to turbine collapse and blade throw, fire risk and hazardous materials exposure, EMF, and stray voltage, and therefore would not contribute to cumulative effects associated with these impacts. Therefore, the direct and indirect effects of Alternative 3 in combination with past, ongoing, and reasonably foreseeable actions would not result in significant adverse cumulative impacts to public health and safety in association with noise and shadow flicker.

4.18.4.5 Summary

Under Alternative 3, effects associated with turbine collapse and blade throw, fire and fuels, EMF, and stray voltage would be minimized by implementation of mitigation measures, including adherence to industry design standards and implementation of the Site Safety Handbook and other Project plans as proposed. Effects on public health and safety associated with noise under Alternative 3 would be considered minor because although the magnitude would be medium (above background conditions with change noticeable but in compliance with industry standards) and long-term (lasting the life of the Project), effects would be localized and would not comprise a new type of effect within the analysis area. Effects on public health and safety associated with shadow flicker under Alternative 3 would be considered moderate because there would be high (more than 30 hours of shadow flicker per year, above the industry recommended threshold), long-term (lasting through the life of the Project) impacts at individual receptors, but impacts would be localized (to individual receptors and limited to the wind farm site), with a majority (approximately 98 percent) of receptors predicted to experience less than 30 hours per year.

4.18.5 Conclusion

Table 4.18-8 summarizes potential impacts to public health and safety from the alternatives considered in this analysis.

Table 4.18-8. Summary of Potential Impacts to Public Health and Safety

Impact Issues	No Action Alternative	Alternative 2 – Proposed Action	Alternative 2a – Modified Proposed Action Option	Alternative 3
Turbine collapse and blade throw	No Impact	Negligible	Negligible	Negligible
Shadow flicker	No Impact	Moderate	Moderate	Moderate
Fire and fuels	No Impact	Minor	Minor	Minor
Noise and vibration	No Impact	Minor/negligible	Minor/negligible	Minor/negligible
Electromagnetic fields	No Impact	Negligible	Negligible	Negligible
Stray voltage	No Impact	Negligible	Negligible	Negligible

4.19 Environmental Justice

The following analysis assesses the potential environmental justice impacts of the Project. The analysis addresses potential impacts associated with construction and operation of the Project, as well as those associated with of HCP conservation measures within the mitigation areas.

4.19.1 Impact Criteria

The proposed alternatives would be considered to have environmental justice impacts if they were to result in high and adverse human health or environmental effects that disproportionately affect minority or low income communities. According to the Hawaii Environmental Justice Initiative Report (Kahihikolo 2008, p 6-3), agencies or applicants "should consider the demographic composition of the affected area to determine whether under-represented populations (Native Hawaiian, minority, and/or low-income) will be significantly impacted by the proposed action. If impacts are identified, it needs to be determined whether there is a disproportionately high and adverse human health or environmental effect on that population." As discussed in Section 3.17, the context for environmental justice in Hawaii is based on where minority populations are concentrated in a disproportionate way within a diverse area with a high overall minority population.

A key part of environmental justice legislation is also providing opportunities for environmental justice communities to participate in the project planning process, including the environmental analysis. The communities surrounding the Project have been actively engaged by NPMPP and their team of outreach specialists since 2013. A summary of outreach efforts is provided in Chapter 1 of the Final EIS and is included in the Project record.

Based on 2000 census data, the communities of Kahuku, Laie, and the coastal area south to Kaneohe Bay were identified as minority environmental justice populations due to the disproportionate concentration of Native Hawaiians and other Pacific Islanders in these communities relative to Oahu as a whole (Oahu Metropolitan Planning Organization and Department of Planning and Permitting 2004). Review of current census data suggests this is likely still the case (see Section 3.17 – Environmental Justice). Adverse environmental impacts identified as a result of the Project have the potential to disproportionately affect these minority communities, especially Kahuku.

4.19.2 Alternative 1—No Action

4.19.2.1 Direct and Indirect Effects

Under Alternative 1, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Therefore, Alternative 1 would have no direct or indirect effects on environmental justice populations in the analysis area. As such, no mitigation measures would be warranted.

4.19.2.2 Cumulative Effects

Under the No Action Alternative, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Therefore, there would be no adverse or beneficial effects on environmental justice populations. Thus, Alternative 1 would not contribute to cumulative effects of past, present, and foreseeable effects on environmental justice populations in the analysis area.

4.19.2.3 Summary

Alternative 1 would have no direct, indirect, or cumulative effects on environmental justice populations as no action would be undertaken.

4.19.3 Alternative 2—8 to 10 Turbine Project

4.19.3.1 Direct and Indirect Effects of Construction and Operation of the Project

The public scoping process conducted for the Project in accordance with the requirements of NEPA and HEPA considered all input from persons or groups regardless of race, income status, or other social and economic characteristics. Public scoping efforts are described in Chapter 1 of this EIS. Separate NEPA and HEPA public scoping meetings were held at the Kahuku Community Center in November 2013 and January 2014, respectively. Appendix A of the Final EIS includes all the public comments received during the public scoping period. A public meeting on the Draft EIS was also held in Kahuku in June 2015. Appendix M of the Final EIS includes all the comments received during the Draft EIS public comment period.

No high or adverse human health or environmental effects are anticipated in association with construction or operation of the Project under Alternative 2. Potential adverse effects to residents living in the communities in the vicinity of the Project, all of which have been determined to be less than significant, are discussed in Sections 4.6 – Noise, 4.12 – Socioeconomics, Section 4.13 – Cultural Resources, Section 4.16 – Visual Resources, Section 4.18 – Public Health and Safety, and Section 4.20 – Public Infrastructure and Services.

Avoidance and minimization measures for these impacts are addressed in their respective sections in this EIS. Because there are no high or adverse effects to *any* population, there would be no high or adverse effects to any minority or low income population and, therefore, no environmental justice issues resulting from this Project.

Construction and operation of the Project would result in short- and long-term socioeconomic benefits to the community through the creation of jobs and generation of tax revenues. Moreover, operation of the Project would have a long-term beneficial effect on air quality and climate change by providing a clean, renewable source of energy, offsetting the amount of CO_2 generated by combustion of fossil fuels. The Project would also contribute to the State's Clean Energy Initiative goal of 100 percent of energy from renewable sources by 2045.

Although all potential human health and environmental effects are anticipated to be less than significant, it is important to note that the location of the Project was selected among other options based on a number of criteria. These include the available wind resource, utility and interconnection and transmission capacity, land availability (quantity and zoned appropriately for wind energy development), and the potential for environmental impacts (see Chapter 2 for additional discussion). The Project was not deliberately sited near the communities of Kahuku, Laie, and the coastal area south to Kaneohe Bay because these areas were identified as minority populations based on the disproportionate concentration of Native Hawaiians and other Pacific Islanders relative to Oahu as a whole. Rather, effects to these communities, although not significant, would occur circumstantially due to the siting of the Project.

4.19.3.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP would have no effect on environmental justice.

Impacts of HCP Mitigation Measures

Implementation of the HCP conservation measures would have limited impacts at the selected sites and would, therefore, not be expected to result in environmental justice impacts.

4.19.3.3 Mitigation for Unavoidable Impacts

No environmental justice impacts are anticipated under Alternative 2; therefore, no mitigation is warranted. Mitigation for potential environmental impacts will include a Community Benefits Package between NPMPP and the community. As described by Kahihikolo (2008), such agreements may be the result of a negotiation process during which the Proponent agrees to shape the proposed Project in a certain way or provide specified community benefits. See Section 4.12 – Socioeconomics for additional discussion.

4.19.3.4 Cumulative Effects

Ongoing and reasonably foreseeable projects in the cumulative effects analysis area for environmental justice (Koolauloa District) include: the ongoing residential and commercial development associated with BYU, which broke ground in 2011; the proposed Turtle Bay Resort expansion, which is expected to occur sometime between 2015 and 2025; and residential development associated with the Envision Laie Project, which is generally anticipated to occur prior to 2019. In addition, transportation safety improvements for the Kamehameha Highway are anticipated sometime between 2015 and 2020 (see Table 4.2-2). The contribution of Alternative 2 to cumulative effects during construction would be localized and temporary. Direct and indirect long-term noise, visual, and shadow flicker impacts from Alternative 2 would contribute to cumulative impacts to nearby residential communities and would add incrementally to the impact of the existing Kahuku wind facility in some locations.

4.19.3.5 Summary

Alternative 2 would not result in a disproportionately high and adverse effect on any minority or low income populations. Mitigation for environmental impacts will include a community benefits package agreed upon between NPMPP and the community (see Section 4.12 – Socioeconomics for additional discussion).

4.19.3.6 Alternative 2a - Modified Proposed Action Option

The direct, indirect, and cumulative effects of the Modified Proposed Action Option related to environmental justice would be the same as those described under the Proposed Action. No significant high adverse human health or environmental effects are anticipated in association with construction and operation of the Project. Therefore, there would be no disproportionate high or adverse effects to any minority or low income population. The Community Benefits Package offered to the Kahuku Community by NPMPP may be slightly reduced as it would be calculated on a per turbine basis, although under the Proposed Action an 8- or 9-turbine Project could be constructed.

4.19.4 Alternative 3—Larger Generation Facility (Up to 12 Turbine Project)

4.19.4.1 Direct and Indirect Effects of Construction and Operation of the Project

The effects of Alternative 3 related to environmental justice would be the same as those described under Alternative 2. No significant high adverse human health or environmental effects are anticipated in association with construction and operation of the Project. Therefore, there would be no disproportionate high or adverse effects to any minority or low income population.

4.19.4.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP would have no effect on environmental justice.

Impacts of HCP Mitigation Measures

Implementation of the HCP conservation measures would have limited impacts at the selected sites and would, therefore, not be expected to result in environmental justice impacts. Prior to construction of additional turbines proposed under Alternative 3, NPMPP would reopen consultation with the USFWS and DOFAW to assess the potential for impacts of the additional turbines to listed species and develop appropriate mitigation measures. The impacts of these mitigation measures to environmental justice populations would be evaluated under a separate environmental analysis at that time.

4.19.4.3 Mitigation for Unavoidable Impacts

No environmental justice impacts are anticipated under Alternative 3; therefore, no mitigation is warranted. Mitigation for potential environmental impacts will include a Community Benefits Package between NPMPP and the community as described above for Alternative 2.

4.19.4.4 Cumulative Effects

Under Alternative 3, cumulative effects for the first phase of the Project are the same as those described for Alternative 2. Even with 2 to 4 additional turbines, the contribution of Alternative 3 to cumulative effects during construction would be minor, localized, and temporary. Direct and indirect long-term noise, visual, and shadow flicker impacts from Alternative 3 would result in moderate impacts to nearby residential communities and would add incrementally to the impact of the existing Kahuku wind facility in some locations. Because there will likely be a delay in time of up to 3 years before additional turbines would be built under Alternative 3, new projects and developments in the area will be assessed and reviewed to determine if there are additional cumulative impacts from future unknown projects.

4.19.4.5 Summary

Alternative 3 would not result in a disproportionately high and adverse effect on any minority or low income populations. Mitigation for environmental impacts will include a community benefits package agreed upon between NPMPP and the community (see Section 4.12 – Socioeconomics for additional discussion).

4.19.5 Conclusion

The communities of Kahuku, Laie, and the coastal area south to Kaneohe Bay may be considered minority environmental justice populations based on the disproportionate concentration of Native Hawaiians and Other Pacific Islanders relative to Oahu as a whole (Oahu Metropolitan Planning Organization and Department of Planning and Permitting 2004, U.S. Census Bureau 2012). Neither Alternative 2 (including the Modified Proposed Action Option), nor Alternative 3 would result in high and adverse human health or environmental impact, and therefore, neither alternative would have the potential to disproportionately impact these minority communities, especially Kahuku.

Table 4.19-1 summarizes potential impacts to environmental justice from the alternatives considered in this analysis.

Table 4.19-1. Summary of Potential Impacts to Environmental Justice

Impact Issues	No Action Alternative	Alternative 2 – Proposed Action	Alternative 2a – Modified Proposed Action Option	Alternative 3
Effects to environmental justice communities	No Impact	Negligible	Negligible	Negligible

4.20 Public Infrastructure

4.20.1 Impact Criteria

This section analyzes potential effects on public infrastructure facilities and services, including electric service, gas service, water supply, wastewater management, stormwater management, education facilities, emergency and health services, solid waste management, and telecommunications. Impacts to public services and infrastructure were evaluated by assessing the effects of Project construction and operation and maintenance activities in the vicinity of the Project, and from implementation of HCP conservation measures.

Factors considered in determining whether an alternative would have a significant impact on utilities include the extent or degree to which its implementation would:

- Interrupt or disrupt any public utility service, from physical displacement and subsequent relocation of public utility infrastructure, in a manner that would be a direct, long-term service interruption or permanent disruption of essential public utilities; and
- Require an increase in demand for public services or utilities beyond the capacity of the utility provider so that substantial expansion, additional facilities, or increased staffing levels would be necessary.

Impacts were assessed based on the magnitude of the effect, its duration, its geographic extent, and on the context of the public infrastructure resource being affected. These impact criteria are described further in Table 4.20-1.

Table 4.20-1. Impact Criteria for Public Infrastructure and Services

Type of Effect	Impact Component	Effects Summary		
Effects on public services and infrastructure	Magnitude or Intensity	**High:** Public utility service disrupted; Project triggers a large increase in demand for public services or utilities beyond the capacity of the provider so that substantial expansion, additional facilities, or increased staffing levels would be necessary	**Medium:** Public utility service disrupted; Project puts additional demands on public services or utilities but does not affect ability to provide service.	**Low:** No disruption in public utility service and additional demands on public services or utilities not measureable.

Table 4.20-1. Impact Criteria for Public Infrastructure and Services (continued)

Type of Effect	Impact Component	Effects Summary		
Effects on public services and infrastructure (cont'd)	Duration	**Permanent:** Chronic effects; changed conditions of infrastructure or ability to provide service would persist beyond Project decommissioning.	**Long-term:** Effects would persist up to the life of the Project, with a return to pre-Project baseline conditions after decommissioning.	**Temporary:** Effects are generally associated with construction and would not last longer than approximately 1 year, with a subsequent return to pre-activity levels.
	Geographic Extent	**Extended:** Affects services or infrastructure beyond the region or analysis area.	**Regional:** Affects services or infrastructure beyond a local area, potentially throughout the region.	**Local:** Impacts limited to the immediate vicinity of the Project.
	Context	**Unique:** NA.	**Important:** NA.	**Common:** NA

4.20.2 Alternative 1—No Action

4.20.2.1 Direct and Indirect Effects

Under Alternative 1, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Alternative 1 would therefore have no adverse impacts to public infrastructure and services. If the Project is not developed, it cannot contribute to the supply of renewable energy on Oahu. HECO would then be obligated to obtain sufficient renewable energy from other sources in order to meet its statutory requirement for a percentage of its electricity to be generated from renewable energy sources.

4.20.2.2 Cumulative Effects

Under Alternative 1, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Therefore, there would be no adverse or beneficial effects on public infrastructure and services. Thus, the No Action Alternative would not contribute to cumulative effects on public infrastructure and services.

4.20.2.3 Summary

The No Action Alternative would have no direct, indirect, or cumulative effects on public infrastructure and services because no action would be undertaken.

4.20.3 Alternative 2—8 to 10 Turbine Project

4.20.3.1 Direct and Indirect Effects of Construction and Operation of the Project

Construction Impacts

Electric Services

During construction, electricity would be required at a temporary modular office space located onsite. Electricity required for onsite facilities during construction may be provided by generators for temporary power or from a temporary or permanent distribution line if installed prior to construction start. The electric demand to operate the modular office space would be minimal. If the permanent distribution line were installed prior to construction activities, the demand on the utilities would not be significant.

Gas

There is no gas infrastructure in or near the wind farm site. Bottled gas (e.g., propane) is delivered to some customers in the area. With the implementation of a traffic management plan during construction, the potential for disruption to bottled gas delivery would be negligible.

Water Supply

The Project would not adversely impact public water supplies or public water infrastructure systems. Construction of the Project would require up to approximately 10,000 to 15,000 gallons (37,854 to 56,781 liters) per day for dust control, equipment washdown, and emergency fire suppression (see Section 4.4 – Hydrology and Water Resources). If a concrete batch plant were required, water would be delivered to the site and stored in an onsite water tank, come from existing private wells, or come from a similar source. Construction of the Project would require excavation and may require blasting, which could result in physical disturbance of existing water wells in the immediate vicinity; however, both excavation and blasting (if necessary) would be relatively shallow and would not impact the deeper aquifers typically used for potable water supplies. NPMPP will coordinate with landowners and tenants to identify the location of private wells within the wind farm site, if any, and will adjust the final layout to avoid impacting existing wells. Should an impact to an existing well prove unavoidable, NPMPP will work with the landowner to provide appropriate mitigation.

The only public water system infrastructure that potentially occurs in the wind farm site are water lines along or near the Kamehameha Highway, where they extend south out of Kahuku to serve the Malaekahana area; the specific location of the water lines is currently unknown. These could be affected by improvements to the Project access road at its intersection with the highway. NPMPP and its construction contractor will work with HWBS to identify the location of any water lines prior to beginning construction such that adverse impacts can be avoided.

Wastewater

Construction of the project would generate a minor amount of wastewater from portable toilets. The existing wastewater infrastructure in Kahuku and its treatment plant have adequate capacity to accommodate the temporary increase in sanitary wastewater during construction.

Stormwater Management

Construction of the Project would not impact existing stormwater drainage infrastructure because there is none in the wind farm site that could be affected. During the detailed design phase of the Project, the construction contractor will confirm stormwater runoff requirements and, if necessary, implement stormwater control measures such as seepage pits, drywells, and/or detention basis in order to manage stormwater onsite and avoid increasing offsite stormwater flows. Additionally, TESC Plan and a site-specific SWPPP would be prepared for the Project. These plans, which would include standard stormwater BMPs, would be implemented during construction (see Section 4.3 – Geology and Soils). Temporary ditches and culverts used to capture and convey stormwater would be installed in areas of temporary disturbance. Permanent stormwater control structures would be installed where access roads, buildings, storage areas, and parking areas are constructed.

Solid Waste Management

Solid wastes generated during construction of the Project would be taken to the City and County of Honolulu's Waimanalo Gulch landfill or the H-power facility in Kapolei; both facilities are operated by Waste Management. The City estimates that the physical capacity of the landfill would enable it to continue to receive solid wastes for at least the next 15 years (City and County of Honolulu, DES 2014), and diversion of wastes for incineration at H-power would potentially extend this lifespan. Alternatively, construction wastes could be taken to the privately-owned PVT landfill, which is authorized specifically to receive construction and demolition waste.

Waste generated during construction of the Project may include scrap metal, wood, plastic and cardboard from shipping of turbine components, and incidental waste from construction workers (e.g., food and beverage containers). The amount of waste generated is not expected to adversely impact existing waste management services or facility capacity.

Education Facilities

Project construction would not directly impact any school or educational facility in the area; however, it could indirectly impact people at the two nearest schools, the Kahuku Elementary School and the Kahuku High and Intermediate School located approximately 0.3 and 0.5 mile from the wind farm site, respectively. Impacts would be limited to temporary increases in traffic and/or noise during construction.

Project-related construction traffic is unlikely to adversely impact the schools or buses bringing students to school. Scheduling the movement of large and oversized loads at night would largely eliminate potential traffic conflicts. The implementation of a traffic management plan and traffic control as needed during construction would limit potential disruptions to traffic in the area, and keep delays to a minimum. The relatively small workforce needed to construct the Project would cause only a minor, temporary increase in morning traffic that may coincide with school buses, while worker commuting in the evenings would not overlap with school bus route timing.

Construction of the Project would create noise that may affect nearby schools. Both schools are considered noise-sensitive receptors. Construction noise is temporary, and periods of particularly loud noise would be intermittent. Sounds generated by construction activities would likely require a permit, to be obtained from the HDOH, to allow the operation of construction equipment that result in exceedance of the maximum permissible at property line locations. While the permits do not limit the sound level generated at the construction site, time restrictions may be placed on when the loudest construction activities are likely to occur, i.e., between 7:00 a.m. and 7:00 p.m. Monday through Friday and between 9:00 a.m. and 6:00 p.m. on Saturday. The HDOH would require reasonable and standard practices be employed to minimize the impact of noise resulting from construction activities (see Section 4.6 – Noise).

Emergency and Health Services

Construction of the Project would have no direct impact to existing health care facilities and emergency services and is not expected to place substantial additional demands on health care or emergency services in the area. The wind farm site and vicinity are well served by a community hospital, fire and emergency medical services, and police service. Should an incident occur during construction of the Project, response times will be short. The implementation of a Site Safety Plan and observance of safe working practices during construction are expected to substantially reduce the potential for serious accidents that could place an undue burden on the local health care facilities and emergency services. Measures to limit traffic impacts during construction, such as movement of most large loads at night and the implementation of a traffic management plan, would also serve to prevent disruptions to the provision of emergency services.

The Kahuku Medical Center is considered a noise-sensitive receptor, and there is the potential for construction noise reaching its vicinity. As described above, sounds generated by construction activities would likely require a permit, to be obtained from the HDOH, to allow the operation of construction equipment that result in exceedance of the maximum permissible at property line locations.

Operation and Maintenance Impacts

Electric Service

Operation of the Project would have no adverse impact on the provision of electric service or on electricity infrastructure near the wind farm site. In order to deliver generated electricity into the distribution grid, a minor modification to HECO's 46.5-kV transmission line would occur at the point of interconnection. The Project does not appear to necessitate any modification of any existing electricity distribution lines or other infrastructure, aside from extension of distribution lines to the O&M building. Should any modifications of existing lines become necessary, NPMPP and its construction contractor will coordinate with HECO and the affected customer(s) in order to limit potential service disruptions and to design and build the modifications to appropriate standards.

With the renewable power generated by operation of the proposed facility, HECO would be able to eliminate the use of oil that would otherwise be consumed to produce conventional electric power. Reducing the proportion of its energy that comes from fossil fuel would decrease the amount of money that HECO spends on imported fuel and buffer the system from the energy cost fluctuations that can be caused by volatile oil prices.

Additionally, the Proposed Action would contribute to the goals outlined in the Hawaii's Renewable Portfolio Standards and the HCEI by increasing the percentage of the state's energy that is derived from clean, renewable sources. It also would support recently passed state statutes designed to promote energy efficiency and renewable energy sources.

Operation and maintenance of the Project would consume only small amounts of electrical power for use in the O&M building and the wind farm control system. Electricity would be supplied from existing distribution lines near these facilities. The electricity generated by the Project would far exceed the amount consumed.

Gas

Operation and maintenance of the Project under Alternative 2 would have no effect on gas service or infrastructure.

Water Supply

The O&M building would include a kitchen and bathroom(s). Water may be provided by existing sources or trucked in and stored in onsite storage tanks. The anticipated average daily water demand, assuming a staff of approximately three to six employees, would be approximately 200 gallons (757 liters) of water per day, with a maximum daily demand of 500 gallons (1,893 liters) and a peak hour demand of 100 gallons per minute (379 liters per minute). These estimates are based on HAR § 11-62, Water Systems Standards, and represent a preliminary, conservative estimate. It is anticipated that actual domestic water consumption during Project operation would be less. Because this increased demand is slight, impacts to the public water supply and distribution system would not be expected to be significant.

Stormwater Management

Operation of the Project would not generate large amounts of stormwater runoff because only a small percentage of the wind farm site would be converted to impervious surface (less than 0.1 percent of the watershed within which the Project is located; see Section 4.4 – Hydrology and Water Resources). Stormwater runoff that is generated will be managed onsite using seepage pits, drywells, and/or detention basins, to avoid increasing offsite stormwater flows. The operations and maintenance building and surrounding storage yard and parking areas would undergo routine maintenance and upkeep to minimize erosion and control stormwater runoff and drainage. Additionally, permanent stormwater control structures would be installed where access roads, buildings, storage areas, and parking areas are constructed.

Solid Waste Management

Solid wastes generated during operation of the Project would be taken to the City and County of Honolulu's Waimanalo Gulch landfill or the H-power facility in Kapolei; both facilities are operated by Waste Management. The City estimates that the physical capacity of the landfill would enable it to continue to receive solid wastes for at least the next 15 years (City and County of Honolulu, DES 2014), and diversion of wastes for incineration at H-power would potentially extend this lifespan. The amount of waste generated during operation of the Project is not expected to adversely impact existing waste management services or facility capacity.

Education Facilities

Operation of the Project would not directly impact any school or educational facility in the area. There is the potential for indirect noise and visual impacts at the Kahuku Elementary School and the Kahuku High and Intermediate School, located approximately 0.2 mile from the wind farm site. These impacts, which would be less than significant, are addressed in detail below.

Both schools are considered noise-sensitive receptors. Noise impacts are analyzed in Section 4.6 – Noise. Worst-case modeled noise levels would be approximately 43 dBA, at Kahuku Elementary School, and 42 dBA at the Kahuku High School, which are roughly equivalent to the sound level in a quiet library and is less than the 55 dBA daytime noise limit established in Hawaii's Community Noise Control regulation (HAR 11-46). The modeled noise levels represent an increase in noise of 3 and 4 dBA above baseline levels at these two receptors, respectively, a level which is just at the threshold of human perception. This is the outdoor noise level predicted; indoor sound levels would be close to 10 dBA lower (see Section 4.6 – Noise and the Noise Impact Assessment in Appendix C for additional discussion). Thus, while the operation of the Project may be audible at the schools, the magnitude of the impact would be considered low, and it would not be sufficient to disrupt the educational function of the schools.

Visual impacts analyzed in Section 4.16 include views of Project turbines. The results of this analysis indicate that the overall impact to viewers from the schools would be moderate to low, because the Project would be visible in conjunction with many man-made elements including the adjacent Kahuku Wind Farm. Visual impacts that might be experienced at the schools could be a nuisance factor for some people at the schools, but they would not disrupt their ability to function as educational facilities.

Emergency and Health Services

Operation of the Project would have no direct impact to existing health care facilities and emergency services, and is not expected to place substantial additional demands on health care or emergency services in the area. The wind farm site and vicinity are well served by a community hospital, fire and emergency medical services, and police service; should an incident occur during operation of the Project, response times will be short. Implementation of a Site Safety Plan and observance of safe working practices during operation is expected to substantially reduce the potential for serious accidents that could place an undue burden on the local health care facilities and emergency services.

The Kahuku Medical Center is considered a noise-sensitive receptor, and noise impacts are a concern. Noise impacts are analyzed in Section 4.6. Worst-case modeled noise levels at the hospital would be approximately 41 dBA, which is less than the 55 dBA (daytime) and 45 dBA (nighttime) noise limit established in Hawaii's Community Noise Control regulation (HAR 11-46). The modeled noise levels represent a 3-dBA increase above baseline sound levels, which is just at the threshold of human perception. This is the outdoor noise level predicted; indoor sound levels would be close to 10 dBA lower (see Section 4.6 – Noise and the Noise Impact Assessment in Appendix C for additional discussion).

Visual impacts would include views of the Project turbines. Visual impacts are analyzed in Section 4.16. The results of this analysis indicate that the overall impact of the Project would be moderate, due to distance, screening, and views of the Project in conjunction with many other man-made elements. Visual impacts that might be experienced at the hospital could be a nuisance factor for some people at the hospital, but they would not disrupt its ability to function as a community health provider.

Telecommunications

Members of the public and the military have expressed concerns over the potential that operation of the Project may interfere with telecommunications in the area. Interference with telecommunications could arise due to the location of the turbines or due to EMF associated with the turbine generators, electrical collection system, or transmission line. Wind turbines can interfere with microwave signals if placed in the line-of-sight pathway between two communicating towers. A microwave beam path study has been completed for the area surrounding the Project and one beam path has been identified that crosses the wind farm site. The locations of the proposed turbines have been adjusted to avoid interference with that beam path.

An EMF would be present anywhere electricity is generated or conducted by Project facilities; these would be 60 Hz "power frequency" alternating current fields. The presence of EMF does not inherently cause interference with telecommunications. However, if the electrical charge and current are sufficiently high, as may occur with the above ground portions of the Project's transmission line or at the Project substation, corona activity may occur which produces broadband electromagnetic radiation (EMR) that may be perceived as interference. The transmission line would be a 46-kV line, and may exhibit a very low level of corona activity and thus very low levels of EMR interference. Corona activity is known to produce EMR in the frequency spectrum from below 100 kHz to approximately 1,000 MHz, which partially overlaps with the frequencies used for AM and FM radio and some television signals. The effects are most pronounced directly underneath the line conductors, and decrease with distance from the transmission line. Moreover, EMF is not measureable beyond 25 feet (8 meters) from the base of a turbine.

In general, complaints related to corona-generated interference are infrequent. Moreover, the advent of cable and satellite television service, and the Federally-mandated conversion to digital television broadcast in June 2009, have greatly reduced the occurrence of corona-generated interference; cable, satellite, and digital broadcast are generally not affected by corona-generated interference. Low-frequency corona-induced EMR, such as that generated by the Project, does not interact with the higher-frequency satellite signals or with wired communication network systems, while digital television receivers are equipped with systems to filter out interference. Many radio stations also broadcast in digital, further reducing the likelihood of corona-induced EMR interference.

Wireless computer network systems, cell phones, GPS units, and satellite receivers typically operate at high frequencies in the tens to hundreds of megahertz (MHz) or gigahertz (GHz). In general, the low frequency EMR that can be generated by corona activity would not interact with the much higher frequencies used by these types of communications. These systems also often use FM or digital coding of the signals so they are relatively immune to electromagnetic interference. GPS units operate in the frequency range of 1.2 to 1.6 GHz. Satellite receivers operate at frequencies of 3.4 GHz to 7 GHz and have shown no effect from transmission lines unless the receiver was trying to view the satellite through the transmission tower or conductor bundle of the transmission line (Chartier et al. 1986). Repositioning the receiver by a few feet was sufficient to eliminate the obstruction and reduced signal. Mobile phones operate in the radio frequency range of about 800 MHz to 1,900 MHz or higher. The City and County of Honolulu have utilized VHF band (30 MHz to 300 MHz) radios for emergency communications, and are currently in the process of migrating to a more secure 800 MHz system. Military communications that may be used during exercises in the Kahuku Training Area (KTA) would also operate at VHF or higher frequencies. Due to the high frequencies used by these devices, built-in modulation and processing techniques, and the typically lower-frequency corona-induced EMR, effects from interference due to operation of the Project are unlikely. Interference effects would be most pronounced directly underneath the transmission line and would rapidly decrease with increasing distance from the line. Because of the location of the line relative to the KTA, interference with military communications is highly unlikely.

4.20.3.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP would have no effect on public infrastructure and services.

Impacts of HCP Mitigation

Because of the limited nature of the physical actions and their location within the mitigation sites, the Project's HCP conservation measures are expected to have no impact on public infrastructure or on the provision of public services.

4.20.3.3 Mitigation for Unavoidable Impacts

Standard practices and procedures that would minimize the potential impacts of the Project on public infrastructure services and facilities include implementation of a traffic management and Site Safety plans. The implementation of a construction Site Safety Plan would help to prevent serious incidents and limit the Project's demand on local health care and emergency service providers. Coordination with HBWS and HECO during final design will ensure that potential impacts to water systems and electrical distribution systems are avoided or minimized. The implementation of appropriate stormwater management methods, as will be required by the Project's NPDES permit and TESC Plan, will prevent off-site stormwater impacts and help to protect groundwater supplies. The implementation of a SWPP will further act to protect groundwater supplies. Construction and other wastes will be recycled to the extent practicable to limit the impacts to existing landfills. While no impacts to telecommunications are anticipated, NPMPP will work with affected landowners on a case-by-case basis to resolve complaints, should they arise.

4.20.3.4 Cumulative Effects

The analysis area for cumulative effects on public infrastructure and facilities includes the Proposed Action footprint and the surrounding area serviced by utility providers on Oahu. The communities surrounding the wind farm site would continue to use the existing infrastructure and services. Under Alternative 2, the Project would have negligible effect on gas service, and minor effects on electrical service, water supply, wastewater, stormwater management, solid waste, education facilities (indirectly), emergency and health services, and telecommunications. These minor impacts would be temporary and/or highly localized. With its small permanent staff, operation of the Project would place little additional long-term burden on public service providers. Ultimately, as a source of renewable wind energy the Project would contribute to the state's renewable energy portfolio, fulfilling the government mandate to increase renewable energy as a percentage of generation capability. Together with other alternative energy development on the north shore of Oahu (Table 4.2-2), the Project would make progress toward reducing Hawaii's dependence on oil imports. Therefore, when viewed in conjunction with past, present, and foreseeable projects in the cumulative effects analysis area, Alternative 2 would have beneficial cumulative impacts to public infrastructure and services by increasing the amount of renewable energy.

4.20.3.5 Summary

Alternative 2 would result in a small additional demand on electrical, water, wastewater, stormwater management, solid waste, and emergency and health services during construction and operation. There would be no direct impacts to education facilities, although indirectly these facilities as well as the Kahuku medical center could experience temporary traffic impacts (mitigated by scheduling large shipments to avoid peak hours and implementing a traffic management plan) and both temporary and long-term noise (compliant with state noise standards) and visual impacts. These impacts would not adversely impact the provision of public services or the ability of public infrastructure to continue to fulfill their intended roles. Thus, the adverse effects of the Proposed Action on public infrastructure and the provision of public services would be considered, at most, minor, because although some effects would be long term (persisting up to the life of the project), the magnitude of effects would be low (no disruption in public utility service and additional demands on public services or utilities not measureable) and localized.

4.20.3.6 Alternative 2a - Modified Proposed Action Option

Under Alternative 2a, direct, indirect, and cumulative effects on public infrastructure would be similar to those described under Alternative 2. The minor increase in demands on electrical, water, wastewater, stormwater management, solid waste, and emergency and health services during construction and operation are comparable to that described for Alternative 2. Similar to the Proposed Action, there would be no direct impacts to education facilities under Modified Proposed Action Option and the indirect noise and visual impacts would not adversely impact the provision of public services. Implementation of standard BMPs and other mitigation measures, as described under the Proposed Action, would minimize any adverse impacts to public infrastructure from the Modified Proposed Action Option.

4.20.4 Alternative 3—Larger Generation Facility (Up to 12 Turbine Project)

4.20.4.1 Direct and Indirect Effects of Construction and Operation of the Project

Construction Impacts

Construction of the first 8 to 10 turbines under Alternative 3 would have the same impacts as Alternative 2. Construction of the additional 2 to 4 turbines, which would be separated by a period of at least 3 years, would result in a separate construction period with additional, minor demands for electricity, water, wastewater services, stormwater management, solid waste services, and emergency and health services comparable to that described for Alternative 2. Average daily water demands however, would be the same as described above for Alternative 2, which would be supplied by existing sources or trucked in. Similar to Alternative 2, wastewater generated during construction would be handled by the provision of portable toilets. Implementation of a SWPPP and TESC plan during construction would be implemented to minimize stormwater runoff during construction. Project construction, under Alternative 3, is not expected to place an undue burden on local health care or emergency services, and the implementation of a traffic management plan would prevent disruption to the ability of emergency service vehicles to serve the area.

Operation and Maintenance Impacts

In general, operation of Alternative 3 would have similar impacts as Alternative 2. Operation of an additional 2 to 4 turbines would not result in substantial adverse effects to existing electrical services, water, wastewater, or stormwater infrastructure, gas delivery service, or health care and emergency services. Similar to Alternative 2, wastewater generated by the Project would be handled by an onsite septic system serving the O&M building. Stormwater would be handled onsite through the use of seepage pits, drywells, and/or detention basins, such that off-site stormwater flows would not be increased and no existing stormwater infrastructure would be affected.

Operation of the Project under Alternative 3 is not expected to place an undue burden on local health care or emergency services. Alternative 3 would have localized and at most minor impacts to telecommunications in the area, similar to Alternative 2. Potential interference effects would be most pronounced directly under the transmission line, and would rapidly decrease with increasing distance from the line. Because of the location of the line and the substation, noticeable interference effects for the residents of Kahuku or within the KTA are unlikely to occur.

Alternative 3 would not directly affect the schools or hospital in Kahuku. These are noise-sensitive receptors that may be indirectly affected, as addressed in Section 4.6. The worst-case modeled noise level at the Kahuku Elementary School and Kahuku High and Intermediate School is 44 dBA, and would be 43 dBA at the Kahuku Medical Center. These modeled noise levels are below the 55 dBA (daytime) and 45 dBA (nightime) limit established in Hawaii's Community Noise Control regulation (HAR 46-11), and represent an increase of 4 dBA (at the schools) and 3 dBA (at the hospital), respectively. This increase is just at the threshold of human perception. This 3- to 4-dBA increase is indicative of predicted outdoor noise levels; indoor noise levels would be expected to be about 10 dBA lower (see Section 4.6 – Noise and the Noise Impact Assessment in Appendix C for additional discussion).

The turbines would be visible from the schools and hospital. While views of the turbines may be considered a nuisance by some people, the visual impact would not affect the ability of those facilities to continue to fulfill their roles as educational and health service providers.

Operation of the Project, under Alternative 3, would generate far more electricity than it would consume, and the larger generating capacity of Alternative 3 would help HECO to meet its mandatory renewable energy targets while offsetting more fossil fuel generation.

4.20.4.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP would have no effect on public infrastructure and services.

Impacts of HCP Mitigation

Impacts of HCP mitigation measures under Alternative 3 would be identical to those of Alternative 2; it is anticipated that there would be no effect to public infrastructure or the provision of public services. Prior to construction of additional turbines proposed under Alternative 3, NPMPP would reopen consultation with the USFWS and DOFAW to assess the potential for impacts of the additional turbines to listed species and develop appropriate mitigation measures. The impacts of these mitigation measures to public infrastructure or provision of public services would be evaluated under a separate environmental analysis at that time.

4.20.4.3 Mitigation for Unavoidable Impacts

Mitigation measures to be implemented for Alternative 3 would be the same as described under the Alternative 2. These include the implementation of a traffic management plan, observance of BMPs for stormwater management, and coordination with agencies prior to and during construction to avoid or minimize impacts to public infrastructure and services.

4.20.4.4 Cumulative Effects

As discussed for Alternative 2, under Alternative 3 the Project would have negligible effect on gas service, and minor effects on electrical service, water supply, wastewater, stormwater management, solid waste, education facilities (indirectly), emergency and health services, and telecommunications. These minor impacts would be temporary and/or highly localized. Alternative 3 would contribute to the state's renewable energy portfolio, fulfilling the government mandate to increase renewable energy as a percentage of generation capability. Together with other alternative energy development on the north shore of Oahu (Table 4.2-1), the Project under Alternative 3 would make progress toward reducing Hawaii's dependence on oil imports. Therefore, when viewed in conjunction with past, present, and foreseeable projects in the cumulative effects analysis area, Alternative 3 would have beneficial cumulative impacts to public infrastructure and services by increasing the amount of renewable energy.

4.20.4.5 Summary

Alternative 3 would result in a small additional demand on electrical, water, wastewater, stormwater management, solid waste, and emergency and health services during construction and operation. Construction-related impacts would occur during two separate construction periods. There would be no direct impacts to education facilities, although indirectly these facilities as well as the Kahuku medical center could experience temporary traffic impacts (mitigated by scheduling large shipments to avoid peak hours and implementing a traffic management plan) and both temporary and long-term noise (compliant with state noise standards) and visual impacts. These impacts would not adversely impact the provision of public services or the ability of public infrastructure to continue to fulfill their intended roles. Thus, the adverse effects of Alternative 3 on public infrastructure and the provision of public services would be considered at most minor, because although some effects would be long term (persisting up to the life of the project), the magnitude of effects would be low (no disruption in public utility service and additional demands on public services or utilities not measureable) and localized.

4.20.5 Conclusion

The effects of Alternatives 2 (including the Modified Proposed Action Option) and 3 related to demand on or provision of public infrastructure and services would be comparable during construction and operation, with the exception of the greater beneficial effect of Alternative 3 associated with provision of renewable energy due to the larger generating capacity of the Project. Table 4.20-2 summarizes potential impacts to public infrastructure and services from the alternatives considered in this analysis.

Table 4.20-2. Summary of Potential Impacts to Public Infrastructure and Services

Impact Issues	No Action Alternative	Alternative 2 – Proposed Action	Alternative 2a – Modified Proposed Action Option	Alternative 3
Electric service	No Impact	Minor Adverse/ Moderate Beneficial	Minor Adverse/ Moderate Beneficial	Minor Adverse/ Moderate Beneficial
Gas service	No Impact	Negligible	Negligible	Negligible
Water supply	No Impact	Negligible	Negligible	Negligible
Wastewater management	No Impact	Minor	Minor	Minor
Stormwater management	No Impact	Minor	Minor	Minor
Solid waste management	No Impact	Minor	Minor	Minor
Education facilities and emergency and health services	No Impact	Minor	Minor	Minor
Telecommunications	No Impact	Minor	Minor	Minor

4.21 Military Interests

4.21.1 Impact Criteria

Impact criteria for assessing impacts to military interests are related to the potential effects of the Project on the adjacent KTA, KLOA, and the A-311 TFTA. The analysis focused on the ability of the military to conduct training exercises in these areas. A significant impact could result if the Project:

- Resulted in a major loss of land area available to the military for training;
- Resulted in a major change in training practices or activities with a resulting adverse change in military readiness;
- Seriously degraded the function of military communications systems throughout a wide area; or
- Resulted in a serious hazard to training flight operations in the A-311 TFTA.

Impacts to military interests were assessed based on the magnitude of the effect, its duration, its geographic extent, and on the context of the resource being affected; these impact criteria are described further in Table 4.21-1.

Table 4.21-1. Impact Criteria for Military Interests

Type of Effect	Impact Component	Effects Summary		
Effects on Military Interests	Magnitude or Intensity	**High:** Loss of land area available to military for training purposes; Project causes major changes to nature or location of military training activities with a noticeable adverse change in military readiness; Project represents a serious hazard to training flight operations or a substantial reduction in navigable airspace used for training.	**Medium:** Reduction in the location or nature of military training activities and communications but no resulting change in military readiness. Moderate reduction in navigable airspace used for training.	**Low:** No change in the location or nature of military training activities or communications; moderate reduction in navigable airspace used for training.
	Duration	**Permanent:** Chronic effects; degraded conditions of military resources would persist after decommissioning.	**Long-term:** Effects would persist up to the life of the Project and would return to pre-Project conditions levels after decommissioning.	**Temporary:** Effects are generally associated with construction and would not last longer than approximately 1 year, with a subsequent return to pre-activity levels.
	Geographic Extent	**Extended:** Affects military interests or training capabilities beyond the region or analysis area.	**Regional:** Affects military interests or training capabilities beyond a local area, potentially throughout the region.	**Local:** Impacts limited to the Project footprint or the immediate vicinity.
	Context	**Unique:** Affects military training area or facilities that are based on inherent natural resource characteristics that could not feasibly be recreated in the same place or at another location.	**Important:** Affects a type of a training area or facility that is relatively uncommon in the region but could feasibly be replaced or recreated at another location.	**Common:** Affects a type of military training area that is commonly found in the region or based on facilities or infrastructure that could feasibly be replaced; affects a general-purpose training area.

4.21.2 Alternative 1 – No Action

4.21.2.1 Direct and Indirect Effects

Under the No Action Alternative, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Therefore, Alternative 1 would have no effect on military interests or operations in the analysis area.

4.21.2.2 Cumulative Effects

Under the No Action Alternative, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Therefore, there would be no effect on military interests or operations. Thus, Alternative 1 would not contribute to cumulative effects on military interests or operations in the analysis area.

4.21.2.3 Summary

Alternative 1 would have no effect on military resources because no action would be undertaken.

4.21.3 Alternative 2 – 8 to 10 Turbine Project

4.21.3.1 Direct and Indirect Effects of Construction and Operation of the Project

Construction Impacts

Construction of the Project would not directly impact any lands used by the military for training or other purposes. Additionally, construction of the Project would not occupy any land currently used by the military, and would not reduce the area of land available for training.

Operation and Maintenance Impacts

Operation and maintenance of the Project would not directly impact any lands used by the military for training or other purposes. While the wind farm site abuts the KTA, the turbines are set back by at a distance at least equal to the turbine blade tip height above ground from the property boundary, such that no direct impact would occur to the KTA even in the unlikely event of a catastrophic failure of a turbine (see Section 4.18 – Public Health and Safety).

Scoping input from military sources expressed concerns over the potential for operation of the Project to adversely affect military aviation activity and communications. In response, this EIS includes an analysis of potential indirect effects of the Project on operations within the KTA, KLOA and A-311 TFTA. Specific considerations addressed in the analysis are the potential for the Project turbines to present hazards for aviation training operations and unmanned aircraft system (UAS) use, and for Project electrical systems to interfere with military telecommunications during training activities.

Safety for helicopter operations has been expressed as the primary concern for military training operations. Of particular concern is that helicopters land and take off into the wind, which in this case, would normally be toward the proposed turbines. There are 11 designated helicopter landing zones within the KTA (U.S. Army 2010); the nearest of these is a pair of sites located approximately 2,680 feet (817 meters) southwest of the nearest turbine location on the DLNR parcel. Another relatively close landing zone is located near the CACTF; it is approximately 3,050 feet (930 meters) west of the nearest turbine location on the DLNR parcel. The remaining designated helicopter landing zones are located more than 3,470 feet (1,058 meters) from the turbines (U.S. Army 2010).

In its Advisory Circular 150/5390-2C, the FAA published guidance related to obstruction clearance for heliports. While this guidance pertains to civil facilities and is not specifically applicable to military operations, it is nevertheless instructional in determining whether the Project would pose a hazard to helicopter use in the KTA. The concern in this case is maintaining clear approach and departure routes for the designated landing zones. The approach/departure path defined in the FAA guidance starts at the edge of the final takeoff and landing area and slopes upward at 8:1 (8 units horizontal in 1 unit vertical) for a distance of 4,000 feet (1,219 meters), where the width is 500 feet (152 meters) at a height of 500 feet (152 meters) above the heliport elevation. Distance between the landing zone and a proposed turbine location, the elevation above sea level of both the landing zone and the proposed turbine location, maximum height (blade tip height above ground), and the slope of the flight path can be used to determine if a portion of the turbine may coincide with a potential approach/departure flight path or clearance plane (see below). However, unlike clearance areas for airports serving fixed-wing aircraft, the FAA allows heliport approach/departure paths to be curved, allowing them to avoid pre-existing or new obstructions and fit into tighter, often urban spaces.

Based on the FAA's heliport approach and departure clearance requirements, under Alternative 2 the turbines would not represent an obstruction to helicopter operations if the designated landing zones were treated as general aviation heliports. That is, a 512-foot-tall turbine at any of the 10 proposed turbine locations would not intersect a potential helicopter approach/departure path from any of the KTA helicopter landing zones. Therefore, it is assumed the turbines should also not represent an obstruction for military helicopter flights. The two nearest designated landing zones sit at approximately 538 feet (164 meters) and 557 feet (170 meters) above sea level, respectively. The departure clearance plane at distances of 2,680 feet (817 meters) and 3,050 feet (930 meters) from these landing zones (i.e., the distance between these helicopter landing zones and the nearest proposed turbine) would be approximately 873 feet (266 meters) and 939 feet (286 meters) above sea level at the turbine's proposed location, respectively. The proposed turbine location is situated at approximately 350 feet (93 meters) above sea level, placing the top of the blades of a 512-foot (156-meter) wind turbine at nearly 817 feet (249 meters) above sea level. This would be 56 feet (17 meters) and 122 feet (37 meters) below the level of the clearance plane from these landing zones, respectively. All other KTA landing zone clearance planes would be at least 56 feet (17 meters) higher than all of the proposed wind turbines. Therefore, the proposed wind turbines under Alternative 2 would not be considered an obstruction under FAA rules.

The turbines will be marked and lighted according to FAA guidance. The turbines will be painted a uniform white or off-white, so that they are highly visible to pilots during the daytime, and red flashing lighting will be installed on the nacelles of turbines. The lights will flash in unison so that the entire facility appears as a coherent unit to pilots flying at night. Lighting at other Project facilities will be minimal, and will be aimed downward and inward to prevent offsite or upward glare. Lighting at other Project facilities will therefore not impair pilot vision even with the use of night vision devices.

Military representatives have expressed a concern of the visibility of the wind turbines to pilots using night vision devices. Night vision devices work by gathering existing ambient visible light and infrared light and amplifying it for display on a view screen. Technologies used in the current generation of night vision devices are sensitive enough to use in near-total darkness. Moonlight, starlight, lights in Kahuku town, and cloud-reflected light from other cities on Oahu should be sufficient to make the turbines visible for night vision device users. The white coloring of the turbines would also enhance their visibility with night vision devices due to greater reflectivity and a different heat signature than most of the vegetated surroundings. While the red flashing FAA lighting is expected to be visible through night vision devices, some systems use filters to block or reduce certain wavelengths and may make those lights less visible to night pilots. The addition of infrared lighting on the turbines would improve the ability of pilots using night vision devices to identify the turbines at a safe distance, while avoiding an additional visual impact for others. Some FAA-approved lighting includes both a visible light and an infrared light for just this purpose.

The northeastern portion of the A-311 TFTA alert area overlaps the western part of the wind farm site (Figure 3.19-1). Approximately 198.1 acres (80.2 hectares) of the wind farm site lies within the 61,116-acre (24,733-hectare) TFTA, representing approximately 0.32 percent of the flight training area. Therefore, relative to the overall size of the TFTA and the amount of unencumbered air space available, the magnitude of the Project impact to the available flight training area would be considered negligible. NPMPP continues to coordinate with the Department of the Amy and Army National Guard to ensure the proposed Project will not encumber use of the TFTA for military training.

Members of the military have also expressed a concern over the impact of the Project on the use of UAS (or “drones”). As discussed in Section 3.19, locations on Oahu where Special Use Airspace (SUA) is designated and UAS flights are currently permitted are limited to the WAAF and the associated FAA-designated restricted airspace over Schofield Barracks and the adjacent Waianae Range and Makua Valley (the Restricted Areas R-3109 and R-3110), the controlled airspace of the Marine Corps Base Hawaii Kaneohe Bay (MCB Hawaii), and within the Marine Corps Training Area Bellows (DoD 2014). UAS are not currently permitted to fly in the A-311 TFTA alert area, except for transiting across it to travel between MCB Hawaii and WAAF and the Schofield Barracks/Makua Valley restricted airspace. Because UAS are not permitted to fly in the A-311 TFTA alert area except in transit, there would be no Project impacts to UAS use for training purposes.

Members of the military have also expressed concern over the impact of the Project in terms of interference with radio transmissions and GIS transmitters. Telecommunications interference issues are discussed in Section 4.20 – Public Infrastructure and Services. In general, wind turbines do not cause interference with radio frequency transmissions or satellite signals unless they are placed directly between a transmitter and a receiver. The proposed turbines would be sited outside the KTA and there are no transmitters or receivers farther to the northeast beyond the turbines; therefore it is highly unlikely that the wind turbines would interfere with communication signals.

EMF levels in the turbines are not sufficiently strong to create EMR interference. EMF along the Project transmission line could be sufficiently strong to generate corona activity, which in turn produces broadband EMR that can be perceived as interference with some communication signals. Should corona activity occur, it would produce EMR in the frequency spectrum from below 100 kHz to approximately 1,000 MHz, which partially overlaps with the frequencies used for AM and FM radio and some television signals. The military has long used FM radios for field communications, which operate in the VHF band (30 MHz to 300 MHz); some interference with FM radio transmissions is therefore possible. The level of potential interference with communications signals is highly location-dependent. Interference effects would be most pronounced directly under the transmission line and would rapidly decrease with increasing distance from the line. Because of the location of the line approximately 0.4 mile (0.6 kilometer) outside of the KTA boundaries, it is highly unlikely that there would be any interference with military radios used during training operations.

GPS units operate in the frequency range of 1.2 to 1.6 GHz, and satellite receivers operate at frequencies of 3.4 GHz to 7 GHz. The low frequency corona-induced EMR produced by the transmission line does not interact with the much higher frequencies used for GPS or other satellite communications. In addition, these systems also often use frequency modulation or digital coding of the signals so they are relatively immune to electromagnetic interference. The Project would therefore have at most a negligible impact to GPS and satellite communications.

4.21.3.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP would have no effect on military interests or operations.

Impacts of HCP Mitigation

The provision of funding for research and management activities for Newell's shearwater and Hawaiian short-eared owl, and minor physical improvements at the Hamakua Marsh Mitigation Area for waterbirds would have no direct or indirect impacts on military interests or operations. A portion of the Poamoho Ridge Mitigation Area lies within the KLOA. Funding for forest restoration and monitoring for bat mitigation at the Poamoho Ridge Mitigation Area would go toward activities such as maintenance of the ungulate-proof fence installed by DLNR, feral pig control and monitoring, and invasive plant removal. These actions are consistent with the plan described in the Army's Integrated Natural Resource Management Plan (U.S. Army 2010), and are covered under DLNR's existing exemption from Chapter 343 environmental analysis for the Koolau Forest Watershed Protection Project, and therefore would have negligible effects on military interests and operations.

4.21.3.3 Mitigation for Unavoidable Impacts

Mitigation including compliance with FAA marking and lighting guidelines, notice to FAA, and the general layout of the Project render its impacts to military interests and operations negligible. The FAA would include notation of the new structures on civilian and military aeronautical maps and charts, as appropriate. The addition of infrared lighting to the turbines would further serve to improve their visibility to military pilots. Additionally, NPMPP, the Department of the Army, and the Department of Defense are finalizing a Memorandum of Understanding which includes additional measures to ensure that the Project will not affect military activities. These measures include:

- Marking turbine blade tips and tower hubs to ensure visibility for aviation activities which must be visible while air crews are flying with night vision devices (e.g., "Glint" based adhesive tape and infrared capable lighting);
- Installing the electrical collection system underground to eliminate non-turbine physical obstacles as a hazard to aviation; and
- Installing infrared-capable lighting on the permanent met tower.

4.21.3.4 Cumulative Effects

The cumulative analysis area for effects on military resources includes military interests within 5 miles (8 kilometers) of the wind farm site and within 1 mile of the respective mitigation areas. Both ground-based and airborne military training activities would continue to occur within the KTA and KLOA training areas. Existing and reasonably foreseeable projects within the analysis area that could incrementally add to impacts to military interests and operations include the Kahuku Wind Farm and the Kawailoa Wind Farm. Each of these projects separately contributes negligible effects on the use of the KTA or KLOA for military training, and contributes negligible effects on the amount of airspace available in the A-311 TFTA (U.S. DOE 2010, First Wind 2011). While the Project, in combination with the Kahuku and Kawailoa Wind Farm together do limit some air training operations in the immediate vicinity of the turbines, collectively they affect approximately 1.4 percent of the total area of the TFTA and therefore cumulatively represent a negligible impact to air training. Therefore, when viewed in conjunction with past, present, and foreseeable future projects in the cumulative effects analysis area, the contribution of Alternative 2 to cumulative effects on military resources would be negligible.

4.21.3.5 Summary

Effects of the Proposed Action on military interests or the ability of the military to conduct training operations within the KTA, KLOA, or TFTA would be negligible. There would be no direct impact to lands within the KTA or KLOA and there would be a negligible impact on available flight training area within the TFTA. Project facilities are unlikely to interfere with military communications during training operations. Applying the FAA's obstruction clearance standards to the designated helicopter landing zones in the KTA indicates that none of the turbines would be considered an obstruction to takeoff and landing clearance for those landing zones. UAS use is not currently permitted in the KTA or A-311 alert area, so impacts to UAS use would not be expected. Marking and lighting of the turbines according to FAA guidance and the Memorandum of Understanding between NPMPP, the Department of the Army, and the Department of Defense would make the turbines visible to pilots during the day or night, and the use of infrared lighting would further enhance their visibility for pilots using night vision devices. Filing of notice with the FAA will put the turbines on aeronautical charts to provide warning to pilots flying in the area.

4.21.3.6 Alternative 2a - Modified Proposed Action Option

Under Alternative 2a, direct, indirect, and cumulative effects on military interests would be the same as those described under Alternative 2. As with the Proposed Action, the Modified Proposed Action Option would have no direct impacts to lands used for military training purposes including flight training, would be unlikely to interfere with military communications, and would not affect UAS use. One difference under Alternative 2a is that with the taller turbine models which would have a maximum blade tip height above ground of 656 feet (200 meters), there would be one proposed turbine on the DLNR property which, given its elevation of 415 feet (126 meters) above sea level, would coincide with a potential approach/departure clearance plane from two different helicopter landing zones in the KTA. These landing zones are located approximately 3,470 feet (1,058 meters) and 3,810 feet (1,161 meters) from the proposed turbine location, at elevations of 538 feet (164 meters) and 557 feet (170 meters) above sea level, respectively. Given the flight path trajectory, the proposed turbine would extend 99 feet (30 meters) and 37 feet (11 meters) into the approach/departure clearance plane from these landing zones, respectively. However, because the FAA allows heliport approach/departure paths to be curved, allowing them to avoid pre-existing or new obstructions, this turbine would not represent an obstruction for designated helicopter landing zones. The clearance planes from all other landing zones would be at least 76 feet (23 meters) higher than the maximum height of the turbines at this location and all other proposed turbine locations under Alternative 2a. Implementation of standard BMPs and other mitigation measures, as described under the Proposed Action, would minimize any adverse impacts to military interests from the Modified Proposed Action Option.

4.21.4 Alternative 3 – Larger Generation Facility (Up to 12 Turbine Project)

4.21.4.1 Direct and Indirect Effects of Construction and Operation of the Project

Effects of Alternative 3 on military interests and operations would be similar to those discussed above for Alternative 2. Despite the larger size of Alternative 3, the additional 2 to 4 wind turbines would not overlap with the TFTA flight training area and would be sited farther from the KTA and, therefore, would have no greater impact than the Proposed Action. As with the Proposed Action, Alternative 3 would have no direct impacts to lands used for military training purposes, would be unlikely to interfere with military communications, would not represent an obstruction for designated helicopter landing zones (minimum distances between proposed turbines and clearance planes from KTA helicopter landing zones would be the same), and would not affect UAS use. Marking and lighting of the turbines according to FAA guidance and the Memorandum of Understanding between NPMPP, the Department of the Army, and the Department of Defense would make the turbines visible to pilots during the day or night, and the use of additional infrared lighting would further enhance their visibility for night vision device users. Filing of notice with the FAA will put the turbines on aeronautical charts to provide warning to pilots flying in the area.

4.21.4.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP are not expected to affect military resources in the analysis area.

Impacts of HCP Mitigation

Impacts of HCP mitigation measures under Alternative 3 would be the same as described under the Proposed Action and would, likewise, have a negligible effect on military interests or operations. Prior to construction of additional turbines proposed under Alternative 3, NPMPP would reopen consultation with the USFWS and DOFAW to assess the potential for impacts of the additional turbines to listed species and develop appropriate mitigation measures. The impacts of these mitigation measures to military interests would be evaluated under a separate environmental analysis at that time.

4.21.4.3 Mitigation for Unavoidable Impacts

Mitigation for unavoidable impacts under Alternative 3 would be the same as described under the Proposed Action.

4.21.4.4 Cumulative Effects

The cumulative effects on military resources under Alternative 3 are the same as those described under the Proposed Action. Therefore, when viewed in conjunction with past, present, and foreseeable future projects in the cumulative effects analysis area, the contribution of Alternative 3 to cumulative effects on military resources would be negligible. Because there will likely be a delay in time of up to 3 years before additional turbines would be built under Alternative 3, new projects and developments in the area will be assessed and reviewed to determine if there are additional cumulative impacts from future unknown projects.

4.21.4.5 Summary

Effects of Alternative 3 on military interests or the ability of the military to conduct training operations within the KTA, KLOA or TFTA would be negligible. There would be no direct impact to lands within the KTA or KLOA and there would be a negligible impact on available flight training area within the TFTA. Project facilities are unlikely to interfere with military communications during training operations. Applying the FAA’s obstruction clearance standards to the designated helicopter landing zones in the KTA indicates that none of the turbines would be considered an obstruction to takeoff and landing clearance for those landing zones. UAS use is not currently permitted in the KTA or A-311 alert area, so impacts to UAS use would not be expected. Marking and lighting of the turbines according to FAA guidance and the Memorandum of Understanding between NPMPP, the Department of the Army, and the Department of Defense would make the turbines visible to pilots during the day or night, and the use of infrared lighting would further enhance their visibility for pilots using night vision devices. Filing of notice with the FAA will put the turbines on aeronautical charts to provide warning to pilots flying in the area.

4.21.5 Conclusion

Given adherence to FAA and Department of the Army/Department of Defense requirements, Alternatives 2 (including the Modified Proposed action Option) and Alternative 3 would have negligible effect to military resources. Table 4.21-2 summarizes potential impacts to military resources from the alternatives considered in this analysis.

Table 4.21-2. Summary of Potential Impacts to Military Resources

Impact Issues	No Action Alternative	Alternative 2 – Proposed Action	Alternative 2a – Modified Proposed Action Option	Alternative 3
Loss of land area available to the military for training.	No Impact	Negligible	Negligible	Negligible
Change in training practices or activities with a resulting change in military readiness	No Impact	Negligible	Negligible	Negligible
Degradation of function of military communication systems	No Impact	Negligible	Negligible	Negligible
Hazard to training flight operations in the A-311 TFTA	No Impact	Negligible	Negligible	Negligible

4.22 Agriculture

As noted in Chapter 3, public comments received on the Draft EIS requested an expanded discussion of impacts to agriculture. Therefore, the discussion of impacts to agriculture (originally in Section 4.14 – Land Use of the Draft EIS) has been expanded and placed in this standalone section. This section describes impacts to agricultural lands based on agricultural land use classifications (inclusive of actively farmed and fallow areas) as well as to existing agricultural uses and activities within the wind farm site. Comments specifically requested additional discussion of effects to farmers who currently and would continue to farm lands within the wind farm site during construction and operation. These topics are addressed in detail below.

4.22.1 Impact Criteria

Impacts to agriculture were assessed based on whether the construction and operation of the Project and implementation of HCP conservation measures would:

- Result in the loss of prime or unique farmland,
- Loss of land favorable for agricultural production (based on land use classifications), or
- Result in the loss of actively farmed land.

Impact criteria for determining effects on agricultural resources from the Project are described further in Table 4.22-1 below.

Table 4.22-1. Impact Criteria for Agricultural Resources

Type of Effect	Impact Component	Effects Summary		
Changes to Agricultural Resources	Magnitude or Intensity	**High:** Acute or obvious changes in agricultural resources	**Medium:** Noticeable change to agricultural resources	**Low/No Impact:** Changes to agricultural resources may or may not be measureable or noticeable
	Duration	**Permanent:** Chronic effects; agricultural resources would not be anticipated to return to previous condition	**Long-term:** Agricultural resources would be adversely affected through the life of the Project and would return to pre-activity conditions at some point after completion of the Project	**Temporary:** Agricultural resources would be adversely affected but not longer than the span of the Project construction and would be expected to return to pre-activity conditions at the completion of construction.
	Geographic Extent	**Extended:** Affects agricultural resources beyond the region and wind farm site	**Regional:** Affects agricultural resources beyond the wind farm site	**Local:** Impacts limited to the discrete portions of the wind farm site.
	Context	**Unique:** Affects unique agricultural resources or resources protected by legislation	**Important:** Affects depleted agricultural resources or resources protected by legislation	**Common:** Affects usual or ordinary agricultural resources; resources not depleted or protected by legislation

4.22.2 Alternative 1—No Action

4.22.2.1 Direct and Indirect Effects

Under the No Action Alternative, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservation measures would not be implemented. Therefore, Alternative 1 would have no effect on agricultural resources or activities. As such, no mitigation measures would be warranted.

4.22.2.2 Cumulative Effects

Under the No Action Alternative, the Project would not be constructed, an ITP would not be issued by the USFWS, and the HCP conservations measures would not be implemented. Therefore, there would be no effect on agricultural resources or activities. Thus, Alternative 1 would not contribute to cumulative effects on agricultural resources or activities.

4.22.2.3 Summary

Alternative 1 would have no direct, indirect or cumulative effects on agricultural resources or activities as no action would be undertaken.

4.22.3 Alternative 2—8 to 10 Turbine Project

4.22.3.1 Direct and Indirect Effects of Construction and Operation of the Project

Construction Impacts

Impacts by Agricultural Land Classification

An overview of the agricultural land classification systems, including Land Study Bureau (LSB), Agricultural Lands of Importance to the State of Hawaii (ALISH), NRCS Land Capability, and State of Hawaii Important Agricultural Lands (IAL) classification systems that were used in the analysis of Project impacts are provided in Chapter 3. As noted in Chapter 3, these classification systems are designed to identify high quality soils and productive agricultural lands. Table 4.22-2 provides an overview of impacts that would occur within each of the agricultural land classification systems, which are indicative of Project-related impacts to high quality soils and productive agricultural lands (i.e., lands potentially favorable for agricultural production).

In total, up to approximately 36.3 acres (14.7 hectares) of land with LSB ratings of A and B (most productive soils) would be directly impacted by construction activities under Alternative 2 (12 percent of these lands within the wind farm site with LSB ratings of A and B); Table 4.22-2, see also Table 3.20-1 for acreages). Additionally, approximately 26.1 acres (10.6 hectares) of ALISH Prime Agricultural lands, as well as approximately 10.8 acres (4.4 hectares) of land classified as Other Agricultural Land would be impacted during construction of the Project under Alternative 2 (11 percent of each of these lands within the wind farm site with ALISH Prime and Other Agricultural lands, respectively). Construction under Alternative 2 would also impact approximately 5.7 acres (2.3 hectares) of land with an NRCS land capability classification of Class II (conducive to agricultural production; 12 percent of this land within the wind farm site with NRCS Class II lands). Approximately 10.3 acres (4.2 hectares) of land within the wind farm site with all three top-rated IAL criteria (potentially eligible for IAL designation), would be impacted by construction activities under Alternative 2 (5 percent of the potentially eligible IAL lands within the wind farm site). Therefore, construction under Alternative 2 would result in minor impacts to high quality soils and productive agricultural lands within the wind farm site.

Table 4.22-2. Impacts by Agricultural Land Classifications under Alternatives 2, 2a, and 3

Land Classification	Alternative 2		Alternative 2a		Alternative 3	
	Construction	Operation1/	Construction	Operation1/	Construction	Operation1/
LSB Agricultural Productivity Rating						
No Data	0.2	0.1	0.2	0.1	1.1	0.9
A	1.2	0.3	1.2	0.3	1.2	0.3
B	35.1	21.3	31.2	18.5	43.8	30.4
C	8.1	3.9	8.1	3.9	8.1	3.9
D	1.2	0.7	0.6	0.3	1.2	0.7
E	43.1	33.5	43.1	33.5	43.1	33.6
Total2/	**89.0**	**59.9**	**84.5**	**56.7**	**98.6**	**69.8**
ALISH Classification						
No Data	44.6	32.0	44.4	32.0	44.6	32.0
Other	10.8	8.8	10.8	8.8	10.8	8.8

Table 4.22-2. Impacts by Agricultural Land Classifications under Alternatives 2, 2a, and 3 (continued)

Land Classification	Alternative 2		Alternative 2a		Alternative 3	
	Construction	Operation[1/]	Construction	Operation[1/]	Construction	Operation[1/]
Prime	26.1	12.6	21.7	9.4	35.7	22.4
Unclassified	7.6	6.5	7.6	6.5	7.6	6.6
Total[2]	**89.0**	**59.9**	**84.5**	**56.7**	**98.6**	**69.8**
NRCS Land Capability Classification						
Class II	5.7	2.9	2.9	1.2	5.7	3.0
Class III	34.2	19.2	32.7	17.9	34.2	29.0
Class IV	1.7	1.3	1.6	1.3	1.7	1.3
Class VI	2.4	1.0	2.4	1.0	2.4	1.0
Class VII	37.2	28.7	37.1	28.7	37.2	28.7
Class VII	7.7	6.6	7.7	6.6	7.7	6.6
Total[2/]	**89.0**	**59.9**	**84.5**	**56.7**	**89.0**	**69.8**
Important Agricultural Lands						
Area with 3 Top-rated Criteria	10.3	4.6	8.4	3.0	17.4	11.0

[1/] Operational impacts are a subset of construction impacts
[2/] Column totals may not sum exactly due to rounding

Impacts to Agricultural Uses and Activities

Malaekahana Hui West, LLC currently leases approximately 452.7 acres (183 hectares) of land within the wind farm site to five farmers. Up to approximately 41.6 acres (16.9 hectares) of leased land would be impacted during construction of the Project; of which, approximately 25.7 acres (10.4 hectares) would be impacted over the long term (Table 4.22-3; Figure 4.22-1). Of this amount, less than 10 acres of land would be leased by NPMPP over the long term from Malaekahana Hui West, LLC for locating the Project facilities.

A subset of these leased acres are actively farmed (identified in recent aerial photos), and impacts to actively farmed areas are indicative of potential temporary or permanent reductions in agricultural production. Under Alternative 2, up to approximately 8.2 acres (3.3 hectares) of actively farmed lands, spread across three of the five lease areas, would be disrupted during construction; of this, approximately 4.6 acres (1.8 hectares) would be impacted over the long term (for the life of the Project). Table 4.22-3 provides a summary of impacts by farmer. In total, long-term impacts represent up to approximately 3 percent of actively farmed land within the wind farm site. Therefore, long-term operations under Alternative 2 would result in minor impacts to actively formed land within the wind farm site.

Indirect impacts during construction of the Project would include temporary disruption to existing farming activities due to reduced access to farm plots. It is anticipated that there may be temporary access restrictions along existing roads to ensure the safety of farmers within the wind farm site. General safety risks during construction are discussed in Section 4.18 – Public Health and Safety. A Site Safety Handbook would be developed and implemented during construction which would include measures for notifying farmers of upcoming construction activities, access restrictions, and other measures to ensure safety is maintained during construction. Standard construction BMPs would be implemented to reduce the potential for accidents or injuries.

Table 4.22-3. Impacts to Leased Agricultural Land and Actively Farmed Land under Alternative 2

Lease Area	Existing Leased Agricultural Land Identified as Agricultural Use Area (Acres)[1/]	Existing Leased Agricultural Land Actively Farmed (Acres)[2/]	Existing Agricultural Use Area Not Actively Farmed (Acres)[1/, 3/]	Impacts to Lease Area[1/] (Acres)		Impacts to Actively Farmed Land (Acres)[2/]	
				Construction	Operation[4/]	Construction	Operation[4/]
Farmer A	10.5	3.8	6.7	0.3	0.2	–	–
Farmer B	11.4	4.2	7.2	1.8	1.1	–	–
Farmer C	14.0	4.9	9.0	2.1	1.7	1.5	1.2
Farmer D	20.5	13.7	6.8	1.4	0.7	0.6	0.4
Farmer E	190.9	134.4	56.5	36.2	22.2	6.2	3.0
Total[5/]	**452.7**	**161.0**	**86.2**	**41.6**	**25.7**	**8.2**	**4.6**

[1/] Size of leased area designated as agricultural use area is based on Real Property Tax Assessment Forms
[2/] Based on GIS delineation of aerial imagery
[3/] Acreages represent potential for replacement acres within leased agricultural lands to compensate for permanently lost actively farmed areas
[4/] Operational impacts are a subset of construction impacts
[5/] Column totals may not sum exactly due to rounding

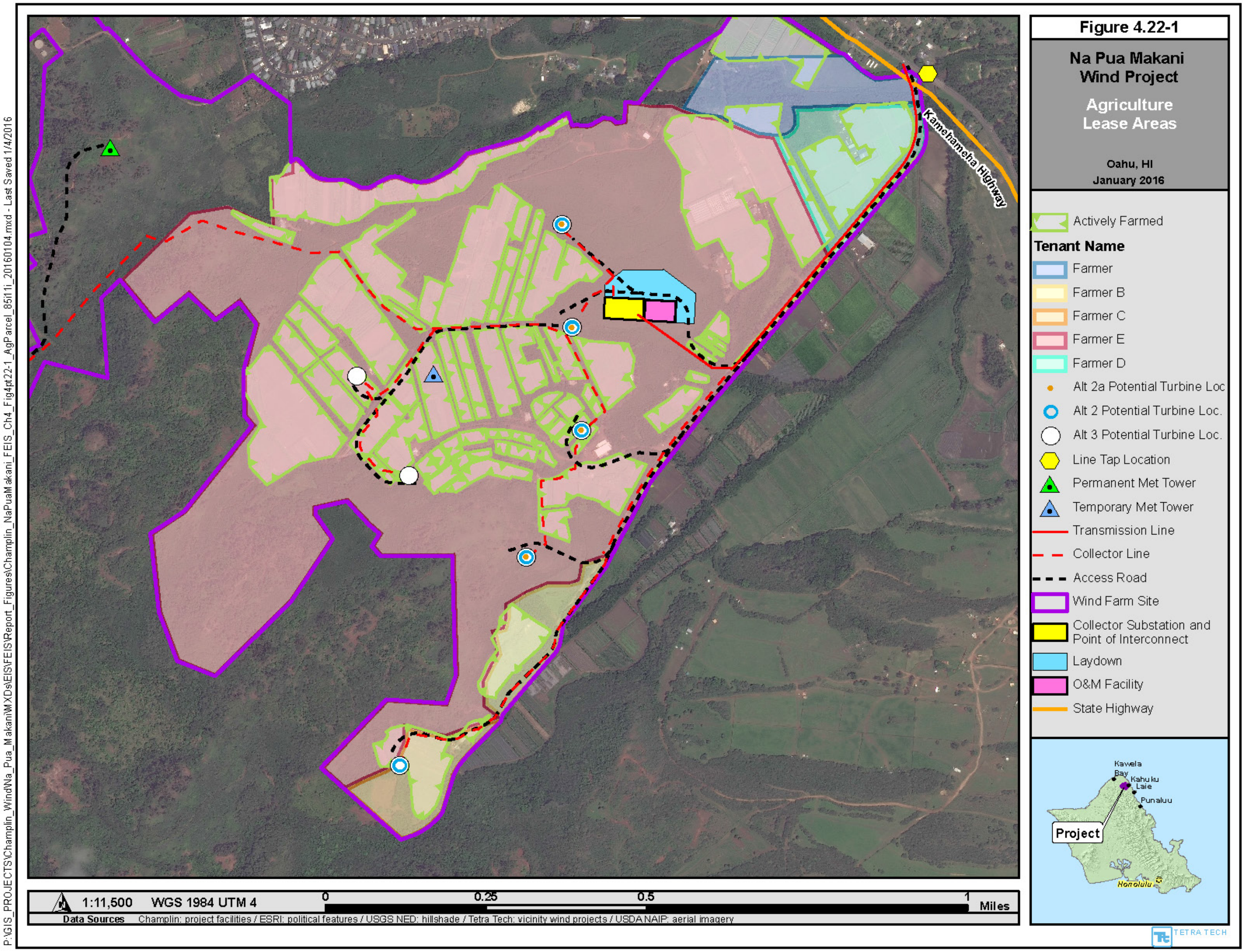
Figure 4.22-1
Na Pua Makani Wind Project
Agriculture Lease Areas
Oahu, HI
January 2016
Actively Farmed
Tenant Name
Farmer
Farmer B
Farmer C
Farmer E
Farmer D
Alt 2a Potential Turbine Loc
Alt 2 Potential Turbine Loc.
Alt 3 Potential Turbine Loc.
Line Tap Location
Permanent Met Tower
Temporary Met Tower
Transmission Line
Collector Line
Access Road
Wind Farm Site
Collector Substation and Point of Interconnect
Laydown
O&M Facility
State Highway
Kamehameha Highway
Kawela Bay
Kahuku
Laie
Punaluu
Project
Honolulu
1:11,500 WGS 1984 UTM 4
0 0.25 0.5 1 Miles
Data Sources Champlin: project facilities / ESRI: political features / USGS NED: hillshade / Tetra Tech: vicinity wind projects / USDA NAIP: aerial imagery
P:\GIS_PROJECTS\Champlin_Wind\Na_Pua_Makani\MXDs\EIS\FEIS\Report_Figures\Champlin_NaPuaMakani_FEIS_Ch4_Fig4pt22-1_AgParcel_85i11i_20160104.mxd - Last Saved 1/4/2016
TETRA TECH

Likewise, access to irrigation water may temporarily be restricted during operation if irrigation lines need to be moved or shut off during construction. If requested by Malaekahana Hui West, LLC and to avoid this indirect effect, NPMPP would work with Malaekahana Hui West, LLC, to temporarily re-route irrigation lines or provide alternative access to irrigation water to the extent possible.

To avoid impacts to individual farmers for potential lost agricultural productivity during construction, either due to direct impacts to crops or indirectly through reduced access along roads or to irrigation water, where possible NPMPP would coordinate construction activities such that the impacts on crops would be minimized. If impacts associated with agricultural productivity cannot be avoided during construction, NPMPP would compensate farmers for the season's lost crops.

Along the Department of Agriculture Kahuku Agricultural Park interior roadway, farmers leasing land may be temporarily affected during construction through access limitations or where minor road modifications could affect crops. NPMPP is currently working with the Department of Agriculture to ensure that measures are in place for notifying farmers of temporary access restrictions and will compensate these farmers for any crop losses incurred during Project construction.

Operation Impacts

Impacts by Agricultural Land Classification

The presence of permanent Project facilities would affect a small number of acres within the wind farm site classified as high-quality soils or productive agricultural lands under several agricultural land classification systems. Approximately 21.6 acres (8.7 hectares) of land with LSB ratings of A and B (most productive soils); 12.6 acres (5.1 hectares) of Prime Agricultural Land; 2.9 acres (1.2 hectares) of soils with an NRCS Class II (conducive to agricultural production) rating; and 4.6 acres (1.9 hectares) of land with all three top-rated IAL criteria (potentially eligible for IAL designation) would be impacted over the long term under Alternative 2 (Table 4.22-2). This amounts to long-term impacts to approximately 7 percent of land within the wind farm site with LSB productivity ratings of A or B; 5 percent of the Prime Agricultural Lands in the wind farm site; 6 percent of soils within the wind farm site with an NRCS Class II rating; and 2 percent of land within the wind farm site with all three top-rated IAL criteria. Therefore, the Project would have a very minor permanent impact on high-quality and productive agricultural lands within the wind farm site. Mitigation to compensate for impacts to active agricultural lands is described below.

Impacts to Agricultural Uses and Activities

Wind energy facilities are widely recognized as being a compatible use of land with active farming. Agricultural uses and activities would continue within the wind farm site during Project operation. Upon completion of the planned operational life of the Project (if the Project is not repowered), the Project would be decommissioned and the wind farm site would be rehabilitated, thereby allowing permitted agricultural uses to return to the lands occupied by Project facilities. As a result, direct impacts to existing agriculture from Project operations are considered to be long term rather than permanent.

To ensure that there is no net loss of active agricultural activities during Project operation, NPMPP would work with Malaekahana Hui West, LLC to identify suitable agricultural land within each of the three parcels leased by farmers from Malaekahana Hui West, LLC where active agricultural activities would be impacted by the Project (totaling 4.6 acres [1.8 hectares] among 3 farmers; Table 4.22-3). Within each of these lease areas, only a portion of the area identified in the Real Property Tax Assessment reports as agricultural use is actively farmed, leaving remaining acreage that could be converted to actively farmed lands. To the extent requested by Malaekahana Hui West, LLC, NPMPP would work with Malaekahana Hui West, LLC to assist farmers in preparing this non-farmed lands for agricultural production so that there would be no net loss in active agriculture.

Also, a Site Safety Handbook would be developed and implemented during operations which would include measures for notifying farmers of upcoming maintenance activities, access restrictions, natural events, and other measures to ensure safety is maintained during operations. NPMPP would work with Malaekahana Hui West, LLC to identify any additional measures such as signage which could be implemented during Project operation to keep farmers working in proximity to Project facilities apprised of safety issues. Indirect impacts to agricultural activities during the operation of the Project would include modifications or expansion of the existing roadway system within the wind farm site to accommodate Project operation. This would result in a beneficial impact to farmers through expanded and improved access along the existing road system. There would be no permanent reduction in access along wind farm sites roads; however, during Project operation there may be temporary, localized reductions in access in association with routine maintenance activities to ensure farmer safety. NPMPP would work with Malaekahana Hui West, LLC, to ensure that a notification system is in place to inform farmers of the timing and location of maintenance activities, restrictions in access and alternative access routes, and other important information.

If in the unlikely event that irrigation lines need to be permanently relocated to accommodate Project facilities, this could indirectly impact agricultural activities if access to water is reduced. However, NPMPP and Malaekahana Hui West, LLC, would provide and maintain the irrigation system to the existing and potential future farm areas; thereby avoiding this potential indirect impact.

4.22.3.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed under the Project HCP would have a minor effect on agricultural resources. Post-construction mortality monitoring plots would coincide with approximately 170 acres (69 hectares) of leased agricultural land (lands leased by Farmer B, Farmer C, and Farmer E from Malaekahana Hui West, LLC). There would be some potential for minor ground disturbance in conjunction with routine post-construction monitoring efforts associated with surveyors traversing transects beneath the turbines. However, this impact is expected to be negligible. Within the monitoring plots there are approximately 21 acres (8 hectares) of land that are actively farmed (1 acre leased by Farmer C and 20 acres leased by Farmer E). To facilitate surveyors traversing the plots and maintain good ground visibility for detection of downed birds and bats, crops in these actively farmed areas may be replanted with crops that are compatible with monitoring activities. These might include low-growing crops without large leaves, such as onions, basil, and eggplant. Replanting of crops that would be compatible with monitoring activities is not anticipated to have a measurable impact on agricultural production due to the small amount of acreage (approximately 14 percent of the current actively farmed land within the area leased by Farmer E). Therefore, under Alternative 2, the avoidance and minimization measures proposed under the Project HCP would result in a minor impact to agricultural resources within the wind farm site.

Impacts of HCP Mitigation Measures

No direct or indirect effects to agricultural lands, uses, or activities would occur in association with funding provided for Newell's shearwater research and management and short-eared owl research and management.

The Hamakua Marsh and Poamoho Ridge HCP mitigation areas are not located in the State Agricultural Land Use District and the County agricultural zoning designation and no active agricultural activities are occurring on the mitigation areas. In addition, there are no lands classified as Prime Agricultural Lands or with LSB soil productivity ratings of A or B within the Hamakua Marsh or Poamoho Ridge mitigation areas. Therefore, installation of the partial fence at the Hamakua Marsh for waterbird mitigation and funding applied toward forest restoration and monitoring at Poamoho Ridge for bat mitigation would not impact agricultural lands, uses or activities in the mitigation areas.

4.22.3.3 Mitigation of Unavoidable Impacts

Upon reviewing aerial photography of each of the five farms within the wind farm site, suitable agricultural land exists outside the area of permanent impacts within each of the parcels leased by farmers. NPMPP would work with farmers to prepare this existing non-arable land for agricultural production (e.g., grubbing, grading, soil amendments, extend irrigation, etc.) so that there would be no net loss in active agriculture. NPMPP would also work with Malaekahana Hui West, LLC to provide and maintain the irrigation system to the existing and potential future farm areas.

NPMPP would also develop a Site Safety Handbook that would include a process for communicating with farmers to inform them of temporary restrictions on access to their farms and other safety issues. If access to actively farmed areas is prohibited for an extended period of time, NPMPP will work with Malaekahana Hui West, LLC to provide alternative access when possible. Construction of permanent structures (e.g., turbines) would occur in actively farmed areas after impacts to crops are minimized.

4.22.3.4 Cumulative Effects

The cumulative effects analysis area for impacts to agricultural resources is the Koolauloa District. This area encompasses the area where potential direct and indirect effects to agricultural resources could occur and provides context for the importance of agriculture in the region.

Portions of the wind farm site have been historically used for agriculture since the plantation era (see Section 4.13 – Historic, Archaeological, and Cultural Resources for additional detail). Ongoing agricultural uses and activities including farming of truck crops as well as operation of the agribusiness zip line facility will continue into the foreseeable future. The only other foreseeable projects in the cumulative effects analysis area with the potential to impact agricultural resources are the Envision Laie and Turtle Bay Expansion projects (see Section 4.1 for descriptions). Each of these projects could potentially impact agricultural resources in the Koolauloa District.

Alternative 2 would result in long-term displacement to 4.6 acres (1.9 hectares), of existing farming activities in the wind farm site. This is 3 percent of the actively farmed lands within the wind farm site, which would be mitigated by relocating displaced actively farmed lands within the farmers' leased parcel, and approximately 0.1 percent of existing agricultural production within the Koolauloa District (although it should be noted that this regional context includes areas of grazing and fallow lands; City and County of Honolulu, DPP 2015). Therefore, when viewed in conjunction with past, present, and foreseeable future projects in the cumulative effects analysis area, the contribution of Alternative 2 to cumulative effects on agricultural resources would be minor.

4.22.3.5 Summary

Construction and operation of the Project would impact less than12 percent and 7 percent, respectively, of the high quality soils and productive agricultural lands, based on all of the agricultural land classification system designations, within the wind farm site over the long term (life of the Project). Alternative 2 would directly impact up to approximately 8.2 acres (3.3 hectares) of actively farmed land within the wind farm site, of which 4.6 acres (1.8 hectares) acres would be displaced over the long term. Alternative 2 has the potential for short-term reductions in road access and/or access to irrigation water during construction. Due to timing of construction (minimizing impacts to crops), and/or enhancement of areas identified as agricultural use areas within individual farmer's leased plots that are not currently being farmed no net loss of agriculture would occur under Alternative 2. There would be no impact to agricultural resources or activities within the mitigation areas from HCP conservation measures.

Impacts to agriculture under Alternative 2 would be considered minor because although there would be some long-term impacts associated with operation of the Project, effects would be of low magnitude (minor loss of actively farmed lands such that changes to agricultural resources may or may not be measureable or noticeable), localized (limited to portions of the wind farm site), and a small amount of important agricultural land would be impacted. Agricultural uses and activities would continue during Project operation.

4.22.3.6 Alternative 2a - Modified Proposed Action Option

Under Alternative 2a, direct, indirect, and cumulative effects to agricultural resources would be similar to those described under Alternative 2, however the magnitude of impacts would be slightly less than under Alternative 2. Differences in impacts to agriculture under Alternative 2a are briefly discussed below. Mitigation measures would be as described under Alternative 2.

Impacts by Agricultural Land Classification

Approximately 31.4 acres (13.1 hectares) of land with LSB soil productivity ratings of A and B (most productive soils) would be temporarily impacted during construction under Alternative 2a (Table 4.22-2). Of this, 18.8 acres (7.6 hectares) of A and B rated land would be impacted over the long term, through the life of the Project under the Modified Proposed Action Option. This amounts to long-term impacts to approximately 6 percent of land with LSB productivity ratings of A or B within the wind farm site.

Up to approximately 21.7 acres (8.8 hectares) of Prime Agricultural Lands would be impacted in association with construction of Alternative 2a, including 9.4 acres (3.4 hectares) that would be impacted over the long term, through the life of the Project. This comprises approximately 4 percent of the Prime Agricultural Lands in the wind farm site.

Up to approximately 2.9 acres (1.2 hectares) of land with an NRCS Class II (conducive to agricultural production) land capability classification would be impacted under Alternative 2a; which includes 1.2 acres (0.5 hectares) of Class II lands that would be impacted over the long term. This amounts to long-term impacts to approximately 3 percent of Class II lands in the wind farm site.

Up to approximately 8.4 acres (3.4 hectares) of lands with all three top-rated IAL criteria (lands potentially eligible for IAL designation) lands would be impacted by construction activities under Alternative 2a; of which, 3.0 acres (1.2 hectares) would be impacted over the long term, through the life of the Project. This amounts to long-term impacts to approximately 1 percent of lands with all three top-rated IAL criteria within the wind farm site.

Impacts to Agricultural Uses and Activities

Up to approximately 37.2 acres (15.1 acres) of leased land would be impacted during construction of Alternative 2a, of which approximately 22.5 acres (9.1 hectares) would be impacted over the long term (Table 4.22-4). Under Alternative 2a, up to approximately 6.0 acres (2.4 hectares) of actively farmed lands, spread across two of the five lease areas, would be disrupted during construction; of this, approximately 2.7 acres (1.1 hectares) would be impacted over the long term (for the life of the Project). Table 4.22-4 provides a summary of impacts by farmer. In total, long-term impacts represent up to approximately 2 percent of actively farmed land within the wind farm site. Measures for avoiding, minimizing, and mitigating impacts to agricultural uses and activities such that there would be no net loss of active agriculture would be the same as described under Alternative 2.

Under the Project HCP, Alternative 2a would have fewer effects on agricultural resources than Alternative 2. In total, 108 acres (44 hectares) of land leased by farmers from Malaekahana Hui

West, LLC would coincide with monitoring plots where minor ground disturbance would occur in association with surveyors traversing transects beneath the wind turbines. Within this area, 19 acres (8 hectares) is actively farmed and may be replanted with crops that are conducive to post-construction mortality monitoring activities, as described under Alternative 2.

Table 4.22-4. Impacts to Leased Agricultural Land and Actively Farmed Land under Alternative 2a

Lease Area	Impacts to Lease Area[1/] (Acres)		Impacts to Actively Farmed Land (Acres)[2/]	
	Construction	Operation[3/]	Construction	Operation[3/]
Farmer A	0.3	0.2	–	–
Farmer B	0.3	0.2	–	–
Farmer C	–	–	–	–
Farmer D	1.4	0.7	0.6	0.3
Farmer E	35.3	21.5	5.4	2.4
Total[4/]	**37.3**	**22.5**	**6.0**	**2.7**

[1/] Size of leased area based on Real Property Tax Assessment Forms
[2/] Based on GIS delineation of aerial imagery
[3/] Operational impacts are a subset of construction impacts; thus, these acres are not additive
[4/] Column totals may not sum exactly due to rounding

4.22.4 Alternative 3—Larger Generation Facility (Up to 12 Turbine Project)

4.22.4.1 Direct and Indirect Effects of Construction and Operation of the Project

Construction Impacts

Under Alternative 3, impacts to agricultural resources and activities would be similar to those discussed above for Alternative 2; however, Alternative 3 would result in construction of 2 to 4 additional turbines resulting in greater impacts to agriculture than Alternative 2.

Impacts by Agricultural Land Classification

Table 4.22-2 summarizes impacts by agricultural land classification under Alternative 3. Up to approximately 45 acres (18.2 hectares) of land with LSB soil productivity ratings of A and B (most productive soils) would be impacted by construction activities under Alternative 3 (14 percent of these lands within the wind farm site with LSB soil ratings of A and B). Additionally, up to approximately 35.7 acres (14.5 hectares) of Prime Agricultural Lands and 10.8 acres (11 hectares) of Other Agricultural Lands would be impacted during construction of Alternative 3, respectively (14 percent and 11 percent, respectively, of these lands within the wind farm site with Prime and Other Agricultural lands). Approximately 5.7 acres (2.3 hectares) of land with NRCS Class II (conducive to agricultural production) land capability classification would be impacted during construction under Alternative 3 (12 percent of these lands within the wind farm site of NRCS Class II lands). Finally, up to approximately 17.4 acres (7.1 hectares) of lands with all three top-rated IAL criteria (lands potentially eligible for IAL designation) would be impacted by construction activities under Alternative 3 (8 percent of the potentially eligible IAL lands within the wind farm site). Therefore, construction under Alternative 3 would result in minor impacts to high-quality soils and productive agricultural lands within the wind farm site.

Impacts to Agricultural Uses and Activities

Construction of Alternative 3 would temporarily impact approximately 51.4 acres of land leased to five farmers, of which approximately 35.8 acres would be impacted over the long term. Alternative 3 has the potential to affect existing agricultural production of three of the five farmers during construction and operation due to disturbance to actively farmed areas. Alternative 3 would affect up to approximately 13.3 acres (5.4 hectares) of actively farmed land, of which approximately 9.3 acres (3.7 hectares) would be displaced over the long term (Table 4.22-5). This comprises approximately 6 percent of existing actively farmed land within the wind farm site.

Impacts to farmers associated with safety, road access, and irrigation water would be the same as described under Alternative 2. Measure to avoid, minimize, and mitigate direct and indirect impacts to farmers would be the same as described under Alternative 2.

Because there would be a lag time of at least 3 years between construction of the first 8 to 10 turbines and the additional 2 to 4 turbines under Alternative 3, the time frame of construction-related impacts associated with disruption to existing farming activities would be extended.

Operation Impacts

Impacts by Agricultural Land Classification

Up to approximately 30.7 acres (12.4 hectares) of land with LSB soil productivity ratings of A and B would be impacted over the long term, through the life of the Project under Alternative 3. This amounts to long-term impacts to approximately 10 percent of land with LSB productivity ratings of A or B within the wind farm site under Alternative 3. Additionally, approximately 22.4 acres (9.0 hectares) of ALISH Prime Agricultural Lands and 6.6 acres (2.7 hectares) of Other Agricultural Lands would be impacted over the long term (9 percent and 7 percent of the Prime and Other Agricultural Lands in the wind farm site, respectively). Approximately 3.0 acres (1.2 hectares) of NRCS Class II (conducive to agricultural production) would be impacted over the long term under Alternative 3. This amounts to long-term impacts to approximately 7 percent of Class II lands in the wind farm site. Finally, approximately 11.0 acres (4.4 hectares) of potentially eligible IAL lands would be impacted over the long term under Alternative 3. This is approximately 5 percent of lands with all three top-rated IAL criteria within the wind farm site.

Impacts to Agricultural Uses and Activities

Similar to Alternative 2, NPMPP would work with Malaekahana Hui West, LLC to identify suitable agricultural land within each of the three leased parcels where active agricultural activities would be impacted by the Project (approximately 9.3 acres [7.3 hectares] among three farmers; Table 4.22-5). Within each of the lease areas only a portion of the acres identified in the Real Property Tax Assessment Forms as agricultural use is actively farmed, leaving remaining acreage that could be converted to crops. NPMPP would work with farmers to prepare this land for agricultural production so that there would be no net loss in active agriculture under Alternative 3.

Table 4.22-5. Impacts to Leased Agricultural Land and Actively Farmed Land under Alternative 3

Lease Area	Existing Leased Agricultural Land Identified as Agricultural Use Area (Acres)[1/]	Existing Leased Agricultural Land Actively Farmed (Acres)[2/]	Existing Agricultural Use Area Not Actively Farmed (Acres)[1/, 3/]	Impacts to Lease Area[1/] (Acres)		Impacts to Actively Farmed Land (Acres)[2/]	
				Construction	Operation[4/]	Construction	Operation[4/]
Farmer A	10.5	3.8	6.7	0.3	0.2	–	–
Farmer B	11.4	4.2	7.2	1.8	1.1	–	–
Farmer C	14.0	4.9	9.0	2.1	1.7	1.5	1.2
Farmer D	20.5	13.7	6.8	1.4	0.7	0.6	0.3
Farmer E	190.9	134.4	56.5	45.8	32.1	11.2	7.7
Total[5/]	**452.7**	**161.0**	**86.2**	**51.4**	**35.8**	**13.3**	**9.3**

[1/] Size of Leased Area based on Real Property Tax Assessment Forms
[2/] Based on GIS delineation of aerial imagery
[3/] Acreages represent potential for replacement acres within leased agricultural lands to compensate for permanently lost actively farmed areas
[4/] Operational impacts are a subset of construction impacts; thus, these acres are not additive
[5/] Column totals may not sum exactly due to rounding

4.22.4.2 Direct and Indirect Effects of the HCP Conservation Measures

Impacts of Avoidance and Minimization Measures

Similar to Alternative 2, the avoidance and minimization measures proposed under the Project HCP would have a minor effect on agricultural resources under Alternative 3. An additional 2 to 4 turbines would be monitored, resulting in additional actively farmed acreage on land leased by Farmer E that would potentially need to be replanted to low-growing crops.

Impacts of HCP Mitigation

Impacts of HCP mitigation under Alternative 3 would be the same as described under Alternative 2. Prior to construction of additional turbines proposed under Alternative 3, NPMPP would reopen consultation with the USFWS and DOFAW to assess the potential for impacts of the additional turbines to listed species and develop appropriate mitigation measures. The impacts of these mitigation measures to agricultural resources would be evaluated under a separate environmental analysis at that time.

4.22.4.3 Mitigation of Unavoidable Impacts

Mitigation for unavoidable impacts under Alternative 3 would be the same as described under Alternative 2 (Section 4.22.3.3).

4.22.4.4 Cumulative Effects

Cumulative effects to agricultural resources under Alternative 3 are the same as described under Alternative 2, with the exception that Alternative 3 would result in long-term displacement to 9.3 acres (3.7 hectares) of actively farmed land within the wind farm site. This is amounts to approximately 6 percent of actively farmed land within the wind farm site and approximately 0.2 percent of areas of existing agricultural production in the Koolauloa District (although this acreage includes areas of grazing and fallow land; City and County of Honolulu, DPP 2015). Therefore, when viewed in conjunction with past, present, and foreseeable future projects in the cumulative effects analysis area, the contribution of Alternative 3 to cumulative effects on agricultural resources would be minor. Because there would likely be a delay in time of up to 3 years before additional turbines would be built under Alternative 3, new projects and developments in the area will be assessed and reviewed to determine if there are additional cumulative impacts from unknown future projects. Regardless of the time lag, all future projects would need to comply with applicable land use plans, regulations and policies.

4.22.4.5 Summary

Based on agricultural land classification system designations, construction and operation of the Project under Alternative 3 would impact less than 14 percent and 10 percent, respectively, of any of the classified high-quality soils and productive agricultural lands within the wind farm site, and less than 1 percent of these lands within the greater Koolauloa District, over the long term (life of the Project). Alternative 3 would result in minor direct and indirect impacts to agricultural resources due to displacement of 13.3 acres (5.4 hectares) of actively farmed land in the wind farm site during construction. This includes long-term displacement to 9.3 acres (3.7 hectares) of actively farmed land.

Impacts to agriculture under Alternative 3 would be considered minor because although there would be some long-term impacts associated with operation of the Project, effects would be of low magnitude (minor loss of actively farmed lands such that changes to agricultural resources may or may not be measureable or noticeable), localized (limited to portions of the wind farm site), and a small amount of important agricultural land (Prime Agricultural Land) would be impacted. Agricultural uses and activities would continue during Project operation.

4.22.5 Conclusion

Based on the temporary, localize nature of impacts to active agriculture, Alternative 2 (including the Modified Proposed Action Option) and 3 would have a minor impact to agriculture. Long-term impacts (i.e., lasting through Project operation) to active agricultural lands would be compensated, for through the preparation of non-arable land for agricultural production (e.g., grubbing, grading, soil amendments, extend irrigation, etc.) so that there would be no net loss in active agriculture. Table 4.22-6 summarizes potential impacts to agricultural resources and activities from the alternatives considered in this analysis.

Table 4.22-6. Summary of Impacts to Agricultural Resources

Impact Criteria	No Action Alternative	Alternative 2 – Proposed Action	Alternative 2a – Modified Proposed Action Option	Alternative 3
Changes to existing agricultural lands	No Impact	Minor	Minor	Minor
Changes to agricultural uses and activities	No Impact	Minor	Minor	Minor

5.0 STATUTORY AND REGULATORY FRAMEWORK/CONSISTENCY WITH PLANS AND POLICIES

This chapter discusses the relationship of the Proposed Action to land use plans, policies, and controls. In addition, a variety of other Federal and State laws would be (or could potentially be) applicable to the Project. Following is a discussion of the key Federal, State, and local regulations and land use plans, policies, and controls. In addition, a list of permits and approvals that would be obtained for the Project is presented at the end of this chapter. This discussion pertains to the Proposed Action and Modified Proposed Action Option (see Chapter 2 for additional details).

5.1 Key Federal Statutes and Regulations

5.1.1 Federal Endangered Species Act

The ESA and its implementing regulations in Title 50 of the CFR Section 17 prohibit the take of any fish or wildlife species that is Federally listed as threatened or endangered without prior approval pursuant to either Section 7 or Section 10 of the ESA.

Section 3 of the ESA defines "take" as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or to attempt to engage in any such conduct" (16 U.S.C. § 1532 (19)). Harm, in this case, means an act that actually kills or injures a federally listed wildlife species, and "may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering" (50 CFR §17.3). To harass means to perform "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include but are not limited to, breeding, feeding or sheltering" (50 CFR § 17.3). In addition, Section 9 of the ESA details generally prohibited acts and Section 11 provides for both civil and criminal penalties for violators regarding species federally listed as threatened or endangered.

ESA Section 7(a)(2) requires each Federal agency to ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of critical habitat (16 U.S.C. § 1536 (a)(2)). If the actions of a Federal agency are not likely to jeopardize the continued existence of any endangered or threatened species, but could adversely affect the species or result in a take, the action must be addressed under Section 7 of the ESA (16 U.S.C. § 1536 (a)(2)).

Section 10 of the ESA allows a non-Federal applicant, under certain terms and conditions, to incidentally take an ESA-listed species that would otherwise be prohibited under Section 9 of the ESA. When a non-Federal landowner wishes to proceed with an activity that is legal in all other respects, but that may result in the incidental taking of a listed species, an ITP, as defined under Section 10 of the ESA, is required. Incidental take is defined as take that is "incidental to, and not the purpose of, the carrying out of an otherwise lawful activity" (50 CFR § 17.3). Under Section 10, a USFWS-approved HCP is required to accompany an application for an ITP to demonstrate that all reasonable and prudent efforts have been made to avoid, minimize, and mitigate for the effects of the potential incidental take.

An ITP can only be issued if the following six criteria listed in 50 CFR § 17.22(b)(2) and 50 CFR § 17.32 (b)(2) are addressed:

- All takings must be incidental;
- Impacts of such taking must be minimized and mitigated "to the maximum extent practicable;"
- There must be both adequate funding for the HCP and provisions to address "unforeseen circumstances;"
- The taking must "not appreciably reduce the likelihood of the survival and recovery of the species in the wild;"
- The applicant must ensure that additional measures required by the Secretary will be implemented; and
- Federal regulators must be assured that the HCP can and will be implemented.

Guidance for preparation and required components of an HCP is provided in the USFWS's HCP Handbook (USFWS and NMFS 1996). The USFWS and National Marine Fisheries Service (NMFS) issued an addendum to the handbook in 2000 (USFWS and NMFS 2000). Known as the Five-point Policy, this addendum provides additional guidance on:

- Establishing and stating biological goals for HCPs;
- Clarifying and expanding the use of adaptive management where there is uncertainty about the experimental design and scientific evidence with respect to the HCP's approach to conservation;
- Clarifying the purpose and means of how to undertake species and habitat monitoring;
- Providing criteria to be considered by the USFWS and NMFS in determining incidental take permit duration; and
- Expanding public participation.

The issuance of an ITP under Section 10 of the ESA is considered a Federal action under Section 7(a)(2) of the ESA; therefore, the USFWS must comply with the requirements of Section 7 which includes the preparation of a BO. A BO evaluates the impacts of the proposed action (i.e., issuance of an ITP) and establishes an overall effect determination.

In compliance with Section 10 of the ESA and HRS §195D-4(g), NPMPP has made a commitment to prepare an HCP and apply for an ITP and ITL from the USFWS and DOFAW, respectively, for the Project. The purpose of the HCP is to ensure that measures to minimize and mitigate the adverse effects of the proposed action on the Covered Species are adequate. Details of the measures included in the HCP are provided in Chapter 2 of this EIS.

5.1.2 National Environmental Policy Act

Issuance of an ITP by the USFWS is a Federal action subject to NEPA compliance. The purpose of NEPA is to promote agency analysis and public disclosure of the environmental issues surrounding a proposed Federal action. The scope of NEPA goes beyond that of the ESA by considering the impact of a Federal action on non-wildlife resources such as water quality, air quality, and cultural resources. The USFWS is preparing and providing for public review this EIS to evaluate the potential environmental impacts of issuing the ITP to NPMPP and approving the proposed Project HCP. The purpose of the EIS is to determine if ITP issuance and HCP implementation would significantly affect the quality of the human environment. After the USFWS completes their review of the EIS, they will issue a ROD. The USFWS will not issue an ITP until the NEPA process is complete.

5.1.3 Migratory Bird Treaty Act and Service's Land-based Wind Energy Guidelines

Under the MBTA, as amended (16 U.S.C. § 703-712), taking, killing or possessing migratory birds is unlawful. Birds protected under this act include most native birds, including their body parts (e.g., feathers), nests, and eggs. A list of birds protected under the MBTA implementing regulations is provided on the USFWS's Migratory Bird Program website (USFWS 2012a).

Unless permitted by regulations, under the MBTA it is unlawful to pursue, hunt, take, capture, or kill; attempt to take, capture, or kill; possess, offer to or sell, barter, purchase, deliver or cause to be shipped, exported, imported, transported, carried, or received any migratory bird, part, nest, egg, or product. The MBTA provides no inherent process for authorizing incidental take of MBTA-protected birds. All birds included in the Covered Species are protected under the MBTA (USFWS 2012a). If the HCP is approved and the USFWS issues an ITP to the Project, the terms and conditions of that ITP would constitute a special purpose permit under 50 CFR Section 21.27 for the take of the Newell's shearwater, Hawaiian stilt, Hawaiian coot, Hawaiian moorhen, Hawaiian goose, and Hawaiian short-eared owl under the MBTA. Therefore, any such take of the Covered Species would not be in violation of the MBTA. Avoidance and minimization measures proposed for the Covered Species would also avoid and minimize impacts to MBTA-protected species.

On March 23, 2012, the USFWS released their Land-Based Wind Energy Guidelines (USFWS 2012b). These voluntary guidelines provide recommended approaches for assessing and avoiding impacts to wildlife and their habitats, including migratory birds, associated with wind energy project development. The guidelines also help ensure compliance with Federal laws such as the MBTA. To avoid and minimize impacts to MBTA-protected species, design and operational features have been incorporated based on the Land-Based Wind Energy Guidelines (USFWS 2012b). The approaches described in the Project HCP for the proposed development of this Project are consistent with the intent of the guidelines.

5.1.4 Clean Water Act

The CWA (33 U.S.C. §§ 1251 to 1387) is the principal law governing protection of the nation's surface waters. The CWA provides the basic structure for regulating discharges of pollutants into U.S. waters. U.S. Army Corp of Engineers (USACE) is directed by Congress under Section 404 of the CWA (33 U.S.C. 1344) to regulate the discharge of dredged and fill material into all waters of the U.S. (WoUS), including wetlands. A preliminary jurisdictional determination was issued by the USACE on April 6, 2015 (USACE 2015) concluding that the delineated non-wetland waters within the Project area may be WoUS requiring a Department of Army permit for any activity resulting in the discharge and/or placement of dredged or fill materials into these waters. NPMPP is coordinating with the USACE to avoid impacts to WoUS and to ensure compliance with Section 4 of the CWA.

5.1.5 Rivers and Harbors Act of 1899

The USACE is directed by Congress under Section 10 of the RHA to prevent the unauthorized obstruction or alteration of navigable WoUS. Navigable waters are defined as "subject to the ebb and flow of the tide and/or presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce" (33 CFR 325.5(c)(2)). NPMPP is coordinating with the USACE to avoid impacts to WoUS and to ensure compliance with Section 10 of the RHA.

5.1.6 National Historic Preservation Act

Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA; 16 U.S.C. § 40 et seq.), requires Federal agencies to take into account the effects of their proposed actions on properties eligible for inclusion in the National Register of Historic Places. "Properties" are defined as "cultural resources," which includes prehistoric and historic sites, buildings, and structures that are listed on or eligible to the National Register of Historic Places. An undertaking is defined as a project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a Federal agency; including those carried out by or on behalf of a Federal agency; those carried out with Federal financial assistance; those requiring a Federal permit, license or approval; and those subject to State or local regulation administered pursuant to a delegation or approval by a Federal agency. The issuance of an ITP is an undertaking subject to Section 106 of the NHPA.

A CIA and AIS have been conducted for the Project (see Section 4.13 – Historic, Archaeological, and Cultural Resources for additional information, and Appendices F and G of the Final EIS). The USFWS will provide these studies to the SHPO and will continue to coordinate on cultural resources and address any potential impacts.

5.1.7 Executive Order 12898 – Environmental Justice

President Clinton issued Executive Order 12898 on Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations on February 11, 1994. Executive Order 12898 requires Federal agencies to take appropriate steps to identify and avoid disproportionately high and adverse effects of Federal actions on the health and surrounding environment of minority and low income persons and populations. All Federal programs, policies, and activities that substantially affect human health or the environment shall be conducted to ensure that the action does not exclude persons or populations from participation in, deny persons or populations the benefits of, or subject persons or populations to discrimination under such actions because of their race, color, income level, or national origin. The Executive Order was also intended to provide minority and low-income communities with access to public information and public participation in matters relating to human health and the environment.

The EPA, working with the Enforcement Subcommittee of the National Environmental Justice Advisory Council, has developed technical guidance to ensure that environmental justice concerns are effectively identified and addressed throughout the NEPA process. The State of Hawaii has also developed its own legislation and guidance related to environmental justice. Act 294 was signed by Governor Lingle in July 2006 to define environmental justice in the unique context of Hawaii and to develop and adopt environmental justice guidance document that addresses environmental justice in all phases of the environmental review process (Kahihikolo 2008). Environmental justice is discussed further in Section 3.16 – Socioeconomic Resources. Based on 2000 census data, the communities of Kahuku, Laie, and the coastal area south to Kaneohe Bay were identified as minority environmental justice populations due to the disproportionate concentration of Native Hawaiians and Other Pacific Islanders in these communities relative to Oahu as a whole (Oahu Metropolitan Planning Organization 2004). No high or adverse human health or environmental effects are anticipated in association with construction or operation of the Project. Potential adverse effects to residents living in these communities, all of which have been determined to be negligible to moderate based on criteria outlined in Chapter 4 for each resource, are discussed in Sections 4.6 – Noise, 4.12 – Socioeconomics, Section 4.13 – Cultural Resources, Section 4.16 – Visual Resources, Section 4.18 – Public Health and Safety, and Section 4.20 – Public Infrastructure and Services.

5.1.8 Federal Aviation Regulations

Part 77 of the FAA Federal Aviation Regulations (14 CFR Part 77) applies to objects that may obstruct navigable airspace. Proposed projects exceeding 200 feet above ground level must file FAA Form 7460-1, Notice of Proposed Construction or Alteration with the FAA before construction. A Notice of Proposed Construction or Alteration was filed for the Project with the FAA in in March and October, 2014 and in June, 2015. The notice provided information for the FAA to conduct an aeronautical study and determination on the proposed Project of the effect on navigable airspace. This form was also made available to military representatives for their review of effects on the military tactical flight training areas. The FAA issued Determinations of No Hazard based on the filings made in 2014. Revised FAA filings have been made based on the final site plan and the final FAA determination is pending.

5.2 State Statutes and Regulations

5.2.1 HRS 195-D

HRS Section 195D-4 states that any species of aquatic life, wildlife, or land plant that has been determined to be an endangered or threatened species under the ESA shall be deemed so under this state chapter, as well as any other indigenous species designated by DLNR as endangered or threatened by rule. The "take" of any endangered or threatened species is prohibited by both the ESA and State statute Subsection 195D-4(e). Similar to the ESA, Section 195D-2 defines "take" as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect endangered or threatened species of aquatic life or wildlife, or to cut, collect, uproot, destroy, injure, or possess endangered or threatened species of aquatic life or land plants, or to attempt to engage in any such conduct." Per HRS Subsection 195D-4(g), the Board of Land and Natural Resources (BLNR) may issue an ITL to permit take otherwise prohibited under Subsection 195D-4(e) if the take is incidental to and not the purpose of, the carrying out of an otherwise lawful activity. As part of the ITL application process, an applicant must develop, fund, and implement a DOFAW-approved HCP to minimize and mitigate the effects of the incidental take. The HCP must result in a net environmental benefit and increased likelihood that the species would survive and recover. The applicant must guarantee that adequate funding for the HCP and its mitigation measures will be provided. The required components of a State HCP are listed in Section 195D-21. HRS Section 195D-5(i) directs the DLNR to work cooperatively with Federal agencies in concurrently processing State and Federal HCPs and ITP and ITL applications.

HRS Section 195D-25 establishes the Endangered Species Recovery Committee (ESRC), an advisory committee created to review all applications and proposals for HCPs and ITLs and make recommendations to the BLNR whether or not to approve, amend, or reject the HCP or license. ESRC members include representatives of the USFWS, DOFAW, the U.S. Geological Survey Biological Resources Division (USGS-BRD), the University of Hawaii Environmental Center, and other professionals with expertise in the area of conservation biology.

As mentioned above, in compliance with Section 10 of the ESA and HRS §195D-4(g), NPMPP has made a commitment to prepare an HCP and apply for an ITP and ITL from the USFWS and DOFAW, respectively, for the Project. The purpose of the HCP is to ensure that measures to minimize and mitigate the adverse effects of the proposed action on the Covered Species are adequate. Details of the measures included in the HCP are provided in Chapter 2 of this EIS.

5.2.2 Hawaii State Environmental Policy (HRS Chapter 343)

HRS Chapter 343 establishes a system of environmental review that ensures environmental concerns are given appropriate consideration along with economic and technical considerations in the decision making process of existing planning procedures of the State and counties. The Project requires Chapter 343 environmental review as a portion is located on State-owned land. The use of State lands is a trigger for compliance with HRS Chapter 343. HRS Chapter 343-5(h) specifies that whenever an action is subject to both NEPA and Chapter 343, the OEQC and State agencies shall cooperate with Federal agencies to the fullest extent possible to reduce duplication between Federal and State requirements. A separate EIS has been prepared to satisfy the HRS Chapter 343 requirements.

5.2.3 HRS Chapter 6E

HRS Chapter 6E establishes a comprehensive historic preservation program that is intended to preserve, restore and maintain historic and cultural properties. The regulations are implemented by the SHPD, and require evaluation of any project that is funded or permitted by the State. In addition, HRS Chapter 343 includes a requirement to consider cultural practices as part of an environmental review of the effects of a proposed action; a CIA is typically prepared to address this requirement. A detailed AIS and CIA have been conducted for this Project; results are presented in Section 4.13- Historic, Archaeological and Cultural Resources. The AIS and CIA reports are included in Appendices F and G of the Final EIS, respectively. The AIS was approved by the SHPD on December 18, 2015; the approval letter is included in Appendix F of the Final EIS. This EIS reflects the comments and recommendations made by SHPD. Consultation with the SHPO under the NHPA is being conducted for the NEPA compliance process (see above).

5.2.4 Hawaii State Planning Act (HRS § 226)

The Hawaii State Plan (HRS§ 226) serves as a guide for the long-range development of the State. The purpose of the plan is to:

- Identify the goals, objectives, policies, and priorities for the State;
- Provide a basis for determining priorities and allocating limited resources, such as public funds, services, human resources, land, energy, water, and other resources;
- Improve coordination of Federal, State, and county plans, policies, programs, projects, and regulatory activities; and
- To establish a system for plan formulation and program coordination to provide for an integration of all major State and county activities.

The sections of the plan that are most relevant to the Proposed Action are HRS §226-18(a) and (b), which present the objectives and policies for energy facility systems. These are listed as follows:

> *§226-18 (a) Planning for the State's facility systems with regard to energy shall be directed toward the achievement of the following objectives, giving due consideration to all:*
>
> *(1) Dependable, efficient, and economical statewide energy systems capable of supporting the needs of the people;*
>
> *(2) Increased energy self-sufficiency where the ratio of indigenous to imported energy use is increased;*
>
> *(3) Greater energy security in the face of threats to Hawaii's energy supplies and systems;*
>
> *(4) Reduction, avoidance, or sequestration of greenhouse gas emissions from energy supply and use; and*

(b) To achieve the energy objectives, it shall be the policy of this State to ensure the provision of adequate, reasonably priced, and dependable energy services to accommodate demand.

By producing clean, renewable energy, the Project would contribute to energy self-sufficiency by increasing the ratio of indigenous to imported energy use. As a source of renewable energy, the Project would increase energy security for the State and reduce reliance on fossil-fuel based energy production, thereby reducing greenhouse gas emissions associated with the State's energy supply. The Project would also generate electricity at a cost that is approximately half the cost of generating electricity by burning fossil fuels and HECO has stated in filings with the PUC that the Project would save the ratepayers millions of dollars over the life of the Project.

In addition, sustainability guidelines and priorities of the plan that are most relevant to the Proposed Action in relation to HRS §226-108 Sustainability are listed below:

(2) Encouraging planning that respects and promotes living within the natural resources and limits of the State;

The Proposed Action would help the State in meeting its sustainability goals and contribute to the State's goal of 100 percent renewable electric energy by 2045. The Project would produce clean, renewable energy from a local natural wind resource, eliminating the need to import fossil fuels. As noted above, the Project would increase energy security for the State and reduce greenhouse gas emissions.

5.2.5 State of Hawaii Land Use Law (HRS § 205)

State of Hawaii Land Use Law (HRS § 205) established the State Land Use Commission (LUC) that has the authority to designate all State lands into one of four districts: Urban, Rural, Agricultural, or Conservation. Permitted uses within each district are listed under HRS Chapter 205 and the State LUC's Administrative Rules (HAR Title 15, Chapter 15, Subchapter 3). The wind farm site is located almost entirely within lands classified as Agricultural District, with only a small portion of the wind farm site (2 acres [1 hectare]) near Kamehameha Highway falling within the State Urban District (Hawaii Office of Planning 2013). All of the Project's components are located within the State Agricultural District. Wind energy facilities are a permitted use on State Agricultural District lands.

In addition HRS § 205-4.5(a)(15) states that the wind energy facilities are a permitted use on State Agricultural District lands with the following criteria.

Wind energy facilities, including the appurtenances associated with the production and transmission of wind generated energy; provided that the wind energy facilities and appurtenances are compatible with agriculture uses and cause minimal adverse impact on agricultural land;

According to City and County of Honolulu Department of Planning and Permitting, this criteria relates to the compatibility and impacts on agricultural lands rated A and B by the Land Study Bureau (LSB). As discussed in Section 3.20 – Agriculture, and Section 4.22 – Agriculture, soils classified as LSB rated A and B lands represent approximately 315 acres (45 percent) of the wind farm site. Of the 315 acres, up to approximately 21.6 acres (8.6 hectares) of land with LSB rating of A and B would be directly impacted by the operations of the wind farm under Alternative 2, the Proposed Action (or 18.8 acres [7.6 hectares] under the Modified Proposed Action Option). This amounts to long-term impacts to approximately 7 percent of land within the wind farm site with LSB productivity ratings of A or B, or 0.6 percent of these lands within the Koolauloa District. The long-term impacts (lasting through Project operation) to active agricultural production, totaling 4.6 acres (1.8 hectares) among three farmers, would be mitigated by preparation of non-arable land for agricultural production (e.g., grubbing, grading, soil amendments, extend irrigation, etc.) so that there would be no net loss in active agriculture. Therefore, the Project would have a minor long-term impact on high-quality and productive agricultural lands within the wind farm site, and much less so within the region.

Wind energy facilities are widely recognized as being a compatible use of land with active farming. Agricultural uses and activities would continue within the wind farm site during Project operation. Upon completion of the planned operational life of the Project (if the Project is not repowered), the Project would be decommissioned and the wind farm site would be rehabilitated, thereby allowing permitted agricultural uses to return to the lands occupied by Project facilities. As a result, direct impacts to existing agriculture from Project operations are considered to be long term, rather than permanent.

To ensure that there is no net loss of active agricultural uses and activities during Project operation, NPMPP would work with Malaekahana Hui West, LLC to identify suitable agricultural land within each of the three parcels leased by farmers from Malaekahana Hui West, LLC where active agricultural activities would be impacted by the Project (totaling 4.6 acres [1.8 hectares] among three farmers; refer to Table 4.22-3). Within each of these lease areas, only a portion of the area identified in the Real Property Tax Assessment reports as agricultural use is actively farmed, leaving remaining agricultural land that could be converted to crops. To the extent requested by Malaekahana Hui West, LLC, NPMPP would work with Malaekahana Hui West, LLC to assist farmers in preparing this alternative lands for agricultural production so that there would be no net loss in active agriculture.

A State Special Use Permit may be required if the City and County of Honolulu Department of Planning and Permitting determines that the Project is not compatible with agriculture uses. However, as discussed in Section 3.20 – Agriculture, and Section 4.22 – Agriculture, construction and operation of the Project would impact less than 7 percent of LSB rated A and B lands within the wind farm site temporarily over the long term and less than 1 percent of these lands within the Koolauloa District. Alternative 2 would directly impact up to approximately 8.2 acres (3.3 hectares) of actively farmed land during construction within the wind farm site, of which 4.6 acres (1.9 hectares) would be displaced over the long term (under the Modified Proposed Action Option this would be reduced to 6.0 acres [2.4 hectares] during construction and 2.7 acres [1.1 hectares] during operation). As noted above, displaced active farm lands would be relocated to existing un-used farm lands within each farmer’s lease area (see Tables 4.22-3 and 4.22-4 for a breakdown by farmer), therefore no net loss of agriculture would occur under Alternative 2 (or the Modified Proposed

Action Option). As noted above, to the extent requested by Malaekahana Hui West, LLC, NPMPP would work with farmers to prepare this suitable land for agricultural production (e.g., grubbing, grading, soil amendments, extend irrigation, etc.) so that there would be no net loss in active agriculture. NPMPP would also work with Malaekahana Hui West, LLC to provide and maintain the irrigation system to the existing and potential future farm areas. The Poamoho Ridge mitigation area is classified as Conservation District. Land uses within the State Conservation District are under the sole jurisdiction of the State and are governed by HRS Chapter 183C and HAR §13-5. The Conservation District was created to protect important natural resources essential to the preservation of the State's fragile natural ecosystems and the sustainability of the State's water supply. The purpose of the Conservation District is to conserve, protect, and preserve the important natural resources of the State through appropriate management and use to promote their long-term sustainability and the public's health, safety, and welfare (HAR §13-5-1). The Conservation District is divided into five subzones: protective, limited, resource, and general, and a "special" subzone to accommodate unique projects (HRS §183C-1). The Poamoho Ridge mitigation area is within the Protective Subzone. By protecting and enhancing Hawaiian hoary bat habitat within the Poamoho Ridge mitigation area the proposed mitigation activities under the HCP are consistent with the purpose of the Conservation District. The Hamakua marsh mitigation area is classified predominately as Urban District, with some slivers within the State Conservation District within the General, Limited, and Protective subzones within which the installation of a conservation fence is a permissible use.

5.2.6 Hawaii Coastal Zone Management Program (HRS § 205A-2)

The Hawaii Coastal Zone Management (CZM) Program (HRS § 205A-2) complies with the Federal Coastal Zone Management Act (CZMA) of 1972 (16 U.S.C. §§ 1451-1456). It is designed to protect valuable and vulnerable coastal resources. All lands of the State are considered to be within the Coastal Zone Management Area. Furthermore, the area extending inland generally a minimum of 300 feet (91 meters) from the shoreline is considered as Special Management Area (SMA) regulated to ensure permitted activities are consistent with the objectives and policies of the CZMA and SMA guidelines. Additionally, in general, the area extending from the high water mark of the shore inland to 40 feet is considered the shoreline setback area. The City and County of Honolulu has regulatory control over development within the SMA and Shoreline Setback Area of the coastal zone management area

The Project is on the inland side of Kamehameha Highway and may include a limited area at the entrance of the access road into the DLNR property adjacent to Kamehameha Highway may require grading, grubbing, and installation of a gravel surface to provide a clear and safe path. The work is anticipated to cost less than $500,000. If during detailed design it is determined that work will need to be conducted within the SMA, NPMPP will submit a SMA Minor application to the City and County of Honolulu in compliance with the SMA requirements. The Project would not include any development in the Shoreline Setback Area. Likewise, the proposed Poamoho Ridge bat mitigation area is not within the SMA. The Hamakua Marsh mitigation area is within the SMA, where activities would include installation of a conservation fence and predator control. Any action within the SMA will require a SMA permit. The Project will be contributing funds to the long-term efforts at Hamakua Marsh. As such, the entity that will be installing the fence will seek a SMA permit as required. The proposed mitigation activities would not significantly affect coastal resources, and as such, are considered to the consistent with the CZM program.

The following is a discussion of the Project's consistency with the objectives and policies of HRS § 205A.

Recreational Resources

- Objective: *Provide coastal recreational opportunities accessible to the public.*
- Policies:

  Improve coordination and funding of coastal recreational planning and management; and;

  Provide adequate, accessible, and diverse recreational opportunities in the coastal zone management area by:

  - *Protecting coastal resources uniquely suited for recreational activities that cannot be provided in other areas;*
  - *Requiring replacement of coastal resources having significant recreational value including, but not limited to surfing sites, fishponds, and sand beaches, when such resources will be unavoidably damaged by development; or requiring reasonable monetary compensation to the State for recreation when replacement is not feasible or desirable;*
  - *Providing and managing adequate public access, consistent with conservation of natural resources, to and along shorelines with recreational value;*
  - *Providing an adequate supply of shoreline parks and other recreational facilities suitable for public recreation;*
  - *Ensuring public recreational uses of county, state, and federally owned or controlled shoreline lands and waters having recreational value consistent with public safety standards and conservation of natural resources;*
  - *Adopting water quality standards and regulating point and nonpoint sources of pollution to protect, and where feasible, restore the recreational value of coastal waters;*
  - *Developing new shoreline recreational opportunities, where appropriate, such as artificial lagoons, artificial beaches, and artificial reefs for surfing and fishing; and*
  - *Encouraging reasonable dedication of shoreline areas with recreational value for public use as part of discretionary approvals or permits by the land use commission, board of land and natural resources, and county authorities; and crediting such dedication against the requirements of section 46-6.*

Discussion: The wind farm site is partially on private lands. There is no access to the shoreline through the wind farm site, as it is bordered on the inland/mauka side by military lands.

Traditional Hawaiian practices in and around the wind farm site include pig hunting and plant gathering. Based upon the ethnographic interviews conducted as part of the CIA there does not appear to be a need for traditional mauka/makai access through the wind farm site from the shoreline for these activities. NPMPP does not plan to change the current status mauka/makai access in this area (see Section 4.13 – Historic, Archaeological, and Cultural Resources for additional discussion and the CIA in Appendix G). Best management practices, including implementation of site-specific SWPPP and TESC plan, as well as avoidance of streams within the wind farm site, would minimize any water quality-related impacts to coastal waters downstream of the Project. Section 4.4 – Hydrology and Water Resources addresses potential impacts related to water quality in more detail.

<u>Historic Resources</u>

- Objective: *Protect, preserve, and, where desirable, restore those natural and manmade historic and prehistoric resources in the coastal zone management area that are significant in Hawaiian and American history and culture.*
- Policies:

  Identify and analyze significant archaeological resources;

  Maximize information retention through preservation of remains and artifacts or salvage operations; and

  Support state goals for protection, restoration, interpretation and display of historic resources.

Discussion: An AIS and CIA are included in Appendices F and G, respectively. Section 4.13 – Historic, Archaeological, and Cultural Resources addresses issues and potential impacts to cultural resources in more detail. The AIS was approved by the SHPD on December 8, 2015; the approval letter is included in Appendix F of the Final EIS. This EIS reflects the comments and recommendations made by the SHPD.

<u>Scenic and Open Space Resources</u>

- Objective: *Protect, preserve, and, where desirable, restore or improve the quality of coastal scenic and open space resources*.

- Policies:

  Identify valued scenic resources in the coastal zone management areas;

  Ensure that new developments are compatible with their visual environment by designing and locating such developments to minimize the alteration of natural landforms and existing public views to and along the shoreline;

  Preserve, maintain and where desirable, improve and restore shoreline open space and scenic resources; and

  Encourage those developments that are not coastal dependent to locate in inland areas.

Discussion: The Project is located inland; not within the coastal land area. A visual analysis (Section 4.16 – Visual Resources and Appendix J) was conducted to assess the potential effect of the Proposed Action on the North Shore's scenic resources. Consideration was taken with regard to maximizing the distance of associated Project components from Kamehameha Highway and sensitive viewpoints (see Section 4.16 – Visual Resources for additional detail). To the extent possible, visual impacts will be minimized by undergrounding the electrical collection system. Although the Project is expected to have a visual impact, the Project is located adjacent to an existing wind farm and in an area with existing development and alternative energy sources such as wind are an integral part of meeting the State's and City and County of Honolulu's renewable energy goals. The Project would not change the open space character of the wind farm site or surrounding area in that existing agricultural uses and activities and other uses of the wind farm site would continue during Project operation. The Project would not result in a change in Land Use Designation. Section 4.16 – Visual Resources addresses issues and potential impacts to open space in more detail.

Coastal Ecosystems

- Objective: *Protect valuable coastal ecosystems, including reefs, from disruption and minimize adverse impacts on all coastal ecosystems*.
- Policies:

  Exercise an overall conservation ethic, and practice stewardship in the protection, use, and development of marine and coastal resources;

  Improve the technical basis for natural resource management;

  Preserve valuable coastal ecosystems, including reefs, of significant biological or economic importance;

  Minimize disruption or degradation of coastal water ecosystems by effective regulation of stream diversions, channelization, and similar land and water uses, recognizing competing water needs; and

  Promote water quantity and quality planning and management practices that reflect the tolerance of fresh water and marine ecosystems and maintain and enhance water quality through the development and implementation of point and nonpoint source water pollution control measures;

Discussion: The Project would not have an adverse impact on coastal ecosystems. There is no fringing reef along the coastline. Best management practices, including implementation of site-specific SWPPP and TESC, SPCC, and HMWMP plans, as well as conducting construction activities outside of the ordinary high water mark of all streams, would avoid or minimize any potential water quality-related impacts to coastal waters downstream of the Project. Section 4.4 – Hydrology and Water Resources addresses potential impacts related to surface water and stormwater runoff. Section 4.7 – Hazardous and Regulated Materials and Wastes, and Section 4.18 – Public Health and

Safety address potential impacts and mitigation measures related to point and nonpoint source pollution hazards.

Economic Uses

- Objective: *Provide public or private facilities and improvements important to the state's economy in suitable locations*.
- Policies:

  Concentrate coastal dependent development in appropriate areas;

  Ensure that coastal dependent development such as harbors and ports, visitor industry facilities and energy generating facilities are located, designed, and constructed to minimize adverse social, visual, and environmental impacts in the coastal zone management area;

  Direct the location and expansion of coastal dependent developments to areas presently designated and used for such developments and permit reasonable long-term growth at such areas, and permit coastal dependent development outside of presently designated areas when:

  - *Use of presently designated locations is not feasible;*
  - *Adverse environmental effects are minimized; and*
  - *The development is important to the State's economy.*

Discussion: The Project is not located within the SMA or the coastal areas of the Coastal Zone Management Area. The Project would help to meet the need for renewable energy generation in a location where the wind energy resource is good, land is available, and transmission capacity is available. The Project would also generate electricity at a cost that is approximately half the cost of generating electricity by burning fossil fuels and HECO has stated in filings with the PUC that the Project would save the ratepayers millions of dollars over the life of the Project.

The Project would potentially have minor beneficial socioeconomic impacts on local businesses, population demand on housing and employment and income because, in the long-term, the Project would employ three to six full-time employees. At most, moderate visual impacts are anticipated. Section 4.12 – Socioeconomic Resources and Section 4.16 – Visual Resources address issues and potential impacts related to social and visual impacts in the coastal zone management area, respectively. Potential impacts to biological resources are discussed in Sections 4.9 – Vegetation and 4.10 – Wildlife. There are no listed plants within the wind farm site. The wind farm site does not contain suitable habitat for listed species, although listed birds and bats could transit through (see Section 4.10 – Wildlife). Avoidance and minimization measures would reduce the likelihood of bird (including MBTA species) collisions with turbines or seabird attraction to Project lighting.

Coastal Hazards

- Objective: *Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion, subsidence, and pollution*.

- Policies:

  Develop and communicate adequate information about storm wave, tsunami, flood, erosion, subsidence, and point and nonpoint source pollution hazards;

  Control development in areas subject to storm wave, tsunami, flood, erosion, hurricane, wind, subsidence, and point and nonpoint source pollution hazards;

  Ensure that developments comply with requirements of the Federal Flood Insurance Program; and

  Prevent coastal flooding from inland projects.

Discussion: Only a small portion of the wind farm site, along the northeastern edge near Kamehameha Highway, is within the tsunami evacuation zone. The probability of impacts to the Project resulting from tsunamis is low. A small segment of the wind farm site lies within zones designated by FEMA as special flood hazard, or high risk areas. Implementation of stormwater control measures would minimize the potential for flood events. In the event of a flood event, the site construction safety manager would be responsible for implementing the appropriate procedures in accordance with the Site Safety Handbook to ensure the safety of staff. Best management practices, including implementation of SWPPP, SPCC, TESC, and HMWMP plans would also reduce the potential for flood, as well as reduce erosion and pollution hazards.

Section 4.4 – Hydrology and Water, Section 4.7 – Hazardous and Regulated Materials and Wastes, Section 4.8 – Natural Hazards, and Section 4.18 – Public Health and Safety address potential impacts and mitigation measures related to coastal hazards including erosion, subsidence, flooding and point and nonpoint source pollution hazards.

Managing Development

- Objective: *Improve the development review process, communication, and public participation in the management of coastal resources and hazards*.
- Policies:

  Use, implement, and enforce existing law effectively to the maximum extent possible in managing present and future coastal zone development;

  Facilitate timely processing of applications for development permits and resolve overlapping or conflicting permit requirements; and

  Communicate the potential short and long-term impacts of proposed significant coastal developments early in their life cycle and in terms understandable to the public to facilitate public participation in the planning and review process.

Discussion: Throughout the planning process, NPMPP has actively engaged government regulators, stakeholders, community groups, and individuals. The processing of this EIS facilitated the review process and public participation.

Public Participation

- Objective: *Stimulate public awareness, education, and participation in coastal management*.
- Policies:

  Promote public involvement in coastal zone management processes;

  Disseminate information on coastal management issues by means of educational materials, published reports, staff contact, and public workshops for persons and organizations concerned with coastal issues, developments, and government activities; and

  Organize workshops, policy dialogues, and site-specific mediations to respond to coastal issues and conflicts.

Discussion: Throughout the planning process, NPMPP has actively engagement the public. Section 7– Consulted Parties discusses the public involvement activities related to the proposed Project.

Beach Protection

- Objective: *Protect beaches for public use and recreation.*
- Policies:

  Locate new structures inland from the shoreline setback to conserve open space, minimize interference with natural shoreline processes, and minimize loss of improvements due to erosion;

  Prohibit construction of private erosion-protection structures seaward of the shoreline, except when they result in improved aesthetic and engineering solutions to erosion at the sites and do not interfere with existing recreational and waterline activities;

  Minimize the construction of public erosion-protection structures seaward of the shoreline;

  Prohibit private property owners from creating a public nuisance by inducing or cultivating the private property owner's vegetation in a beach transit corridor; and

  Prohibit private property owners from creating a public nuisance by allowing the private property owner's unmaintained vegetation to interfere or encroach upon a beach transit corridor.

Discussion: The Project is not located within a beach or a coastal land area. It is set inland. Nonetheless, best management practices would be implemented to avoid and minimize impacts to stormwater runoff that may affect beach processes. These BMPs include:

- Preparation and implementation of a TESC Plan which would include standard stormwater BMPs such as building during the summer months when rainfall potential is low, using silt fences or hay bales to prevent eroded soil from being transported off-site, and contouring to minimize impacts to site drainage and to prevent runoff from entering surface water.

- Siting Project access roads to follow natural contours and minimize sidehill cuts to the extent possible to minimize the potential for erosion and impacts to site drainage patterns.
- Construction of a retention basin at the onsite substation to avoid erosion and eliminate the possibility of degrading downstream waters.
- Using ditches and culverts and other erosion controls to capture and convey stormwater in areas of temporary disturbance.
- Restoration of disturbed areas, with the exception of areas where permanent surface recontouring is required, to pre-existing grades and revegetation of these areas.
- Installation of permanent stormwater control structures to prevent erosion where access roads, buildings, storage areas, and parking areas are constructed.
- Preparation of an SPCC Plan.
- Preparation and implementation of a site-specific SWPPP.

Marine Resources

- Objective: *Promote the protection, use, and development of marine and coastal resources to assure their sustainability*.
- Policies:

  Ensure that the use and development of marine and coastal resources are ecologically and environmentally sound and economically beneficial;

  Coordinate the management of marine and coastal resources and activities to improve effectiveness and efficiency;

  Assert and articulate the interests of the State as a partner with federal agencies in the sound management of ocean resources within the United States exclusive economic zone;

  Promote research, study, and understanding of ocean processes, marine life, and other ocean resources to acquire and inventory information necessary to understand how ocean development activities relate to and impact upon ocean and coastal resources; and

  Encourage research and development of new, innovative technologies for exploring, using, or protecting marine and coastal resources.

Discussion: No impacts to marine resources are anticipated from the Project. Section 4.4–Hydrology and Water Resources addresses potential impacts related to surface water and stormwater runoff.

5.2.7 Kawai Nui-Hamakua Marsh Complex Master Plan (1994, update draft plan 2014)

The goals and objectives for resource management within the Kawai Nui-Hamakua marsh complex are guided by the Resource Management Plan for Kawai Marsh prepared by the State Department of Planning and Economic Development (Department of Planning and Economic Development 1983). This plan is currently being updated. The overall goal of resource management within the marsh complex is to "protect, enhance, and use the natural, cultural, and economic resources of Kawai Nui marsh consistent with the greatest public good." Applicable objectives include:

- *Protect, maintain, and enhance wildlife species, their habitats, and related ecological systems.*
- *Protect waterbird species and enhance their habitat.*
- *Protect identified stream, estuarine, and terrestrial wildlife and fish and enhance their habitat.*

Discussion: Fencing an approximately 1,555-foot (474-meter) stretch of fence along the border of the Hamakua portion of the marsh complex to create a boundary between the adjacent shopping center and the edge of marsh, and conducting predator control in this area for waterbird mitigation would enhance waterbird habitat and will also protect waterbird species.

5.3 Local Regulations

5.3.1 City and County of Honolulu General Plan

The City and County of Honolulu guides and directs land use and growth through a three-tier system of objectives, policies, planning principles, guidelines, and regulations. The General Plan (Department of General Planning, City and County of Honolulu 1992, amended in 2002) forms the first tier of this system and is the guiding document for long-range development of the Island of Oahu. The General Plan describes general conditions to be sought over the 20-year planning horizon and outlines policies to help direct attainment of the plan's objectives. An update to the General Plan is currently underway that will look at the critical issues of growth, development, and quality of life that island residents are most concerned about, including regional population, economic health, affordable housing, and sustainability.

The General Plan includes a list of county-wide goals, objectives, policies, and implementing actions related to the following themes:

- Population;
- Economic Activity;
- Natural Environment;
- Housing;
- Transportation;
- Energy;
- Physical Development and Urban Design;
- Public Safety;
- Health and Education;
- Culture and Recreation; and
- Government Operations and Fiscal Management.

Discussion: Specific General Plan goals and policies applicable to the Proposed Action are discussed in detail below.

Natural Environment

- *Objective A – To protect and preserve the natural environment*
  - *Policy 1 – Protect Oahu's natural environment, especially the shoreline, valleys, and ridges from incompatible development.*
  - *Policy 7 – Protect the natural environment from damaging levels of air, water, and noise pollution.*
  - *Policy 8 – Protect plants, birds, and other animals that are unique to the State of Hawaii and the Island of Oahu.*
- *Objective B – To preserve and enhance the natural monuments and scenic views of Oahu for the benefit of both residents and visitors.*
  - *Policy 1 – Protect the Island's well-known resources: its mountains and craters; forests and watershed areas; marshes, rivers, and streams; shoreline, fishponds, and bays; and reefs and offshore islands.*
  - *Policy 2 – Protect Oahu's scenic views, especially those seen from highly developed and heavily traveled areas.*
  - *Policy 3 – Locate roads, highways, and other public facilities and utilities in areas where they will least obstruct important views of the mountains and the sea.*

Discussion: Environmental due diligence conducted to date includes comprehensive biological surveys of the wind farm site to identify native habitats, wetlands and streams, and threatened and endangered species. The Project does not coincide with any natural reserves or other sensitive areas. As described in Section 3.2 – Hydrology and Water Resources, natural gulches, streams, and drainages were identified and have been excluded from the Project footprint. As described in Sections 3.2 – Hydrology and Water Resources, 3.3 – Air Quality and Climate, and 3.4 - Noise, the Proposed Action would be in compliance with Federal, State, and local regulations pertaining to water quality, air quality, and noise, respectively.

Measures to avoid and minimize impacts to vegetation, wildlife, and threatened and endangered species, as well as wildlife species of cultural importance, are identified in Sections 4.7, 4.8, and 4.9, respectively. However, because incidental take of listed wildlife species is not completely avoidable, NPMPP has prepared an HCP that outlines mitigation measures for these impacts (described in detail in Chapter 2 and analyzed in this EIS). Mitigation measures proposed for the Hamakua marsh and Poamoho mitigation areas would benefit the natural environment on Oahu.

A visual analysis (Appendix J) was conducted to assess the potential effect of the Proposed Action on the North Shore's scenic resources. Consideration was taken with regard to maximizing the distance of associated Project components from Kamehameha Highway and sensitive viewpoints (see Section 4.16 – Visual Resources for additional detail). To the extent possible, visual impacts will be minimized by undergrounding the electrical collection system. Although the Project is expected to have a visual impact, alternative energy sources such as wind are an integral part of meeting the State's and City and County of Honolulu's renewable energy goals.

Energy

- *Objective A – To maintain an adequate, dependable, and economical supply of energy for Oahu residents.*
  - *Policy 3 – Support programs and projects which contribute to the attainment of energy self-efficiency on Oahu.*
- *Objective D – To Develop and apply new, locally available energy resources.*
  - *Policy 1 – Support and participate in research, development, demonstration, and commercialization aimed at producing new, economical, and environmentally sound energy supplies from :*
    - *Solar insolation;*
    - *Biomass energy conversion;*
    - *Wind energy conversion;*
    - *Geothermal energy; and*
    - *Ocean thermal* energy conversion.

Discussion: The nature of the Proposed Action meets the County General Plan's energy objectives and policies as stated above.

Public Safety

- *Objective B – To protect the people of Oahu and their property against natural disasters and other emergencies, traffic and fire hazards, and unsafe conditions.*
  - *Policy 7 – adequate fire protection and effective fire prevention programs.*

Discussion: A Fire Management Plan (Appendix B) has been prepared for the Project. Engineering design measures, O&M activities, and fuels management practices outlined in the plan would minimize the fire risk posed by the Project to acceptable levels (also see Sections 4.7 – Hazardous and Regulated Materials and Wastes and 4.18 – Public Health and Safety for additional information).

5.3.2 Sustainable Communities Plans

The second tier of the land use planning and management system is formed by the Development Plans (DPs). The City and County of Honolulu is divided into eight regional areas. Each area is guided by DPs or Sustainable Community Plans (SCPs) required by City Charter and administered by the Department of Planning and Permitting (DPP). The plans are intended to help guide public policy, investment, and decision-making through the 2020 planning horizon (City and County of Honolulu 2012).

The wind farm site is located within the boundaries of the Koolau Loa SCP (City and County of Honolulu, DPP 2012), which extends from Waialee in the northwest to Kaoio Point in the southeast. This region includes the communities of Kahuku, Laie, Hauula, Punaluu, Kahana, and Kaaawa. The wind farm site is designated for agricultural, military, and rural residential use (City and County of Honolulu, DPP 2012). The Project components are predominately designated within agricultural use, with one wind turbine proposed only under Alternative 3 straddling agricultural and military use designations. Wind energy facilities are permitted uses with the State agricultural designation and the City and County of Honolulu agricultural designation with an approved CUPm (see discussion below). In addition, discussion with the military regarding the adjacent Kahuku Training Area and the Tactical Flight Training Area is ongoing (see Chapter 4 for conditions of a pending MOU between NPMPP and the Department of Defense).

Guidelines and Policies relating to the Project within the Koolau Loa SCP are as follows:

- *Mountain Areas and Trails: Avoid the establishment of utility corridors and other uses that would disturb areas with high concentration of native and endangered species.*

Discussion: The Project requires compliance with the Federal ESA and MBTA, and the State HRS 196-D which prohibits the "take" of any endangered or threatened species (see Section 5.1.1, 5.1.3, and 5.2.1, respectively and Section 4.9 – Vegetation, Section 4.10 – Wildlife, and Section 4.11 – Threatened and Endangered Species. Prior to NPMPP's proposal of the Project, other locations on Oahu and the North Shore with sufficient wind resource and potential for interconnection with the HECO grid were considered but eliminated (see Section 2.3.4 – Alternative Project Location on Oahu). One of the reason for eliminating potential project sites was "land use restrictions, environmental concerns, and potential environmental impacts (e.g., proximity to wildlife refuges or other natural areas) made the location not feasible." The proposed wind farm site met siting criteria including, but not limited to, minimizing adverse impacts to native and endangered species. The proposed Project is not located within any natural reserves or other sensitive biological areas.

Measures to avoid and minimize impacts to vegetation, wildlife, and threatened and endangered species are identified in Sections 4.9, 4.10, and 4.11, respectively. However, because incidental take of listed wildlife species is unavoidable, NPMPP has prepared an HCP that outlines mitigation measures of these impacts (described in detailed in Section 2 and analyzed in this EIS). Section 2.5.1 outlines onsite mitigation measures including but not limited to:

- The three Project met towers were fitted with bird flight diverters and/or white poly tape (1 inch [2.5 centimeters]) to increase visibility and, as a result, the likelihood of avoidance by Covered Species.
- The Project plans to install an un-guyed, free-standing permanent met tower to maximize the detectability of all features of the structure for birds and bats and minimize the risk of collision. This permanent tower would replace one temporary guyed met tower, and the remaining temporary met towers would be removed before the commercial operation date.
- The majority of the wind farm site is sited in disturbed agricultural habitat, which minimizes impacts to most native species.

- The wind farm site does not have suitable listed waterbird breeding or foraging habitat thereby minimizing Hawaiian stilt, Hawaiian coot, and Hawaiian moorhen use of the wind farm site and minimizing potential Project impacts to these species.
- To minimize potential impacts to wildlife, onsite lighting at the O&M building and substation will be shielded and/or directed downward, triggered by a motion detector, and fitted with non-white light bulbs. Lighting is only expected to be used when workers are at the site at night. Most O&M activities are expected to occur during daylight hours. Nighttime activities during construction are addressed in the General Project Development Measures below.
- Flashing red lights on the nacelle have been shown not to be attractive to birds and will be used in accordance with FAA requirements.
- The collection line will be placed below ground to the maximum extent practicable, thereby reducing the risk of collision of the Covered Species.
- New above-ground portions of the power lines associated with the Project will use line marking devices to improve visibility to birds and follow Avian Protection Plan Guidelines (APLIC 2012).

The HCP offsite mitigation measures propose research funding, and improvements to Hamakua marsh and Poamoho mitigation areas. These measures would benefit the natural environment on Oahu, providing a net benefit to Covered Species. HCP measures to avoid and minimize as well as provide a net benefit to endangered species would do the same for other native species.

- *Agriculture: Protect and preserve the agricultural lands from conversion to uses that are primarily residential, industrial, or commercial in purpose.*

Discussion: As discussed in Section 3.20 – and 4.22 - Agriculture, construction and operation of the Project would impact less than 7 percent of LSB rated A and B lands within the wind farm site over the long-term, and less that 1 percent within the Koolauloa District. Alternative 2 would directly impact up to approximately 8.2 acres of actively farmed land during construction within the wind farm site, of which 4.6 acres would be temporarily displaced over the long term. Under the Proposed Action Option this would be reduced to 6.0 acres (2.4 hectares) during construction and 2.7 acres (1.1 hectares) during operations. This displaced active farm land would be relocated to existing unused farm land within each farmer's lease area on the Malaekahana Hui West, LLC property; therefore, no net loss of agriculture would occur under Alternative 2 or the Modified Proposed Action Option. To the extent requested by Malaekahana Hui West, LLC, NPMPP would work with farmers to prepare this suitable land for agricultural production (e.g., grubbing, grading, soil amendments, extend irrigation, etc.) so that there would be no net loss in active agriculture. NPMPP would also work with Malaekahana Hui West, LLC to provide and maintain the irrigation system to the existing and potential future farm areas.

- *Agriculture: Allow recreational or educational programs or other activities which provide supplemental income necessary to sustain the primary agricultural activity, as long as they are compatible with the character of the rural agricultural area and are accessory to the primary agricultural use of the site.*

Discussion: As discussed in Section 3.20 – Agriculture, and Section 4.22 - Agriculture, construction and operation of the Project would impact less than 7 percent of LSB rated A and B lands within the wind farm site over the long term. Alternative 2 would directly impact up to approximately 8.2 acres of actively farmed land during construction within the wind farm site, of which 4.6 acres would be temporary displaced over the long term. Under the Proposed Action Option this would be reduced to 6.0 acres (2.4 hectares) during construction and 2.7 acres (1.1 hectares) during operations. This temporary displaced active farm lands would be relocated to existing uncultivated farm lands within each individual farmer's lease area, therefore no net loss of agriculture would occur under Alternative 2. NPMPP would work with farmers to prepare this suitable land for agricultural production (e.g., grubbing, grading, soil amendments, extend irrigation, etc.) so that there would be no net loss in active agriculture.

In 2008, the Board of the Agriculture withdrew the portion of the wind farm site that is owned by the State DLNR from the Kahuku Agricultural Park as the lands were not used for the intended farming purposes because the area acted as a buffer between the Kahuku Agricultural Park, the military training area, and the existing Kahuku Wind Farm. Additionally, these lands are steep with no road access and no water infrastructure and are therefore not conducive to farming in this area. As such, the Board of Agriculture returned the lands to the DLNR Land Division for other economic uses.

- *Electrical Systems: Locate and design system elements such as renewable energy facilities (e.g. wind and solar), electrical sub-stations, communication sites, and transmission lines, including consideration of underground transmission lines, to avoid or mitigate visual impacts on scenic and natural resources, as well as public safety considerations.*

Discussion: As discussed in Section 2.1 – Alternative Development and Screening Criteria, there were five criteria that were used to select the Project site that would meet the Project purpose and need. The five criteria are 1) good wind resource, 2) access to adequate and available transmission capacity, 3) land availability where wind energy development is a permitted use, 4) site conditions such as topography, and 5) potential impacts including visual impacts and meeting setback requirements for safety reasons. These criteria eliminated other sites from being considered as discussed in Section 2.3.4 – Alternative Project Location on Oahu. Prior to NPMPP's acquisition of the Project, other locations on Oahu were considered but eliminated for several reasons with one being that the land use restrictions, environmental concerns and potential environmental impacts (e.g., proximately to wildlife refuges or other natural areas) made the location not feasible. At least some visual impact from a utility-scale wind farm is unavoidable no matter where a project is located on Oahu. Although the Project is expected to have a visual impact, alternative energy sources such as wind are an integral part of meeting the State's renewable energy goals.

- *Electrical Systems: Encourage the development and use of renewable energy sources and energy conservation measures.*

Discussion: The purpose of the Project is to provide clean, renewable wind energy for the island of Oahu. The implementation of the Project would be consistent with this SCP policy.

The Hamakua Marsh mitigation area is within the region guided by the Koolaupoko SCP, which encompasses the windward coastal and valley areas of Oahu from Makapuu Point to Kaoio Point, bounded by the Koolau mountain range and the ocean. This region includes the rural communities of Kahaluu, Waiahole-Waikane, Kualoa, and Waimanalo and the urban fringe communities of Kaneohe and Kailua (City and County of Honolulu, DPP 2000). The Hamakua Marsh mitigation area is within the Open Space/Preservation designated area.

Specific Koolaupoko SCP guidelines applicable to the Hamakua Marsh mitigation area are discussed in detail below. Guidelines relating to wildlife preserves in Koolaupoko SCP are as follows:

- *Prohibit encroachment or intensification of residential or other urban uses near wildlife sanctuaries and nature parks.*
- *Wildlife preserve management plans should emphasize conservation and restoration of native plans, birds, fish and invertebrates. Private landowners should be encouraged to investigate the various State and Federal programs that provide incentives for landowners to manage their lands for the benefit of the wildlife.*

Installation of fencing at the Hamakua Marsh for waterbird mitigation under the HCP is intended to minimize the presences of waterbirds in the adjacent parking lot, limit the access of dogs to the area, and control illegal trash dumping. The fencing will provide an improvement to the waterbird species.

The Poamoho Ridge bat mitigation area is within the region guided by the Central Oahu SCP, which encompasses central areas of Oahu bounded by Koolau and the Waianae mountain ranges on the east and west ends, respectively. This region includes the towns of Wahiawa, Mililani, and Waipahu (City and County of Honolulu, DPP 2002). The Poamoho Ridge mitigation area is within the Open Space/Preservation designated area.

A guideline relating to protecting endangered species and their habitats in the Central Oahu SCP is as follows:

- *Identifying and protecting endangered species habitats and other important ecological zones from threats such as fire, weeds, feral animals, and human activity.*

This mitigation area has been identify as areas to protect the Hawaiian hoary bat; therefore, these areas and the mitigation activities associated with them are consistent with the Central Oahu SCP.

5.3.3 City and County of Honolulu Zoning

The wind farm site is zoned AG-2 General Agricultural and AG-1 Restricted Agricultural by the City and County of Honolulu. Wind energy facilities are a permitted use within these zoning districts with a CUPm. As such, NPMPP will submit an application for a CUPm to the City and County of Honolulu in compliance with the requirements.

The Project is consistent with the City and County of Honolulu zoning requirements. The Project conforms to the AG-1 and AG-2 zoning district as the Project is consistent with the intent of the Agricultural district. No change in zoning would occur or be requested as a result of the Project. The wind farm site is suitable for a wind generating facility considering the size, shape, location, topography, infrastructure, and natural features. The Project would not alter the character of the surrounding area that would limit agricultural uses. Finally, the Project would contribute to the general welfare of the community by providing renewable energy generation. The Project will also comply with the development standards as outlined in the Land Use Ordinance.

The Project is also in compliance with setback requirements for the wind turbines heights and noise standards. The maximum height of the tallest turbine would be up to 656 feet (200 meters) above ground level (refer to Table 2-2). Smaller turbine models (i.e., those with shorter hub heights) would be considered for turbine locations nearest the TMK boundaries to ensure compliance with City and County of Honolulu setback requirements. Figure 5-1 shows the compliance of the Project with these setback requirements (Note that Figure 5-1 shows all 12 turbine locations, including those included under Alternative 3). Through community consultation during early planning for the Project, the local community voiced concerns about appropriate setbacks for the wind turbines. In response, the original layout of the wind turbines was altered several times to remove four turbines from Cross Hill and relocate at least one other turbine closest to the community. This change increased the distance from the turbines to the Kahuku Mauka Village and the Kahuku Elementary School.

The Hamakua Marsh mitigation area is a mix of several classifications of the City and County of Honolulu zoning districts, including P-2 General Preservation, P-1 Restricted Preservation, R-10 / R-5 / R-7.5 Residential, and B-1 / B-2 / BMX-3 Neighborhood Business, Community Business, Community Business Mixed Use.

The existing use of the Hamakua Marsh mitigation area will continue as a waterbird sanctuary. The Project intends to fund fencing of the Hamakua Marsh to protect the waterbirds as well as a deterrent to illegal dumping. The fencing will provide a net benefit to the area. The fencing activity is an allowed action with the various zoning districts listed above.

The Poamoho Ridge bat mitigation area is within the City and County of Honolulu P-1 Restricted Preservation zoning district. The existing use of the Poamoho Ridge area will continue as a forest reserve. The Project intends to fund conservation activities including fence installation, native forest restoration, and bat research, which will be carried out by DOFAW. These activities will provide a net benefit to the area. Within the P-1 Restricted Preservation District, all uses, structures, and development standards shall be governed by the appropriate State agencies. As such, the conservation activities are an allowed action within the P-1 Restricted Preservation zoning district.

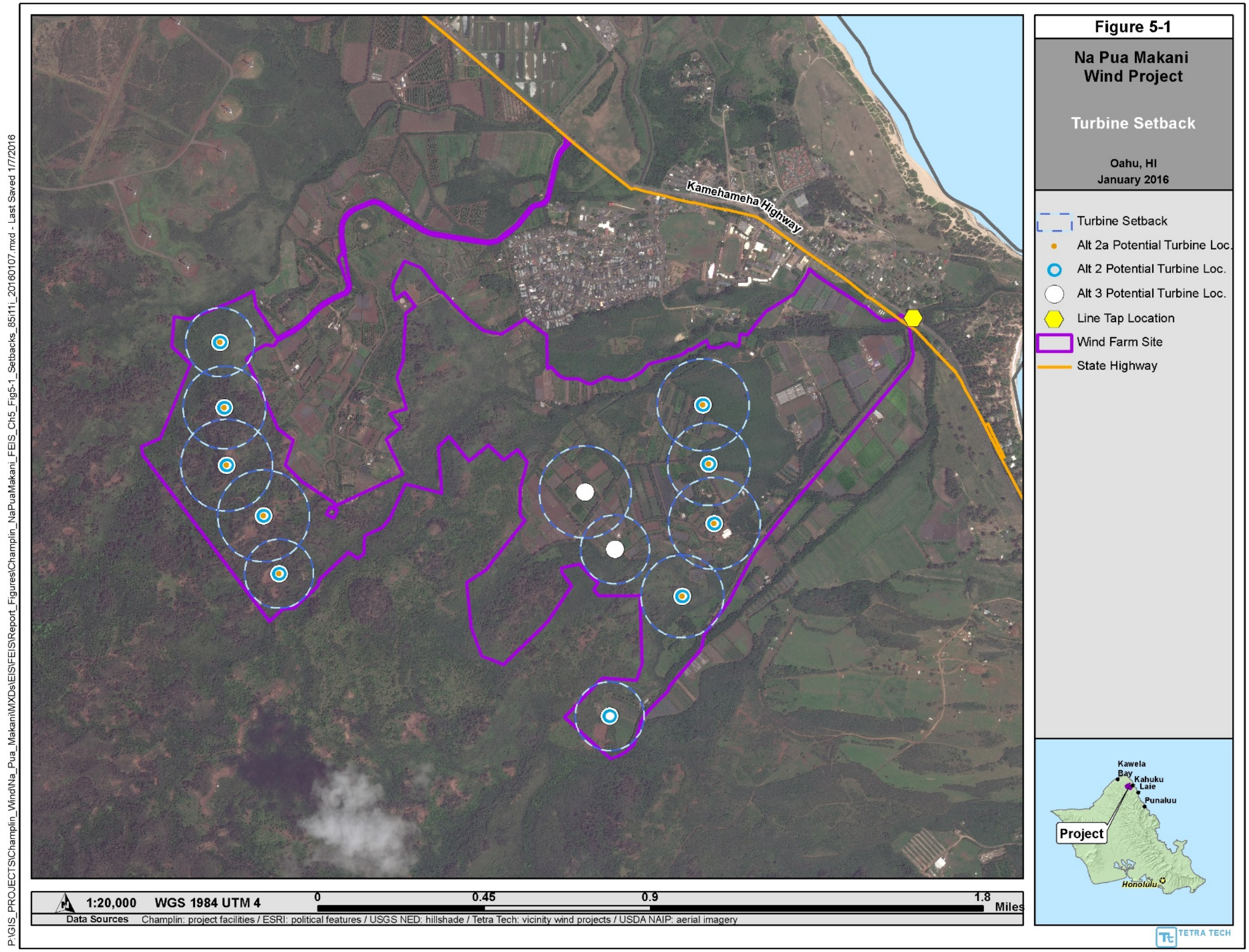
Figure 5-1
Na Pua Makani Wind Project
Turbine Setback
Oahu, HI
January 2016
Turbine Setback
Alt 2a Potential Turbine Loc.
Alt 2 Potential Turbine Loc.
Alt 3 Potential Turbine Loc.
Line Tap Location
Wind Farm Site
State Highway
Kamehameha Highway
Kawela Bay
Kahuku
Laie
Punaluu
Project
Honolulu
1:20,000
WGS 1984 UTM 4
0
0.45
0.9
1.8
Miles
Data Sources
Champlin: project facilities / ESRI: political features / USGS NED: hillshade / Tetra Tech: vicinity wind projects / USDA NAIP: aerial imagery
TETRA TECH
P:\GIS_PROJECTS\Champlin_Wind\Na_Pua_Makani\MXDs\EIS\FEIS\Report_Figures\Champlin_NaPuaMakani_FEIS_Ch5_Fig5-1_Setbacks_85i11i_20160107.mxd - Last Saved 1/7/2016

5.3.4 City and County of Honolulu Special Management Area

The City and County of Honolulu has regulatory authority over development within the SMA. The Revised Ordinances of Honolulu (ROH) Chapter 25 Special Management Area ensures that activities within the SMA are consistent with objectives and policies of the SMA guidelines. Although the Project is outside of the SMA, during transport of the turbines a limited area at the entrance of the access road into the DLNR property adjacent to Kamehameha Highway may require grading, grubbing, and installation of a gravel surface to provide a clear and safe path. The work is anticipated to cost less than $500,000. If during detailed design it is determined that work will need to be conducted within the SMA, NPMPP will submit a SMA Minor application to the City and County of Honolulu in compliance with the SMA requirements.

5.4 Other Applicable Regulations

In addition to the regulations discussed above, there are numerous other Federal, State, and local regulations that apply to the Project, some of which require permits or authorizations from authorizing agencies. Table 5-1 summarizes these regulations, their relevance to the Project, and permits or authorizations required where applicable.

Table 5-1. Applicable Federal, State, and Local Statutes, Regulations, Permits, and Authorizations Required for the Na Pua Makani Wind Project

Agency	Permit/Approval	Status
Federal		
USFWS	National Environmental Policy Act (NEPA) Compliance	Joint Federal/State DEIS published in 2015; NEPA-only FEIS published in 2016; Supplemental Final EIS publication anticipated in 2016
USFWS	Incidental Take Permit and Habitat Conservation Plan(Endangered Species Act, Section 10(a)(1)(B))	Ongoing consultation (initiated in 2013); Joint Federal/State draft HCP published in 2015 concurrently with the DEIS; Final HCP published in 2016 concurrently with the FEIS, and again with this Supplemental FEIS.
Federal Aviation Administration (FAA)	49 U.S.C. § 44718; 14 CFR Part 77; Objects Affecting Navigable Airspace; Determination of No Hazard and Notice of Proposed Construction or Alteration	Determination of No Hazard information provided to the FAA 03/04/2014 and 10/17/2014; revised FAA filings made based on the final site plan (final determination pending). Application for Notice of Proposed Construction or Alteration submitted.
Hawaiʻi State Historic Preservation Division	National Historic Preservation Act Section 106 Compliance	USFWS consultation with SHPD complete
U.S. Army Corps of Engineers (USACE)	Clean Water Act Section 401, 402, 404 approval	To be completed as necessary
State		
State of Hawaii, DLNR	Chapter 343/Hawaii Environmental Policy Act (HEPA) Compliance	Joint Federal/State DEIS published in 2015; HEPA-only Second Draft EIS and Final EIS published in 2016

Table 5-1. Applicable Federal, State, and Local Statutes, Regulations, Permits, and Authorizations Required for the Na Pua Makani Wind Project (continued)

Agency	Permit/Approval	Status
State of Hawaii, Department of Health, Clean Water	Clean Water Act Compliance (Sections 401 / 402 / 404)	To be completed as necessary
State of Hawaii, Commission on Water Resource Management	Stream Channel Alteration Permit (SCAP)	To be completed as necessary
State of Hawaii, DLNR DOFAW	Incidental Take License/Habitat Conservation Plan (HRS Chapter 195-D)	Ongoing consultation (initiated in 2013); Joint Federal/State draft HCP published concurrently with the DEIS; Final HCP will be considered for approval in 2016.
State of Hawaii, Department of Transportation	Use and Occupancy Agreement	To be completed
State of Hawaii, Department of Transportation	Lane Use Permit for Construction Work	To be completed
State of Hawaii, Department of Transportation	Parking Permit	To be completed as necessary
State of Hawaii, Department of Transportation and City & County of Honolulu, Department of Transportation Services	Oversized and Overweight Moving Permits	To be completed
State of Hawaii, Department of Health	Noise Permit	To be completed
State of Hawaii, Department of Health	Air Quality Permit	To be completed
State of Hawaii, Department of Agriculture	Long-term non-exclusive easement for use of Kahuku Agricultural Park interior roadway	Approved, subject to terms and conditions
Hawaii Public Utility Commission	Power Purchase Agreement	Approved
City & County of Honolulu	Conditional Use Permit Minor	To be completed
City & County of Honolulu	Special Management Area Use Permit Minor	To be completed as necessary
Various Agencies	Construction-related Permits	To be completed

6.0 OTHER NEPA REQUIREMENTS

Content requirements for a NEPA EIS are defined in 40 CFR § 1502. Most of these components are addressed in the previous chapters. This chapter addresses additional components required under NEPA including a discussion of short-term uses of the environment versus long-term productivity, irreversible and irretrievable commitment of resources, identification of the preferred alternative and environmentally preferable alternative, consistency with the purposes of NEPA, unavoidable adverse impacts, and connected actions.

6.1 Relationship between Short-Term Uses and Long-Term Productivity

NEPA (40 CFR 1502.16) require that an EIS include a discussion of the relationship between short-term uses of the human environment and the maintenance and enhancement of long-term productivity. HAR §11-200-17(J) requires a brief discussion of the "extent to which the proposed action involves tradeoffs between short-term losses and long-term gains and losses, or vice versa, and a discussion of the extent to which the proposed action forecloses future options, narrows the range of beneficial uses of the environment, or poses long-term risks to health or safety."

Short-term tradeoffs include impacts to soil, hydrology, vegetation, wildlife, and agricultural resources in the wind farm site. The Project would result in ground disturbance, much of which would be temporary and subject to restoration activities at the end of Project construction. Ground disturbance during construction increases the potential for soil erosion and runoff. Grading and blasting (if required) have the potential to alter drainage patterns within the wind farm site and result in stormwater runoff in adjacent areas. Implementation of best management practices, including implementation of SWPPP, TESC, and SPCC plans, would minimize these impacts such that the short-term impacts to soils, surface water, and groundwater in the wind farm site would be minor.

Construction of the Project would result in removal and degradation of vegetation and vegetation communities in the wind farm site. Project construction would generally occur in existing agricultural areas or areas that consist predominantly of non-native shrubland and forest dominated by non-native weedy species. Thus, vegetation communities and wildlife habitat being impacted is of low quality. Revegetating temporarily disturbed areas and implementing measures to reduce the introduction and spread of invasive plant species will minimize impacts to vegetation communities and wildlife habitat. There is also the potential for wildlife to be killed or injured during construction of the Project. Avoidance and minimization measures included under the Project HCP would reduce the likelihood of potential construction-related impacts associated with attraction to nighttime construction lighting (seabirds) and removal of bat roosting habitat. Construction noise could also potentially disturb wildlife in the wind farm site. However, given the temporary nature of the construction period and the existing level of human activity in the wind farm site associated with agriculture, construction of the Project would not preclude wildlife from using the wind farm site.

Long-term impacts of the Project would primarily be beneficial. Operation of the Project would provide a source of electrical energy generated from an abundant, clean, local, and infinitely renewable energy source. Generation and integration of wind energy into the electric grid further reduces fossil fuel consumption, thereby reducing GHG emissions, particulate-related health effects, and other forms of pollution associated with coal or diesel fuel electric generation. The use of a local renewable resource, as compared to imported foreign fuels, also provides greater security in maintaining an energy supply and reduces state expenditures on imported fossil fuels. As proposed, the Project could provide 88,000 MWh/year of electricity to HECO's grid, enough to provide electricity to approximately 8,000 households, and is expected to do so continuously over its approximately 20-year lifespan.

The proposed Project would provide both short-term and long-term economic benefits to the State and county. Short-term beneficial economic impacts would include direct wages to local workers and secondary spending by construction workers for housing, food, and other goods and services that would further stimulate the local economy. Over the long term, the Project would provide a stable, long-term source of tax revenue for the State and county. The Project would also provide a revenue stream for the State in terms of lease payments. In addition, the power generated by the Project would be sold to HECO under a long-term, set base price contract with fixed annual escalation, providing long-term price stability for HECO consumers.

The proposed Project is compatible with the existing agricultural uses, and as such, does not preclude the present and future agricultural productivity of the wind farm site or the Kahuku area. With the exception of the short-term temporary disruption to existing farming activities and the 59.9 acres (24.2 hectares) permanent project footprint, of which 4.6 acres (1.8 hectares) are actively farmed, the Project would allow for continued agricultural uses and open space within the wind farm site. Impacts would be slightly less under the Modified Proposed Action Option (56.7 acres [22.9 hectares]) total impacts, of which 2.7 acres (1.1 hectares) are actively farmed. However, there would be no net loss of active agriculture under either Alternative 2 (including the Modified Proposed Action Option) or Alternative 3, as NPMPP would work with Malaekahana Hui West, LLC to prepare unfarmed lands within the individual farmer's lease areas where Project-related impacts would occur for agricultural production (see Section 4.22 – Agriculture for additional discussion). In addition, the use, efficiency, and productivity of agricultural operations are expected to increase on a portion of the wind farm site through the availability of new access roads. Long-term impacts of the Project would also include visual impacts that may be considered negative to some viewers; however, the visual assessment indicates that the potential visual impacts from the Project for Alternative 2 (including the Modified Proposed Action Option [Alternative 2a]) or 3 would be considered moderate.

The Project would not pose a long-term risk to health and safety of workers or residents in the vicinity. Once in operation, the Project would not cause any emissions of air, water, or soil pollutants, and the potential for release of hazardous materials during construction would be limited by the implementation of appropriate construction best management systems and practices. Wind turbines are not known to have direct or indirect health effects. The turbines are designed and will be assembled according to robust engineering standards that are anticipated to prevent potential safety issues; proper routine maintenance over the lifetime of the Project would keep the turbines in good working order and further prevent safety issues. Tower collapse and blade throw are very rare occurrences and often are linked to improper assembly or exceedance of design limits (see Section 4.18 – Public Health and Safety). Additionally, the risk of fire from operation of the turbines is relatively low and minimized by design features. To date, no scientific peer-reviewed study has demonstrated a direct causal link between people living in proximity to modern wind turbines, and the noise they emit (audible and inaudible sounds), and resulting physiological health effects.

6.2 Irreversible and Irretrievable Commitments of Resources

Pursuant to NEPA regulations (40 CFR 1502.16), an EIS must disclose the irreversible and irretrievable commitments of resources associated with the Proposed Action should it be implemented. An irreversible commitment of resources applies primarily to the loss of non-renewable resources and resources that are renewable only over a long period of time (e.g., soil productivity). Nonrenewable resources generally include biological habitat, agricultural land, mineral deposits, water, cultural resources, and some energy sources. Irretrievable commitments apply to loss of production or use of renewable resources. These opportunities are forgone for the period of the proposed action, during which the resource cannot be used. Resources that are committed irreversibly or irretrievably are those that cannot be recovered if the Project is implemented.

Construction and operations of the Project would require the use of non-renewable resources used in the manufacturing of the Project components, construction materials, and fuel consumed during the construction and operations of the Project. However, to the extent feasible, construction waste would be recycled. As Project components wear out, they could also be recycled. During decommissioning, the Project components would be salvaged and reused and the wind farm site would be returned to its original condition to the extent possible (see Section 2.2.1.9).

Relatively minor impacts would occur to primarily non-native vegetation, wildlife habitat, soils, hydrology, agricultural lands, and public services, in association with construction (e.g., ground disturbance) and operation of the Project. These impacts comprise an irreversible commitment of resources, but would be less than significant. Additionally, agricultural activities within the wind farm site would still continue with the operations of Project.

Issuance of the ITP/ITL and implementation of the HCP would authorize incidental take of the Covered Species. These impacts would occur over the 21-year term of the permit. Avoidance, minimization, and mitigation measures outlined in the HCP would reduce these biological resources impacts to below a level of significance. However, the incidental take of Covered Species would comprise a small, but irreversible, environmental change associated with implementation of any action alternative. Additionally, operations of the Project would impact some species of wildlife that are considered culturally important; however, the mitigation measures outlined in the Project HCP would reduce these impacts.

Archaeological resources within the wind farm site that have been identified for no further work or data recovery would be fully recorded with the potential for sites to be demolished. NPMPP would avoid demolishing any site unless absolutely necessary. Of the 14 identified archaeological sites within the APE, 2 would be impacted by the Project and the remaining 12 are outside of the area of direct disturbance. Of the sites documented, 5 sites are recommended for no further work, 3 sites are recommended for data recovery, and 5 sites and a portion of a 6th site are recommended for preservation based upon their significance (see the AIS in Appendix F of the Final EIS for additional information).

6.3 Identification of the Agency's Preferred Alternative

Under NEPA, the "agency's preferred alternative" is a preliminary indication of the Federal responsible official's preference of action, which is chosen from among the Proposed Action and alternatives analyzed in an EIS. It is the alternative which the agency believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical and other factors (40 CFR 1500-1508, CEQ 46 FR 18026-18038). The preferred alternative may be identified for a variety of reasons (such as the priorities of the particular lead agency) in addition to the environmental considerations discussed in the EIS. The preferred alternative is not a final agency decision; rather, it is an indication of the agency's preference. The final agency decision is presented in the Record of Decision.

In accordance with NEPA (40 CFR §1502.14(e)), the USFWS has identified the Proposed Action (Alternative 2), including the Modified Proposed Action Option (2a), as the preferred alternative. Of the alternatives evaluated in this EIS, this alternative best fulfills the agency's statutory mission and responsibilities while meeting the agency purpose and need to conserve listed species while responding to an ITP application, and giving consideration to economic, environmental, and other factors. The identification of the Proposed Action as the preferred alternative is based on the following:

- The issuance of the ITP by the USFWS under the Proposed Action would result in protections (via mitigation and conservation measures) to the Covered Species due to implementation of the HCP. The HCP that would be implemented under this alternative would also minimize impacts to birds protected under the MBTA.
- The renewable energy generated by the Project would provide a dependable source of electrical energy and eliminate the need for an equivalent amount of fossil-fueled derived energy and capacity, which reduces use of nonrenewable resources and limits atmospheric pollution.

Under Alternative 1 (No Action) the USFWS would not approve the HCP or issue an ITP and the Project would not be constructed. This alternative would not result in the incidental take of listed species but would also not result in the generation of renewable energy or contribute to the State's RPS goals. The No Action Alternative would also not provide the additional ecological benefits that would be provided with the development and implementation of the HCP.

Alternative 3 (a larger generation facility) would result in a greater amount of incidental take of listed species than Alternative 2/2a but would also produce a greater amount of renewable energy. However, because the timing of the construction of the additional turbines under Alternative 3 is dependent on upgrades to the existing HECO transmission lines, Alternative 3 only includes approval of an HCP and issuance of an ITP for the first 8 to 10 turbines (the same as under Alternative 2/2a). Therefore, Alternative 3 would require reinitiating consultation with the USFWS to assess the potential impacts of the additional turbines to listed species and develop appropriate mitigation measures. The USFWS generally considers increasing take limits authorized under an ITP (and thus not fully considered, analyzed or included in the original HCP and EIS) as triggering the amendment process. Thus, the additional undetermined level of incidental take and associated mitigation under Alternative 3 would be addressed through a separate environmental analysis conducted prior to construction of the additional turbines.

6.4 Identification of the Environmentally Preferable Alternative

Under NEPA, the "environmentally preferable alternative" is the alternative required by 40 CFR 1505.2(b) that causes the least damage to the biological and physical environment and best protects, preserves, and enhances historical, cultural, and natural resources, as expressed in Section 101(b) of NEPA (43 CFR 46.30). The USFWS identified the No Action Alternative (no approval of the HCP/no issuance of the ITP) as the environmentally preferable alternative. Under this alternative, the Project would not be constructed or operated. Therefore, there would be no ground disturbance during construction and associated effects to the environment including historic, cultural, and natural resources (e.g., soil, water resources, and vegetation). There would also be no operational effects associated with noise or visual impacts, and no take of listed species. Through avoidance of impacts, the No Action Alternative would cause the least damage to the biological and physical environment; however, it would also produce no renewable energy and therefore would not contribute to reductions in greenhouse gas emissions or contribute to the State's RPS goals.

6.5 Consistency with the Purposes of NEPA

Section 101(b) of NEPA requires an analysis of how each alternative meets or achieves the purposes of the act. The purposes of NEPA include the following:

1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
2. Ensure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings;
3. Attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences;
4. Preserve important historic, cultural, and natural aspects of our national heritage and maintain, wherever possible, an environment that supports diversity and variety of individual choice;
5. Achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities; and

6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources (42 USC 4331).

The No Action Alternative would provide more resource protection than Alternatives 2, 2a, and 3 because the USFWS would not approve the HCP or issue the ITP and the Project would not be constructed or operated. Since no development would occur under the No Action Alternative, it would meet Purpose 2 and Purpose 4 better than Alternatives 2, 2a, and 3 would because no adverse impacts would occur.

However, the No Action Alternative would not meet Purpose 3 (to attain the widest range of beneficial uses of the environment without degradation) or Purpose 5 (to achieve a balance between population and resources) as well as Alternatives 2, 2a and 3 because it would not have the long-term beneficial impacts associated with renewable energy generation and reduction in greenhouse gas emissions. Alternatives 2, 2a, and 3 would result in some adverse environmental effects associated with construction and operation of the Project; however, through implementation of the proposed avoidance and minimization measures, all impacts would be reduced to less than significant. Additionally, under Alternatives 2, 2a, and 3, existing agricultural land uses within the wind farm site would continue during Project operation, and access would be maintained for cultural practices. Under Alternatives 2, 2a, and 3 the long-term beneficial effects to climate change due to the potential offset of carbon emissions resulting from Project operation would better meet Purpose 1 (to fulfill the responsibilities of each generation as trustee of the environment for succeeding generations) than the No Action Alternative.

6.6 Unavoidable Impacts

NEPA implementing regulations require a discussion of “all probable adverse environmental effects which cannot be avoided.” A full discussion of adverse and unavoidable environmental effects is provided in Chapter 4 of this EIS. In summary, there is a potential for adverse impacts to threatened and endangered birds and bats as well as culturally important species that cannot be avoided, although the avoidance, minimization, and mitigation measures outlined in the Project HCP would reduce these impacts.

In addition, visual impacts of the Project cannot be avoided. The Project would alter the visual resources in the Kahuku area. Overall potential visual impacts from the Project are expected to be, at most, moderate, with viewers closest to the wind farm site experiencing the greatest visual impacts.

Construction of the Project may also result in unavoidable short-term, localized impacts related to noise and air quality. However, construction-related impacts are temporary and mitigated through implementation of BMPs.

Additionally, archaeological resources within the wind farm site that have been identified for no further work or data recovery would be fully recorded with the potential for sites to be demolished. NPMPP would avoid demolishing any site unless absolutely necessary. Of the 14 identified archaeological sites within the APE, 2 would be impacted by the Project. Of the sites documented, 5 sites are recommended for no further work, 3 sites are recommended for data recovery, and 5 sites plus a portion of a 6th site are recommended for preservation based on their significance (see the AIS in Appendix F of the Final EIS for additional information).

NPMPP is committed to avoiding or mitigating adverse effects to the extent practical. To the extent that some adverse environmental impacts may be unavoidable, the strengths of the Project location, the benefits of the Project, and the ability of the Project to fulfill the requirements of State energy policies are believed to outweigh those impacts.

The Project would provide clean, renewable wind energy for the island of Oahu, and would assist HECO in meeting Hawaii's RPS requirements. The Project would diversify Oahu's power supply, and contribute to the State's energy independence and security. Production of wind-generated energy would replace a portion of the State's electricity that is currently generated by burning fossil fuels, thus reducing greenhouse gas emissions and other forms of pollution that are detrimental to the environment and human health. Thus, the Project would also help to meet goals embodied in the State's Global Warming Solutions Act of 2007 and in the 2008 Hawaii Clean Energy Initiative.

The Project location is one of the strengths of this proposal. The area has excellent wind resources, as demonstrated by the nearby Kahuku and Kawailoa wind farms. The area also has well-developed electrical infrastructure that is capable of receiving the additional energy from the Project with minimal additional improvements. Because of the proximity of the wind farm site to existing electrical infrastructure, no new transmission line outside of the wind farm site would be needed, limiting the impacts of the Project. The transportation infrastructure to the area has already proven sufficient for delivery of turbine components and construction equipment, without the need for significant offsite improvements. In addition, the wind farm site does not represent valuable native habitat for rare or protected species. To the extent that development at the wind farm site would impact protected species, NPMPP would mitigate for those impacts through the protection of valuable native habitat elsewhere on the island.

As noted above, the Project would provide both short- and long-term economic benefits to the county and State. Short-term benefits would arise from increased local employment during construction and secondary spending in the local economy by construction workers. Long-term benefits include a stable, long-term source of tax revenue for the State and county, long-term revenue for the State through lease payments, and long-term energy price stability for HECO consumers. Additionally, as part of its mitigation strategies, the Project would provide long-term funding to protect critical habitat for protected species, easing the burden on government to find alternate sources of funding. The Project would also provide a community benefit fund to the local Kahuku community for the life of the Project.

While there may be alternatives to the Project that would provide similar benefits, any alternative would carry similar or greater unavoidable impacts; NPMPP believes that the Project represents the best balance of impacts and benefits of any available alternative.

6.7 Connected Actions

In connection to the Project, HECO anticipates the need to implement system additions and modifications to integrate the Project. These system additions and modifications, which have been preliminarily identified during HECO's ongoing interconnection requirements study, include activities at the existing Koolau Substation and the existing Kawela relay station, described in detail below.

6.7.1 Koolau Substation

The existing Koolau substation is located at 45-580 Kionaole Road in Kaneohe near the H-3 Highway and Kamehameha Highway interchange, just north of the Pali Golf Course, within TMK 4-5-042:007. The existing substation site consists of 4.2 acres (1.7 hectares; Figure 6-1) owned by HECO. It is located within the General Subzone of the State Land Use Conservation District. It is zoned by the City and County of Honolulu as P-1 Restricted Preservation. The Koolau substation is not located within a Special Management Area (SMA) and is outside of the tsunami evacuation zone. It is located within the FEMA Flood Designation D, an area where flood hazard is undetermined.

Project Description

The Koolau substation retransmits incoming 138-kV power to the 46-kV substations located across the windward side of Oahu, from Kahuku to Waimanalo. The connected action for the Project at the Koolau substation involves installation of new telecommunications (telcom) equipment. The telcom equipment would be accessory to the Koolau substation as it transmits information regarding the substation to monitor and control the electric grid. Preliminary design for the new telcom equipment includes installation of a new concrete pad (approximately 8 feet by 4 feet [2.4 meters by 1.2 meters]) that would support an approximately 6-foot-tall (1.8-meter-tall) telcom cabinet. No plumbing or drainage is required. The new telcom equipment would not require any change to how the existing substation is operated and maintained.

Land Use Regulations and Permits

Lands within the State Land Use Conservation District are regulated by HRS §183C Conservation District and administered by HAR §13-5 Conservation District. The new telcom equipment is an identified use pursuant to HAR §13-5-22 *Identified Land Uses in the Protective Subzone, P-9 Structures, Accessory (B-1) Construction or placement of structures accessory to the existing facilities or uses*. This new accessory structure to the Koolau substation would require a Site Plan Approval from DLNR Office of Conservation and Coastal Lands.

In addition, the new telcom equipment is identified as an exempt action for HRS Chapter 343 pursuant to HAR §11-200-8 *Exempt Class of Action (6) Construction or placement of minor structures accessory to existing facilities*. Therefore, there is no additional requirement for environmental review under HRS Chapter 343 for the new telcom equipment.

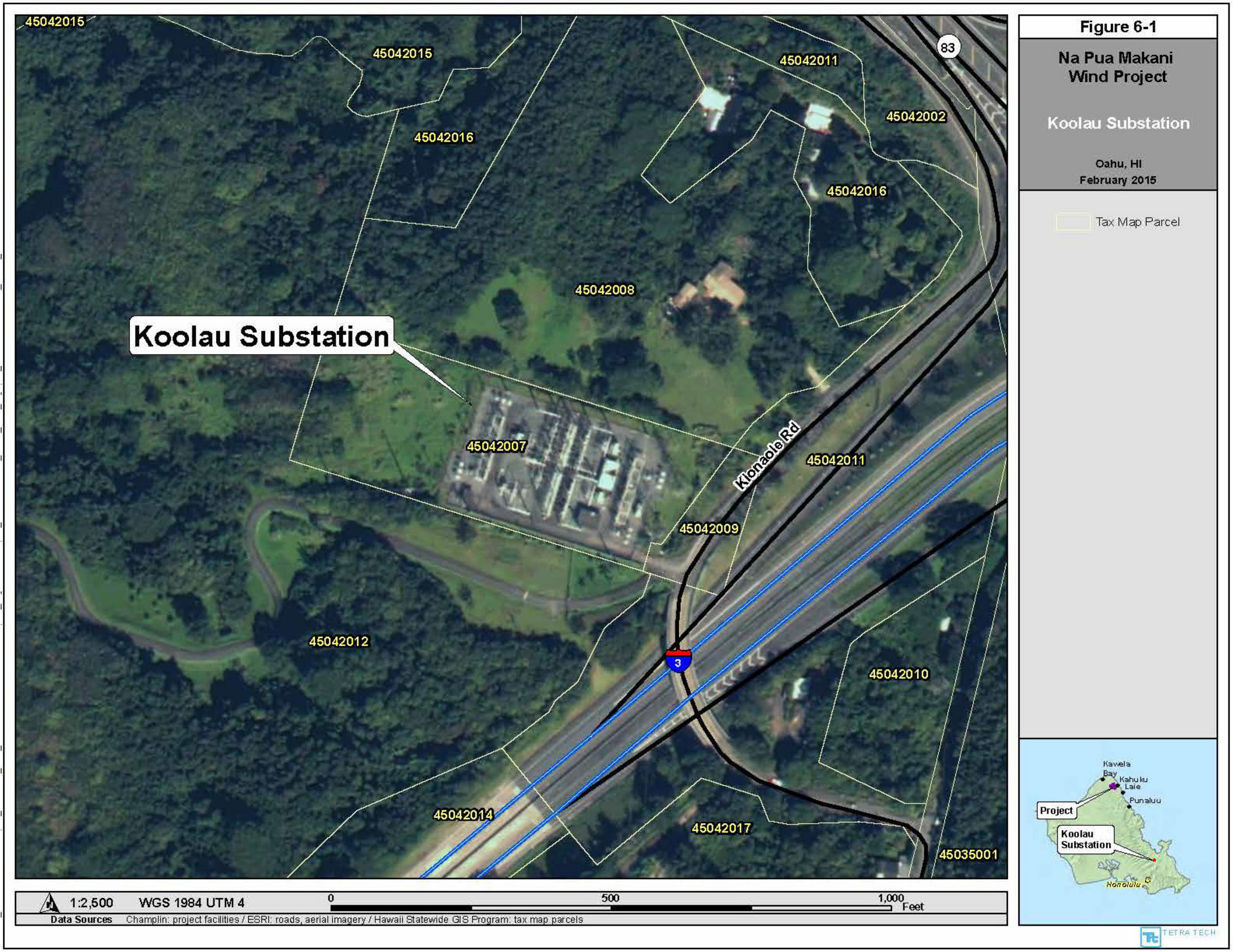
Figure 6-1
Na Pua Makani Wind Project
Koolau Substation
Oahu, HI
February 2015
Tax Map Parcel
Koolau Substation
Kionaole Rd
45042015
45042015
45042011
45042002
45042016
45042016
45042008
45042007
45042011
45042009
45042012
45042010
45042014
45042017
45035001
83
3
1:2,500
WGS 1984 UTM 4
0
500
1,000
Feet
Data Sources Champlin: project facilities / ESRI: roads, aerial imagery / Hawaii Statewide GIS Program: tax map parcels
Kawela Bay
Kahuku
Laie
Punaluu
Project
Koolau Substation
Honolulu
TETRA TECH

Environmental Effects

The installation and operation of the new telcom equipment at the Koolau substation are not anticipated to result in adverse impacts. The telcom equipment would be installed within the existing boundary of the Koolau substation. Minimal site preparation would be required. The new telcom equipment would be visually consistent with the existing facility, and visual impacts are expected to be minimal because the height of the telcom equipment would be approximately 6 feet (1.8 meters) above ground. No permanent employees would be assigned to the new telcom equipment, and maintenance would be performed by existing staff, such that the operation of the equipment would not generate additional traffic or human activity at the site. Temporary noise or dust generated during construction would be negligible. Installation and operation of the new telcom equipment would not require any public services such as water or sewer systems.

6.7.2 Kawela Relay Station

The existing Kawela relay station is located within the Kahuku Training Area on TMK 5-8-002:006 in Kahuku. The Kawela relay station is south (mauka) of Kawela Bay approximately 2.2 miles (3.5 kilometers). The Kawela relay station is located on approximately 1 acre (0.4 hectare) owned by the Department of Army. It is located within the State Land Use Agricultural District and zoned by the City and County of Honolulu as AG-2 General Agricultural District. The Kawela relay station is not located in the SMA and is outside of the tsunami evacuation zone. It is located within the FEMA Flood Designations of X and D, which are beyond the 500-year flood plan and the flood hazard is undetermined, respectively.

Project Description

The Kawela relay station relays HECO telecommunications for the HECO electric grid. The connected action to the Project for the Kawela relay station involves installation of a dish on the existing 200-foot tower. No earthwork would be performed and no plumbing or drainage improvements would be required. The new dish would not require any change to how the existing Kawela relay station is operated and maintained.

Land Use Regulations and Permits

Permitted uses within the State Land Use Agricultural District are outlined in HRS §205-4.5 *Permissible uses within the agricultural districts*. The Kawela relay station is a permitted use within the State Land Use Agriculture District. Additionally, lands within the AG-2 General Agricultural zoning are regulated by the City and County of Honolulu; and the Kawela relay station is permitted as a use with an existing Conditional Use Minor Permit. The new dish will require a modification to the existing Conditional Use Minor Permit (No. 95/CUP1-106); and as such, one will be prepared and processed. Consultation with the Department of Army would need to occur because the Department of Army is the landowner of the Kawela relay station.

Environmental Effects

The installation and operation of the new dish at the Kawela relay station are not anticipated to result in adverse impacts. The dish would be installed on the existing tower. The new dish would be visually consistent with the existing facility, and therefore, visual impacts would be negligible. No permanent employees would be assigned to the new dish, and maintenance would be performed by existing staff, such that the operation of the equipment would not generate additional traffic. No significant amount of noise or dust would be created during construction, and installation and operation of the new dish would not require any public services such as water or sewer systems.

7.0 CONSULTED PARTIES

This chapter provides a summary of the parties consulted during preparation of the EIS. The first steps in the environmental review process for the Project were conducted to meet both Federal NEPA and State HEPA requirements because the Draft EIS was prepared as a joint Federal/State document. Therefore, the summary below includes reference to HEPA-specific requirements (i.e., publication/distribution of an EIS preparation notice (EISPN)) and other outreach efforts that were conducted jointly prior to divergence of the NEPA process (this EIS) and the HEPA process (a Final EIS was prepared under separate cover).

7.1 Consultation

Early coordination meetings with agencies, Kahuku Community Association, Kahuku organizations, and community members began in May 2013. The list of parties consulted before and during the public scoping period and preparation of the Draft EIS is presented below in Table 7-1.

Table 7-1. Consulted Parties

Agency/Entity	Contact Name
U.S. Fish and Wildlife Service	Mr. Aaron Nadig Ms. Jodi Charrier Mr. Dan Clark Ms. Dawn Bruns Mr. Ian Bordenave Ms. Jenny Hoskins Mr. Ken Foote
Maui and Oahu National Wildlife Refuge Complex	Mr. David Ellis
U.S. Army Corps of Engineers, Honolulu District	Ms. Katy Damico
U.S. Department of Agriculture	Mr. Larry Yamamoto, State Conservationist Mr. Mike Johanns, Secretary of Agriculture
Marine Corps Base Hawaii	Ms. Tiffany Patrick
U.S. Army Garrison, Hawaii Department of Army, Kahuku Training Area	Mr. Daniel W. Whitney
Federal Aviation Administration	Flight Standards District Office
U.S. Legislators	Senator Brian E. Schatz Senator Mazie K. Hirono Representative Tulsi Gabbard Representative Colleen Hanabusa
State of Hawai‘i, Department of Land and Natural Resources (DLNR)	Mr. William Aila, Chairperson (former) Ms. Suzanne Case, Chairperson (current)
State of Hawai‘i, DLNR, Land Division	Mr. Russell Tsuji, Administrator Mr. Ian Hirokawa Ms. Malama Minn
State of Hawai‘i, DLNR, Division of Forestry and Wildlife (DOFAW)	Ms. Afsheen Siddiqi Ms. Angela Amlin
State of Hawai‘i, DLNR, Historic Preservation Division	Ms. Nona Neboa
State of Hawai‘i, Department of Business, Economic Development and Tourism (DBEDT)	Mr. Mark Glick, Administrator Mr. Cameron Black Ms. Veronica Rocha
State of Hawaii, Department of Agriculture	Mr. Russell Kokubun, Chair

Table 7-1. Consulted Parties (continued)

Agency/Entity	Contact Name
State of Hawaii, Office of the Governor	Governor Neil Abercrombie Mr. Bruce Coppa, Chief of Staff
State of Hawaiʻi Legislators	Senator Clayton Hee Senator Mike Gabbard Representative Chris Lee Representative Richard Fale
City and County of Honolulu, Office of the Mayor	Mayor Kirk Caldwell
City and County of Honolulu, Department of Planning and Permitting	Mr. George I. Atta, Director
City and County Legislator	Mr. Ernest Martin, Chair Mr. Reed Matsuura
Community Groups	Kahuku Community Association Laie Community Association Hau ula Community Association Koolauloa Neighborhood Board North Shore Neighborhood Board Koolauloa Community Health and Wellness Center Turtle Bay Resort Kahuku Medical Center Keep North Shore Country Laie Hawaii Temple Kahuku Elderly EAH Housing North Shore Community Land Trust Sunset Beach Community Defend Oahu Coalition Kahuku High and Intermediate School Kahuku Elementary School Laie Elementary School Kamehameha Preschool Kahuku

7.2 EISPN Distribution

The parties listed below in Table 7-2 were provided a copy of the EISPN for review during the 30-day public comment period that ended on January 22, 2014, following the notice of availability published in the OEQC's *Environmental Notice* on December 23, 2013. They also received the republished EISPN for review during the second public comment period that ended on December 8, 2014, after a second notice of availability was published in OEQC's *Environmental Notice* on November 8, 2014.

Table 7-2. EISPN Distribution List

Name	Organization
Ernest Y.W. Lau	Board of Water Supply
Chris Takashige, P.E.	City and County of Honolulu
Lori M.K. Kahikina	City and County of Honolulu
Michele K. Nekota	City and County of Honolulu
George I. Atta, FAICP, LEED AP, CEI	City and County of Honolulu
Michael D. Formby	City and County of Honolulu
Manuel P. Neves	City and County of Honolulu
Sophie Cocke	Civil Beat Honolulu
Carolyn Unser	First Wind
	Hawaii State Library (Honolulu), Hawaii Documents Center

Table 7-2. EISPN Distribution List (continued)

Name	Organization
Kaiulani Shinsato	Hawaiian Electric Company
	Kahuku Public Library
Rachel James	Office of Congresswoman Tulsi Gabbard
Vandeth Sek	Office of Congresswoman Tulsi Gabbard
Kamanaʻopono Crabbe	Office of Hawaiian Affairs
Russell Kokubun	State of Hawaii
Richard Lim	State of Hawaii
Linda M. Rosen, M.D., M.P.H.	State of Hawaii
Jobie Masagatani	State of Hawaii
Ford Fuchigami	State of Hawaii, Department of Transportation
Cameron Black	State of Hawaii, Department of Business, Economic Development & Tourism
Mark Glick	State of Hawaii, Department of Business, Economic Development & Tourism
Russell Y. Tsuji	State of Hawaii, Department of Land and Natural Resources
Christine Clarke	U.S. Department of Agriculture, Natural Resources Conservation Service
George Young	U.S. Department of Army, U.S. Army Engineer District, Honolulu, Regulatory Branch
Carl Borgstrom	U.S. Department of Energy, Office of NEPA Policy & Compliance
Wayne Nastri	U.S. Environmental Protection Agency, Region 9
Tulsi Gabbard	United States Representative
Colleen Hanabusa	United States Representative
Mazie K. Hirono	United States Senator
Brian E. Schatz	United States Senator
	University of Hawaii at Manoa
Crystal Bikle	
Joseph Bruey	
Aaron Campbell	
Susan Carstenn	
Paul Conry	
Kent Fonoimoana	
Al Gardnor	
Carl Hubbell	
Thomas P. Navaez	
Kamilla Sporsheim	
Kurt Tsue	
Alan Yonan	

7.3 Comments Received on EISPN

During the initial public scoping period, three public scoping meetings were held at Kahuku Community Center—the first on November 13, 2013 (hosted by USFWS for the NEPA process), the second on January 10, 2014, and the third on November 19, 2014 (hosted by the Applicant for the HEPA process). In addition to the public meetings, a media advisory was sent out prior to each meeting (see Appendix A). The parties listed in Table 7-3 provided comments on the EISPN either in writing or verbally, at one of the public meetings. Copies of the comment letters and responses are included in Appendix A. Summaries of the oral testimonies given at the public meetings and the individual responses are also included in Appendix A.

Table 7-3. EISPN Comments

Name	Organization
Kent Fonoimoana	Board Member Kahuku Community Association, Board Member Koolauloa Neighborhood Board #28
Ernest Y. W. Lau	Board of Water Supply
Melissa Primacio	Chair, Kahuku Community Association
Chris Takashige, P.E.	City and County of Honolulu, Department of Design and Construction
Ross S. Sasamura, P.E.	City and County of Honolulu, Department of Facility Maintenance
Michele K. Nekota	City and County of Honolulu, Department of Parks and Recreation
George I. Atta, FAICP, LEED AP, CEI	City and County of Honolulu, Department of Planning and Permitting
Louis M. Kealoha	City and County of Honolulu, Police Department
Michael D. Formby	City and County of Honolulu, Department of Transportation Services
Tim Vandeveer	Co-Chair, Defend Oahu Coalition
Daniel Whitney	Colonel, U.S. Army Installation Management Command, Pacific Region Headquarters United States Garrison, Hawaii
Henry Curtis	Executive Director, Life of the Land
Gordon Wong	Federal Aviation Administration, Honolulu Airports District
Casey Willis	Infinity Wind Power
DeeDee Letts	Koolauloa Neighborhood Board
Scott Sysum	National Older Worker Career Center, Energy Specialist, U.S. EPA Region IX, Environmental Review Office
Dean H. Seki	State of Hawaii, Department of Accounting and General Services
Marvin Manuel	State of Hawaii, Department of Hawaiian Home Lands
Herman Tuiolosega	State of Hawaii, Office of Environmental Quality Control
Leo R. Asuncion	State of Hawaii, Office of Planning
Alec Wong	State of Hawaii, Department of Health, Clean Water Branch
Susan Lebo	State of Hawaii, Department of Land and Natural Resources, State Historic Preservation Division
Steve Molmen	State of Hawaii, Department of Land and Natural Resources, Land Division
Russel Tsuji	State of Hawaii, Department of Land and Natural Resources, Land Division
Ford N. Fuchigami	State of Hawaii, Department of Transportation
Lauren A	
Ann Allred	
Andrea Anixt	
Ghia Borges	
Harry Brown	
Rebecca Carlson	
Aaron Curtis	
Maria Feagai	
Karen Gallagher	
Al Gardnor	
Fred Geibelt	
Carter Griffin	

Table 7-1: EISPN Comments (continued)

Name	Organization
Larissa Hekau	
Angela Huntemer	
Choon James	
Mary Kamauoha	
Merania Kekaula	
Kealoha Mercurio	
Delsa Moe	
Joshua Noga	
Aliitasi Ponder	
Tasi Ponder	
Makaiau Ralph	
Suzanne Reed	
Tanoai Reed	
Ben Shafer	
Theone Taala	
Vasa Taualii	
Cindy Tutor	

7.4 Comments Received on the Draft EIS

The Draft EIS was published in the OEQC's *The Environmental Notice* on June 8, 2015, and a Notice of Availability of the Draft EIS was published in the Federal Register on June 12, 2015 by the USFWS (80 FR 33535-33537), and on the same date by the U.S. EPA ((80 FR 33519), in accordance with requirements set forth under HEPA (HRS § 343-3) and NEPA (40 CFR 1506.6) implementing regulations. Public comments were accepted during the 45-day and 60-day State and Federal public comment periods, respectively. A public open house meeting was held during the comment periods on June 23, 2015, in Kahuku. The parties listed in Table 7-4 provided comments, either in writing or verbally, during the HEPA and NEPA public comment periods. Copies of the comment letters and responses are included in Appendix M. Oral testimonies given at the public meeting and the individual responses are also included in Appendix M of the Final EIS.

Table 7-4. Draft EIS Comments

Name	Organization
Kathleen Goforth	U.S. Environmental Protection Agency
Bruce Petersen	U.S. Department of Agriculture, Natural Resource Conservation Service
Leo Asuncion	State of Hawaii, Office of Planning
Alec Wong	State of Hawaii, Department of Health
Laura Leialoha Phillips McIntyre	State of Hawaii, Department of Health
Scott Enright	State of Hawaii, Department of Agriculture
Brooke Wilson	Pacific Resource Partnership
Kent Fonoimoana and various other commenters	Kahuku Community Association
Barry Cheung	State of Hawaii Department of Land and Natural Resources, Land Division

Table 7-4. Draft EIS Comments (continued)

Name	Organization
Lauren Yasaka	State of Hawaii Department of Land and Natural Resources, Office of Conservation and Coastal Lands
Alton Miyasaka	State of Hawaii Department of Land and Natural Resources, Division of Aquatic Resources
Daniel Quinn	State of Hawaii Department of Land and Natural Resources, Division of State Parks
Cody Chang	State of Hawaii Department of Land and Natural Resources, Engineering Division
Tyler Dos Santos-Tam	Hawaii Construction Alliance
Sherry Menor-McNamara	Chamber of Commerce
Louis Kealoha	City and County of Honolulu Police Department
Socrates D. Bratakos	City and County of Honolulu Fire Department
Michael Formby	City and County of Honolulu Department of Transportation Services
George Atta	City and County of Honolulu Department of Planning and Permitting
Ross Sasamura, PE	City and County of Honolulu Department of Facility Maintenance
Robert J. Kroning	City and County of Honolulu Department of Design and Construction
Ernest Lau	State of Hawaii Board of Water Supply
Richard Wallsgrove	Blue Planet
Michael Hutchins	American Bird Conservancy
Billy Long	
Daniel Aemslvong	
Hudson Lote	
Daniel Aemslvong	
Samuel Midallia	
Emmett Nothnagle	
Michaela Primacio	
Dr. Don Sand	
Nainoa Soren	
Abraham Ueda	
Abraham Ueda	
Unknown	
Unknown	
Dino Vendiola	
Stacy Ako	
Mona Wago	
Stacy Ako	
Kainaiu Werner	
Kekoa Werner	
Timmy Wescot	
Aisa Wily	
Andrea Anixt	
Dana Woolsey	
Mana Feagai	
George Wallace	
Melissa Primacio	
Steve Anderson	

Table 7-4. Draft EIS Comments (continued)

Name	Organization
Ghia Borges	
Nakia Mae'ole	
Vasaloloa Taualii	
Jon Barlow	
Mitch Dmohowski	
Detreck Abraham	
Lorraine Aho	
Bob Comeau	
Lexie Latu	
Penni Latu	
Simplicio Caban	
Roxanne Latu	
Gillian Yamagata	
John Primacio	
Ben Rabanal	
Tom Narvaez	
Cheryl Wago	
Wade Wago	
Bob Uyeda	
Keawe Rillamas	
Phyllis Moses	
Samson Chun	
James Moses	
Kealohilani Fotu	
Tukuafu Fotu	
Debi Lee	
Chris Wilson	
Joshua Mendez	
Katrina Comeau	
Matthew Comeau	
Robert Comeau	
Seamus Fitzgerald	
Jon Hipa	
Jolene Kanahele	
Shawn Keliiki	
Cindy Tutor	
Sara M. Johnson	
Mibi Harp	
Daniel Johnson	
Lee Harp	
John keliiliki	
Charlene Keliiliki	
Joe Kalili	
Frederick Lawrence	
Sandy Budlong	

7.5 Other Outreach Efforts

NPMPP has undertaken a comprehensive local public affairs strategy for the development of the Project. Taking into account the diversity of the population as well as the Project's overall size, scope, and potential impact, it has been imperative to engage in community outreach and education through a variety of methods. In addition to the public meetings discussed above, the NPMPP has conducted well over a hundred small group meetings with State and County Agencies, legislators, organizations, and individuals. Additionally, a Web page has been developed (http://napuamakaniwind.com) that features general Project information. A brochure has been created containing information regarding the proposed Project's energy output, a timeline, a map of the area, and a detailed outline of how wind energy works. This brochure has been distributed to interested parties at stakeholder meetings as well as larger community events. Informational post-cards and monthly newsletters have also been distributed to keep the community up to date on the status of the Project. A Facebook page was created that provides up-to-date information on the Project and other community-interest information. In addition, as part of the NEPA process, the USFWS posted a News Release, FR Notice, Notice of Public Scoping Meeting, Draft HCP and Draft EIS on their website, http://www.fws.gov/pacificislands/, on June 10, 2015. The Final EIS (Notice of Availability published in the Federal Register on June 12, 2016 [81 FR 45174-45176]), is also available on this website for the public's reference.

8.0 REFERENCES

Agricultural Resource Management Division. 2015. Irrigation Systems. State of Hawaii, Department of Agriculture. Available online at: http://hdoa.hawaii.gov/arm/irrigation-systems/. Accessed December 10, 2015.

Ainley, D.G., R. Podolsky, L. de Forest, G. Spencer, N. Nur. 1995. Kauai Endangered Seabird Study Volume 2. The ecology of Newell's shearwater and dark-rumped petrel on the island of Kauai, Hawaii. Final report prepared for Electric Power Research Institute, Palo Alto, CA. Stinson Beach, CA: Prepared by Point Reyes Bird Observatory. 74 pp.

Ainley, D.G., R. Podolsky, L. de Forest, G. Spencer, and N. Nur. 2001. The status and population trends of the Newell's shearwater on Kauai: insights from modeling. Studies in Avian Biology. 22:108 – 123.

Ainley, D.G., T.C. Telfer, and M.H. Reynolds. 1997. Townsend's and Newell's shearwater (*Puffinus auricularis*). In A. Poole and F. Gill, editors, The Birds of North America, No. 297. Academy of Natural Sciences, Philadelphia and American Ornithologists' Union, Washington, D.C.

American Wind Wildlife Institute (AWWI). 2016. Wind turbine interactions with wildlife and their habitats: a summary of research results and priority questions. Available online at: https://awwi.org/resources/summary-of-wind-wildlife-interactions-2/#section-summary-of-windwildlife-interactions (Accessed September 2016).

ANSI (American National Standards Institute). 2005. Quantities and Procedures for Description and Measurement of Environmental Sound – Part 4: Noise Assessment and Prediction of Long-Term Community Response. Acoustical Society of America. Melville, New York.

AOU (American Ornithologists' Union). 1998. Checklist of North American birds, 7th edition. American Ornithologists' Union. Washington, DC. 829pp. http://www.aou.org/checklist/north/print.php (accessed on January 13, 2014)

APLIC (Avian Power Line Interaction Committee). 2012. Reducing avian collisions with power lines: the state of the art in 2012. Edison Electric Institute and APLIC. Washington, D.C.

Arnett, E.B. (Ed). 2005. Relationships between bats and wind turbines in Pennsylvania and West Virginia: an assessment of bat fatality search protocols, patterns of fatality, and behavioral interactions with wind turbines. A final report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, TX.

Arnett, E.B. and E.F. Baerwald. 2013. Impacts of wind energy development on bats: implications for conservation. In*:* Bat Evolution, Ecology, and Conservation*.* Springer New York: 435-456.

Arnett, E.B., D.B. Inkley, D.H. Johnson, R.P. Larkin, S. Manes, A.M. Manville, J.R. Mason, M.L. Morrison, M.D. Strickland, and R. Thresher. 2007. Impacts of wind energy facilities on wildlife and wildlife habitat. Wildlife Society Technical Review 07-2. The Wildlife Society, Bethesda, Maryland, USA.

Arnett, E.B., J.P. Hayes, M.M.P. Huso, and M. Schirmacher. 2010. Effectiveness of changing wind turbine cut-in speed to reduce bat fatalities at wind facilities. Austin, TX: Bat Conservation International. www.batsandwind.org/pdf/Curtailment Final Report 5-15-10 v2.pdf.

Arnett, E.B., M. Schirmacher, M.M.P. Huso and J.P. Hayes. 2009. Effectiveness of Changing Wind Turbine-Cut in Speed to Reduce Bat Fatalities at Wind Facilities. An annual report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, Texas, USA.

Arnett, E.B., W.K. Brown, W.P. Erickson, K.K. Fiedler, B.L. Hamilton, T.H. Henry, A. Jain, G.D. Johnson, J. Kerns, R.R. Koford, C.P. Nicholson, T.J. O'Connell, M.D. Piorkowski, and R.D. Tankersley, Jr. 2008. Patterns of bat fatalities at wind energy facilities in North America. Journal of Wildlife Management 72:61 – 78.

AWEA (American Wind Energy Association). 2008. In the Public Interest: How and Why to Permit for Small Wind Systems. A Guide for State and Local Government. September 2008. Available online at http://distributedwind.org/assets/2012/12/InThePublicInterest.pdf. Accessed March 2014.

AWEA (American Wind Energy Association). 2014. "The Cost of Wind Energy in the U.S." Available at: http://www.awea.org/Resources/Content.aspx?ItemNumber=5547. Accessed July 3, 2014.

Baerwald, E.F. and R.M.R. Barclay. 2009. Geographic variations in activity and fatality of migratory bats at wind energy facilities. Journal of Mammalogy 90(6): 1341-1349.

Baldwin, P.H. 1950. Occurrence and behavior of the Hawaiian bat. Journal of Mammology 31:455 – 456.

Banko, P. C. 1988. Breeding biology and conservation of the Nēnē, Hawaiian Goose (Nesochen sandvicensis). Phd Thesis. University of Washington, Seattle, WA.

Banko, W.E. 1987. History of endemic Hawaiian birds. Part I. Population histories – species accounts. Freshwater birds: Hawaiian Gallinule (`Alae-`ula). CPSU-UH Avian History Report 12A:1-138.

Banko, P.C., J.M. Black, and W.E. Banko. 1999. Hawaiian Goose (*Branta sandvicensis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/434/articles/introduction.

Bannor, B.K and E. Kiviat. 2002. Common Moorhen (*Gallinula chloropus*). No.685 *in* The Birds of North America (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadephia, PA. 27 pp.

Barclay, R., E. Baerwald, and J. Gruver. 2007. Variation in bat and bird mortalities at wind energy facilities: assessing the effects of rotor size and tower height. Canadian Journal of Zoology 85(3): 381–387.

Belt Collins Hawaii LLC. 2016a. Preliminary Drainage Report: Na Pua Makani Wind Farm. Prepared for Champlin Hawaii Wind Holdings LLC. Honolulu, Hawaii. February.

Belt Collins Hawaii LLC. 2016b. Traffic Assessment Report: Na Pua Makani Wind Farm. Prepared for Champlin Hawaii Wind Holdings LLC. Honolulu, Hawaii. June.

Beranek, L. 1988. Noise and Vibration Control, Chapter 7 - Sound Propagation Outdoors. Institute of Noise Control Engineering, Washington, DC.

Berger, A.J. 1981. Hawaiian birdlife, second edition. University of Hawaii Press, Honolulu, HI. 275 pp.

Black, J.M. and P.C. Banko. 1994. Is the Hawaiian Goose (Branta sandvicensis) saved from extinction? In: Creative Conservation – the Interface Between Captive and Wild Animals, Ed. P.J.S. Olney, G.M. Mace, and A.T.C Fesitner. pp 394-410. Chapman & Hall, London.

Black, J.M., A.P. Marshall, A. Gilburn, N. Santos, H. Hoshide, J. Medeiros, J. Mello, C.N. Hodges and L. Katahira. 1997. Survival, movements, and breeding of released Hawaiian Geese: an assessment of the reintroduction program. Wildl. Manage. 61:1161-1172.

BLM (United States Department of the Interior Bureau of Land Management). 1986. BLM Manual. H-8410-1 Visual Resource Management Inventory.

Bogan, M.A. 1972. Observations on parturition and development in the hoary bat *Lasiurus cinereus*. *Journal of Mammalogy.* 53:611–614.

Bolin, Karl, Gosta Bluhm, Gabrielle Eriksson, and Mats E Nilsson. 2011. Infrasound and low frequency noise from wind turbines: exposure and health effects. *Environmental Research Letters.* 6 035103. http://iopscience.iop.org/1748-9326/6/3/035103/pdf/1748-9326_6_3_035103.pdf (accessed July 22, 2014).

Bolt Beranek and Newman, Inc. 1977. Power Plant Construction Noise Guide, prepared for the Empire State Electric Energy Research Corporation, Report No. 3321, 1977.

Bostwick, J.M. 1982. Habitat loss and hybridization: the dual threat to the koloa. Senior Honors Thesis, Department of Zoology, University of Hawaii at Manoa, Honolulu, Hawaii. 80 pp.

Brisbin, I.L., H.D. Pratt, and T.B. Mowbray. 2002. American coot (*Fulica americana*) and Hawaiian coot (*Fulica alai*). In The Birds of North America, No. 697 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Brooke, M. 2004. Albatrosses and petrels across the world. Oxford University Press, Oxford

Browne, R.A., C.R. Griffin, P.R. Chang, M. Hubley, and A.E. Martin. 1993. Genetic divergence among populations of the Hawaiian duck, Laysan duck, and mallard. Auk 110:49 – 56.

Businger, S. 1998. Hurricanes in Hawai`i. University of Hawai`i, Department of Meteorology. September 1988. http://www.soest.Hawai`i.edu/MET/Faculty/businger/poster/hurricane/ (accessed on December 18, 2013).

Byrd, G.V. and C.F. Zeillemaker. 1981. Ecology of nesting Hawaiian Common Gallinules at Hanalei, Hawaii. Western Birds 12:105 – 136.

Byrd, G.V., R.A. Coleman, R.J. Shallenberger, and C.S. Arume. 1985. Notes on the breeding biology of the Hawaiian race of the American Coot. `Elepaio

Canning, G., and L.J. Simmons. 2010. Wind Energy Study – Effect on Real Estate Values in the Municipality of Chatham-Kent, Ontario. Prepared by Canning Consultants Inc. & John Simmons Realty Services Ltd. Prepared for Canadian Wind Energy Association. February, 2010. 85 pages.

CanWEA. Undated. About Stray Voltage. Available online at http://www.prowind.ca/downloads/Resources/StrayVoltageFactSheet.pdf. Accessed March 2014.

Carter, J. 2011. The Effect of Wind Farms on Residential Property Values in Lee County, Illinois. Thesis Prepared for Master's Degree. Illinois State University. 35 pages.

CEQ (Council on Environmental Quality). 1997a. Environmental Justice Guidance under the National Environmental Policy Act. Executive Office of the President. Washington, D.C. December 10. Available online at: http://www.epa.gov/compliance/resources/policies/ej/index.html

CEQ. 1997b. Considering Cumulative Effects Under the National Environmental Policy Act. Executive Office of the President. Washington, D.C. Available online at: http://energy.gov/sites/prod/files/nepapub/nepa_documents/RedDont/G-CEQ-ConsidCumulEffects.pdf

CEQ. 2005a. Regulations For Implementing the Procedural Provisions of the National Environmental Policy Act. Executive Office of the President. Washington, D.C. Available online at: http://energy.gov/sites/prod/files/NEPA-40CFR1500_1508.pdf.

CEQ. 2005b. Guidance on the Consideration of Past Actions in Cumulative Effects Analysis. Executive Office of the President. Washington, D.C. Available online at: http://energy.gov/sites/prod/files/nepapub/nepa_documents/RedDont/G-CEQ-PastActsCumulEffects.pdf

Chang, P.R. 1990. Strategies for managing endangered waterbirds on Hawaiian National Wildlife Refuges. M.S. thesis, University Massachusetts, Department of Forestry and Wildlife Management, Amherst, MA. 87 pp.

Chapman, S., A. St. George, K. Waller, and V. Cakic. 2013. Spatio-temporal differences in the history of health and noise complaints about Australian wind farms: evidence for the psychogenic, "communicated disease" hypothesis. *Pre-Print: Submitted for publication.* Sydney School of Public Health, University of Sydney, Australia. March 2013. Available online at http://ses.library.usyd.edu.au//bitstream/2123/8977/4/Complaints%20FINAL.pdf. Accessed March 2014.

Chartier, V.L., R. Sheridan, J.N. DiPlacido, M.O., Loftness. 1986. Electromagnetic Interference Measurements at 900 MHZ on 230-kV and 500-kV Transmission Lines. IEEE Transactions on Power Delivery 1(2):140-149

Chatham-Kent Public Health Unit. 2008. The Health Impact of Wind Turbines: A Review of the Current White, Grey, and Published Literature. Prepared for Chatham-Kent Municipal Council, Chatham Ontario. June 2008.

Chief Medical Officer of Health (CMOH). 2010. The Potential Health Impact of Wind Turbines. Chief Medical Officer of Health Report. Available online at: http://www.health.gov.on.ca/en/common/ministry/publications/reports/wind_turbine/wind_turbine.pdf (accessed July 22, 014).

Chu, P-S., W. Yan, and F. Fujioka. 2002. Fire-Climate Relationships and the Long-Lead Seasonal Wildfire Prediction for Hawaii. International Journal of Wildland Fire 11(1): 25-31.

CIER (Center for Integrative Environmental Research). 2007. Regional Highlight: Hawaii and US Affiliated Islands. The US Economic Impacts of Climate Change and the Costs of Inaction. A Review and Assessment by the Center for Integrative Environmental Research at the University of Maryland. October 2007

City and County of Honolulu, Department of Planning and Permitting (DPP). 1999. Ko'olau Loa Sustainable Communities Plan. http://www.honoluludpp.org/Portals/0/pdfs/planning/Koolauloa/KoolauloaSCP.pdf (accessed December 31, 2013). Department of Planning and Permitting (DPP) City and County of Honolulu. October 1999.

City and County of Honolulu, DPP. 2000. Koolaupoko Sustainable Communities Plan, August 2000. Honolulu, Hawaii. Available online at: http://www.honoluludpp.org/Portals/0/pdfs/planning/Koolaupoko/KoolaupokoSCP.pdf.

City and County of Honolulu, DPP. 2002. Central Oahu Sustainable Communities Plan, December 2002. Available online at: http://www.honoluludpp.org/Planning/DevelopmentSustainableCommunitiesPlans/CentralOahuPlan.aspx.

City and County of Honolulu, DPP. 2012. Koolau Loa Sustainable Communities Plan, December 2012. Honolulu, Hawaii. Available online at: http://www.honoluludpp.org/Portals/0/pdfs/planning/Koolauloa/Kloa5Yr/Final/Final_KLSCP(Dec2012).pdf.

City and County of Honolulu, DPP. 2015. Oahu IAL Web Map. Important Agricultural Lands Map, GIS Data. Available online at: http://hhf.maps.arcgis.com/home/item.html?id=693a7ed99e9b421391bf03353bd01271 (Accessed on December 29, 2015)

City and County of Honolulu, Department of Budget and Fiscal Services (DBFS). 2013. Comprehensive Annual Financial Report. Fiscal Year Ended June 30, 2013. Honolulu, Hawaii.

City and County of Honolulu, HPD (Honolulu Police Department). 2014. Honolulu Police Department Patrol Districts. Web site available at: http://www.honolulupd.org/department/index.php?page=patrol_districts

City and County of Honolulu, EMS (Emergency Medical Services Division). 2014. Ambulance Locations. Web site available at: http://www.honolulu.gov/cms-esd-menu/site-esd-sitearticles/717-ambulance-locations.html

City and County of Honolulu, HFD (Honolulu Fire Department). 2013. Honolulu Fire Department Today. Web site available at: http://www.honolulu.gov/hfd/abouthfd.html

City and County of Honolulu, DES (Department of Environmental Services). 2012. Report of the Mayor's Advisory Committee on Landfill Site Selection. September 2012. Available at: http://www.opala.org/solid_waste/pdfs/MACLSS%20REPORT%20FINAL%20092512.pdf

City and County of Honolulu, DES. 2014. Landfill Status web page. Available at: http://www.opala.org/solid_waste/Landfill_Status.htm

Colby, David W., M.D.; Robert Dobie, M.D.; Geoff Leventhall, Ph.D.; David M. Lipscomb, Ph.D.; Robert J. McCunney, M.D.; Michael T. Seilo, Ph.D.; and Bo Søndergaard, M.Sc. 2009. Wind Turbine Sound and Health Effects: An Expert Panel Review. Prepared for: American Wind Energy Association and Canadian Wind Energy Association. December 2009. Available online at: http://www.nwea.nl/sites/default/files/Wind%20Turbine%20Sound%20and%20Health%20Effects%202009,%20onderzoek%20uit%20USA%20Canada%202010.pdf, accessed March 2014.

Coleman, R.A. 1981. The reproductive biology of the Hawaiian subspecies of the black-necked stilt, *Himantopus mexicanus knudseni*. Ph.D. dissertation, Pennsylvania State University, PA. 106 pp.

Continental Pacific, LLC. 2013. Kahuku Village. Available online at: www.kahukuvillage.com/home.html (accessed on January 27, 2014).

Cook, James and James King. 1784. *A Voyage to the Pacific Ocean. Undertaken, by the Command of His Majesty for Making Discoveries in the Northern Hemisphere, 1776-1780*. 3 volumes. W. and A. Strahan, London.

Cooper, B.A., P.M. Sanzenbacher, and R.H. Day. 2009. Radar and visual studies of seabirds at the proposed Kawailoa Wind Energy Facility, Oahu Island, Hawaii, 2009. Unpublished report prepared for First Wind LLC, Newton, MA by ABR, Inc., Forest Grove, OR, and Fairbanks, AK. 32 pp. Appendix 3 in Kawailoa Wind Power Draft Habitat Conservation Plan. July 2011. Prepared by SWCA, Honolulu, HI, for Kawailoa Wind Power LLC, Honolulu, HI. 144 pp + appendices.

Crichton, F., G. Dodd, G. Schmid, G. Gamble, and K. Petrie. 2013. Can Expectations Produce Symptoms From Infrasound Associated With Wind Turbines? Journal of Health Psychology, Mar 11, 2013. Available online at: http://psycnet.apa.org/psycinfo/2013-07740-001/. Accessed March 2014.

Cuddihy, L.W. and C.P. Stone. 1990. Alteration of Native Hawaiian Vegetation-Effects of Humans, their Activities and Introductions. University of Hawaii Press. Honolulu, Hawaii.

CWIF (Caithness Windfarm Information Forum). 2013. Summary of Wind Turbine Accident data to 31 December 2013. Accessed http://www.caithnesswindfarms.co.uk/accidents.pdf. Accessed March 2014.

CWRM (Commission on Water Resources Management). 2008. Hawai'i Water Plan, Water Resources Protection Plan. Prepared for the State of Hawai'i Commission on Water Resource Management. Prepared by Wilson Okamoto Corporation. Honolulu, Hawaii. http://state.hi.us/dlnr/cwrm/planning_wrpp.htm (accessed on December 23, 2013).

DAR (Hawaii Division of Aquatic Resources). 2013. Hawaiian Streams. http://state.hi.us/dlnr/dar/streams.html (accessed on December 27, 2013).

DAR and Bishop Museum. 2008. Atlas of Hawaiian Watersheds and Their Aquatic Resources. http://www.hawaiiwatershedatlas.com/index.html (accessed on December 24, 2013).

Dahl, T.E. 1990. Wetland losses in the United States 1780s to 1980s. U.S. Department of Interior, U.S. Fish and Wildlife Service, Washington, D.C. 13 pp.

DataKustik GmbH. 2013. Computer-Aided Noise Abatement Model CadnaA, Version 4.3.143 Munich, Germany.

Day, R.H. and B.A. Cooper. 2002. Petrel and shearwater surveys near Kalaupapa, Molokai Island, June, 2002. Final report to the National Park Service, Hawaii National Park. ABR, Inc., Fairbanks, Alaska.

Day, R.H. and B.A. Cooper. 2008. Results of endangered seabird and Hawaiian hoary bat surveys on northern Oahu Island, October 2007 and July 2008. Unpublished report prepared for First Wind, Newton, MA, by ABR, Inc.—Environmental Research & Services, Fairbanks, AK, and Forest Grove, OR. 27 pp. Appendix 3 in Kahuku Wind Power Draft Habitat Conservation Plan. August 2009. Prepared by SWCA, Honolulu, HI, for Kahuku Wind Power LLC, Honolulu, HI. 144 pp + appendices.

Day, R.H., B.A. Cooper, and T.C. Telfer. 2003. Decline of Townsend's (Newell's) sheawaters (*Puffinus auricularis newelli*) on Kauai, Hawaii. Auk 120:669 – 679.

Day, R.H., A.K. Prichard, and J.R. Rose. 2005. Migration and collision avoidance of eiders and other birds at Northstar Island, Alaska, 2001 – 2004: Final Report. Prepared for BP Exploration (Alaska) Inc. Anchorage, AK. Prepared by ABR, Inc.—Environmental Research & Services, Fairbanks, AK.

DEFRA (United Kingdom Department for Environment, Food, & Rural Affairs). 2005. Procedure for the Assessment of Low Frequency Noise Complaints. (Prepared by University of Salford, Contract no. NANR45)

Desholm, M. and J. Kahlert. 2005. Avian collision risk at an offshore wind farm. Royal Society Biology Letters 1: 296 – 298.

DLNR (Department of Land and Natural Resources). 2008. DLNR Aquifers. GIS Data. http://planning.hawaii.gov/gis/download-gis-data-expanded/ (accessed on December 24, 2013).

DLNR. 2011. Wetland Restoration and Habitat Enhancement Plan. Kawainui Marsh. Department of Land and Natural Resources. Division of Forestry and Wildlife. March 2011.

DLNR. 2012. Declaration of exemption from the preparation of an environmental assessment under authority of Chapter 343, HRS and Chapter 11-200, HAR for the Koolau Forest Watershed Protection Project.

DLNR. 2013. Kawainui-Hamakua Marsh Complex Master Plan. Prepared for Department of Land and Natural Resources. Division of Forestry and Wildlife. http://www.hhf.com/kawainui/about.html (accessed on December 26, 2013).

DLNR. 2014. Hawaii State Parks website. Available at: http://hawaiistateparks.org.

DLNR. Undated. Poamoho Biological Surveys Report. Department of Land and Natural Resources. Division of Forestry and Wildlife.

DOD (Department of Defense). 2014. Final Environmental Assessment to Relocate Marine Unmanned Aerial Vehicle Squadron Three to Hawaii. Prepared for Naval Facilities Engineering Command Pacific and United States Marine Corps. March 2014. Available at: http://www.mcbhawaii.marines.mil/UnitHome/FeaturedInformation/UAV.aspx

DOFAW (Hawaii Department of Land and Natural Resources, Division of Forestry and Wildlife). 1999. Title 13, Chapter 123, Rules Regulating Game Mammal Hunting. Available online at: http://www.state.hi.us/dlnr/dofaw/hunting/MammalHuntingRegs_Chap123.pdf. Accessed January 2, 2014.

DOFAW. 1976–2008. Biannual Hawaiian waterbird survey data. Summarized by Hawaii Natural Heritage Program and Pacific Islands Fish and Wildlife Office, Honolulu, HI.

DOFAW. 2013a. December 2012 waterbird nesting activity Hamakua Marsh, Island of Oahu. Prepared by K. Doyle for the Oahu Division of Forestry and Wildlife.

DOFAW. 2013b. Na Ala Hele State of Hawaii Trail and Access Program website. Available at http://hawaiitrails.ehawaii.gov/home.php. Accessed January 2014.

DOFAW. 2015. Endangered Species Recovery Committee Hawaiian Hoary Bat Guidance Document. State of Hawaii Department of Land and Natural Resources, Division of Forestry and Wildlife, Honolulu, HI. September 2015

Drewitt, A.L. and R.H.W. Langston. 2008. Collision effects of wind-power generators and other obstacles on birds. Year in Ecology and Conservation Biology 2008. R. S. Ostfeld and W. H. Schlesinger. Oxford, Blackwell Publishing. 1134:233 – 266.

Ducks Unlimited, Inc. 1992. Hamakua Wetland Protection and Enhancement Project, Kailua, Honolulu County, Hawaii; Final Environmental Assessment, Enhancement, and Management Plans. Prepared for U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, State of Hawaii, and the City and County of Honolulu. Sacramento, California.

Engilis, A., Jr. and M. Naughton. 2004. U.S. Pacific Islands Regional Shorebird Conservation Plan. U.S. Shorebird Conservation Plan. U.S. Department of the Interior, Fish and Wildlife Service. Portland, Oregon.

Engilis, A., Jr. and T.K. Pratt. 1993. Status and population trends of Hawaii's native waterbirds, 1977-1987. Wilson Bulletin 105:142 – 158.

Engilis, A., Jr., K.J. Uyehara, and J.G. Giffin. 2002. Hawaiian duck (*Anas wyvilliana*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online. http://bna.birds.cornell.edu/bna/species/694doi:10.2173/bna.694

EPA (U.S. Environmental Protection Agency). 1971. Community Noise. NTID300.3 (N-96-01 IIA-231). Prepared by Wylie Laboratories.

EPA. 1972. Noise Control Act of 1972 (42 USC 7641).

EPA. 1978. Quiet Communities Act of 1978 (42 USC 4901-4918).

EPA. 1998. Final Guidance for Incorporating Environmental Justice Concerns in EPA's NEPA Compliance Analyses. April. Available online at: http://www.epa.gov/environmentaljustice/resources/policy/ej_guidance_nepa_epa0498.pdf

EPA. 1999. Consideration of Cumulative Impacts in EPA Review of NEPA Documents. U.S. Environmental Protection Agency, Office of Federal Activities (2252A). EPA 315-R-99-002/May 1999. Available online at: http://www.epa.gov/sites/production/files/2014-08/documents/cumulative.pdf.

EPA. 2009. Procedures for Implementing the National Environmental Policy Act and Assessing the Environmental Effects Abroad of EPA Actions. Code of Federal Regulations, Title 40, Part 6. Available online at: http://www.ecfr.gov/cgi-bin/text-idx?SID=c2c0aed2d7f162d5cef02a61d58bd1a3&mc=true&node=pt40.1.6&rgn=div5

EPA. 2011. AP-42, Compilation of Air Pollutant Emission Factors, Fifth Edition, Volume I Chapter 13: Miscellaneous Sources – Section 13.2.1. http://www.epa.gov/ttn/chief/ap42/ch13/index.html (Accessed on July 1, 2014).

EPA. 2012. Climate Change Indicators in the United States, 2012.

EPA. 2013. Definition of solid waste. www.epa.gov/epawaste/nonhaz/index.htm

EPA. 2014a. MOVES (Motor Vehicle Emission Simulator). http://www.epa.gov/otaq/models/moves/ (accessed on April 7, 2014).

EPA. 2014b. Green Power Equivalency Calculator Methodologies. http://www.epa.gov/greenpower/pubs/calcmeth.htm (accessed on April 7, 2014).

EPA. 2014c. NONROAD Model (Nonroad Engines, Equipment, and Vehicles). http://www.epa.gov/otaq/nonrdmdl.htm (accessed on April 7, 2014).

Epilepsy Action. 2008. British Epilepsy Association. http://www.epilepsy.org.uk/info/photo_other.html. Accessed January 9, 2014.

Epsilon Associates, Inc. 2009. A Study of Low Frequency Noise and Infrasound from Wind Turbines. Prepared for NextEra Energy Resources, LLC. July 2009. Maynard, Massachusetts.

Erickson, W.P., G.D. Johnson, M.D. Strickland, D.P. Young Jr., K.J. Sernka, and R.E. Good. 2001. Avian collisions with wind turbines: a summary of existing studies and comparisons to other sources of avian collision mortality in the United States. National Wind Coordinating Committee, Washington, DC. http://www.west-inc.com/reports/avian_collisions.pdf.

Erickson, W.P., G.D. Johnson, D.P. Young, Jr., M.D. Strickland, R.E. Good, M. Bourassa, and K. Bay. 2002. Synthesis and comparison of baseline avian and bat use, raptor nesting and mortality information from proposed and existing wind developments. Technical Report prepared for Bonneville Power Administration, Portland, Oregon.

FHWA (Federal Highway Administration). 2006. FHWA Roadway Construction Noise Model User's Guide, FHWA-HEP-05-054, January 2006.

FHWA. 2011. Highway Traffic Noise: Analysis and Abatement Guidance. U.S. Department of Transportation, Federal Highway Administration. FHWA-HEP-10-025. Available online at: https://www.fhwa.dot.gov/environment/noise/regulations_and_guidance/analysis_and_abatement_guidance/revguidance.pdf.

Fiumicelli, D. 2011. Windfarm noise dose-response: a literature review. Acoustics Bulletin 2011; Nov/Dec: 26-34.

FEMA (Federal Emergency Management Agency). 2013a. Hawaii – National Flood Insurance Program; Flood Hazard Assessment Tool. http://gis.hawaiinfip.org/FHAT/ (accessed on December 27, 2013).

FEMA. 2013b. Map Service Center. Definitions of Flood Zones. https://msc.fema.gov/webapp/wcs/stores/servlet/info?storeId=10001&catalo%2520gId=10001&langId=-1&content=floodZones&title=FEMA%2520Flood%2520Zone%2520%2520Designations. (accessed on December 23, 2013).

Fletcher, C.H. III., E. E. Grossman, B. M. Richmond, and A.E. Gibbs. 2002. Atlas of Natural Hazards in the Hawaiian Coastal Zone. U.S. Geological Survey, Geologic Investigations Series I-2761.

May 2002. http://pubs.usgs.gov/imap/i2761/sections/3_Oahu.pdf (accessed on December 18, 2013).

Foote, D.E., E.L. Hill, S. Nakamura, and F. Stephens. 1972. Soil survey of the islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. US Department of Agriculture, Soil Conservation Service, in cooperation with the University of Hawaii Agricultural Experiment Station. Washington, D.C.: U.S. Government Printing Office. August 1972.

Fowler, A.C., J.M. Eadie, and A. Engilis, Jr. 2009. Identification of endangered Hawaiian ducks (*Anas wyvilliana*), introduced North American mallards (*A. platyrhynchos*), and their hybrids using multilocus genotypes. Conservation Genetics 10:1747 – 1758.

Garcia, Michael 1979. Introduction to the Geology of Oahu. *In* M.O. Garcia and J.M. Sinton. Field Trip Guide to the Hawaiian Islands, Oahu and Maui. Hawaii Institute of Geophysics Special Publication, 1, 117 pp.

Gee, H.K. 2007. Habitat characteristics of refuge wetlands and taro lo`i used by endangered waterbirds at Hanalei National Wildlife Refuge, Hawaii. M.S. thesis, South Dakota State University. 154 pp.

Giambelluca, T.W., Q. Chen, A.G. Frazier, J.P. Price, Y.-L. Chen, P.-S. Chu, J.K. Eischeid, and D.M. Delparte. 2013. Online Rainfall Atlas of Hawai'i. *Bulletin of American Meteorological Society* 94:313-316, doi: 10.1175/BAMS-D-11-00225.1 http://rainfall.geography.hawaii.edu/ (accessed on December 26, 2013).

Giffin, J. 1983. Abundance and distribution of koloa on the Island of Hawaii. Hawai`i Department of Land and Natural Resources PR Project No. W-18-R-7. Honolulu, Hawaii. 9 pp.

Gorressen, M.P., F.J. Bonaccorso, C.A. Pinzari, C.M. Todd, K. Montoya-Aiona, and K. Brinck. 2013. A five-year study of Hawaiian hoary bat (*Lasiurus cinereus semotus)* occupancy on the island of Hawai'i. Technical report HCSU-041. University of Hawai'I at Hilo. Hilo, Hawaii.

Gray, C.M. and K.C. Hamer. 2001. Prefledging mass recession in Manx shearwaters: parental desertion or nestling anorexia? Animal Behaviour 62:705 – 709.

Griesemer, A.M. and N.D. Holmes. 2011. Newell's shearwater population modeling for Habitat Conservation Plan and Recovery Planning. Technical Report No. 176. The Hawaii-Pacific Islands Cooperative Ecosystem Studies Unit & Pacific Cooperative Studies Unit, University of Hawaii, Honolulu, Hawaii. 68 pp.

HAIS (Hawaii Association of Independent Schools). 2012. Find a School search tool results. Available at: http://www.hais.org/pages/42425_Find_a_School.asp

Handy, E.S. Craighill and Elizabeth Green Handy. 1991. *Native Planters in Old Hawaii*. 2004 reprint. Bishop Museum Press, Honolulu. Originally published 1972, Bernice P. Bishop Museum Bulletin 233, Bishop Museum Press, Honolulu.

Harding, G. F. and P.M. Jeavons. 1994. Photosensitive Epilepsy. MacKeith Press, London. 182 pp.

Harding, G., P. Harding, and A. Wilkins. 2008. Wind turbines, flicker, and photosensitive epilepsy: Characterizing the flashing that may precipitate seizures and optimizing guidelines to prevent them. Epilepsia 49:1095-98.

Harris, M.P. 1966. Breeding biology of the Manx shearwater Puffinus puffinus. Ibis 108: 17 – 33.

HHSC (Hawaii Health Services Corporation). 2014. "Governance" Available at: http://www.hhsc.org/Legal/Governance/11294/Content.aspx

Hawaii News Now. 2012. Fire at Kahuku Wind Farm Destroys Crucial Building. http://www.hawaiinewsnow.com/story/19173811/hfd-battling-kahuku-wind-farm-blaze. Accessed January 28, 2014

Hawaii State Department of Agriculture. 1977. Agriculture Lands of Importance to the State of Hawaii. Revised. Available: http://planning.hawaii.gov/gis/download-gis-data-expanded/ (Accessed on March 28. 2014)

Department of Business, Economic Development and Tourism. 2013. Hawaii Energy Facts and Figures. Hawaii State Energy Office.

DOTAX (Hawaii State Department of Taxation). 2014a. General Excise Tax (GET) Information. Available online at: http://tax.hawaii.gov/geninfo/a2_b2_7csurchg_faq/

DOTAX. 2014b. County Surcharge FAQs. Available online at: http://tax.hawaii.gov/geninfo/a2_b2_7csurchg_faq/

Hawaiian Electric Company, Inc., Hawaii Electric Light Company, Inc., and Maui Electric Company, Limited. 2014. 2014 Renewable Portfolio Standard Status Report.

Hawaii Statewide GIS Program. 2013. Watershed Unit Boundary Polygons and Attributes. Available online at: http://planning.hawaii.gov/gis/download-gis-data/. Accessed September 24, 2013.

Hawaiian Studies Institute. 1987. O'ahu pre-Mahele Moku and Ahupua'a map. As cited in University of Hawaii, Pacific Cooperative Studies Unit. 2012. Cultural Resource Management of the Army Sub-Installations on the Island of O'Ahu, Annual Report [June 2007-May 2009]. Prepared for the United States Army Garrison-Hawaii, Hawaii.

HBMP (Hawaii Biodiversity Mapping Program). 2007. Hawaiian hoary bat. Available online at: http://hbmpweb.pbrc.hawaii.edu/ccrt/hbmp

HBWS (Honolulu Board of Water Supply). 2009. Koolau Loa Watershed Management Plan. Prepared for the Honolulu Board of Water Supply by Group 70 International. August 2009. Available online at: http://www.boardofwatersupply.com/cssweb/display.cfm?sid=1620 (accessed December 30, 2013).

HCEI (Hawaii Clean Energy Initiative). 2014. "Goals" Available at: http://www.hawaiicleanenergyinitiative.org/

HDOE (Hawaii Department of Education). 2013a. Kahuku High and Intermediate School Status and Improvement Report, 2011-2012. January 8, 2013. Available at: http://arch.k12.hi.us/PDFs/ssir/2012/Windward/SSIR307-4.pdf

HDOE. 2013b. Kahuku Elementary School Status and Improvement Report, 2011-2012. January 8, 2013. Available at: http://arch.k12.hi.us/PDFs/ssir/2012/Windward/SSIR331-4.pdf

HDOH (Hawaii Department of Health). 1992. Groundwater Protection Program. DOH Aquifers. Based on maps prepared by J.F. Mink and L.S. Lau (Water Resources Research Center) for the Groundwater Protection Program. Metadata and GIS data: http://planning.hawaii.gov/gis/download-gis-data-expanded/ (accessed on December 24, 2013).

HDOH. 1996. Chapter 46, Community Noise Control, Department of Health, State of Hawaii, Administrative Rules, Title 11, September 23, 1996.

HDOH. 2012. State of Hawaii Annual Summary 2012 Air Quality Data.

Heintzelman, M. D. and Tuttle, C. 2012. Values in the Wind: A Hedonic Analysis of Wind Power Facilities. Land Economics. August 1, 2012. Vol. 88 No. 3, 571-588.

Helber Hastert & Fee. 2001. Kawai Nui Marsh Pathway Plan, Prepared for the Kailua Community Vision Team. May 2001. Available online at: http://www.hhf.com/kawainui/Downloads/kawainui_marsh_pathwayplan.pdf

Helber Hastert & Fee. 2011. Wetland Restoration and Habitat Enhancement Plan, Kawainui Marsh, Kailua, O`ahu. Prepared for State of Hawaii Department of Land and Natural Resources Division of Forestry and Wildlife. March.

HHF Planners. 2014. O‘ahu Important Agricultural Lands Phase I Study. Prepared for the City and County of Honolulu Department of Planning & Permitting. April.

HIDOT (Hawaii Department of Transportation). 2002. Bike Plan Hawaii Master Plan. Available online at: http://hidot.hawaii.gov/highways/bike-plan-hawaii-master-plan/.

Hinman, J. L. 2010. Wind Farm Proximity and Property Values: A Pooled Hedonic Regression Analysis of Property Values in Central Illinois. Thesis Prepared for Master's Degree in Applied Economics. Illinois State University, Normal. May, 2010. 143 pages.

HNP (Haleakala National Park). 2009. Hawaiian Goose. Haleakala National Park, Endangered Species Management. Available online at: http://www.nps.gov/hale/naturescience/upload/NPSNeneInformation.pdf.

Hobdy, R. 2013a. Biological resources survey Na Pua Makani Wind Project, Kahuku, Ko`olauloa, Oahu, Hawaii. Na Pua Makani Power, LLC.

Hobdy, R. 2013b. Wetlands and Waters of the U.S. Assessment and Determination for the Na Pua Makani Wind Project, Kahuku, Ko`olauloa, Oahu, Hawaii. Na Pua Makani Power, LLC.

Hoen, B., Wiser, R., Cappers, P., Thayer, M. and Sethi, G. 2009. The Impact of Wind Power Projects on Residential Property Values in the United States: A Multi-Site Hedonic Analysis. Earnest Orlando Lawrence Berkeley National Laboratory. LBNL-2829E. Environmental Energy. Technologies Division. December.

Hoen, B., Wiser, R., Cappers, P., Thayer, M. and Sethi, G. 2011. Wind Energy Facilities and Residential Properties: The Effect of Proximity and View on Sales Prices. Journal of Real Estate Research. 33(3): 279-316

HoLIS (Honolulu Land Information System). 2014. City and County of Honolulu GIS database. Available at: http://www.honoluludpp.org/OnlineServices/OnlineGISMaps.aspx

Holmes, N., J.R. Troy, and T.W. Joyce. 2009. Status and conservation of Newell's shearwaters on Kauai, Hawaii. Reduction in breeding range and developments towards protecting colonies. Spoken paper, 36th Pacific Seabird Group Annual Meeting. Hakodate, Japan.

Honolulu Civil Beat. 2012. After Fire, Kahuku Wind Farm Fends Off Safety Concerns. http://www.civilbeat.com/articles/2012/12/04/17819-after-fire-kahuku-wind-farm-fends-off-safety-concerns/. Accessed January 28, 2014

Howarth, F.G. and W.P. Mull. 1992. Hawaiian Insects and Their Kin. University of Hawaii Press, Honolulu, Hawaii.

Howell, G., D. Shubat, and C. Krogh. 2015. Autism and the effect of introducing a new noise source into quiet rural communities: risk factor from industrial wind power generation. Selected Works of Grace Howell. Western University. London, Ontario.

HTA (Hawaii Tourism Authority). 2012. 2012 Annual Visitor Research Report. Available online at http://www.hawaiitourismauthority.org/research/reports/annual-visitor-research/. Accessed January 27, 2014.

HTA. 2014a. Hawaii's Official Tourism Site. Available at: http://www.gohawaii.com.

HTA. 2014b. Oahu Accommodations. Available online at: http://www.gohawaii.com/oahu/plan-a-trip/accommodations

Hu, D. 1998. Causes of extinction and endangerment in Hawaiian birds. Ph.D. dissertation, University of California, Davis, CA.

Humphrey, S.R. 1982. Bats, Vespertilionidae and Molossidae. Pp 52 – 70 in Wild mammals of North America: biology, management, and economics (J.A. Chapman and G.A. Feldhamer, eds.). Johns Hopkins University Press, Baltimore, MD.

Humphrey, S.R. and J.B. Cope. 1976. Population ecology of the little brown bat, Myotis lucifugus, in Indiana and north-central Kentucky. American Society of Mammalogists. Stillwater, OK.

Hunt, C.D. 1996. Geohydrology of the Island of Oahu, Hawai'i: U.S. Geological Survey Professional Paper 1412-B. 54 p.

IEC (International Electrotechnical Commission). 2005. International Standard IEC 61400-1, Wind Turbines Part 1: Design Requirements. IEC 61400-1:2005(E)

IHMM (Institute of Hazardous Materials Management). 2014. Definition of hazardous materials. www.ihmm.org/about-ihmm/what-are-hazardous-materials

IUCN (International Union for Conservation of Nature and Natural Resources). 2013. IUCN red list of threatened species. Version 2013.1. www.iucnredlist.org. (accessed on July 2, 2013).

Jain, A.A. 2005. Bird and bat behavior and mortality at a northern Iowa windfarm. M.S.Thesis. Iowa State University, Ames, IA.

Jakobsen, J. 2005. Infrasound emission from wind turbines. *J Low Frequency Noise, Vibration and Active Control* 2005; 24(3):145-155.

Johnson, G.D. and W.P. Erickson. 2011. Avian, Bat and Habitat Cumulative Impacts Associated with Wind Energy Development in the Columbia Plateau Ecoregion of Eastern Washington and Oregon. Prepared by West, Inc. for Klickitat County, Washington.

Kahihikolo, L.R. 2008. Hawaii Environmental Justice Initiative Report. In Harmony Solutions, LLC. January.

Kahuku Wind Power. 2013. Kahuku Habitat Conservation Plan—ITL 10: FY 2013 Annual Report—Year 3. Kahuku, HI.

Kahuku Wind Power. 2014. Kahuku Habitat Conservation Plan—ITL 10: FY 2014 Annual Report—Year 4. Kahuku, HI.Kawailoa Wind Power. 2013. Kawailoa Habitat Conservation Plan—ITL 14: FY 2013 Annual Report—Year 1. Haleiwa, HI.

Keith, S.E., D.S. Michaud, and S.H.P Bly. 2008. A proposal for evaluating the potential health effects of wind turbine noise for projects under the Canadian Environmental Assessment Act. Journal of Low Frequency Noise, Vibration, and Active Control 27:253-265.

Kellerman, G.R., J. Fan, and J.M. Gorman. 2005. Auditory Abnormalities in Autism: Toward Functional Distinctions Among Findings. CNS Spectrums 10(9): 748-756. Mount Sinai School of Medicine. New York, New York.

Kepler, C.B. and J.M. Scott. 1990. Notes on distribution and behavior of the endangered Hawaiian hoary bat *(Lasiurus cinereus semotus*), 1964 – 1983. `Elepaio 50:59 – 64.

Kerns, J., W.P. Erickson, and E.B. Arnett. 2005. Bat and bird fatality at wind energy facilities in Pennsylvania and West Virginia. Pages 24 – 95 in E.B. Arnett, (Ed.), Relationships between bats and wind turbines in Pennsylvania and West Virginia: an assessment of bat fatality search protocols, patterns of fatality, and behavioral interactions with wind turbines. A final report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, TX.

Kingsley, A. and B. Whittam. 2001. Potential impacts of wind turbines on birds at North Cape, Prince Edward Island. A report for the Prince Edward Island Energy Corporation.

Kingsley, A. and B. Whittam. 2005. Wind turbines and birds: a background review for environmental assessment, Draft. Canadian Wildlife Service, Environment Canada, Gatineau, Quebec.

Kirch, P. V. and M. Sahlins. 1994. Anahulu: The Anthropology of History of the Kingdom of Hawaii, Volume 1: Historical Ethnography. University of Chicago Press

Klavitter, J. 2009. The ecology and conservation of Hawaiian raptors. Pp. 293-311 *in* Conservation biology of Hawaiian forest birds (T.K. Pratt et al., eds.). Yale University Press, New Haven, Connecticut.

KMC (Kahuku Medical Center). 2014. "About Us" Available at: http://kahuku.hhsc.org/About-Us/about-us/12033/Content.aspx

Knopper, L.D. and C.A. Ollsen. 2011. Health effects and wind turbines: A review of the literature. *Environmental Health* 2011, 10:78. http://www.ehjournal.net/content/pdf/1476-069X-10-78.pdf (accessed July 22, 2014).

Koehler, C.E. and R.M.R. Barclay. 2000. Post-natal growth and breeding biology of the hoary bat (*Lasiurus cinereus*). Journal of Mammalogy 81:234-244.

Korn, Alfons. 1958. *The Victorian Visitors.* University of Hawai'i Press, Honolulu.

Krogh, Carmen, Lorrie Gillis, and Nicholas Kouwen. 2011. A Self-reporting Survey of Adverse Health Effects Associated with Industrial Wind Turbines: The Need for Vigilance. Wind Vigilance for Ontario Communities. March 2011.

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

Kwong, H. 2009. Climate Change Impacts on Hawaii. Reprinted from *Perspectives on Global Issues.*

Kaheawa Wind Power, LLC. 2006. Kaheawa Pastures Wind Energy Generation Facility Habitat Conservation Plan. Kaheawa Wind Power, LLC. Ukumehame, Hawaii.

Laposa, S. P. and A. Mueller. 2010. Wind Farm Announcements and Rural Home Prices: Maxwell Ranch and Rural Northern Colorado. Journal of Sustainable Real Estate. 2(1).

LaRosa, A.M., J. Tunison, A. Ainsworth, J.B. Kauffman and R.F. Hughes. 2008. Fire and Nonnative Invasive Plants in the Hawaiian Islands Bioregion. *In*, Wildland fire in ecosystems: fire and nonnative invasive plants. General Technical Report RMRS-GTR-42-volume 6. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. Ogden, Utah. 355 p.

Larsen, J.K. and M. Guillemette. 2007. Effects of wind turbines on flight behaviour of wintering common eiders: implications for habitat use and collision risk. Journal of Applied Ecology 44:516 – 522.

Leventhall, G. 2006. Infrasound from wind turbines - fact, fiction or deception? Canadian Acoustics 34:29-36. Magnusson, M. and R. Gittell. 2012. Impact of the Lempster Wind Power Project on Local Residential Property Values. Whittemore School of Business & Economics, University of New Hampshire. January.

Leventhall, H.G. 2004. Low Frequency Noise and Annoyance. Noise Health. 2004; 6:59-72. Available online at: http://www.noiseandhealth.org/text.asp?2004/6/23/59/31663

Loss, S.R., T. Will, and P.P. Marra. 2013. Estimates of bird collision mortality at wind facilities in the contiguous United States. Biological Conservation 168: 201-209.

Magnusson, M. and R. Gittell. 2012. Impact of the Lempster Wind Power Project on Local Residential Property Values. Whittemore School of Business & Economics, University of New Hampshire. January.

Marques, A.T., H. Batalha, S. Rodrigues, H. Costa, M.J.R. Pereira, C. Fonseca, M. Mascarenhas, and J. Bernardino. 2014. Understanding bird collision at wind farms: an updated review on the causes and possible mitigation strategies. Biological Conservation 179: 40-52.

MassDEP and MDPH (Massachusetts Department of Public Health). 2012. Wind Turbine Health Impact Study: Report of Independent Expert Panel. January 2012. Available online at: http://www.mass.gov/eea/docs/dep/energy/wind/turbine-impact-study.pdf, accessed March 2014.

McCunney, R.J., K.A. Mundt, D. Colby, R. Dobie, K. Kaliski, and M. Blais. 2014. Wind Turbines and Health: A Critical Review of the Scientific Literature. Journal of Environmental and Occupational Medicine 56(11):e108-e130. Available online at: http://canwea.ca/comprehensive-scientific-literature-review-on-wind-turbines-and-human-health-now-published/

McIntosh, J.D., and P. Cleghorn. 2013. Archaeological Assessment for the Proposed Na Pua Makani Windfarm In the Lands of Kahuku, Island of O'ahu [TMK (1) 5-6-006:018 and (1) 5-6008:006]. Pacific Legacy, Inc., Kailua, Hi.

Menard, T. 2001. Activity patterns of the Hawaiian hoary bat (*Lasiurus cinereus semotus*) in relation to reproductive time periods. M.S. Thesis, University of Hawaii, Honolulu.

Minnesota Department of Health. 2009. Public Health Impacts of Wind Turbines. Prepared by Minnesota Department of Health Environmental Health Division. Prepared for Minnesota Department of Commerce Office of Energy Security. May 2009. http://www.health.state.mn.us/divs/eh/hazardous/topics/windturbines.pdf (accessed June 2014).

Mitchell, C., C. Ogura, D.W. Meadows, A. Kane, L. Strommer, S. Fretz, D. Leonard, and A. McClung. 2005. Hawaii's Comprehensive Wildlife Conservation Strategy. Department of Land and Natural Resources. Honolulu, Hawaii. 722 pp. October 2005.

Mooney, K.M., E. Kahahane, and P. Cleghorn. 2015. Cultural Impact Assessment for the Na Pua Makani Wind Project, Kahuku, Keana, and Malaekahana Ahupuaa, Koolau Loa District, Island of O'ahu [TMK (1) 5-6-005:018; (1) 5-6-006:018, 047, 051, 055, and (1) 5-6-008:006]. Pacific Legacy, Inc., Kailua, Hi.

Morrison, Alex. 2009. Archaeological Background Report for the Proposed Na Pua Makani Windfarm Project, Kahuku, O'ahu (TMK 5-6-008:006). In the Environmental Assessment for the Na Pua Makani Windfarm, Oahu, Hawaii. On file at the Office of Environmental Quality Control (OEQC).

Mostello, C.S. 1996. Diets of the Pueo, Barn Owl, the Cat, and the Mongoose in Hawaii: Evidence for Competition. Master's Thesis, University of Hawaii at Manoa.

Munro, G.C. 1960. Birds of Hawaii. Charles E. Tuttle Company, Rutland, VT and Tokyo, Japan. 192 pp.

Nagata, S.E. 1983. Status of the Hawaiian gallinule on lotus farms and a marsh on Oahu, Hawaii. M.S. thesis, Colorado State University, Fort Collins, CO.

National Renewable Energy Laboratory. 2014. Jobs and Economic Development Impact Models (JEDI) Models. Available online at: http://www.nrel.gov/analysis/jedi/about_jedi.html

NHMRC (Australian Government National Health and Medical Research Council). 2010. Wind Turbines and Health – A Rapid Review of Evidence. July 2010. http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/new0048_evidence_review_wind_turbines_and_health.pdf (accessed July 22, 2014).

NIEHS (National Institute of Environmental Health Sciences). 2002. EMF: Electric and Magnetic Fields Associated with the use of Electric Power. Questions and Answers. June 2002. Available online at: http://www.niehs.nih.gov/health/materials/electric_and_magnetic_fields_associated_with_the_use_of_electric_power_questions_and_answers_english_508.pdf#search=Health%20Effects%20from%20Exposure%20to%20Power-Line%20Frequency%

Nissenbaum, Michael. 2010. Affidavit of Dr. Michael M. Nissenbaum. In the Court of Queen's Bench Judicial Centre of Saskatoon. Province of Sasktchewan. September 10, 2010. http://www. wind-watch.org/documents/affidavit-of-dr-michael-m-nissenbaum-m-d/ (accessed July 22, 2014)

NOAA (National Oceanic and Atmospheric Administration). 2007. Climate of Hawaii. http://www.prh.noaa.gov/hnl/pages/climate_summary.php (accessed on September 1, 2013). The above product is a condensed chapter on Hawaii's climate from the Second Edition (University of Hawaii Press, 1983) of the Atlas of Hawaii. The author is the late Saul Price, former Hawaii State Climatologist and Staff Meteorologist for the National Weather Service Pacific Region.

NOAA. 2013a. National Hurricane Center. Saffir-Simpson Hurricane Wind Scale. http://www.nhc.noaa.gov/aboutsshws.php (accessed on December 18, 2013).

NOAA. 2013b. Tsunami Hazard Map. http://tsunami.csc.noaa.gov/map.html?mapname=OAHU&submit1=Search+Island+Area (accessed on December 18, 2013).

NRC (National Research Council). 2007. Impact of wind energy development on humans. *Environmental Impacts of Wind-Energy Projects*. Chapter 4: pp 97-120.

NRCS (Natural Resources Conservation Service). 2013. Soil Survey Geographic (SSURGO) Database for Oahu, Hawaii. United States Department of Agriculture. http://datagateway.nrcs.usda.gov/ (accessed on December 20, 2013).

NRCS. 2014. Official Soil Series Descriptions. USDA-NRCS, Soil Survey Staff. Lincoln, NE. https://soilseries.sc.egov.usda.gov (Accessed on January 2, 2014).

NRCS. 2015. Land Capability Classes. Available online at: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/mn/technical/dma/nri/?cid=nrcs142p2_023556. Accessed December 21, 2015.

Oahu Metropolitan Planning Organization. 2011. Oahu Regional Transportation Plan 2035. Honolulu, Hawaii. Available online at: http://www.oahumpo.org/wp-content/uploads/2013/01/11.1.2AdoptedPlan20110411.pdf.

Oahu Metropolitan Planning Organization and Department of Planning and Permitting. 2004. Environmental Justice in the OMPO Planning Process: Defining Environmental Justice Populations. Oahu Metropolitan Planning Organization and City and County of Honolulu, Department of Planning and Permitting. March.

OANRP (O'ahu Army Natural Resource Program). 2012. 2012 Makua and Oahu Implementation Status Report. Chapter 1: Ecosystem Management. http://manoa.hawaii.edu/hpicesu/DPW/ERMUP/2012_Waimano.pdf (accessed January 24, 2014)

OEQC (Office of Environmental Quality Control). 2011. Guidelines for Assessing Cultural Impacts, as Adopted by the State of Hawaiʻi Environmental Council in 1997 and amended in 2000. Electronic document, http://oeqc.doh.hawaii.gov/Shared%20Documents/Environmental_Assessment_PrepKit/Cultural_Impact_Assessments/Guidelines-Assessing-Cultural-Impacts.pdf, accessed April 2011.

OEQC. 2012. Guide to the Implementation and Practice of the Hawaii Environmental Policy Act, 2012 Edition. State of Hawaii, Honolulu, Hawii. Available online at: http://oeqc.doh.hawaii.gov/Shared%20Documents/Misc_Documents/Guide%20to%20the%20Implementation%20and%20Practice%20of%20the%20HEPA.pdf

ODOE (Oregon Department of Energy). 2014. ODOE: Energy Conservation Climate of Hawaii; Energy Conversion Factors. http://www.oregon.gov/energy/cons/pages/industry/ecf.aspx (accessed on April 7, 2014).

OHA (Oregon Health Authority). 2013. Strategic Health Impact Assessment on Wind Energy Development in Oregon. Prepared by Public Health Division, OHA. March 2013.

Oki, D.S., S.B. Gingerich, and R.L. Whitehead. 1999. Hawaii. *In* Ground Water Atlas of the United States, Segment 13, Alaska, Hawaii, Puerto Rico, and the U.S. Virgin Islands; Fact Sheet. U.S. Geological Survey Hydrologic Investigations Atlas 730-N, p. N12-N22, N36. http://hi.water.usgs.gov/publications/pubs/fs/fs126-00.pdf (accessed on December 24, 2013).

O'Neal, R.D., J. Hellweg, R.M. Lampeter. 2011. Low frequency noise and infrasound from wind turbines. Noise Control Engineering Journal 59:135-157.

Pacific Disaster Center. 2013. Tsunamis. http://www.pdc.org/resources/natural-hazards/tsunami/(accessed on December 18, 2013).

Pacific Tsunami Museum. 2013. Mission Statement. http://www.tsunami.org/about.html (accessed on December 18, 2013).

Paton, P.W.C. 1981. The koloa (Hawaiian duck) on the Island of Hawaii. `Elepaio 41:131 – 133.

Pedersen, E. 2011. Health aspects associated with wind turbine noise--Results from three field studies. Noise Control Engineering Journal 59:47-53.

Pedersen, E., F. van den Berg, R. Bakker, and J. Bouma. 2009. Response to noise from modern wind farms in The Netherlands. Journal of the Acoustical Society of America 126:634-643.

Pedersen, E., F. van den Berg, R. Bakker, and J. Bouma. 2010. Can road traffic mask the sound from wind turbines? Response to wind turbine sound at different levels of road traffic. Energy Policy 38:2520-2527.

Pedersen, Eja and Hogskolan i Halmstad. 2003. Noise Annoyance from Wind Turbines – A Review. Prepared for the Swedish Environmental Protection Agency. August 2003. http://www.naturvardsverket.se/Nerladdningssida/?fileType=pdf&downloadUrl=/Documents/publikationer/620-5308-6.pdf (accessed June 2014).

Pedersen, E., and K. Persson Waye. 2004. Perception and annoyance due to wind turbine noise - a dose - response relationship. Journal of the Acoustical Society of America 116:3460-3470.

Pedersen, E., and K. Persson Waye. 2007. Wind turbine noise, annoyance and self-reported health and well-being in different living environments. Journal of Occupational and Environmental Medicine 64:480-486.

Pedersen, E., and K. Persson Waye. 2008. Wind turbines - low level noise sources interfering with restoration? Environmental Research Letters 3:1-5.

Pedersen, E., L.R.M. Hallberg, and K. Persson Waye. 2007. Living in the vicinity of wind turbines--a grounded theory study. Qualitative Research in Psychology 4:49-63.

Pedersen, E. and P. Larsman. 2008. The impact of visual factors on noise annoyance among people living in the vicinity of wind turbines. Journal of Environmental Psychology 28:379-89.

Perkins, R.C.L. 1895. Notes on some Hawaiian Birds. Ibis (7th ser.) 1:117 – 129.

Pettersson, J. 2005. The Impact of Offshore Wind Farms on Bird Life in Southern Kalmar Sound, Sweden, a Final Report Based on Studies 1999-2003. Report by Lund University. 128 pp. Available online at https://tethys.pnnl.gov/publications/impact-offshore-wind-farms-bird-life-southern-kalmar-sound-sweden.

Pierpont, Nina. 2009. *Wind turbine syndrome: a report on a natural experiment*. Santa Fe, NM: K-Selected Books; 2009. Available from: http://www.windturbinesyndrome.com/wp-content/uploads/2009/03/ms-ready-for-posting-on-wtscom-3-7-09.pdf

Polhemus, D.A. 2007. Biology recapitulates geology: the distribution of *Megalagrion* damselflies on the Koolau Volcano of Oahu, Hawaii. Biology of Hawaiian Streams and Estuaries. Edited by N.L. Evenhuis & J.M. Fitzsimons. Bishop Museum Bulletin in Cultural and Environmental Studies 3:233 – 246.

Powlesland, R. 2009. Impact of wind farms on birds: a review. Science for Conservation 289. Department of Conservation, Wellington, New Zealand. Available online at: http://www.doc.govt.nz/Documents/science-and-technical/sfc289entire.pdf

Pratt, H.D. and I.L. Brisbin Jr. 2002. Hawaiian Coot (*Fulica alai*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online. http://bna.birds.cornell.edu/bna/species/697b/articles/. (accessed on January 14, 2014).

Pyle, R.L. and P. Pyle. 2009. The birds of the Hawaiian Islands: occurrence, history, distribution, and status. B.P. Bishop Museum, Honolulu, HI, U.S.A. Version 1 (31 December 2009). http://hbs.bishopmuseum.org/birds/rlp-monograph. (accessed April 2, 2013).

Reed, J.M. and L.W. Oring. 1993. Long-term population trends of the endangered Ae`o (Hawaiian stilt, *Himantopus mexicanus knudseni*). Transactions of the Western Section of the Wildlife Society 29:54 – 60.

Reed, J.M., L.W. Oring, and M. Silbernagle. 1994. Metapopulation dynamics and conservation of the endangered Hawaiian stilt (*Himantopus mexicanus knudseni*). Transactions of the Western Section of the Wildlife Society 30:7 – 14.

Reed, J.M., C.S. Elphick, and L. Oring. 1998a. Life-history and viability analysis of the endangered Hawaiian stilt. Biological Conservation 84:35 – 45.

Reed, J.M., M.D. Silbernagle, K. Evans, A. Engilis, Jr., and L. Oring. 1998b. Subadult movement patterns of the endangered Hawaiian stilt (*Himantopus mexicanus knudseni*) as revealed by banding evidence. Auk 115:791 – 797.

Reynolds, M.H. and G.L. Ritchotte. 1997. Evidence of Newell's shearwater breeding in Puna District, Hawaii. Journal of Field Ornithology 68(1):26 – 32.

R.M. Towill Corporation. 2008. Kahuku Village Subdivision Draft Environmental Assessment. http://oeqc.doh.hawaii.gov/Shared%20Documents/EA_and_EIS_Online_Library/Oahu/200

0s/2008-07-08-DEA-Kahuku-Village.pdf (accessed December 26, 2013). Prepared for Continental Pacific, LLC. June 2008.

Robinson, J.A., J.M. Reed, J.P. Skorupa, and L.W. Oring. 1999. Black-necked stilt (*Himantopus mexicanus*). The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online. http://bna.birds.cornell.edu/bna/species/449/articles/. (accessed on January 14, 2014).

Roy, S.B., S.W. Pacala, and R.L. Walco. 2004. Can Large Wind Farms Affect Local Meteorology? Journal of Geophysical Research Volume 109:D19101.

Salt, A.N. and T.E. Hullar. 2010. Responses of the ear to low frequency sounds, infrasound and wind turbines. Hearing Research 268:12-21.

Sanzenbacher, P.M and B.A. Cooper. 2013. Radar and visual studies of seabirds and bats at the proposed Na Pua Makani Wind Energy Project, Oahu Island, Hawaii, fall 2012, spring 2013, and summer 2013. ABR, Inc.—Environmental Research & Services, Forest Grove, OR. Prepared for Tetra Tech, Inc. Portland, Oregon.

Schwartz, C.W. and E.R. Schwartz. 1949. The game birds in Hawaii. Hawaii Division of Fish and Game and Board of Commissioners of Agriculture and Forestry, Honolulu, HI. 168 pp.

Shallenberger, R.J. 1977. An ornithological survey of Hawaiian wetlands. U.S. Army Corps of Engineers Contract DACW 84-77-C-0036, Honolulu, HI. 406 pp.

Shepherd D., D. McBride, D. Welch, K. Dirks, and E.M. Hill. 2011. Evaluating the impact of wind turbine noise on health related quality of life. Noise & Health 13 (54):333–9.

Smedley, A.R.D., A.R. Webb, and A.J. Wilkins. 2010. Potential of wind turbines to elicit seizures under various meteorological conditions. Epilepsia 51:1146-1151.

Smith, D.G. and J.T. Polhemus. 2003. Habitat use and nesting activity by the Hawaiian stilt (*Himantopus mexicanus knudseni*) and Hawaiian moorhen (*Gallinula chloropus sandvicensis*) at the Hamakua Marsh State Wildlife Sanctuary, Kailua, Oahu. `Elepaio 63:59–62.

Snetsinger, T.J., S.G. Fancy, J.C. Simon, and J.D. Jacoby. 1994. Diets of owls and feral cats in Hawaii. `Elepaio 54:47-50.

Soil Conservation Service. 1961. Land-Capability Classification. Agriculture Handbook No. 210. U.S. Department of Agriculture, Soil Conservation Service. Available online at: http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf (Accessed December 21, 2015)

Solar Electric Power Association. 2013. 2012 SEPA Utility Solar Rankings, Report #02-13. Solar Electric Power Association, Washington, D.C. Available online at: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwii5unNz-3KAhXmw4MKHfEFDfcQFggdMAA&url=https%3A%2F%2Fwww.solarelectricpower.org%2Fmedia%2F51302%2Ffinal-2012-top-10-report-

v2.pdf&usg=AFQjCNE4Ob6Pq5wGD0SjDBo_RHh3vEHxLg&sig2=L6nBmiZRCFeybCENBRaU_w

Spear, L.B., D.G. Ainley, N. Nur, and S.N.G. Howell. 1995. Population size and factors affecting at-sea distributions of four endangered Procellariids in the tropical Pacific. Condor 97: 613–638.

Spiegel, Herbert M.D. 1997. Nocebo: The Power of Suggestibility. Preventive Medicine 26:616-621.

Strickland, M.D., E.B. Arnett, W.P. Erickson, D.H. Johnson, G.D. Johnson, M.L. Morrison, J.A.Shaffer, and W. Warren-Hicks. 2011. Comprehensive guide to studying wind energy/wildlife interactions. Prepared for the National Wind Coordinating Collaborative, Washington, DC.

Stride, M., T. Craddock, and H. Hammatt. 2003. *Archaeological Inventory Survey of the proposed 785-Acre Kahuku Agricultural Park*. Cultural Surveys Hawai'i. Report on file at the State Historic Preservation Division (Report No.O-1059).

Sunak, Y. and R. Madlener. 2012. The Impact of Wind Farms on Property Values: A Geographically Weighted Hedonic Pricing Model. FCN Working Paper No. 03/2012 (revised March 2013).

SWCA (SWCA Environmental Consultants). 2010. Kahuku Wind Power Habitat Conservation Plan. Prepared for Kahuku Wind Power, LLC, Kahului, HI.

SWCA. 2011a. Kaheawa Wind Power II Wind Energy Generation Facility Habitat Conservation Plan. Prepared by SWCA, Honolulu, HI, for Kaheawa Wind power II, LLC, Honolulu, HI. October.

SWCA. 2011b. Kawailoa Wind Power wildlife monitoring report for waterbirds and bats, October 2009 – April 2011. Prepared by SWCA, Honolulu, HI, for First Wind, Honolulu, HI. 26 pp. Appendix 4 in Kawailoa Wind Power Draft Habitat Conservation Plan. Prepared by SWCA, Honolulu, HI, for Kawailoa Wind Power LLC, Honolulu, HI. 144 pp + appendices.

SWCA. 2015. Determination and Delineation of Non-wetland Waters of the U.S. for the Na Pua Makani Wind Energy Project. Prepared for Tetra Tech, Inc. Honolulu, HI. February.

Swedberg, G.E. 1967. The koloa, a preliminary report on the life history and status of the Hawaiian duck (*Anas wyvilliana*). Federal Aid to Wildlife Restoration Act Report (W-5-R), Department of Land and Natural Resources, Division of Fish and Game, Honolulu, HI. 56 pp.

Swift, R. 2004. Potential effects of ungulate exclusion fencing on displaying Hawaiian petrels (*Pterodroma sandwichensis*) at Hawaii Volcanoes National Park. M.S. thesis, Oregon State University, Corvallis, OR.

Telfer, T.C. 1986. Newell's shearwater nesting colony establishment study on the island of Kauai. Final report, Statewide Pittman-Robertson Program. Department of Land and Natural Resources, State of Hawaii. Honolulu, HI.

Tetra Tech, Inc. 2012a. The Auwahi Wind Farm Project, Final Habitat Conservation Plan. Document prepared for Auwahi Wind Farm LLC.

Tetra Tech, Inc. 2012b. Shadow Flicker Impact Analysis for the Wilton IV Wind Energy Center. October 2012.

Tetra Tech, Inc. 2013a. Database of post-construction mortality monitoring results from North American wind projects. Unpublished data.

Tetra Tech, Inc. 2013b. Hawaiian hoary bat acoustic monitoring results for the Na Pua Makani Wind Energy Project. Unpublished data.

Tetra Tech, Inc. 2014a. Phase I Environmental Site Assessment. 56-452 and 56-668 Kamehameha Highway, Kahuku, Hawaii 96731, TMK: (2) 5-6-006-018 and 5-6-008-006, April 2014.

Tetra Tech, Inc. 2014b. Na Pua Makani Wind Farm 2012 – 2013 Avian report. Prepared for Na Pua Makani Power Partners, LLC by Tetra Tech, Inc. Honolulu, HI.

Tetra Tech, Inc. 2014c. Na Pua Makani Wind Energy Project Draft Habitat Conservation Plan. Prepared for Na Pua Makani Power Partners, LLC.

The Center for Environmental Management of Military Lands. 2014. Wildland Fire Management Plan: Na Pua Makani Wind Farm. Na Pua Makani Fire Management Sections. Prepared for Champlin Hawaii Wind Holdings LLC. The Center for Environmental Management of Military Lands, Colorado State University, Fort Collins, Colorado. July.

Tomich, P.Q. 1986. Mammals in Hawaii. Bishop Museum Press, Honolulu, HI. 375 pp.

Townscape, Inc. 2012. Ko`olau Poko Watershed Management Plan. Prepared for the Honolulu Board of Water Supply. September 2012.

Troy, J.R. and N.D. Holmes. 2008. Reduction in the breeding range of Newell's Shearwaters *Puffinus newelli* on Kauai, Hawaii: evidence and insights from field surveys and GIS modelling.

Ueoka, M. 1979. Limited study of nesting stilt on the islands. Hawaii Department of Land and Natural Resources, Division of Forestry and Wildlife, Wailuku, Maui, Hawaii. Unpublished Pittman-Robert Report W-18-R-1/4, R-III-C.

UK Health Protection Agency. 2010a. Environmental Noise and Health in the UK. Report for the independent Advisory Group on Non-ionising Radiation. 2010.

UK Health Protection Agency. 2010b. Health Effects of Exposure to Ultrasound and Infrasound. Report for the Ad Hoc Expert Group on Noise and Health by the Health Protection Agency. February 2010. http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1265028759369 (accessed July 22, 2014).

University of Hawaii, Land Study Bureau. 1972. Detailed Land Classification, Island of Oahu.

University of Hawaii, Pacific Cooperative Studies Unit. 2012. Cultural Resource Management of the Army Sub-Installations on the Island of O'Ahu, Annual Report [June 2007-May 2009]. Prepared for the United States Army Garrison-Hawaii, Hawaii

USACE (U.S. Army Corps of Engineers). 2008. Kawai Nui Marsh Environmental Restoration Project, Kailua, Island Of O'ahu. Hawaii: Final Supplemental Environmental Assessment. Honolulu, Hawaii.

USACE. 2015. Preliminary Jurisdictional Determination for Na Pua Makani Wind Energy Project, Kahuku, Island of Oahu, Hawaii, DA File No. POH-2015-11141.

USACE. Undated. Wetlands Management Plan for the U.S Army Corps of Engineers Kawainui Marsh Adaptive Restoration Project. U.S. Army Corps of Engineers. Undated.

U.S. Army (U.S. Army Garrison, Hawaii). 2008. Final Implementation Plan for Oahu Training Areas: Schofield Barracks Military Reservation, Schofield Barracks East Range, Kawailoa Training Area, Kahuku Training Area, and Dillingham Military Reservation. U.S. Army Garrison, Hawaii Environmental Division. Schofield Barracks, Hawaii. October 2008. Available at: http://manoa.hawaii.edu/hpicesu/DPW/2008_OIP/2008_OIP_edited.pdf (accessed January 1, 2014).

U.S. Army. 2010. Integrated Natural Resources Management Plan 2010-2014. Island of O'ahu, Schofield Barracks Military Reservation, Schofield BarracksEast Range, Kawailoa Training Area, Kahuku Training Area, Dillingham Military Reservation, Makua Military Reservation, and Tripler Army Medical Center. Prepared for the Directorate of Public Works, Environmental Division, Natural Resources Section by the Center for Environmental Management of Military Lands, Colorado State University, Fort Collins, Colorado. Available at: http://www.garrison.hawaii.army.mil/sustainability/NaturalResources.aspx (accessed January 1, 2014).

U.S. Census Bureau. 2000. Census 2000 Summary File 1 and 3, Table DP-1: Profile of General Demographic Characteristics: 2000. Table DP-2: Profile of Selected Social Characteristics: 2000. Table DP-3: Profile of Selected Economic Characteristics: 2000. Table DP-4: Profile of Selected Housing Characteristics: 2000.. Available online at: http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml

U.S. Census Bureau. 2012. American Community Survey 5-Year Estimates: Table DP01: Selected General Demographic Estimates. Table DP02: Selected Social Characteristics. Table DP03: Selected Economic Characteristics. Table DP04: Selected Housing Characteristics. Table DP05: ACS Demographic and Housing Estimates. 2008-2012. . Available online at: http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml

U.S. Census Bureau. 2013. Poverty Definitions. Available online at: http://www.census.gov/hhes/www/poverty/methods/definitions.html

U.S. DOE (Department of Energy). 2010. Environmental Assessment for Department of Energy Loan Guarantee to Kahuku Wind Power, LLC for Construction of the Kahuku Wind Power Facility in Kahuku, Oahu, Hawaii. Prepared for U.S. DOE Loan Guarantee Program Office. May 2010.

USFWS (U.S. Fish and Wildlife Service). 1983. Hawaiian dark-rumped petrel and Newell's manx shearwater recovery plan. Portland, Oregon.

USFWS. 1998. Recovery plan for the Hawaiian hoary bat. U.S. Fish and Wildlife Service, Portland, OR. 50 pp.

USFWS. 2004. Draft Revised Recovery Plan for the nene or Hawaiian goose (*Branta sandvicensis*). U.S. Fish and Wildlife Service, Portland, OR. 148 + xi pp.

USFWS. 2005. Seabird Conservation Plan – Pacific Region. Accessed at: http://www.fws.gov/pacific/migratorybirds/PDF/Seabird%20Conservation%20Plan%20Complete.pdf. (January 14, 2014).

USFWS. 2010. Hakalau Forest National Wildlife Refuge Comprehensive Conservation Plan. Hilo, Hawaii and Honolulu, Hawaii. http://www.fws.gov/hakalauforest/Hakalau%20Forest%20NWR%20Final%20CCP.pdf (accessed January 15, 2014).

USFWS. 2011a. James Campbell National Wildlife Refuge Draft Comprehensive Conservation Plan and Environmental Assessment. Oahu National Wildlife Refuge Complex, Haleiwa, Hawaii, and U.S. Fish and Wildlife Service, Honolulu, Hawaii. June

USFWS. 2011b. Nene or Hawaiian goose (*Branta sandvicensis*), 5-year review summary and evaluation. U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Service, Honolulu, HI. 16pp.

USFWS. 2011c. Newell's shearwater (*Puffinus auricularis newelli*), 5-year review summary and evaluation. U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Service, Honolulu, HI. 17pp.

USFWS. 2011d. Ope`ape`a or Hawaiian hoary bat (*Lasiurus cinereus semotus*) 5-year review summary and evaluation. U.S. Fish and Wildlife Service. Pacific Islands Fish and Wildlife Service, Honolulu, HI. 13 pp.

USFWS. 2011e. Recovery Plan for Hawaiian Waterbirds, Second Revision. U.S. Fish and Wildlife Service, Portland, Oregon.

USFWS. 2012a. Endangered Species in the Pacific Islands: Hawaiian Hoary Bat. http://www.fws.gov/pacificislands/fauna/HIhoarybat.html. (accessed on January 15, 2014).

USFWS. 2012b. Endangered and Threatened Wildlife and Plants; Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species 77 FR 57647 – 57862. http://www.gpo.gov/fdsys/pkg/FR-2012-09-18/pdf/2012-19561.pdf. (accessed on January 15, 2014).

USFWS. 2013a National Wetlands Inventory (NWI) Wetlands Mapper. http://www.fws.gov/wetlands/Data/Mapper.html (accessed on December 20, 2013).

USFWS. 2013b. Information website for the Oahu Forest National Wildlife Refuge. Available at http://www.fws.gov/refuges/profiles/index.cfm?id=12532. Reviewed January 2014.

USFWS and NMFS (National Marine Fisheries Service). 2000. Final Addendum to the Handbook for Habitat Conservation Planning and Incidental Take Permitting Process. "5 Point Policy Initiative" 65 FR 35242, June 1, 2000.

USGS (U.S. Geological Survey). 2001. Hawaiian Volcano Observatory: Earthquakes. http://hvo.wr.usgs.gov/earthquakes/ and http://hvo.wr.usgs.gov/earthquakes/hazards/ (accessed on December 18, 2013).

USGS. 2011. Gap Analysis Program, national land cover, version 2. Accessed at: http://dingo.gapanalysisprogram.com/landcoverv2/

USGS. 2013. Earthquakes Hazards Program. http://earthquake.usgs.gov/learning/topics/canit.php (accessed on December 18, 2013).

van den Berg, G.P. 2003 Effects of the wind profile at night on wind turbine sound. Journal of Sound and Vibration 277:955-970.

VanderWerf, E.A., K.R. Wood, M. LeGrande, H. Eijzenga, C. Swenson, and R.L. Walker. 2004. Biological inventory and assessment of Lehua Islet Kauai County, Hawaii, Final Report. Prepared for the U.S. Fish and Wildlife Service Pacific Islands Fish and Wildlife Office. USFWS Research Grant No: 12200-1-J014 May 2004

VanderWerf, E.A., K.R. Wood, M. LeGrande, H. Eijzenga, C. Swenson, and R.L. Walker. 2007. Avifauna of Lehua Islet, Hawaii, conservation and value management needs. Pacific Science 61:39 – 52.

WC (The Weather Channel). 2013. Weather for Kanaha Pond. Available online at: http://www.weather.com/weather/wxclimatology/monthly/graph/19:21 (accessed on December 18, 2012).

Whitaker, J.O., Jr. and P.Q. Tomich. 1983. Food habits of the hoary bat, *Lasiurus cinereus*, from Hawaii. Journal of Mammology 64:151 – 152

Wiggins, D.A., D.W. Holt, and S.M. Leasure. 2006. Short-eared Owl (*Asio flammeus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online. http://bna.birds.cornell.edu/bna/species/062.

Wilson Okamoto & Associates, Inc. 1994. Kawai Nui Marsh Master Plan, Oahu, Hawaii, Report R-100. Prepared for the State of Hawaii, Dept of Land and Natural Resource, Division of Forestry and Wildlife, Division of Water and Land Development. July 1994. Available online at: http://www.hhf.com/kawainui/Downloads/kawainui_marsh_mp_report100.pdf

Wood, K.R. and P. Bily. 2008. Vegetation description of a nesting site for Newell's Shearwater (*Puffinus auricularis newelli*), Pi`ina`au Stream, East Maui, Hawaii. `Elepaio 68(8): 63 – 66.

Worthington, D.V. 1998. Inter-island dispersal of the Mariana common Moorhen: a recolonization by an endangered species. Wilson Bulletin 110:414 – 417.

WRAP (Western Regional Air Partnership). 2006. WRAP Fugitive Dust Handbook. Prepared for the Western Governor's Association. September 2006. Available online at: http://www.wrapair.org/forums/dejf/fdh/content/FDHandbook_Rev_06.pdf

WRCC (Western Regional Climate Center). 2013. Climate of Hawaii. Climate Narrative of the States. Source: National Oceanic and Atmospheric Administration Narrative Summaries, Tables and Maps for Each State with Overview of State Climatologist Programs, Third Edition. Gale Research Company, 1985. Available online at: http://www.wrcc.dri.edu/narratives/HAWAII.htm (accessed on December 18, 2013).

Zimpfer, J. and F. Bonaccorso. 2010. Barbed wire fences and Hawaiian hoary bats: what we know. Hawaii Conservation Conference August 4 – 6, 2010. Honolulu, HI.

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APPENDIX A
SUPPLEMENTAL TECHNICAL ANALYSIS

Na Pua Makani Wind Project Technical Analysis of Modified Proposed Action Option

Prepared by

Tetra Tech, Inc.

February 2016

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1.0 INTRODUCTION

1.1 Introduction

Na Pua Makani Power Partners, LLC (NPMPP), a wholly owned subsidiary of Champlin Hawaii Wind Holdings, LLC, proposes to construct and operate the proposed Na Pua Makani Wind Project (Project). The Draft Environmental Impact Statement (DEIS) was published the Office of Environmental Quality and Control's (OEQC) The Environmental Notice on June 8, 2015, and a notice of availability of the DEIS was published on June 12, 2015, in the Federal Register by USFWS (80 FR 33535-33537) and on the same date by US EPA (80 FR 33519) in accordance with requirements set forth under the Hawaii Environmental Policy Act (HEPA; HRS § 343-3) and NEPA (40 CFR 1506.6) implementing regulations. Public comments on the DEIS were accepted during the 45-day and 60-day State and Federal public comment periods, respectively.

In response to public comments on the DEIS related to visual impacts, NPMPP reevaluated the proposed turbine locations and turbine models considered under the Proposed Action (up to 10 turbines) with the goal of reducing the number of turbines by considering turbines with larger generating capacities. Through this effort, NPMPP was able to reduce the maximum number of turbines needed to meet the target generating capacity for the Project from 10 turbines to 9 turbines. Depending on the selection of the final turbine model, the number of turbines may be as few as eight. This modification takes advantage of recent technological advancements that have resulted in the availability of uprated versions of turbine models that are larger, more efficient, have increased generating capacity, and are better suited for the moderate to low wind conditions of the wind farm site than previous models. These modifications are evaluated here as the Modified Proposed Action Option (Alternative 2a).

The purpose of this technical report is to compare the Proposed Action as presented in the DEIS and the Modified Proposed Action Option to determine whether or not the modification is presents significant new information relative to the DEIS. To make this determination, the technical analysis applies the methods and standards outlined in the DEIS and indicates whether the modification would result in a significant new impact or a significantly more adverse impact not disclosed in the DEIS. Should the impacts of the Modified Proposed Action Option fall into either of these categories, this would indicated the potential need to publish a supplemental NEPA document. If the Modified Proposed Action Option does not constitute new or significantly different information then this provides justification for evaluating the modification as an option to the Proposed Action in the Final EIS.

NPMPP is preparing a Habitat Conservation Plan (HCP) and pursuing and Incidental Take Permit (ITP) from the U.S. Fish and Wildlife Service (USFWS). The federal proposed action (approval of the HCP and issuance of the ITP) is the same under the Proposed Action and the Modified Proposed Action Option. Therefore, the HCP and issuance of the ITP are not discussed further here.

As set forth below, this technical report concludes that the Modified Proposed Action Option would not result in any significant new impact or a significantly more adverse impact than already identified in the DEIS. The analysis supporting the evaluation of these modifications for each environmental topic is provided in Section 2.0. See Section 3.0 for a detailed explanation of this report's conclusions and recommendations for moving forward.

1.2 Description of Modified Proposed Action Option In Comparison to Proposed Action

The Modified Proposed Action Option would include up to 9 turbines and depending on the final turbine model selected may be as few as eight turbines. To meet the minimum required generating capacity for the project of approximately 25 megawatts, these turbines would be larger and more efficient, each with a greater generating capacity than Alternative 2 under the Proposed Action. By eliminating one turbine and the associated access road and collection line, the Modified Proposed Action Option would have a smaller footprint, thereby reducing the amount of temporary and permanent disturbance associated with the Project. All other Project facilities, which include the associated foundations and transformers; an underground electrical collection system; up to three meteorological (met) towers; access roads; construction staging areas; an operations and maintenance building and associated storage yard; a transmission line; and an onsite substation would be the same as under the Proposed Action (see Chapter 2 of the EIS for details).

Table 1 provides a comparison of the turbine model dimensions and project footprint between the Proposed Action and the Modified Proposed Action Option. The Best Management Practices (BMPs) and other avoidance and minimization measures described in Chapter 2 and Chapter 4 of the EIS would also apply to Modified Proposed Action Option and are therefore not discussed further in this technical report.

1.3 Analysis Approach

The analysis presented in this technical report applies the applicable methodologies and standards outlined in Chapter 4 of the DEIS and indicates whether the Modified Proposed Action Option would result in a significant new impact or a significantly more adverse impact than the Proposed Action. The impact issues identified under each resource in the DEIS are evaluated in this analysis and a summary impact category is applied to each impact issue. The impact categories are defined in Chapter 4 of the DEIS and include: negligible, minor, moderate, or major. Cumulative Effects will be the same for both the Proposed Action and the Modified Proposed Action Option; therefore, they are not discussed in this report.

The evaluation here assumes a 9-turbine Project. If only eight turbines were constructed, all impacts that are based on turbine number would be incrementally reduced due to the removal of one turbine and resulting smaller footprint of the Project. That is, there would be less ground disturbance and comparable or reduced visual, shadow flicker, and noise impacts. Impacts to socioeconomics, air quality, natural hazards, public infrastructure and services and other resources which would not change with the removal of one turbine would be the same for an 8- or 9-turbine

Project. The decision to construct an 8- or 9-turbine Project would be ultimately driven by the turbine model selected. This decision is dependent on turbine suitability for the wind regime (based on ongoing wind data collection), consideration of other site-specific factors, the availability and cost of the turbine models, and other factors. Ultimately, the project must produce up to approximately 25 MW of energy; therefore, generating capacity of the individual turbine model would determine the need for 8 or 9 turbines.

Table 1. Comparison of Project Components and Disturbance Areas

Description	Measurement	
Wind Turbine Component	**Proposed Action**	**Modified Proposed Action Option**
Power generation	Up to 3.3 MW[1]	Up to 3.45 MW[1]
Tower height	Up to 302 feet (92 meters)	Up to 443 feet (135 meters)[2]
Rotor type	3-bladed, horizontal axis	3-bladed, horizontal axis
Rotor diameter	Up to 384 feet (117 meters)	Up to 427 feet (130 meters)
Blade length	Up to 187 feet (57 meters)	Up to 208 feet (63 meters)
Number of blades	3	3
Total height above ground	Up to 512 feet (156 meters)	Up to 656 feet (200 meters)
Rotor swept area	Up to 115,723 feet^2 (10,751 meters^2)	Up to 143,160 feet^2 (13,300 meters^2)
Rotor speed	6-16 rotations per minute	6-16 rotations per minute
Cut -in wind speed	10 ft/s (3 m/s)	10 ft/s (3 m/s)
Cut-out wind speed	Up to 82 ft/s (25 m/s)	Up to 82 ft/s (25 m/s)
Project Footprint	**Proposed Action**	**Modified Proposed Action Option**
Total Area of Permanent Site Disturbance	59.9 acres (24.2 hectares)	56.7 acres (22.9 hectares)
Total Area of Site Disturbance During Construction	89.0 acres (36.0 hectares)	84.5 acres (34.2 hectares)

ft/s = feet per second; m/s = meters per second
[1]Should the turbine manufacturers make available up-rated versions of existing turbine models prior to construction, they will be considered for use in this project.
[2]To meet City and County of Honolulu setback requirements (a distance equivalent to the maximum turbine blade tip height), if the largest turbine model under consideration were selected hub heights of individual turbines would range from approximately 85 to 135 meters (blade lengths would be the same).

2.0 RESOURCES EVALUATED IN THE DEIS

2.1 Geology and Soils

Direct effects on geology and soils from the Modified Proposed Action Option would be less than the Proposed Action due to the reduced Project footprint. The Modified Proposed Action Option would disturb up to 84.5 acres (34.2 hectares) during construction, of which 56.7 acres (22.9 hectares) would be disturbed over the long-term during Project operation. The Proposed Action would disturb up to 89.0 acres (36.0 hectares), of which 59.9 acres (24.2 hectares) would be disturbed over the long-term during Project operation. Indirect effects such as impacts to threatened or endangered plant species or sensitive ecosystems, or long term loss of productivity or vegetative growth from compaction or mixing of soils would be the same under the Proposed Action and the Modified Proposed Action Option.

No new impacts or significantly more adverse impact are anticipated from the Modified Proposed Action Option (see Table 2 for an evaluation of each geology and soils impact issue identified in the DEIS). For the impact issues of drainage, erosion, and loss of agricultural land or soil productivity, the Modified Proposed Action Option would result in slightly reduced impacts compared to the Proposed Action due to a decrease in the total area of temporary and permanent ground disturbance.

Table 2. Evaluation of Modified Proposed Action Option Impacts to Geology and Soils

Impact Issues	Summary of Impact		Evaluation of whether Modified Proposed Action Option Impacts are New or More Adverse from Proposed Action
	Proposed Action	Modified Proposed Action Option	
Geologic resources and hazards	Negligible	Negligible	No change in impact. No significant geologic features or mineral resources with economic value are known or expected to occur in the wind farm site; earthquake or seismic activity in the wind farm site is not anticipated.
Drainage patterns and slope failure	Minor	Minor	The Modified Proposed Action Option would have less impact on drainage patterns due to the reduction of the total area of temporary and permanent ground disturbance. (See Preliminary Drainage Study in Appendix H.)
Erosion	Minor	Minor	The Modified Proposed Action Option would have less possibility for erosion due to the reduction of the total area of temporary and permanent ground disturbance.
Sensitive species or ecosystems	Negligible	Negligible	No change in impact. There would be no impact to listed plant species or sensitive ecosystems as none occur at the wind farm site.
Loss of agricultural land or soil productivity	Minor	Minor	The Modified Proposed Action Option would impact less prime agricultural lands due to the reduction of the total area of temporary and permanent ground disturbance. Under the Proposed Action, approximately 12.6 acres (5.1 hectares) of the Prime Agricultural Lands (as classified under the ALISH system by the Hawaii State Department of Agriculture 1977) would be impacted over the long-term, through the life of the Project. Under the Modified Proposed Action Option, approximately 9.4 acres (3.8 hectares) of the Prime Agricultural Lands would be impacted over the long-term, through the life of the Project.

2.2 Hydrology and Water Resources

Direct effects on hydrology and water resources from the Modified Proposed Action Option would be less than the Proposed Action due to the decreased area of disturbance and area of impervious surfaces. The Modified Proposed Action would result in up to approximately 9.1 acres (3.7 hectares) of impervious surfaces in the wind farm site, which includes 9 acres (3.6 hectares; 99 percent) of gravel surfaces which are semi-pervious. Proposed Action would result in up to approximately 10.1 acres (4.1 hectares) of impervious surfaces in the wind farm site, which includes 10 acres (4.1 hectares; 99 percent) of gravel surfaces which are semi-pervious. The net increase in stormwater would also be less under the Modified Proposed Action Option (10.9 cubic feet per second) compared to the Proposed Action (11.9 cubic feet per second).

No new impacts or significantly more adverse impact are anticipated from the Modified Proposed Action Option (see Table 3 for an evaluation of each hydrology and water resources impact issue identified in the DEIS). For the impact issues of drainage, contamination of surface waters, and alteration of surface water quality, the Modified Proposed Action Option would result in slightly less impacts than the Proposed Action due to a decrease in the total area of temporary and permanent ground disturbance and decrease in impervious or semi-pervious surfaces.

Table 3. Evaluation of Modified Proposed Action Option Impacts to Hydrology and Water Resources

Impact Issues	Summary of Impact		Evaluation of whether Modified Proposed Action Option Impacts are New or More Adverse from Proposed Action
	Proposed Action	Modified Proposed Action Option	
Impacts to wetlands and other waters of the U.S.	Minor to Moderate	Minor to Moderate	No change in impact. There are no wetlands within the wind farm site; therefore the Modified Proposed Action Option would have no direct or indirect impact on wetlands. Three jurisdictional streams run through the wind farm site; however the project footprint under both the Proposed Action and Modified Proposed Action Option is designed to avoid impacts to these streams.
Alteration of existing drainage patterns	Negligible	Negligible	The Modified Proposed Action Option would have less impact on drainage patterns due to the reduction of the total area of temporary and permanent ground disturbance. (See the Preliminary Drainage Study in Appendix H of the EIS.)
Contamination of surface water quality from increased erosion, sedimentation, stormwater runoff and/or pollutants.	Minor	Minor	The Modified Proposed Action Option would have less possibility for surface water contamination from erosion, sedimentation, stormwater runoff and/or pollutants due to the reduction of 3.2 acres (1.3 hectares) in the total area of permanent ground disturbance and a reduction of 1 acre (0.4 hectares) in semi--pervious surfaces.
Alteration of surface water quality resulting in long-term loss or use by humans or aquatic wildlife and plants.	Minor	Minor	No change in impact. The Modified Proposed Action Option's smaller Project footprint and total impermeable area would reduce the impacts to surface water quality in comparison to the Proposed Action but it would not measurably change the potential long-term loss of use by humans or aquatic wildlife or plants.
Decrease in available groundwater or groundwater recharge	Negligible	Negligible	No change in impact. The water requirements for construction and operation under the Modified Proposed Action Option would not change.
Degradation of ground water quality	Negligible	Negligible	No change in impact. The Spill Prevention, Containment, and Countermeasures (SPCC) Plan described under the Proposed Action (Section 4.4.3 of DEIS) would be prepared for the Modified Proposed Action Option to ensure adverse impacts to groundwater quality from construction are avoided.

2.3 Air Quality and Climate Change

Direct or indirect effects on air quality and climate conditions from the Modified Proposed Action Option would be the same as the Proposed Action. There may be a slightly reduced amount of air pollutant emissions and fugitive dust levels associated with construction under the Modified Proposed Action Option due to the decrease in the number of turbines; however, this reduction would be negligible.

No new impacts or significantly more adverse impacts to air quality or climate conditions are anticipated from the Modified Proposed Action Option. See Table 4 for an evaluation of each air quality and climate impact issue identified in the DEIS.

Table 4. Evaluation of Modified Proposed Action Option Impacts to Air Quality and Climate Change

Impact Issues	Summary of Impact		Evaluation of whether Modified Proposed Action Option Impacts are New or More Adverse from Proposed Action
	Proposed Action	Modified Proposed Action Option	
Violations of State or Federal air quality standards as a result of construction activity or traffic	No Impact	No Impact	No change in impact. Emissions and increased fugitive dust levels would not violate State or Federal air quality standards under either the Modified Proposed Action Option or the Proposed Action.
Greenhouse gas emissions from Project construction	Minor	Minor	No change in impact. Construction equipment and vehicle emissions are anticipated to be the same under both the Modified Proposed Action Option and the Proposed Action.
Greenhouse gas emissions from Project operation	Negligible Adverse/Moderate Beneficial	Negligible Adverse/Moderate Beneficial	No change in impact. Emission of green-house gasses is anticipated to be the same under both the Modified Proposed Action Option and the Proposed Action.

2.4 Noise

Direct and indirect effects of noise from the Modified Proposed Action Option would be similar to the Proposed Action, only varying in the location of where construction activities would take place within the wind farm site (i.e., construction only occurring at a maximum of nine turbine pad locations rather than 10). Like Alternative 2, construction noise is likely to exceed HAR 11-46 limits at some TMKs in the acoustic analysis area under Alternative 2a and; therefore, a permit from the DOH would likely be required.

Direct and indirect effects of operational noise from the Modified Proposed Action Option would be similar to those described under the Proposed Action. Impacts from Low frequency noise (LFN) and infrasound (IS) would be the same under Alternative 2a as under Alternative 2, because the nearest residence to a proposed wind turbine is the same under both alternatives. Operational broadband (dBA) sound pressure levels for the Modified Proposed Action Option; however, were calculated based on a total of nine Siemens SWT 3.3-130; whereas operational broadband (dBA) sound pressure levels for the Proposed Action were based on two Vestas V110-2.0 and eight Siemens SWT 3.0-113 turbines. Increases at the most sensitive Zone A TMKs are predicted to be slightly less under Alternative 2a (no more than 3 dBA over existing sound levels) than under Alternative 2 (no more than 4 dBA over existing sound levels). Similar to the Proposed Action, the operational noise analysis for the Modified Proposed Action Option demonstrates compliance with HAR 11-46 (see Appendix D of the EIS for details).

No new impacts or significantly more adverse impacts related to noise are anticipated from the Modified Proposed Action Option. See Table 5 for an evaluation of each noise impact issue identified in the DEIS.

Table 5. Evaluation of Modified Proposed Action Option Impacts to Noise

Impact Issues	Summary of Impact		Evaluation of whether Modified Proposed Action Option Impacts are New or More Adverse from Proposed Action
	Proposed Action	Modified Proposed Action Option	
Audible noise	Minor	Minor	No change in impact. The Modified Proposed Action Option would result in a slight decrease in operational noise impacts.
Low frequency noise/infrasound	Negligible	Negligible	No change in impact. Low frequency noise/infrasound impacts would be the same under both the Modified Proposed Action Option and the Proposed Action (no impacts as sound levels would be below the threshold of human hearing). There would be no change in low frequency noise/infrasound levels.

2.5 Hazardous and Regulated Materials and Wastes

Direct or indirect effects from use of hazardous materials, solid waste and petroleum projects under the Modified Proposed Action Option would be the same as the Proposed Action. There may be a reduced amount of hazardous materials, solid waste, or petroleum products generated or used under the Modified Proposed Action Option due to the decrease in the number of turbines; however this reduction would be negligible.

No new impacts or significantly more adverse impacts are anticipated from the Modified Proposed Action Option as the result of the transport, storage, use and disposal of hazardous materials, solid waste and petroleum products. See Table 6 for an evaluation of each hazardous and regulated materials and waste impact issue identified in the DEIS.

Table 6. Evaluation of Modified Proposed Action Option Impacts to Hazardous and Regulated Materials and Waste

Impact Issues	Summary of Impact		Evaluation of whether Modified Proposed Action Option Impacts are New or More Adverse from Proposed Action
	Proposed Action	Modified Proposed Action Option	
Routine use, storage and transport of hazardous materials	Minor	Minor	No change in impact. The impacts as the result of the transport, storage, use, and disposal of hazardous materials during the construction and operation of the Modified Proposed Action Option would be similar to those discussed under the Proposed Action in the DEIS.
Accidental spills and releases	Minor	Minor	No change in impact. The potential for accidental releases or spills under the Modified Proposed Action Option would be the same as the Proposed Action.
Worker exposure to chemicals exceeding OSHA limits	Minor	Minor	No change in impact. The potential for accidental worker exposure to chemicals under the Modified Proposed Action Option would be the same as the Proposed Action.
Disturb existing contamination or improper disposal	Minor	Minor	No change in impact. The potential disturbance of existing contamination during construction of the Modified Proposed Action Option would be similar to the Proposed Action.
Vandalism	Minor	Minor	No change in impact. The risk of vandalism would be the same under the both the Modified Proposed Action Option and the Proposed Action.

2.6 Natural Hazards

Construction and operation of the Project could be adversely affected by a natural hazard such as a hurricane, tsunami, or earthquake. However, the occurrence rates for these natural hazards on Oahu is very low. Table 7 evaluates each impact issue identified in the DEIS under this resource. There would be no change in potential impacts of natural hazards to the Project under the Modified Proposed Action Option.

Table 7. Evaluation of Potential Natural Hazards Impacting the Modified Proposed Action Option Impacts

Impact Issues	Summary of Impact		Evaluation of whether Impacts to the Modified Proposed Action Option are New or More Adverse Compared to the Proposed Action
	Proposed Action	Modified Proposed Action Option	
Hurricanes and tropical storms	None expected/negligible	None expected/negligible	No change in impact. Impacts to construction and operation of the Project from natural hazards under the Modified Proposed Action Option are the same as those described for the Proposed Action.
Tsunamis	Negligible	Negligible	
Earthquakes and seismicity	None expected/negligible	None expected/negligible	
Flooding	Minor	Minor	
Wildfire	Negligible	Negligible	

2.7 Vegetation

Direct effects to vegetation communities from Project construction include the physical destruction or degradation of vegetation and vegetation communities. The Modified Proposed Action Option would have less direct effects on vegetation than the Proposed Action due to the decrease in Project footprint. Construction and operation of the Project under the Modified Proposed Action Option would result in approximately up to 84.5 acres (34.2 hectares) of impacted vegetation, including 56.7 acres (22.9 hectares) of long-term impacts. Construction and operation of the Project under the Proposed Action would result in approximately 89.0 acres (36.0 hectares) of impacted vegetation, including 59.9 acres (24.2 hectares) of long-term impacts.

Indirect impacts to vegetation communities from Project construction include the introduction and spread of noxious weeds and the potential increased risk of wildfire, both of which can impact and alter vegetation communities within the wind farm site. Indirect impacts are anticipated to be the same for the Modified Proposed Action Option as they are for the Proposed Action.

No new impacts or significantly more adverse impacts are anticipated from the Modified Proposed Action Option (Table 8). For the impact issues of loss of plant species populations or loss of native plant communities, the Modified Proposed Action Option would result in slightly reduced impacts compared to the Proposed Action due to a decrease in the total area of temporary and permanent ground disturbance.

Table 8. Evaluation of Modified Proposed Action Option Impacts to Vegetation

Impact Issues	Summary of Impact		Evaluation of whether Modified Proposed Action Option Impacts are New or More Adverse from Proposed Action
	Proposed Action	Modified Proposed Action Option	
Introduction or spread of noxious weeds	Minor	Minor	No change in impact. The Modified Proposed Action Option has the same potential to increase the introduction and spread of noxious weeds as the Proposed Action.
Loss to any population of plant species resulting in proposal for listing or listing	Negligible	Negligible	The Modified Proposed Action Option would have less impact on existing plant species populations due to the reduction of the total area of temporary and permanent ground disturbance.
Loss of native plant communities	Minor	Minor	The Modified Proposed Action Option would have less impact on native plant communities due to the reduction of the total area of temporary and permanent ground disturbance.
Fire	Minor	Minor	No change in impact. The Modified Proposed Action Option has the same potential to increase the risk of wildfire as the Proposed Action.

2.8 Wildlife

Direct effects to wildlife from Project construction activities include injury or mortality (e.g., collision with construction equipment), habitat removal and alteration, and noise and disturbance. Indirect effects to wildlife include the introduction and spread of non-native plant and animal species. Direct impacts would be slightly less under the Modified Proposed Action Option than under the Proposed Action due to the reduction in the total area of temporary and permanent ground disturbance (see Section 2.7). Indirect impacts would be the same for the Modified Proposed Action Option as they are for the Proposed Action. The direct and indirect effects of the Habitat Conservation Plan actions would benefit wildlife over the long term through the protection and enhancement of native habitats similarly for both the Modified Proposed Action Option and the Proposed Action.

No new impacts or significantly more adverse impacts are anticipated from the Modified Proposed Action Option (Table 9). For the impact issues of habitat removal and alteration and direct mortality, the Modified Proposed Action Option would result in slightly less impacts than the Proposed Action due to a decrease in the total area of temporary and permanent ground disturbance and decrease in the number of turbines.

Table 9. Evaluation of Modified Proposed Action Option Impacts to Wildlife

Impact Issues	Summary of Impact		Evaluation of whether Modified Proposed Action Option Impacts are New or More Adverse from Proposed Action
	Proposed Action	Modified Proposed Action Option	
Habitat removal and alteration	Minor adverse/ Moderate Beneficial	Minor adverse/ Moderate Beneficial	The Modified Proposed Action Option would require less vegetation removal due to the reduction of the total area of temporary and permanent ground disturbance (see Section 2.7).
Direct mortality	Minor	Minor	The Modified Proposed Action Option would have one less turbine which may slightly reduce collision risk associated with Project operation.
Noise and disturbance	Minor	Minor	No change in impact. The Modified Proposed Action Option would result in a slight decrease in noise and disturbance related to construction but this decrease would be negligible.

2.9 Threatened and Endangered Species

Construction and operation of the Project would result in direct and indirect effects to threatened and endangered species under both the Proposed Action and the Modified Proposed Action Option. There are eight State and Federally threatened and endangered species that are known to occur, or have the potential to occur, in the vicinity of the wind farm site (see Table 10 for a list of the eight species and see Section 3.9 of DEIS for a description of each species).

The Final HCP includes incidental take calculations based on the Modified Proposed Action Option, incorporating 9 turbines with larger dimensions. However, Project take estimates under the Proposed Action (i.e., included in the Draft HCP and evaluated in the Draft EIS) and Modified Proposed Action Option are comparable (the same or less than presented in the Draft HCP) and do not result in different levels of requested take for any of the Covered Species. Additionally, the Modified Proposed Action Option does not result in changes to the HCP avoidance, minimization, and mitigation measures. Therefore, no new impacts or significantly more adverse impacts would occur under the Modified Proposed Action Option compared to the Proposed Action (Table 10).

Table 10. Evaluation of Modified Proposed Action Option Impacts to Threatened and Endangered Species

Species	Impact Issues	Summary of Impact		Evaluation of whether Modified Proposed Action Option Impacts are New or More Adverse from Proposed Action
		Proposed Action	Modified Proposed Action Option	
Hawaiian hoary bat	Incidental Take	Negligible	Negligible	The Modified Proposed Action Option considers the operation of up to 9 turbines; thereby reducing risk of take by one turbine. However, requested authorized take levels under the HCP would be the same for the Proposed Action and Modified Proposed Action Option.
	Habitat Impacts	Negligible	Negligible	
Newell's shearwater	Incidental Take	Negligible	Negligible	
	Habitat Impacts	No Impact	No Impact	
Hawaiian goose	Incidental Take	Negligible	Negligible	
	Habitat Impacts	Negligible	Negligible	
Hawaiian duck	Incidental Take	Negligible	Negligible	
	Habitat Impacts	No Impact	No Impact	
Hawaiian stilt	Incidental Take	Negligible	Negligible	
	Habitat Impacts	No Impact	No Impact	
Hawaiian coot	Incidental Take	Negligible	Negligible	
	Habitat Impacts	No Impact	No Impact	
Hawaiian moorhen	Incidental Take	Negligible	Negligible	
	Habitat Impacts	No Impact	No Impact	
Hawaiian short-eared owl	Incidental Take	Negligible	Negligible	
	Habitat Impacts	No Impact	No Impact	

2.10 Socioeconomics

Direct or indirect effects on socioeconomic resources from the Modified Proposed Action Option would be the same as the Proposed Action. There are no data providing a clear link between turbine number and dimensions and socioeconomic factors such as property values, population, housing demand, and other factors. No new impacts or significantly more adverse impacts to socioeconomic resources are anticipated from the Modified Proposed Action Option. See Table 11 for an evaluation of each socioeconomic impact issue identified in the DEIS.

Table 11. Evaluation of Modified Proposed Action Option Impacts to Socioeconomic Resources

Impact Issues	Summary of Impact		Evaluation of whether Modified Proposed Action Option Impacts are New or More Adverse from Proposed Action
	Proposed Action	Modified Proposed Action Option	
Property values	Variable	Variable	No change in impact. Property value impacts will be similar under both the Modified Proposed Action Option and the Proposed Action.
Homeowner's insurance rates	Negligible	Negligible	No change in impact. No impact to homeowner insurance rates are anticipated under either the Modified Proposed Action Option or the Proposed Action.
Businesses	Minor	Minor	No change in impact. Project impacts on nearby recreation and tourism businesses would be negligible to minor under either the Modified Proposed Action Option or the Proposed Action.
Residential solar energy/ photovoltaic system installation	Negligible	Negligible	No change in impact. Hawaii Electric Company's limits on rooftop solar installations are not related to existing or planned wind projects.
Population	Minor	Minor	No change in impact. No change is anticipated in the assumed temporary and permanent population gain as described under the Proposed Action in the DEIS.
Demand on housing	Minor	Minor	No change in impact. No change is anticipated in the number of construction or operation workers needed or in the assumption of temporary housing needs described under the Proposed Action in the DEIS.
Employment/income	Minor	Minor	No change in impact. No change is anticipated in the number of construction or operation workers needed as described under the Proposed Action in the DEIS.

2.11 Historic, Archaeological, and Cultural Resources

Direct effects on historic, archaeological, and cultural resources from the Modified Proposed Action Option would be similar to the direct effects from the Proposed Action. Indirect effects from the construction and operation of the Project would be the same under both the Proposed Action and the Modified Proposed Action Option. Indirect impacts to historic, archaeological and cultural resources could result from noise, dust, and vibrations caused by earthmoving and heavy equipment, or from the loss of community access to cultural resources, such as traditional cultural properties. No new impacts or significantly more adverse impacts are anticipated from the Modified Proposed Action Option (Table 12).

Table 12. Evaluation of Modified Proposed Action Option Impacts to Historic, Archaeological, and Cultural Resources

Impact Issues	Summary of Impact		Evaluation of whether Modified Proposed Action Option Impacts are New or More Adverse from Proposed Action
	Proposed Action	Modified Proposed Action Option	
Archaeological sites	Minor	Minor	No change in impacts to archaeological sites are anticipated under the Modified Proposed Action Option. Two archaeological sites identified in the Archaeological Inventory Survey (AIS) are located in proximity to the turbine and access road that would not be included in the Modified Proposed Action Option (archaeological sites 7846 and 7844). These sites are recommended for preservation in the Project AIS; however, both sites are outside of the area of disturbance and would not be affected by Project construction under both the Modified Proposed Action and the Proposed Action.
Traditional cultural uses and practices	Negligible	Negligible	No change in impact. No effects to traditional cultural uses and practices would occur under either the Modified Proposed Action Option or the Proposed Action.

2.12 Land Use

Direct effects on land use from the construction of the Modified Proposed Action Option would be less than the Proposed Action due to the decrease in Project footprint and acres of disturbance to agricultural uses. Indirect effects on land use related to air quality, noise, visual, public health, and traffic considerations would be the same for the Modified Proposed Action Option as they are for the Proposed Action.

No new impacts or significantly more adverse impacts to land use are anticipated from the Modified Proposed Action Option. See Table 13 for an evaluation of each land use impact issue identified in the DEIS.

Table 13. Evaluation of Modified Proposed Action Option Impacts to Land Use

Impact Issues	Summary of Impact		Evaluation of whether Modified Proposed Action Option Impacts are New or More Adverse from Proposed Action
	Proposed Action	Modified Proposed Action Option	
Compatibility with existing and planned land uses	Minor	Minor	No change in impacts. Both the Modified Proposed Action Option and the Proposed Action would be compatible with existing and planned land use, and consistent with land use plans and policies (see Chapter 5 of the EIS for additional discussion).
Consistency with the Koolau Loa Sustainable Communities Plan and land use regulations	Consistent/No Impact	Consistent/No Impact	No change in impact.

2.13 Agriculture

Direct effects on agriculture from the construction and operation of the Project under the Modified Proposed Action Option would be less than the Proposed Action due to the decrease in the Project footprint and resulting acres of disturbance to agricultural uses. Under the Modified Proposed Action Option, approximately 2.7 acres (1.8 hectares) of actively farmed land (row crops) would be permanently affected. Under the Proposed Action approximately 4.6 acres (1.8 hectares) of actively farmed land would be permanently affected. Under both the Modified Proposed Action Option and the Proposed Action no net loss of active agriculture would occur because NPMPP would work with farmers to prepare existing non-arable land for agricultural production (e.g., grubbing, grading, soil amendments, extend irrigation, etc.). Therefore, no new impacts or significantly more adverse impacts to agriculture are anticipated from the Modified Proposed Action Option (Table 14).

Table 14. Evaluation of Modified Proposed Action Option Impacts to Agriculture

Impact Issues	Summary of Impact		Evaluation of whether Modified Proposed Action Option Impacts are New or More Adverse from Proposed Action
	Proposed Action	Modified Proposed Action Option	
Impacts to active agriculture	Minor	Minor	The Modified Proposed Action Option would have reduced impacts to active agriculture compared to the Proposed Action due to a smaller Project footprint.
Impacts to irrigation/water availability or road access for farmers	Minor	Minor	The Modified Proposed Action Option and the Proposed Action would result in temporary disruptions in access to farm plots and/or to irrigation water during construction.

2.14 Recreation and Tourism

Similar to the Proposed Action, the Modified Proposed Action Option would not result in a direct loss of opportunity to any recreation or tourism resource in the analysis area. The Modified Proposed Action would have negligible to minor impacts on recreation and tourism due to construction traffic and noise and will have comparable overall visual impacts as the Proposed Action.

No new impacts or significantly more adverse impacts to recreation and tourism are anticipated from the Modified Proposed Action Option. Table 15 evaluates each recreation and tourism impact issue identified in the DEIS.

Table 15. Evaluation of Modified Proposed Action Option Impacts to Recreation and Tourism

Impact Issues	Summary of Impact		Evaluation of whether Modified Proposed Action Option Impacts are New or More Adverse from Proposed Action
	Proposed Action	Modified Proposed Action Option	
Direct loss of recreation or tourism opportunity	No Impact	No Impact	No change in impact.
Indirect loss of recreation or tourism opportunity due to traffic, noise, or visual impacts	Negligible	Negligible	No change in impact.
Predicted impacts to recreation and tourism use rates	Negligible	Negligible	No change in impact.

2.15 Visual Resources

Direct and indirect effects on visual resources from the Modified Proposed Action Option would be essentially the same as those for the Proposed Action using the same methodology and standards of evaluating impacts on visual resources (see Section 4.16 – Visual Resources). Table 16 summarizes the potential visual impact of the Project for each viewpoint under the Modified Proposed Action Option. At each viewpoint, the visual impact intensity is similar to the Proposed Action and ratings are the same determined for the Proposed Action (see Table 4.16-3 of the EIS).

Visual simulations of the Modified Proposed Action Option and the Proposed Action are shown in Figures 1 through 5 at the four viewpoints that was included in the DEIS. At locations from which the Project would be visible, the view with the Modified Proposed Action Option would typically include one less turbine than would have been visible with the Proposed Action. This aspect of the Modified Proposed Action Option would result in a slight reduction in the incremental visual change created by the Project. Because the Modified Proposed Action Option would employ taller turbines, however, each turbine would create slightly more visual contrast than an individual turbine under the Proposed Action. Reevaluation of the with-Project conditions for each viewpoint under the Modified Proposed Action Option indicated that the difference in visual contrast would not be sufficient to change the contrast rating or the change in visual quality rating for any of the viewpoints.

Table 17 summarizes the updated results of the viewpoint-specific impact evaluation and the overall evaluation of the change to visual resource character, which was the fundamental impact

Table 16. Modified Proposed Action Option: Visual Impact Intensity for Viewpoints

Viewpoint	Viewpoint Name	Closest Wind Turbine to Project (miles)	Viewer Group(s) Represented	Existing Scenic Quality	Contrast Rating	Change in Visual Quality	Overall Viewer Response	Impact Intensity
01	Laie Hawaii Temple	1.7	Recreational, Institutional	High	None	None	Moderate	None
02	Polynesian Cultural Center	2.5	Recreational	Medium	None	None	Moderate	None
03	The Church of Jesus Christ of Latter Day Saints	5.0	Institutional	High	None	None	Moderate	None
04	Kahuku Community	0.5	Residential	Low	Weak	Low	High	Moderate
05	Kahuku Sugar Mill Site	0.5	Commercial	Low	Weak	Low	Low-Moderate	Low
06*	Kahuku Community Center	0.5	Recreational	Moderate	Moderate	Moderate	Moderate	Moderate
07	Malaekahana State Recreation Area	1.0	Recreational	Moderate	Moderate	Moderate	Moderate	Moderate
08	Kamehameha Highway	0.6	Highway travelers	Low	Moderate	Low	Moderate	Low-Moderate
09	Kahuku High and Intermediate School	0.5	Institutional	Low	Weak	Low	Moderate	Low-Moderate
10	Turtle Bay Resort	2.5	Recreational	Moderate	Weak	Low	Moderate	Low-Moderate
11	Punaluu Beach Park	7.3	Recreational	High	None	None	Moderate	None
12	Kahama Valley State Park Beach	9.0	Recreational	High	None	None	Moderate	None
13*	James Campbell National Wildlife Refuge	1.0	Recreational	Moderate	Moderate	Moderate	Moderate	Moderate
14	North Windward Baptist Church	5.0	Institutional	Moderate	None	None	Moderate	None
15	Laie Point Coastal Residences	2.5	Residential	High	Moderate	Moderate-High	Moderate-High	Moderate-High
16	Swanzy Beach Park	9.6	Recreational	High	None	None	Moderate	None

Table 16. Modified Proposed Action Option: Visual Impact Intensity for Viewpoints (continued)

Viewpoint	Viewpoint Name	Distance from Project (miles)	Viewer Group(s) Represented	Existing Scenic Quality	Contrast Rating	Change in Visual Quality	Overall Viewer Response	Impact Intensity
17	Kahuku Hospital and Medical Center	0.5	Institutional	Low	Weak	Low	Moderate	Low-Moderate
18	Kahuku Elementary School	0.3	Institutional	Low	Weak	Low	Moderate	Low-Moderate
19*	Kahuku Golf Course	1.0	Recreational	Moderate	Moderate	Moderate	Moderate	Moderate
20*, **	Malaekahana Bike and Pedestrian Path	1.0	Recreational	Moderate	Moderate	Moderate	Moderate	Moderate
21	Kamehameha Highway	1.6	Highway Travelers	Low	Moderate	Low	Moderate	Low-Moderate

Key:
* - A visual simulation has been completed for the viewpoint.
** - A nighttime visual simulation has been complete for viewpoint

Table 17. Evaluation of Modified Proposed Action Option Impacts to Visual Resources

Impact Issues	Summary of Impact		Evaluation of whether Modified Proposed Action Option Impacts are New or More Adverse from Proposed Action
	Proposed Action	Modified Proposed Action Option	
Number of viewpoints with no visual impact	7	7	Number of viewpoints with no visibility same for Proposed Action and Modified Proposed Action Option.
Number of viewpoints with low or low-moderate visual impact intensity	7	7	No change in impact.
Number of viewpoints with moderate or moderate-high visual impact intensity	7	7	No change in impact.
Number of viewpoints with high visual impact intensity	0	0	No change in impact.
Changes to visual resource character	Moderate	Moderate	No new or substantially more adverse visual impacts with Modified Proposed Action Option.

issue identified in the DEIS under this resource. The summary of visual impact under the Modified Proposed Action Option would be the same as reported in the DEIS for the Proposed Action: visual impact intensity would be moderate or less for all of the viewpoints; the extent of the most noticeable visual impacts would be local; the Project would primarily affect common visual resources that are not rare, unique, or protected by specific legislation; and the overall visual impacts of the Project would be moderate. Therefore, the Modified Proposed Action Option would not result in a significant new impact or a significantly more adverse impact than the Proposed Action.

2.16 Transportation

Direct and indirect effects on transportation infrastructures from the Modified Proposed Action Option would be the comparable to the Proposed Action. There would be no change in the transportation route for construction. The Proposed Action and Modified Proposed Action Option would result in the same number average number of truck trips per day (144 truck trips) and maximum number of truck trips per day (154 truck trips). Therefore, no new impacts or significantly more adverse impacts to transportation would occur under the Modified Proposed Action Option. Table 18 evaluates each impact issue identified in the DEIS under this resource.

Table 18. Evaluation of Modified Proposed Action Option Impacts to Transportation

Impact Issues	Summary of Impact		Evaluation of whether Modified Proposed Action Option Impacts are New or More Adverse from Proposed Action
	Proposed Action	Modified Proposed Action Option	
Increase traffic exceeding a 100 new peak hour trips or 500 daily trips on Kamehameha Highway	Negligible	Negligible	No change in impact. Neither the Proposed Action nor Modified Proposed Action Option would trigger then need for a Traffic Impact Report by HDOT.
Long term traffic delays for a substantial number of motorist	Minor	Minor	No change in impact. Under both the Proposed Action and Modified Proposed Action Option, 90 percent of construction truck trips would occur outside of peak traffic times, and would comprise less than 3 percent of the base traffic levels along Kamehameha Highway.
Changes to traffic patterns that create hazardous situations for motorist, pedestrians, or bicyclists	Minor	Minor	No change in impact.
Changes to air or marine traffic patterns that would cause substantial safety hazards	Negligible	Negligible	No change in impact.
Increase traffic to affect traffic patterns to and from the mitigation areas	Negligible	Negligible	No change in impact.

2.17 Public Health

Impacts associated with construction and operation of the Project under the Modified Proposed Action Option related to public health and safety would be the same as under the Proposed Action with respect to turbine collapse and blade throw, fire risk and hazardous materials exposure, EMF, and stray voltage.

There is no state or national standard that exist for frequency or duration of shadow flicker from wind turbines. However, a threshold of 30 hours per year has been widely used in the industry as a target value in the absence of formal guidelines. However, predicted shadow flicker greater than this threshold does not necessarily create a nuisance and is still well below concerns for impacts to health such as triggering epileptic seizures.

Shadow flicker impacts would be slightly greater under the Modified Proposed Action Option at some sensitive receptors due to the larger size of the turbines. Twenty-five of the 737 receptors modeled in the shadow flicker analysis showed impacts of more than 30 hours per year under the Modified Proposed Action; whereas 17 receptors showed shadow flicker impacts of more than 30 hours per year under the Proposed Action. The maximum predicted shadow flicker impact at any receptor under the Modified Proposed Action is 258 hours 19 minutes per year versus a maximum predicted shadow flicker impact of 244 hours 9 minutes per year under the Proposed Action. This receptor is a farm structure located within the wind farm site used for storing and processing truck crops from the surrounding agricultural fields. Although the number of shadow flicker hours would increase for some receptors (see Appendix K of the EIS), there would be no change in risk to public health and safety.

Under both the Proposed Action and Modified Proposed Action, the potential for shadow flicker would be almost entirely contained within the wind farm site, and the amount of potential flicker extending onto adjacent areas would be relatively short in duration. No shadow flicker impacts would occur at the Kahuku High School, Kahuku Elementary School, or Kahuku Medical Center under either the Modified Proposed Action Option or the Proposed Action. To mitigate for shadow flicker impacts, NPMPP will offer home owners for which shadow flicker is predicted to be greater than 30 hours per year reimbursement for costs up to $800 for adding awnings or blinds to windows facing the wind farm and/or landscaping/trees to block shadow flicker.

Table 19 evaluates each impact issue identified in the DEIS under this resource. No new impacts or significantly more adverse impacts to public health and safety are anticipated from the Modified Proposed Action Option.

Table 19. Evaluation of Modified Proposed Action Option Impacts to Public Health

Impact Issues	Summary of Impact		Evaluation of whether Modified Proposed Action Option Impacts are New or More Adverse from Proposed Action
	Proposed Action	Modified Proposed Action Option	
Turbine collapse and blade throw	Negligible	Negligible	No change in impact. Under both the Modified Proposed Action Option and the Proposed Action there is a negligible risk of impacts to public health and safety in association with turbine collapse and blade throw.
Shadow flicker	Moderate	Moderate	No change in significance of impact; shadow flicker at individual receptors would increase under the Modified Proposed Action Option but there would be no change in effects to public health and safety.
Fire and fuels	Minor	Minor	No change in impact. The reduction of one turbine to the Project layout under the Modified Proposed Action Option will only slightly reduce the risk of fire; therefore the impact is the same as the Proposed Action.
Noise and vibration	Minor/negligible	Minor/negligible	Due to the reduced number of turbines under the Modified Proposed Action Option, there is a reduced risk of impacts to public health and safety in association with noise. No impacts would occur in association with vibration.

Table 19. Evaluation of Modified Proposed Action Option Impacts to Public Health (continued)

Impact Issues	Summary of Impact		Evaluation of whether Modified Proposed Action Option Impacts are New or More Adverse from Proposed Action
	Proposed Action	Modified Proposed Action Option	
Electromagnetic fields (EMF)	Negligible	Negligible	No change in impact. Public or farm worker exposure to EMF is negligible under both the Modified Proposed Action Option and the Proposed Action due to low frequency of the magnetic field.
Stray voltage	Negligible	Negligible	No change in impact. Due to the implementation of standard industry procedures, negligible effects to public health and safety from stray voltage are expected in association with the both the Modified Proposed Action Option and the Proposed Action.

2.18 Environmental Justice

The communities of Kahuku, Laie, and the coastal area south to Kaneohe Bay may be considered minority environmental justice populations based on the disproportionate concentration of Native Hawaiians and Other Pacific Islanders relative to Oahu as a whole (Oahu Metropolitan Planning Organization and Department of Planning and Permitting 2004, U.S. Census Bureau 2012). Neither the Modified Proposed Action Option nor the Proposed Action would result in high and adverse human health or environmental impact; and therefore, neither action alternative would have the potential to disproportionately impact these minority communities, especially Kahuku.

Table 20 provides an evaluation of each environmental justice impact issue identified in the DEIS. No new impacts or significantly more adverse impacts to the environmental justice community are anticipated from the Modified Proposed Action Option.

Table 20. Evaluation of Modified Proposed Action Option Impacts to Environmental Justice

Impact Issues	Summary of Impact		Evaluation of whether Modified Proposed Action Option Impacts are New or More Adverse from Proposed Action
	Proposed Action	Modified Proposed Action Option	
Effects to environmental justice community	Negligible	Negligible	No change in impact.

2.19 Public Infrastructure

Potential effects on public infrastructure facilities and services, including electric service, gas service, water supply, wastewater management, stormwater management, education facilities, emergency and health services, solid waste management, and telecommunications would be the same under the Modified Proposed Action Option as they would be under the Proposed Action. Table 21 provides an evaluation of each public infrastructure impact issue identified in the DEIS. No new impacts or significantly more adverse impacts to public infrastructure are anticipated from the Modified Proposed Action Option.

Table 21. Evaluation of Modified Proposed Action Option Impacts to Public Infrastructure

Impact Issues	Summary of Impact		Evaluation of whether Modified Proposed Action Option Impacts are New or More Adverse from Proposed Action
	Proposed Action	Modified Proposed Action Option	
Electric service	Minor adverse/moderate beneficial	Minor adverse/moderate beneficial	No change in impact. The electricity service required during construction and operation will be the same under both the Modified Proposed Action Option and the Proposed Action.
Gas service	Negligible	Negligible	No change in impact. Traffic management plan prepared under both the Modified Proposed Action Option and the Proposed Action will mitigate any potential for disruption to bottled gas delivery.
Water supply	Negligible	Negligible	No change in impact. Avoidance and minimization measures described under the Proposed Action will be implemented under the Modified Proposed Action Option to avoid any impacts to existing water wells or public water system infrastructure in the vicinity of the Project.
Wastewater management	Minor	Minor	No change in impact. Wastewater generation will be the same (minimal) under the Modified Proposed Action Option as it would be under the Proposed Action.
Stormwater management	Minor	Minor	No change in impact. Construction of the Project would not impact existing stormwater drainage infrastructure, as there is none in the wind farm site that could be affected
Solid waste management	Minor	Minor	No change in impact. The amount of waste generated under the Modified Proposed Action Option would be similar to the Proposed Action and is not expected to adversely impact existing waste management services or facility capacity.

Table 21. Evaluation of Modified Proposed Action Option Impacts to Public Infrastructure (continued)

Impact Issues	Summary of Impact		Evaluation of whether Modified Proposed Action Option Impacts are New or More Adverse from Proposed Action
	Proposed Action	Modified Proposed Action Option	
Education facilities and emergency and health services	Minor	Minor	No change in impact. Direct and indirect impacts to nearby educational facilities and emergency and health services will be the same under both the Modified Proposed Action Option and the Proposed Action.
Telecommunications	Minor	Minor	No change in impact. Minor impacts to telecommunications described under the Proposed Action would be the same for the Modified Proposed Action Option.

2.20 Military Interests

Direct and indirect effects on military interests from the Modified Proposed Action Option would be the same as the Proposed Action. Table 22 provides an evaluation of each military interest impact issue identified in the DEIS. No new impacts or significantly more adverse impacts to military interests are anticipated from the Modified Proposed Action Option.

Table 22. Evaluation of Modified Proposed Action Option Impacts to Military Interests

Impact Issues	Summary of Impact		Evaluation of whether Modified Proposed Action Option Impacts are New or More Adverse from Proposed Action
	Proposed Action	Modified Proposed Action Option	
Loss of land area available to the military for training	Negligible	Negligible	No change in impact. Construction and operation of the Project under both the Modified Proposed Action Option and the Proposed Action would not occupy any land currently used by the military, and would not reduce the area of land available for training.
Change in training practices or activities with a resulting change in military readiness	Negligible	Negligible	No change in impact. Negligible impacts to military helicopter flights and other military air traffic described under the Proposed Action would be the same for the Modified Proposed Action Option.

Table 22. Evaluation of Modified Proposed Action Option Impacts to Military Interests (continued)

Impact Issues	Summary of Impact		Evaluation of whether Modified Proposed Action Option Impacts are New or More Adverse from Proposed Action
	Proposed Action	Modified Proposed Action Option	
Degradation of function of military communication systems	Negligible	Negligible	No change in impact. Negligible impacts to military communication systems described under the Proposed Action would be the same for the Modified Proposed Action Option.
Hazard to training flight operations in the A-311 TFTA[1/]	Negligible	Negligible	No change in impact. Under both the Modified Proposed Action Option and the Proposed Action, approximately 198.1 acres (80.2 hectares) of the wind farm site lies within the TFTA, representing approximately 0.32 percent of the flight training area. All turbines under the Propose Action would be below assumed approach/departure clearance planes helicopter landing zones in the Kahuku Training Area; one turbine under the Modified Proposed Action would coincide with the clearance planes of two landing zones. However, because the FAA allows heliport approach/departure paths to be curved, allowing them to avoid pre-existing or new obstructions, this turbine would not represent an obstruction for designated helicopter landing zones.

1/ The Army's A-311 Alert Area overlays the Kahuku Training Area and Kawailoa Training Area (see Figure 3.19-1 in EIS); it is commonly referred to as the Tactical Flight Training Area (TFTA).

3.0 CONCLUSION

Based on the above analysis, the Modified Proposed Action Option would not result in any new impacts or significantly more adverse impacts than the Proposed Action and already disclosed in the DEIS. Therefore, the Final EIS will carry forward the proposed modifications to the Project as described in Section 2 as the Modified Proposed Action Option evaluated as Alterative 2a.

Figures

Simulated Conditions: Modified Proposed Action Option (Alternative 2a)

Simulated Conditions: Proposed Action (Alternative 2)

Figure 1

Na Pua Makani
Wind Project

Visual Simulation
Kahuku Community Center

January 2016 Oahu, HI

Looking southwest from the Kahuku Community Center

Figure 2

Na Pua Makani
Wind Project

Visual Simulation
James Campbell National Wildlife Refuge

January 2016 Oahu, HI

Looking southwest from the James Campbell National Wildlife Refuge

Simulated Conditions: Modified Proposed Action Option (Alternative 2a)

Simulated Conditions: Proposed Action (Alternative 2)

Figure 3

Na Pua Makani Wind Project

Visual Simulation
Kahuku Golf Course

January 2016 Oahu, HI

Looking southwest from the eastern edge of the Kahuku Golf Course

Simulated Conditions: Modified Proposed Action Option (Alternative 2a)

Simulated Conditions: Proposed Action (Alternative 2)

Figure 4

Na Pua Makani Wind Project

Visual Simulation Kahuku Walking Trail

January 2016 Oahu, HI

Looking northwest from the walking path on the west side of Kamehameha highway, approximately 1/2 mile south of Kahuku

Simulated Conditions: Modified Proposed Action Option (Alternative 2a)

Simulated Conditions: Proposed Action (Alternative 2)

Figure 5

Na Pua Makani
Wind Project

Night Time Visual Simulation
Kahuku Walking Trail

January 2016 Oahu, HI

Looking northwest from the walking path on the west side of Kamehameha highway, approximately 1/2 mile south of Kahuku

APPENDIX B
TRAFFIC ASSESSMENT REPORT

TRAFFIC ASSESSMENT REPORT
NĀ PUA MAKANI WIND FARM

Kahuku, O'ahu, Hawai'i
Tax Map Keys: 5-6-006:018, 047, 051, 055, 5-6-005:018, and 5-6-008:006

January 2015
Revised January 2016

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2014-33-1000

1 INTRODUCTION

This report summarizes the analysis and findings of a traffic assessment for the Nā Pua Makani Wind Farm. This traffic assessment describes the potential traffic impacts during construction and when the project is completed under seven (7) different scenarios, which are based upon the type and quantity of wind turbine generators (WTG) that could be installed.

2 PROJECT DESCRIPTION

The Nā Pua Makani Wind Farm project (Project) is located at the northeast coast of Oʻahu, in Kahuku Town, Tax Map Key (TMK) 5-6-006:018, 047, 051, 055, 5-6-005:018, and 5-6-008:006. See Figure 1 – Location Map. The 707 acre project area is approximately 9,000 feet inland from the coast on a steep sloping ridge with elevations ranging from 13- to 400-feet above mean sea level. There are two proposed access points to the project site off the mauka side of Kamehameha Highway; one will be off an existing paved road owned by the State of Hawaiʻi, Department of Agriculture, just south of Kiʻi Stream Bridge (Proposed Access 1) and the other off a private dirt road between Enos Road and the Mālaekahana Stream Bridge (Proposed Access 2).

Three alternatives evaluated in the Project EIS: Alternative 1 – No Action, Alternative 2 – Proposed Action Wind Project of up to 10 turbines (up to approximately 25 megawatts (MW)), and Alternative 3 – Larger Generation Wind Project of up to 12 turbines (up to 42-MW). Under Alternative 1, there will be no new construction of wind turbines, meteorological towers, supporting structures, and access roadways. Thus, the main focus of this report will only discuss Alternative 2 and 3.

Alternative 2 entails the construction and operation of an approximately 25 MW wind generation facility, consisting of 8 to 10 wind turbines, meteorological tower, operations and maintenance facility, electrical collections system, transmission line, and 16 foot-wide internal access roads. This alternative evaluates construction traffic impacts for three different scenarios (scenarios 1-3), each of which use a specific WTG. Construction would begin in the fourth quarter of 2016 and would be in full operation by the end of 2017. In response to public comments, the Project proponent also evaluated a Modified Proposed Action option (Scenario 2a), which reduces the maximum number of turbines to 9 based on usage of an uprated Siemens turbine model with greater generating capacity. All other project components and details would be the same as under the Proposed Action. The following lists the quantity and models to be evaluated under all 4 scenarios.

Scenario	WTG Manufacturer	Model	Quantity
1	General Electric (GE)	GE 2.85-103	10
2	Siemens	3.0-108	10
2a	Siemens	3.3-130	9
3	Vestas	V110 V117	3 5

Alternative 3 entails the construction and operation of an approximately 42 MW wind generation facility, consisting of up to 12 wind turbines, meteorological tower, operations and maintenance facility, electrical collections system, transmission line, and 16-foot-wide access roads using compacted gravel. It evaluates the impacts for a phased build out plan, whereby phase 1 would begin construction on one of the scenarios by 2016 similar to Alternative 2; then phase 2 would construct additional WTG's of the same manufacturer. Construction of the second phase would start at the beginning of 2020 with operation of those WTGs starting towards the end of 2020. The following lists the number and model of each WTG constructed in each phase for the four scenarios.

Scenario	WTG Manufacturer	Model	Phase 1 Quantity	Phase 2 Quantity	TOTAL
1	General Electric (GE)	GE 2.85-103	10	2	12
2	Siemens	3.0-108	10	2	12
2a	Siemens	3.3-130	9	0	9
3	Vestas	V110 V117	3 5	0 4	12

3 EXISTING TRAFFIC CONDITIONS

Kamehameha Highway (Highway 83) is a two-lane undivided State highway that provides the only access around the north side of O'ahu from Hale'iwa to Kahalu'u. The lanes on this highway are 12' wide and have mostly grassed shoulders with some paved shoulders. Posted speed limits along the roadway vary between 25 and 45 miles per hour (mph) and generally have lower speed limits near towns and schools. The posted speed limit at the entrance to the project site is 35 mph.

Existing traffic volume data was retrieved from the State of Hawai'i Department of Transportation (HDOT), which collects 24-hour traffic count volumes at various locations throughout the island. The nearest HDOT count station to the project site is along Kamehameha Highway at the Mālaekahana Stream bridge and was conducted in 2013. The following table provides the morning and afternoon peak hour volumes as well as the 24 hour volumes at this station. The morning peak hour was between 7:00 to 8:00 a.m. and the afternoon peak was between 3:45 and 4:45 p.m.

Existing 2013 Traffic Counts

Time	Total Traffic Volume (Both Directions)
AM Peak Hour (7:00 – 8:00 a.m.)	1,095
PM Peak Hour (3:45 – 4:45 p.m.)	1,012
24 hour	12,187

Source: State of Hawai'i, Department of Transportation, Highways Division.

Traffic volumes taken by HDOT on previous years are also included in Appendix A and shows that the 2013 data is in line with previous years. The morning peak has also been consistent, while the afternoon peak is trending later. The 24 hour volumes are also showing the modest increase in traffic over the 12 years of available data.

4 FUTURE BASELINE TRAFFIC CONDITIONS

Future baseline conditions have been established for the year 2017 and 2020, when full operations of the project alternatives are expected. Based on the O'ahu Regional Transportation Plan, other Traffic Impact Reports obtained from projects in the area, and the historical HDOT traffic data the average regional traffic for Kahuku is expected to increase 1.23% annually. Therefore, the future baseline traffic volumes, which are also considered Alternative 1, at the Mālaekahana Bridge are anticipated to be the following:

Future Baseline Traffic

Time	2017 Total Traffic Volume (Both Directions)	2020 Total Traffic Volume (Both Directions)
AM Peak Hour (7:00 – 8:00 a.m.)	1,150	1,193
PM Peak Hour (3:45 – 4:45 p.m.)	1,063	1,102
24 Hour	12,797	13,275

5 PROJECT TRAFFIC

The proposed project would generate vehicle traffic on roadways in the vicinity throughout the estimated 6 to 12 month construction period as well as once the WTGs are in full operation. Access to the project site is from the mauka side of Kamehameha Highway just south of Ki'i Stream Bridge (Proposed Access 1) as well as just north of the Mālaekahana Stream Bridge (Proposed Access 2). The first 5 WTG's would likely use the access just south of Ki'i Stream Bridge, while the rest of the WTG's would utilize the access north of Mālaekahana Stream Bridge.

5.1 CONSTRUCTION RELATED TRAFFIC

Construction related traffic to build the proposed project would include the transporting of the major components to build the WTGs from Kalaeloa Harbor, hauling in cement and aggregate for the foundations, other miscellaneous deliveries, and employee related traffic.

The major components to build the WTGs include the blade, tower, nacelles, and electrical transformer. These will be transported by sea and offloaded at Kalaeloa Harbor, which is a heavy lift berthing facility located on the Western Coast of O'ahu. Due to the size and weight of these components permits to transport these oversized and/or overweight loads would need to be obtained from both HDOT and the City and County of Honolulu. The following are anticipated requirements of the permit:

- The roundtrips must be performed Monday through Saturday between the hours of 9:00 p.m. and 5:00 a.m. with all equipment off the roadways between the hours of 5:00 a.m. and 9:00 p.m.
- No oversized loads are allowed to be transported on Sundays or holidays.
- A minimum of 4 police escorts per load are required to help the oversized load navigate turns.

- Police escorts and/or flagmen must provide traffic direction at the entrance to the wind farm site during construction.

The following is a table noting the number of nighttime roundtrips and how many days it would take in order to get all the equipment to the project site.

Anticipated Nighttime Roundtrip Oversized Truck Trips

Alternative	Construction Related Oversized Truck Trips between 9 p.m. to 5 a.m.	Total Days
Alternative 1 – No Action	0	0
Alternative 2 – 10 GE WTGs	100	20
Alternative 2 – 10 Siemens WTGs	90	18
Alternative 2 – 8 Vestas WTGs	77	16
Alternative 2a – 9 Siemens WTGs	108	22
Alternative 3 – 12 GE WTGs	Phase 1 – 100 Phase 2 – 20	Phase 1 – 20 Phase 2 – 4
Alternative 3 – 12 Siemens WTGs	Phase 1 – 90 Phase 2 – 20	Phase 1 – 18 Phase 2 – 4
Alternative 3 – 12 Vestas WTGs	Phase 1 – 77 Phase 2 – 40	Phase 1 – 16 Phase 2 – 8

Note: Assume an average of 5 truck trips could be made each day.

Three proposed routes from Kalaeloa Harbor to the project site were identified by ATS International in transporting the WTG's oversized nacelle component, the tower section or nacelle components, and the blade components (see Figure 2 – Proposed Truck Routes).

The following directions for route 1 would be used to transport the oversized nacelle components, which would be transported using a 19-axel trailer. In their January 2016 route study update ATS concluded that this route could be eliminated unless a 19 axel truck is required to transport a part, otherwise the tower and nacelle parts could utilize route 2.

1. Continue straight out of the Grace Pacific gate onto Hanua Street
2. Turn left on Kauhi Street toward Kalaeloa Boulevard
3. Turn left on Kalaeloa Boulevard
4. Merge onto H-1 East
5. Take Exit 5 to Kunia Waipahu/'Ewa
6. Turn left onto Kunia Road
7. Continue on Kunia Road to Wilikina Drive
8. Turn left on Wilikina Drive
9. Turn right on Kamananui Road
10. Continue north on Kamehameha Highway
11. Continue on Kamehameha Highway to Joseph P. Leong Highway (Highway 99)
12. Continue on Highway 99 to Kamehameha Highway East (Highway 83)

13. Continue on Highway 83 to proposed entrance to the wind farm

The following direction for route 2 would be used to transport the taller tower section and nacelle components.

1. Continue straight out of the Grace Pacific gate onto Hanua Street
2. Turn left on Kauhi Street toward Kalaeloa Boulevard
3. Turn left on Kalaeloa Boulevard
4. Merge onto H-1 East
5. Continue on H-1 East and stay in the right lane
6. Take Exit 8C for Kamehameha Highway North
7. Turn right on Ka Uka Boulevard
8. Turn left onto H-2 North
9. Continue on H-2 North to Wilikina Drive
10. Continue on Wilikina Drive to Kamananui Road
11. Turn right on Kamananui Road
12. Continue north on Kamehameha Highway
13. Continue on Kamehameha Highway to Joseph P. Leong Highway (Highway 99)
14. Continue on Highway 99 to Kamehameha Highway East (Highway 83)
15. Continue on Highway 83 to proposed entrance to the wind farm.

And finally, the following directions for route 3 would be used to transport the wind turbine blade components.

1. Continue straight out of the Grace Pacific gate onto Hanua Street
2. Turn left on Kauhi Street toward Kalaeloa Boulevard
3. Turn left on Kalaeloa Boulevard
4. Merge onto H-1 East
5. Continue on H-1 East and stay in the left lane to merge onto the H-2 North
6. Take Exit 8B for H-2 North to Mililani and Wahiawā
7. Continue on H-2 North to Wilikina Drive
8. Continue on Wilikina Drive to Kamananui Road
9. Turn right on Kamananui Road
10. Continue north on Kamehameha Highway
11. Continue on Kamehameha Highway to Joseph P. Leong Highway (Highway 99)
12. Continue on Highway 99 to Kamehameha Highway East (Highway 83)
13. Continue on Highway 83 to the proposed entrance to the wind farm.

Transport of the oversized components would require tree trimming, sign relocation, and overhead utility lines adjustments in order to provide a clear route. ATS has identified Kalaeloa Boulevard, Kauhi Street, Ka Uka Boulevard, and Kamehameha Highway as having trees that may need trimming to a clearance height minimum of 16 feet and 6 inches prior to transport of the equipment. The left turn onto Kamehameha Highway at Kamananui Road, the left turn onto Wilikina Drive, and the right turn at Ka Uka Boulevard would require police escorts to block traffic in order for the truck to make the turns. Additionally, based upon the type of WTG chosen, some temporary roadway improvements like asphalt curb removal, guardrail relocation, or relocation of a traffic signal and roadway signs may be required since transport dimensions of each part vary by manufacturer and model. After all deliveries are made all temporary improvements shall be restored to previous existing conditions. ATS also recommended that prior to transport of the oversized components that a "high pole" survey be conducted to confirm and identify any new trees or wires that need to be trimmed or raised, respectively, that were not identified in their January 2016 report.

ATS was also informed by HDOT that the Paumalu Bridge along Kamehameha Highway near Sunset Beach had been derated and no overweight loads would be allowed to cross the structure. Per further discussions with HDOT a longer truck with more axels to spread the load or a structural analysis on the bridge would need to be analyzed further for use of the Paumalu Bridge. At the access roads to the proposed site additional improvements to the entrance roadways to clean,fill, and smooth out the grades would be needed along with tree trimming.

Traffic estimates that include passenger vehicles, such as those due to construction workers arriving or departing the work site, as well as cement or aggregate deliveries, and building component or substation deliveries were developed based upon estimated quantities for materials. Cement and aggregate deliveries would come from Hālawa, while other deliveries are also expected to originate from Honolulu. Construction workers are also expected to work between the hours of 7:00 a.m. and 3:30 p.m. with approximately 90% arriving to the site before the morning peak hour and the remaining 10% during the peak. It was also assumed that approximately 90% of the construction trips would occur just before the pm peak hour at 3:30 p.m. when they would be leaving work and 10% during the peak. During daylight hours the following average and maximum daytime round trips are anticipated during construction for all scenarios of Alternatives 2 and 3.

Anticipated Average Daytime Trips

Construction Trips	Average Number of Round Trips Per Day	AM Peak Hour Trips (7-8am)	PM Peak Hour Trips (3:45-4:45pm)
Cement	50	5	5
Aggregate	50	5	5
Substation	1	0	0
Building Components	2	1	0
Miscellaneous Deliveries	1	0	0
Construction Workers	40	4	4
TOTAL TIRPS	**144**	**15**	**14**

Note: Assumed 10% of the daytime truck trips would occur during the peak hours.

Anticipated Maximum Daytime Trips

Construction Trips	Average Number of Round Trips Per Day	AM Peak Hour Trips (7-8am)	PM Peak Hour Trips (3:45-4:45pm)
Cement	50	5	5
Aggregate	50	5	5
Substation	1	0	0
Building Components	2	1	0
Miscellaneous Deliveries	1	0	0
Construction Workers	100	10	10
TOTAL TIRPS	**154**	**21**	**20**

Note: Assumed 10% of the daytime truck trips would occur during the peak hours.

Assuming the rate at which the WTGs are constructed is the same for 2016 and 2019, all scenarios in both alternatives would have similar anticipated average and maximum daytime construction trips. The following table provides a comparison of the anticipated volumes to the baseline traffic volumes in the morning and afternoon peak hours and for a 24 hour period for construction in 2017 and 2020.

Percentage of Peak Project Construction Trips to Baseline Traffic

Time	2017	2020
AM Peak Hour (7:00 – 8:00 a.m.)	1.8%	1.8%
PM Peak Hour (3:15 – 4:15 p.m.)	1.9%	1.8%
24 Hour	2.4%	2.3%

Based upon the HDOT's Best Practices for Traffic Impact Reports (TIR), a typical trigger for preparing a TIR is 100 or more new peak hour trips or 500 daily trips. Based upon the trip numbers calculated and the percentage of the total traffic along Kamehameha Highway, the project will not meet this trigger and is therefore not expected to cause a significant impact.

5.2 PROJECT TRAFFIC

When the WTGs are in full operation there will be approximately three to six full time operations and maintenance employees on the site. Their typical work hours would be between 7:00a.m. and 5:00 p.m. and at the most would result in 6 round trips per day. These employees were estimated to be sufficient manpower to handle daily maintenance for up to 12 WTGs on the site. Their total daily trips would account for less than 0.6% of the future 2017 and 2020 traffic loads on Kamehameha Highway for all alternatives.

Percentage of Project Trips to Baseline Traffic

Time	2017	2020
AM Peak Hour (7:00 – 8:00 a.m.)	0.52%	0.50%
PM Peak Hour (3:45 – 4:45 p.m.)	0.56%	0.54%
24 Hour	0.09%	0.09%

6 CONCLUSION

The proposed project will result in minor construction related impacts due to the transportation of large equipment and materials. The net effects of these impacts were found to be minimal because the oversized WTG components would be delivered at night. A less than 3% increase in traffic on Kamehameha Highway due to construction during the morning and afternoon peaks would not result in a significant increase and would be temporary. Project related traffic once the WTGs are in full operation is also not expected to have any significant impacts to Kamehameha Highway due to the low volume of employees that would access the site. The following table summarizes the traffic impacts showing the percentage of project trips to the estimated base year traffic volumes.

Summary of Impacts – Percentage of Project Trips to Baseline Traffic

		Alternative 1 No Action	Alternative 2 (All 4 scenarios)	Alternative 3 (All 4 scenarios)
Construction Impacts	AM Peak	0	1.8%	Phase 1 – 1.8% Phase 2 – 1.8%
	PM Peak	0	1.9%	Phase 1 – 1.9% Phase 2 – 1.8%
	24 Hour	0	2.4%	Phase 1 – 2.4% Phase 2 – 2.3%
Project Impacts	AM Peak	0	0.53%	Phase 1 – 0.52% Phase 2 – 0.50%
	PM Peak	0	0.57%	Phase 1 – 0.56% Phase 2 – 0.54%
	24 Hour	0	0.09%	Phase 1 – 0.09% Phase 2 – 0.09%

7 REFERENCES

Anderson Trucking Services, Inc*, Nā Pua Makani Transport Route Review*, June 6, 2014.

Anderson Trucking Services, Inc*, Nā Pua Makani Wind Farm*, January 19, 2016.

Hawaiʻi Department of Transportation, *Hawaii Department of Transportation Best Practices for Traffic Impact Reports,* May 2011.

Oʻahu Metropolitan Planning Organization, *Oahu Regional Transportation Plan 2035,* April 2011.

The Traffic Management Consultant, *Revised Traffic Impact Analysis Report for the Proposed Turtle Bay Resort Master Plan,* November 2012, amended May 2013.

Document Path: M:\Na Pua Makani Wind Farm\2014331001 Drainage Study\04 Graphics\GIS\Location Map_2.mxd

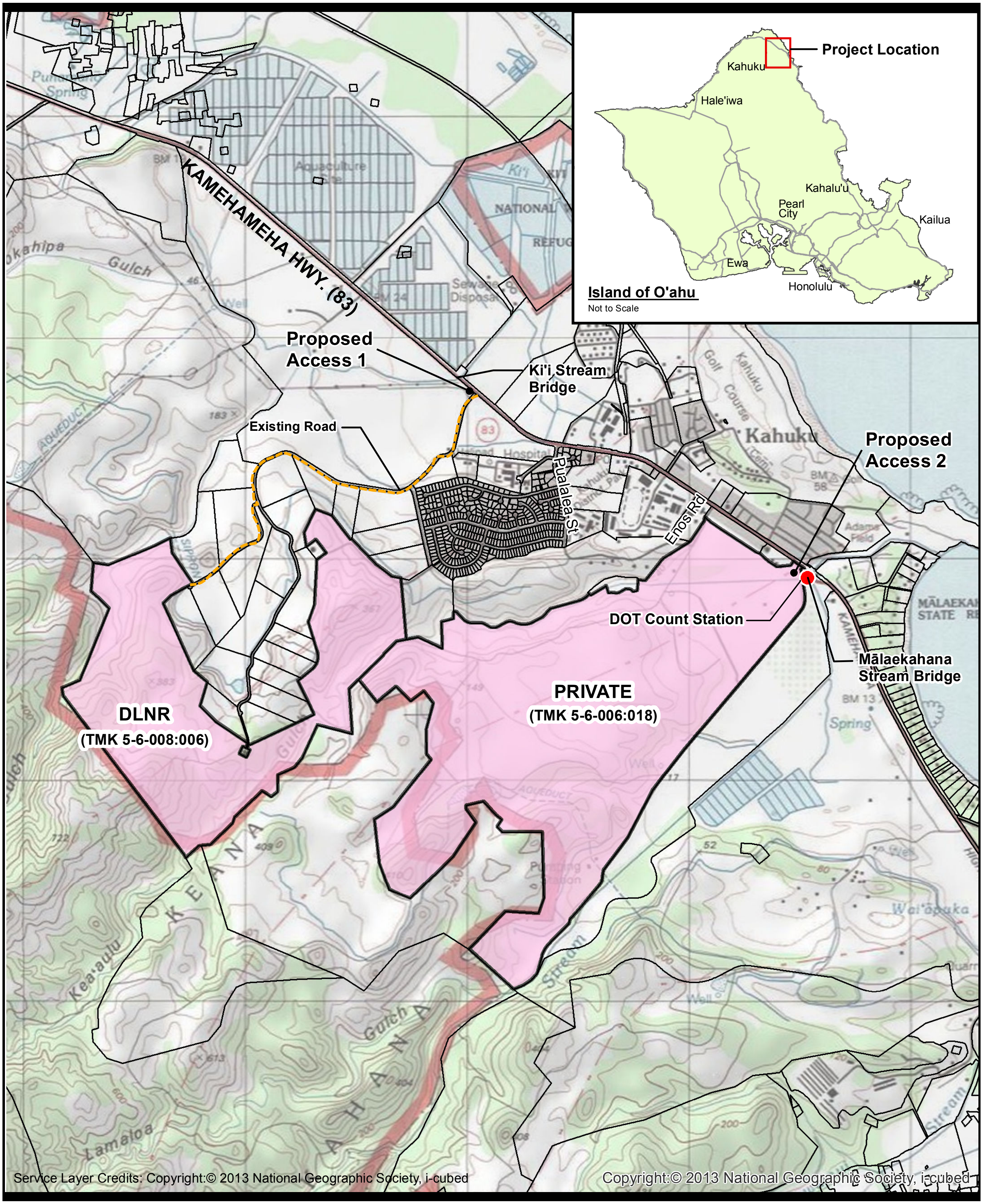
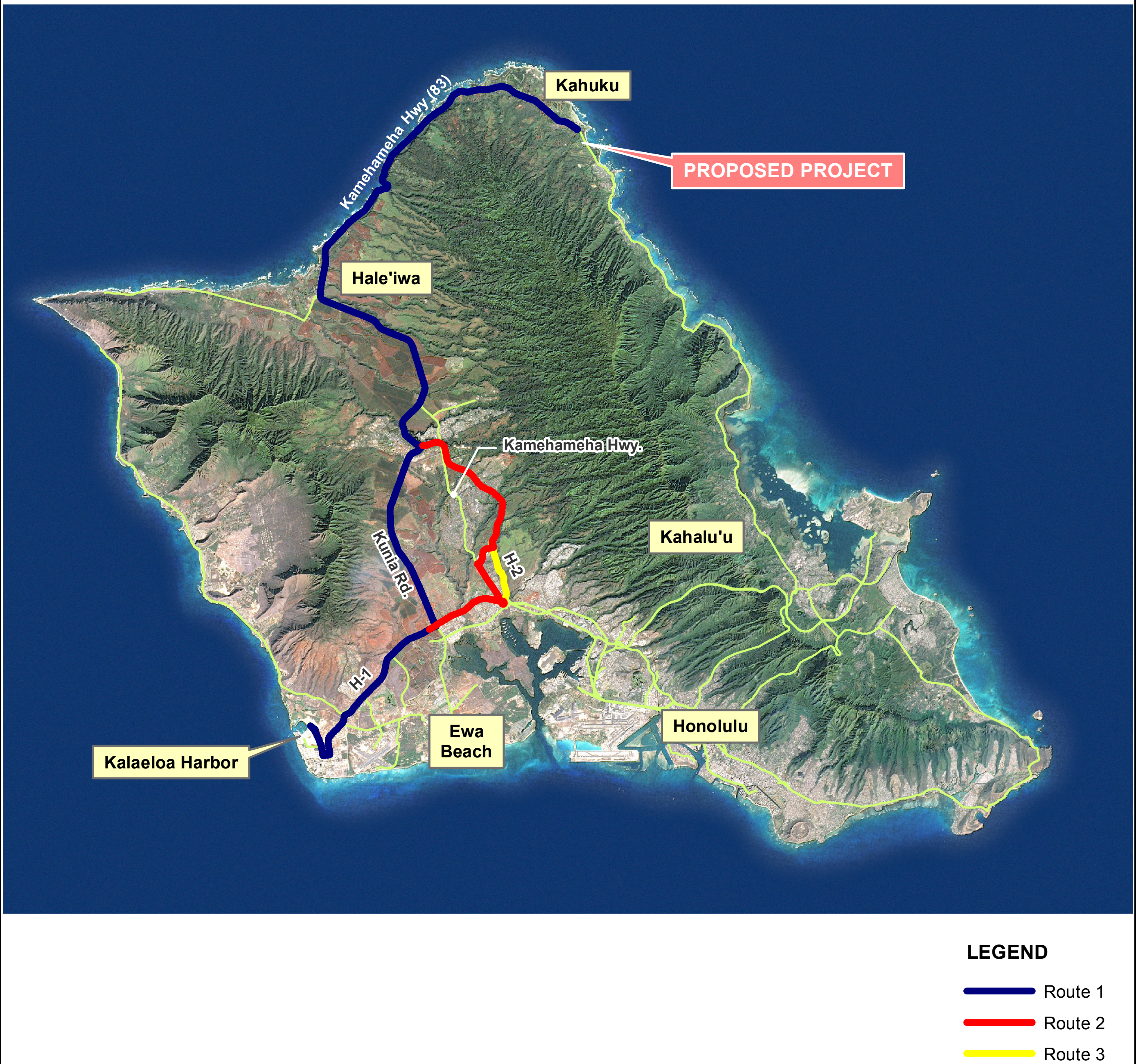


Figure 1

LOCATION MAP

Nā Pua Makani Wind Farm
Champlin Hawaii Wind Holdings LLC
January 2015



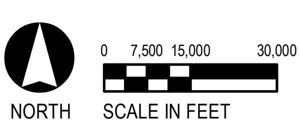


Figure 2

PROPOSED TRUCK ROUTES

Nā Pua Makani Wind Farm
Champlin Hawaii Wind Holdings LLC
January 2015

APPENDIX A – DOT TRAFFIC COUNT DATA

BELT COLLINS	PROJECT:	Nā Pua Makani Wind Farm		JOB NO:	2014-33-1000	
	CLIENT:	Champlin Hawaii Wind Holdings LLC		DATE:	7-May-14	
	SUBJECT:	DOT Count Data		BY:	LN	
	FILE:	M:\Na Pua Makani Wind Farm\2014331000 Traffic Study\05 Basis of Design\Reference Docs\DOT Traffic Count Stations\[DOT Count Data.xlsx]Malaekahana Bridge				

Site ID: B72008301618, 26-E

Location: Kamehameha Highway at Malaekahana Bridge

	AM Peak		PM Peak		24 Hour	
YEAR	Volume	Peak Hour	Volume	Peak Hour	Volume	Rate/year
2001	617	n/a	764	n/a	9,240	
2004	685	n/a	1,018	n/a	11,340	7.6%
2005	845	n/a	1,070	n/a	12,112	6.8%
2006	654	n/a	934	n/a	10,867	-10.3%
2007	689	7:00am	865	3:00pm	10,640	-2.1%
2009	875	7:15am	944	3:15pm	10,943	1.4%
2011					12,200	5.7%
2012	1,055	7:00am	1,014	3:30pm	12,335	1.1%
2013	1,095	7:15am	1,012	3:45pm	12,187	-1.2%
					Average growth per year=	1.1%

APPENDIX C

NOISE IMPACT ASSESSMENT

Na Pua Makani Wind Farm

Honolulu County, Hawaii

Prepared for

CHAMPLIN/GEI WIND HOLDINGS, LLC

Champlin / GEI Wind Holdings, LLC
2020 Alameda Padre Serra, Ste. 123
Santa Barbara, CA 93103

July 2014 - revised December 2015

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Appendix A – Field Equipment Calibration Sheets

1.0 INTRODUCTION

Champlin/GEI Wind Holdings, LLC (Champlin) is proposing to construct and operate the Na Pua Makani Wind Energy Project (the "Project") in Honolulu County, Hawaii. The proposed Project would implement one of two wind turbine generator (WTG) models, quantity, mega-watt (MW), hub-height and rotor diameter as shown in Table 1:

Table 1. Project WTGs under Consideration

Model	Quantity Alt. 2	Quantity Alt. 2a	Quantity Alternative 3	MW Output per WTG	Hub-height (m)	Rotor Diameter (m)
Vestas V110-2.0	2		2	2.0	80	110
Siemens SWT 3.0-113	8		10	3.0	92.5	113
Siemens SWT 3.3-130	-	9		3.3	85, 115, or 135	130

Vestas 2013, Siemens 2013, Siemens 2015

The Project design configurations under consideration translate to a potential power output of approximately 26 (Alternative 2) to 30 (Alternative 3) MW, depending on WTG type and quantity. This noise impact assessment provides a description of the existing acoustic environment, noise impact criteria, acoustic analysis methodology, construction and operational noise levels, and conclusions and mitigation recommendations.

1.1 Environmental Noise Descriptors

Sound levels are presented on a logarithmic scale to account for the large range of acoustic pressures that the human ear is exposed to and is expressed in units of decibels (dB). A decibel is defined as the ratio between a measured value and a reference value usually corresponding to the lower threshold of human hearing defined as 20 micropascals (μPa). Broadband sound includes sound energy summed across the entire audible frequency spectrum. In addition to broadband sound pressure levels, analysis of the various frequency components of the sound spectrum can be completed to determine tonal characteristics. The unit of frequency is Hertz (Hz), and the limit of human hearing is from 20 Hz to 20,000 Hz. WTGs generally produce mechanical sound at a frequency of 20-30 Hz and a "whooshing" aerodynamic sound in the range of 200-1000 Hz (National Health and Medical Research Council 2013). Typically the frequency analysis for an industrial noise source, such as WTGs, examines 11 octave (or 33 1/3-octave) bands ranging from 16 Hz (low) to 16,000 Hz (high). One third (1/3) octave bands take these octave bands and split them into three, providing a higher resolution and a more detailed description of the frequency content of the sound. Since the human ear does not perceive every frequency with equal loudness, spectrally varying sounds are often adjusted with a weighting filter. The A-weighted filter is applied to compensate for the frequency response of the human auditory system. Existing sound exposure in the Na Pua Makani Wind Farm acoustic analysis area are reported in A-weighted decibels (dBA).

An inherent property of the logarithmic decibel scale is that the sound pressure levels of two separate sources are not directly additive. For example, if a sound of 50 dBA is added to another sound of 50 dBA, the result is a 3-decibel increase (or 53 dBA), not an arithmetic doubling of 100 dBA. The human ear does not perceive changes in the sound pressure level as equal changes in loudness. Scientific research demonstrates that the following general relationships hold between sound level and human perception for two sound levels with the same or very similar frequency characteristics:

1. 1 dBA is the practically achievable limit of the accuracy of sound measurement systems and corresponds to an approximate 10 percent variation in sound pressure. A 1 dBA increase or decrease is a non-perceptible change in sound.
2. 3 dBA increase or decrease is a doubling (or halving) of acoustic energy and it corresponds to the threshold of perceptibility of change in a laboratory environment. In practice, the average person is not able to distinguish a 3 dBA difference in environmental sound outdoors.
3. 5 dBA increase or decrease is described as a perceptible change in sound level and is a discernable change in an outdoor environment.
4. 10 dBA increase or decrease is a tenfold increase or decrease in acoustic energy but is perceived as a doubling or halving in sound (i.e., the average person will judge a 10 dBA change in sound level to be twice or half as loud).

To account for the time-varying nature of environmental noise, a single descriptor known as the equivalent sound level (L_{eq}) is often used. The L_{eq} value is the sound energy average over the complete measurement period. It is defined as the steady, continuous sound level over a specified time that has the same acoustic energy as the actual varying sound levels over the same time. The metrics commonly used for environmental sound studies, including the L_{eq}, are reported as dBA (A-weighted decibels) which is a frequency weighting curve that reflects the response of the human ear to sound frequencies across the entire audible frequency range. The equivalent sound level has been shown to provide both an effective and uniform method for describing time-varying sound levels and is widely used in acoustic assessments of wind energy facilities.

Several other statistical descriptors can also be assessed to provide additional understanding of the existing soundscapes. The statistical sound levels (L_n) provide the sound level exceeded for that percentage of time over the given measurement period. An L_{10} level is often referred to as the intrusive noise level and is the A weighted sound level that is exceeded for 10 percent of the time during a specified measurement period. Perhaps more useful is the L_{90} level, which is the A-weighted sound level that is exceeded for 90 percent of the time during the measurement time period. The L_{90} can be thought of as the quietest 10 percent of any time period and is often referred to as the residual sound level and can be an indicator of the potential of audibility for a new sound source. The L_{max} is the maximum sound level during the measurement period and the L_{min} is the minimum sound levels during the measurement period. Estimates of noise sources and outdoor acoustic environments, and the comparison of relative loudness are presented in Table 2. Table 3 provides additional reference information on acoustic terminology.

Table 2. Sound Pressure Levels (L_P) and Relative Loudness of Typical Noise Sources and Soundscapes

Noise Source or Activity	Sound Level (dBA)	Subjective Impression	Relative Loudness (perception of different sound levels)
Jet aircraft takeoff from carrier (50 ft)	140	Threshold of pain	64 times as loud
50-hp siren (100 ft)	130		32 times as loud
Loud rock concert near stage or Jet takeoff (200 ft)	120	Uncomfortably loud	16 times as loud
Float plane takeoff (100 ft)	110		8 times as loud
Jet takeoff (2,000 ft)	100	Very loud	4 times as loud
Heavy truck or motorcycle (25 ft)	90		2 times as loud
Garbage disposal, food blender (2 ft), or Pneumatic drill (50 ft)	80	Loud	Reference loudness
Vacuum cleaner (10 ft)	70	Moderate	1/2 as loud
Passenger car at 65 mph (25 ft)	65		
Large store air-conditioning unit (20 ft)	60		1/4 as loud
Light auto traffic (100 ft)	50	Quiet	1/8 as loud
Quiet rural residential area with no activity	45		
Bedroom or quiet living room or Bird calls	40	Faint	1/16 as loud
Typical wilderness area	35		
Quiet library, soft whisper (15 ft)	30	Very quiet	1/32 as loud
Wilderness with no wind or animal activity	25	Extremely quiet	
High-quality recording studio	20		1/64 as loud
Acoustic test chamber	10	Just audible	
	0	Threshold of hearing	
Adapted from: Beranek (1988) and USEPA (1971a)			

Table 3. Acoustic Terms and Definitions

Term	Definition
Noise	Unwanted sound dependent on level, character, frequency or pitch, time of day, and sensitivity and perception of the listener. This word adds the subjective response of humans to the physical phenomenon of sound. It is commonly used when negative effects on people are known to occur.
Sound Pressure Level (L_P)	Pressure fluctuations in a medium. Sound pressure is measured in decibels referenced to 20 micropascals, the approximate threshold of human perception to sound at 1000 Hz.
Sound Power Level (L_W)	The total acoustic power of a noise source measured in decibels referenced to picowatts (one trillionth of a watt). Equipment specifications are provided by equipment manufacturers as sound power as it is independent of the environment in which it is located. A sound level meter does not directly measure sound power.
Frequency (Hz)	The rate of oscillation of a sound, measured in units of Hertz (Hz) or kilohertz (kHz). One hundred Hz is a rate of one hundred times (or cycles) per second. The frequency of a sound is the property perceived as pitch. For comparative purposes, the lowest note on a full range piano is approximately 32 Hz and middle C is 261 Hz.
A-Weighted Decibel (dBA)	Environmental sound is typically composed of acoustic energy across all frequencies (Hz). To compensate for the auditory frequency response of the human ear, an A-weighting filter is commonly used for describing environmental sound levels. Sound levels that are A-weighted are presented as dBA in this report.
Propagation and Attenuation	Propagation is the decrease in amplitude of an acoustic signal due to geometric spreading losses with increased distance from the source. Additional sound attenuation factors include air absorption, terrain effects, sound interaction with the ground, diffraction of sound around objects and topographical features, foliage, and meteorological conditions including wind velocity, temperature, humidity and atmospheric conditions.
Octave Bands	The audible range of humans spans from 20 to 20,000 Hertz and is typically divided into octave band center frequencies (Hz) ranging from 31 to 8,000 Hz.
Broadband Sound	The audible range of humans spans from 20 to 20,000 Hz and is typically divided into center frequencies ranging from 31 to 8,000 Hz.

Table 3. Acoustic Terms and Definitions

Term	Definition
Masking	Interference in the perception of one sound by the presence of another sound. At elevated wind speeds, leaf rustle and noise made by the wind itself can mask wind turbine sound levels, which remain relatively constant.
Low Frequency Noise (LFN)	The frequency range of 20 to 200 Hz is typically defined as low frequency noise. Studies have shown that low frequency sound from modern wind turbines is generally below the threshold of human perception at standard setback distances.
Infrasound (IS)	The frequency range of infrasound is normally defined as below 20 Hz. Infrasound from wind turbines are significantly below recognized thresholds for both human perceptibility and standardized health.
Note: Compiled by Tetra Tech from multiple technical and engineering resources.	

1.2 Low Frequency noise and Infrasound

Low frequency noise (LFN) and infrasound (IS) are defined by the frequency ranges they represent. LFN comprises noise in the audible human frequency ranges from 20 Hz to 200 Hz. IS represents the frequencies below 20 Hz that while typically inaudible to humans, if the amplitude of IS is very high, for example at least 80 or above for frequencies under 20 Hz and 103 dB or above for 5 Hz, it may be detectible to humans (Massachusetts Department of Public Health or MDPH 2012). Studies have shown that pain from infrasound can result when sound levels are 165 dB or above at 2 Hz and 145 dB or above at 20 Hz (MDPH 2012).

Existing non-WTG related LFN and IS are apparent in most, if not all, environmental settings. The magnitude of these existing background LFN/IS varies, but can be of sufficient strength in to mask much, or all of the LFN and IS from WTGs. Common background natural sound sources of LFN and IS include wind interacting with vegetation in the surrounding environment and ocean waves hitting shores. Additionally, a common anthropogenic sound source with LFN and IS components is roadway noise.

Outside of sleep disturbance from audible noise from WTGs, health effects have not been scientifically demonstrated as a result of low frequency noise from WTGs (MDPH 2012). Additionally, available evidence demonstrates there are no health effects from WTGs infrasound (NHMRC 2013).

2.0 PROJECT NOISE CRITERIA AND GUIDELINES

A review of noise regulations and guideline criteria applicable to the Project was completed at the federal, state, and county level. The Noise Control Act of 1972, along with its subsequent amendments (Quiet Communities Act of 1978 [42 USC 4901-4918]), delegates the authority to regulate environmental noise to each state. No county regulations were found but federal EPA guidelines and the State of Hawaii provide noise thresholds and guidelines applicable to the Project. Additionally, there are no federal, state, or local regulations or guidelines for LFN and IS; however, to provide a framework for assessing potential impacts from operational LFN and IS American National Standards Institute (ANSI) have been identified. Additionally, the United Kingdom (UK) Department of Environment, Food, and Rural Affairs (DEFRA) has proposed LFN 1/3-octave band criteria guidelines which are included in this report to provide another set of guidelines for which to compare against.

2.1 U.S. Environmental Protection Agency

In 1974, the U.S. Environmental Protection Agency (EPA) published Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety (EPA 1974). This report represents the only published study that includes a large database of community reaction to noise to which a proposed project can be readily compared. The EPA has developed widely accepted recommendations for long term exposure to environmental noise with the goal of protecting public health and safety. The publication evaluates the effects of environmental noise with respect to health and safety, and provides information for state and local governments to use in developing their own ambient noise standards. For outdoor residential areas and other locations in which quiet is a basis for use, the recommended EPA guideline is a day-night sound level (L_{dn}) of 55 dBA. The EPA also suggests an L_{eq}(24) of 70 dBA (24-hour) limit to avoid adverse effects on public health and safety at publicly accessible property lines or extents of work areas where extended periods of public exposure are possible. The EPA cause-and-effect criteria limits are summarized in Table 4.

Table 4. Summary of EPA Cause and Effect Noise Levels

Location	Level	Effect
All public accessible areas with prolonged exposure	70 dBA $L_{eq(24)}$	Safety
Outdoor at residential structure and other noise sensitive receptors where a large amount of time is spent	55 dBA L_{dn}	Protection against annoyance and activity interference
Outdoor areas where limited amounts of time are spent, e.g., park areas, school yards, golf courses, etc.	55 dBA $L_{eq(24)}$	
Indoor residential	45 dBA L_{dn}	
Indoor non-residential	55 dBA $L_{eq(24)}$	
Source: EPA 1974.		

2.2 State of Hawaii Community Noise Regulations

The state of Hawaii regulates noise through the Hawaii Administrative Rule (HAR), Title 11, Chapter 46, and “Community Noise Control”, promulgated on September 11, 1996 and limits sound generated by new or expanded developments. The Hawaii Community Noise Regulations (HAR 11-46) provide for the prevention, control, and abatement of noise pollution in the State. The purpose of these rules is to “provide for the prevention, control, and abatement of noise pollution in the State from the following noise sources: stationary noise sources; and equipment related to agricultural, construction, and industrial activities” (HAR 11-46). Sound from routine ongoing maintenance activities is considered part of routine operation and the combined total of the ongoing maintenance and routine operation are subject to the sound level limits. However, the Community Noise Control Regulation is not applicable to most moving sources, i.e. transportation and vehicular movements. Sound from Project construction and the occasional, major equipment overhauls is regulated as construction activity.

The Hawaii noise limits applicable to stationary sources are provided by three receiving zoning class districts and time periods and are enforceable at the facility property boundaries. For mixed zoning districts, the primary land use designation is used to determine the applicable zoning district class and maximum permissible sound level. For the purposes of identifying impact conditions, Class A use on Class C Land has been defined at the residential structure, i.e. agricultural portions of the surrounding properties were considered Class C receivers and the residences considered Class A receivers. This is considered a conservative regulatory assessment approach.

As wind energy generation projects may operate at any time during the day or night, the more stringent nighttime permissible sound level will become the controlling limit. The daytime and nighttime maximum permissible noise limits are provided in dBA according to zoning districts in Table 5. The Hawaii noise limits are assumed to be absolute and independent of the existing acoustic environment; therefore, no baseline sound survey is required to assess conformity.

Table 5. Hawaii Maximum Permissible Sound Levels by Zoning District

Receiving Zoning Class District	Maximum Permissible Sound Level	
	Daytime (7:00am – 10:00pm)	Nighttime (10:00pm – 7:00am)
Class A Zoning districts include all areas equivalent to land zoned residential, conservation, preservation, public space, or similar type.	55	45
Class B Zoning districts include all areas equivalent to lands zoned for multi-family dwellings, apartment, business, commercial, hotel, resort, or similar type.	60	50
Class C Zoning districts include all areas equivalent to lands zoned agriculture, county, industrial, or similar type.	70	70
Source: Hawaii Administrative Rules §11-46, "Community Noise Control"		

The maximum permissible sound levels are assessed and at any point at or beyond the property line of the facility. Noise levels may exceed the prescribed limits up to 10 percent of the time within any 20-minute period. Sound level for impulsive noise, as measured with a fast meter response, is 10 dBA above the maximum permissible sound levels for the given receiving zoning class district. Pursuant to HAR 11-46-7, and HAR 11-48-8 a permit may be obtained for operation of an excessive noise source beyond the maximum permissible sound levels. Factors that are considered in granting of such permits include whether the activity is in the public interest and whether the best available noise control technology is being employed. The standard provides further exemptions to these limits and further guidance on application, compliance procedures and penalties. The State Department of Health (SDOH) is responsible for the implementation, administration, and enforcement of the statutes.

2.3 Low Frequency Noise and Infrasound guidelines

In the absence of LFN and IS noise regulations or guidelines some wind turbine acoustic studies have referenced a variety of guidelines and other country's regulations to assess the potential for impacts (O'Neal 2011). The World Health Organization (WHO) provides a crude method for identifying potential LFN/IS noise issues by comparing the predicted dBA to the predicted C-weighted (dBC). If the dBC is 10 dB greater than the dBA level the WHO indicates that a there is potential for a LFN/IS issue and that more detailed analysis should be conducted. However, since the WHO does not provided a more detailed method Champlin elected to use ANSI and DEFRA guidelines. ANSI provides guidelines for outdoor LFN and IS levels via ANSI S12.9 Parts 4 and 5. Additionally, DEFRA provides guidelines for LFN that are used in the UK.

2.3.1 15BANSI S12.9 Part 4

The ANSI S12.9 Part 4 (ANSI 2005) provides guidelines for determining annoyance from sound propagating outdoors. Annex D of ANSI S12.9 Part 4 includes methods for assessing environmental sounds with strong low-frequency content. Annoyance is found to be minimal when sound levels in the low frequency midband frequencies of 16 – 63 Hz are less than 65 dB, which corresponds to the threshold for the onset of impacts in these lower frequencies. Part 4 also states that LFN passes through structures with relative ease and is nearly equal to outdoor predicted sound levels. For the Project an indication of annoyance would be used as an indication of a LFN impact.

2.3.2 UK Department of Environment, Food, and Rural Affairs (DEFRA)

In February 2005 DEFRA published their *"Procedure for the assessment of low frequency noise disturbance"* which provides indoor LFN thresholds for disturbance. The DEFRA guidelines are based upon existing low frequency noise criteria from several countries (e.g., Sweden, Denmark, Netherlands, Germany, and Poland) and upon complaints of disturbance from LFN. DEFRA provides thresholds for 1/3-octave bands from 10 to 160 Hz for both non-steady and steady outdoor received sound levels in using the L_{eq} metric. The thresholds are generally 5 dB lower than the threshold of hearing to avoid disturbance. Recent studies have used these guidelines to establish outdoor equivalent sound levels for use in impact assessments (O'Neal 2011). Table 6 provides the outdoor non-stead and steady 1/3-octave LFN thresholds in dB L_{eq}. As indicated, there are no laws or regulations pertaining to LFN and IS from wind energy projects; however, the DEFRA guidelines provide thresholds from which an assessment of potential impact can be made.

Table 6. DEFRA Equivalent Outdoor dB L_{eq} 1/3-Octave Band Sound Pressure Thresholds

Location	1/3-Octave Band Center Frequency (Hz)												
	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
Non-Steady Outdoor	94	89	86	78	68.5	61	56	51	51	49	47	45	43
Steady Outdoor	99	94	91	83	73.5	66	61	56	56	54	52	50	48

Source: DEFRA 2005, O'Neal 2011

3.0 EXISTING CONDITIONS

The acoustic analysis area for the Project includes Tax Map Keys (TMKs), or commonly referred to as parcels, located within 2 kilometers (km) or 1.2 miles of the Project. The mitigation areas for the Project are habitat areas for wildlife that may be affected by the Project. These areas are located beyond the 2 km (1.2 mile) analysis area; however, because no operational or construction noise would result in these areas they are not included in the noise analysis area. Project components, such as WTGs and the substation, would be located on agriculturally zoned TMKs or HAR 11-46 Class C districts. The remaining TMKs within the noise analysis area are mostly agriculturally zoned; however, north and west of Project there are Class A (mostly residential) and Class B (mostly commercial) TMKs. Table 2 provides descriptions for each of the HAR 11-46 zoning Class

Districts. The most restrictive land use from a noise compliance perspective with HAR 11-46 are the Class A TMKs located approximately 480 meters (1,575 feet) from the nearest Project WTG.

3.1 Baseline Sound Survey

While HAR 11-46 limits are absolute, Champlin elected to conduct a baseline sound survey to respond to public comments received during the scoping process. A long term and short term baseline sound survey was completed in support of Project permitting, which provided a statistically relevant data set, covering the full range of wind speeds and future operational scenarios. The objective of the baseline sound survey was to establish the existing ambient sound environment of the Project Area. To fulfill this objective Tetra Tech completed the following steps:

1. A measurement program was developed and reviewed by Champlin including instrument selection and setup;
2. Measurement positions (MPs) for the sound survey were pre-selected to give a representative evaluation of baseline sound conditions over the entire Project Area. Landowner permissions were secured prior to the survey and locations were screened on the day of deployment to determine final measure positions;
3. Execution of baseline sound survey, which consisted of a two week monitoring period from April 22, 2014 to May 7, 2014 with data logging for the entire period at three long-term locations;
4. Long term 2-week measurements were supplemented by in-situ short-term (30-minute) measurements;
5. Analysis of baseline data, correlation with the Project's meteorological station representative of wind speed data at hub height of WTGs and presentation of typical values; and
6. Evaluation of masking of wind turbine noise by wind-induced background noise.

3.1.1 Instrumentation

Measurements were completed with either a Larson Davis 831 real-time sound level analyzer equipped with a PCB model 377B02 ½-inch precision condenser microphone or a Norsonic Model Nor140 precision sound analyzer with a Norsonic 1225 ½-inch precision condenser microphone. The Larson Davis 831 instrument has an operating range of 5 dB to 140 dB, and an overall frequency range of 8 to 20,000 Hz and the Norsonic Nor140 has the same operating range but also extends monitoring to lower frequencies with an overall frequency range of 1 to 20,000 Hz. Both devices meet or exceed all requirements set forth in the American National Standards Institute (ANSI) standards for Type 1 sound level meters for quality and accuracy (precision). All real-time sound level analyzers and instrumentation were calibrated per ANSI specifications to ensure the highest data accuracy possible. Laboratory calibrations occurred within the previous 12 month period with calibration documentation provided in Appendix A.

The sound level meters utilized are designed for service as a long-term environmental sound level data logger measuring the A-weighted sound level. Each unattended and weatherproof sound level monitoring position included a sound analyzer enclosed in a weatherproof case and equipped with a self-contained microphone tripod. The microphone and windscreen were tripod-mounted at an approximate height of 1.5 to 1.7 meters (4.9 to 5.6 feet) above grade away from effects of ground level rustling vegetation and fallen leaves. When sound measurements are attempted in the presence of elevated wind speeds, extraneous noise can be self-generated across the microphone. Air blowing over a microphone diaphragm creates a pressure differential and turbulence. All sound level analyzer microphones were protected from wind-induced extraneous noise effects by a 7 inch (180 millimeter) diameter foam windscreen made of specially prepared open-pored polyurethane. By using this microphone protection, the pressure gradient and turbulence is effectively moved further away from the microphone to ensure accurate collection of baseline data.

In addition, weather data were collected at or near the MPs using Vaisala portable weather transmitters, which operated over the full measurement period. Additional information on the Vaisala units is provided in Section 3.1.3.

3.1.2 Measurement Methodology

The baseline sound survey was conducted during a time of year that is representative of typical human activity in the area. Additionally, sounds produced by leaf and crop rustle as well as insect noise can elevate background sound levels and make correlation of background sound levels to wind speed difficult. Because there is little variation seasonally in vegetative cover, agricultural operations, and insect or other wildlife activity, baseline sound monitoring in the noise analysis area is considered to be typical of any time during the year. The lowest background sound levels typically occur on windless nights when the Project would not be operating. Thus, it is important that baseline sound level monitoring document the existing sound levels, day and night, for wind speeds in the range between WTG cut-in and the maximum rated power.

Using mapping and aerial photography of the Project Area, Tetra Tech selected three long term MP locations along the Project's site limit to be representative of noise sensitive receptors (NSRs) nearest to the Project. Tetra Tech attempted to locate monitoring equipment at the structures of the nearest NSR; however, when Champlin requested access from property owners or leases for deployment of monitoring equipment none were agreeable. As a result, Tetra Tech was restricted to placing long-term monitoring equipment at the Project site limit where Champlin had already obtained landowner permission and which was accessible to Tetra Tech. To supplement the long-term data collection short-term measurements were made from public rights-of-way, such as sidewalks, that did not require landowner access permission.

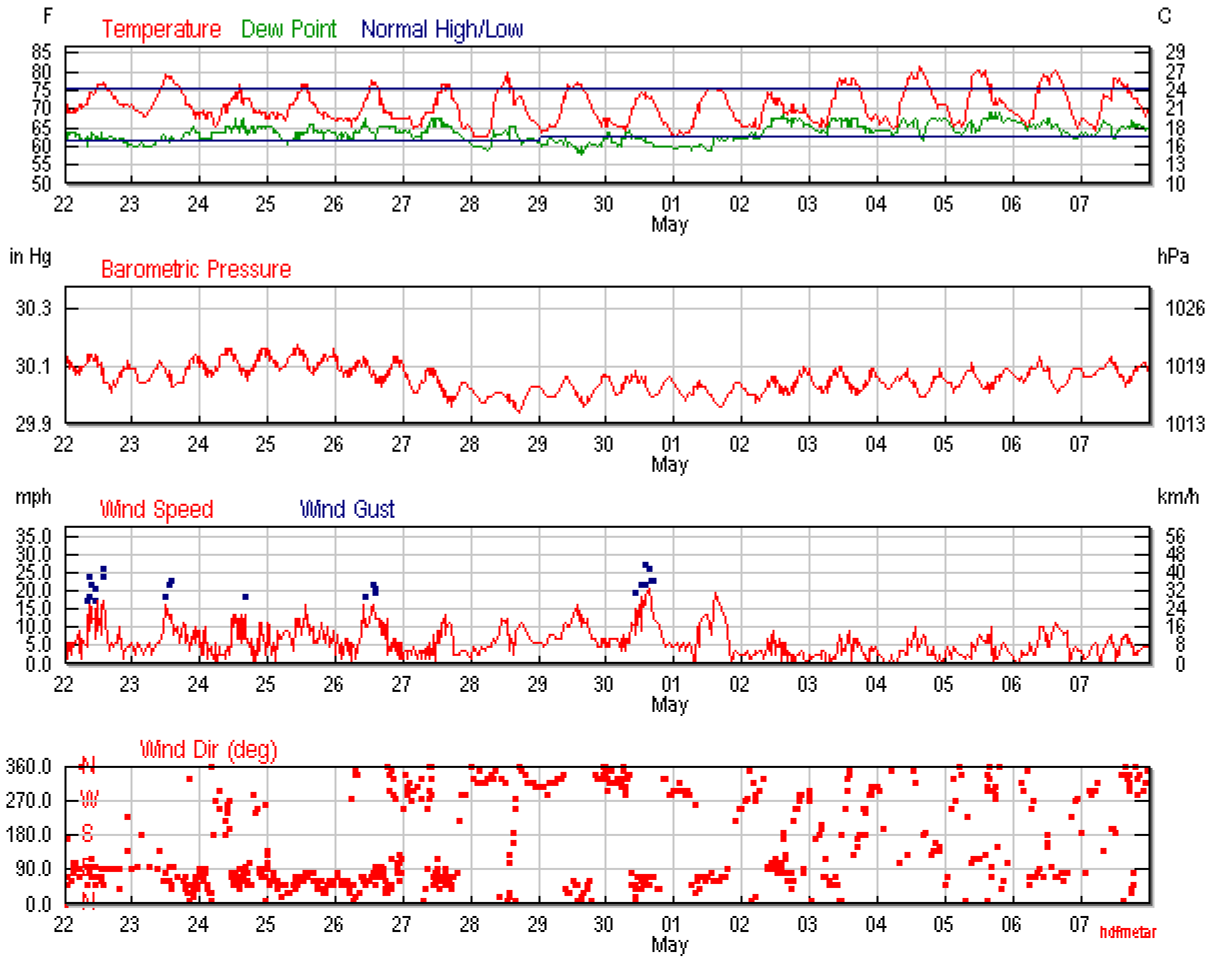
For each long-term measurement, a sound level meter was set up, calibrated, and run continuously in 1-hour and 10-minute intervals during daytime (7:00 am to 10:00 pm) and nighttime (10:00 p.m. to 7:00 a.m.) periods for the two week survey. The maximum observed calibration drift ranged from -0.1 dB to +0.1 dB, which is well within acceptable tolerances for long term baseline sound measurements. Each sound analyzer was programmed to measure and log broadband A-weighted sound pressure levels including a number of statistical parameters such as the average equivalent (L_{eq}), intrusive (L_{10}), median (L_{50}), and residual (L_{90}) sound levels. These data were logged for the duration of the baseline monitoring period to fully characterize the ambient acoustic environment of the Project Area. In addition, full (1/1) and third (1/3) octave band data were collected. All long-term monitoring stations were anchored in a manner that avoided interference from any large vertical reflective surfaces.

Short-term measurements were conducted with the Nor140 sound level meter at selected locations to provide additional information about the acoustical environment. The Nor140 is capable of monitoring to a lower frequency range (e.g., down to 1 Hz) which is useful for describing the LFN and IS content of the existing acoustic environment. Each short-term measurement was conducted for 30-minutes collected in 1-minute intervals, at least once during midday (10:00 a.m. to 3:00 p.m.) to avoid peak hours of traffic noise on area roadways and/or during nighttime hours (12:00 a.m. to 4:00 a.m.), depending on access and safety. The same metrics and octave band data were collected during the short-term measurements as that for the long-term measurements.

Following the completion of the measurement period, all measured data were downloaded and analyzed. Long-term monitoring data were correlated with hub height (approximately 80 meters) wind speed data using a standardized statistical regression analysis methodology. In addition, daytime and nighttime observations were documented during equipment deployment, retrieval, and short-term measurements to identify sound sources with the nighttime period of particular interest as this is a time period of heightened sensitivity to noise (i.e., sleep interruption).

3.1.3 Meteorological Conditions

Champlin provided Tetra Tech wind speed and direction data from their on-site meteorological (MET) towers for the period of the baseline sound survey, given in 10-minute increments. In addition weather data were collected at the long-term MPs using the Vaisala units. The Vaisala unit monitors wind speed and direction via its ultrasonic anemometer, and also measures barometric pressure, temperature and humidity, total rainfall, intensity, and duration of rainfall. The Vaisala unit is also able to distinguish between precipitation type such as rain, hail, and snow. When required, data gaps from the Champlin’s MET data were supplemented with the data from the Vaisala units. Figure 1 shows general weather conditions during the baseline sound survey in the vicinity of the Project Area.



Source: Weather Underground, 2014

Figure 1. Baseline Sound Survey Weather Conditions

3.1.4 Sound Survey Results

The three long-term sound monitoring stations were deployed at the Project site limit at locations closest to the nearest NSRs. Table 7 summarizes the UTM coordinates, distance to the nearest proposed WTG, and sound level meter's serial number (S/N) used to collect data for each long-term MP. Figure 2 provides a map of the MPs and acoustic analysis area HAR 11-46 zoning classes.

Table 7. Long-Term Monitoring Position Location Summary

Monitoring Position	UTM Coordinates (NAD83 UTM Zone 14 N)		Distance to Nearest Project WTG (m)	Distance to Nearest Existing Kahuku WTG (m)	SLM Serial Number
	Easting (m)	Northing (m)			
LT-1	606,540.04	2,396,927.75	68.1	326.7	1350 & 14027964
LT-2	607,962.82	2,396,713.27	495.8	1,674.2	3140
LT-3	608,537.47	2,396,811.61	220.6	2,197.0	1403045

Table 8 provides the summary of short-term monitoring locations conducted from public rights-of-way near selected NSRs in the acoustic analysis area.

Table 8. Short-Term Monitoring Position Location Summary

Monitoring Position	UTM Coordinates (NAD83 UTM Zone 14 N)		Distance to the Nearest WTG (m)	Distance to Nearest Existing Kahuku WTG (m)	Serial Number
	Easting (m)	Northing (m)			
ST-1	607,030.73	2,397,241.57	640.6	670.6	1403045
ST-2	607,875.34	2,396,999.59	783.1	1,517.3	1403045
ST-3	608,444.81	2,397,077.41	496.2	2,017.1	1403045
ST-4	609,940.67	2,395,748.07	1,270.4	3,863.1	1403045
ST-5	606,075.81	2,399,058.66	2,235.9	474.6	14027964 & 1403045
ST-6	606,962.96	2,396,334.02	349.2	1,055.4	14027964

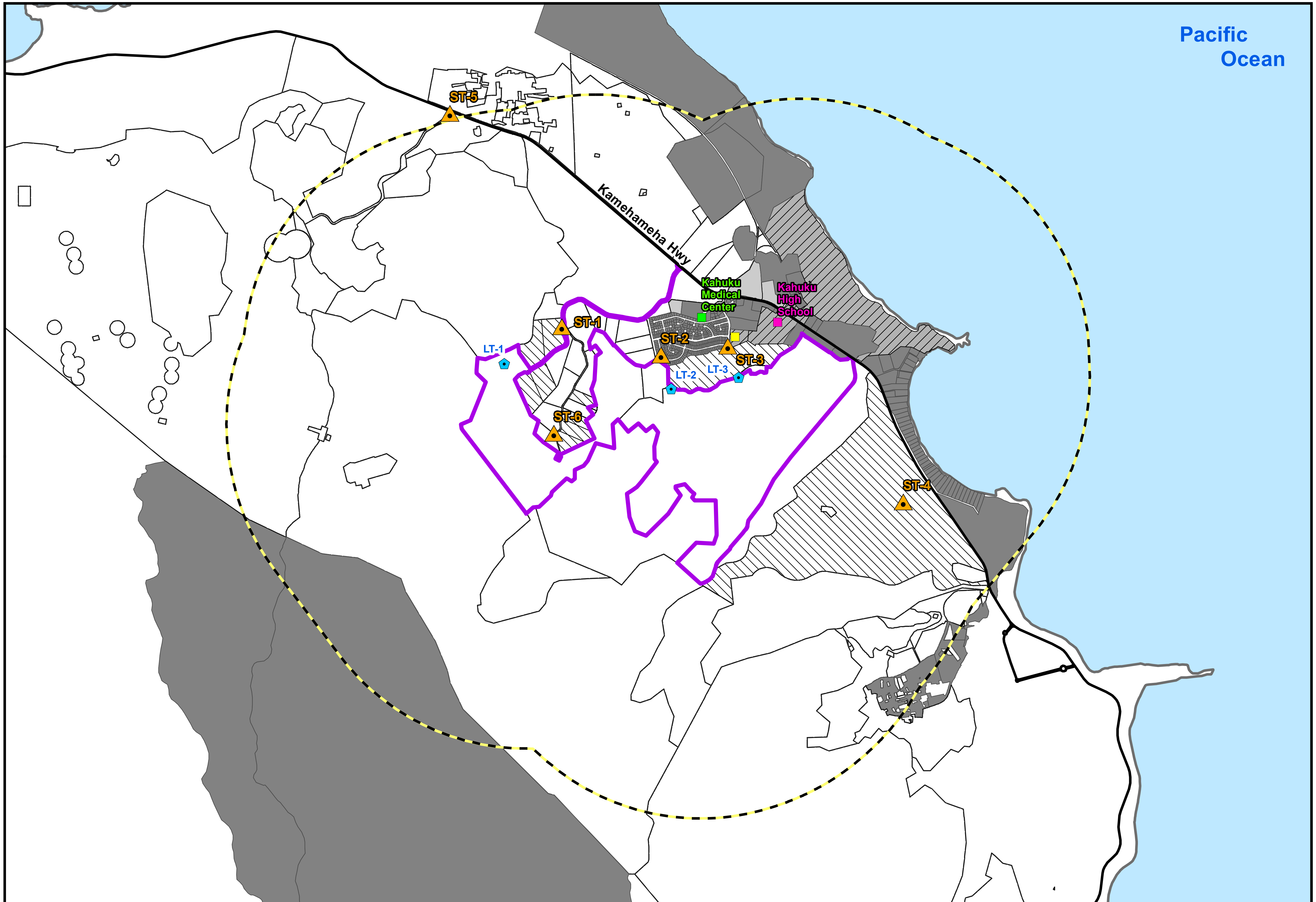


Figure 2

Na Pua Makani Wind Project

Acoustic Monitoring Positions and HAR 11-46 Zoning Classes

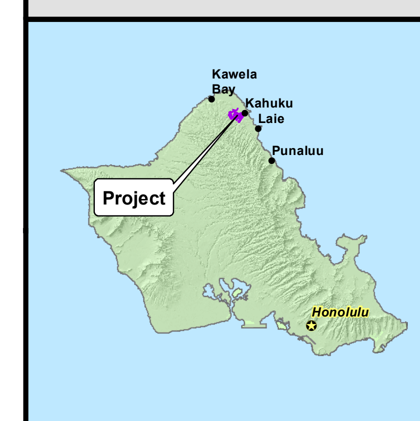
Oahu, HI

December 2015

- Wind Farm Site Boundary
- Acoustic Study Area
- Local Road
- Short Term Monitoring Positions
- Sound Monitoring Position
- Kahuku Elementary School
- Kahuku High School
- Kahuku Medical Center

HAR Zone

- Class A (45 dBA Limit)
- Class A (55 dBA Limit) - Day Use Only
- Class B (50 dBA Limit)
- Class C (70 dBA Limit) - Has Residence
- Class C (70 dBA Limit) - No Residence or Project TMK



1:32,000 WGS84 UTM 4 — 0 0.5 1 2 3 4 5 Miles

Data Sources Champlin: project facilities / ESRI: roads / Hawaii Statewide GIS Program: zoning classification

TETRA TECH

P:\GIS_PROJECTS\Champlin_Wind\Na_Pua_Makani\MXDs\EIS\FEIS\Report_Figures\NoiseImpactAssessment\Champlin_NaPuaMakani_FEIS_Sound_Fig2_AffEnvr_11i17i_20151230.mxd - Last Saved 3/25/2015

The baseline sound survey measurement data incorporate all sounds at the MP including contributions from road traffic, sounds of nature, existing industrial facilities, and other human related activities. Long-term monitoring data points below the cut-in wind speed of three meters per second (m/s) for the proposed WTGs and any adversely affected data (external extraneous noise sources) were excluded from the analysis. The refined dataset was evaluated using a regression analysis for each MP as well as all MPs cumulatively grouped for the entire Project Area. Short-term measurements were all conducted during wind speed conditions where the Project would be in operation according to the Project's MET tower with wind speeds ranging from 6 m/s to 11 m/s.

The acoustic monitoring data collected at each MP were matched to Champlin's MET station which monitors wind speeds at 50 meters and that Champlin scaled up to 80 meters, roughly the hub height of the WTGs under consideration. Additionally, each MP's respective Vaisala unit was also matched to the acoustic monitoring data. These two wind speed datasets accurately characterize wind speed conditions at each MP. The 10-minute L_{eq} sound levels were correlated to wind speed (m/s) at an 80 meter (262 feet) hub height with a regression analysis and the best fit correlation coefficient using a second order polynomial equation. The 10-minute L_{eq} sound levels were divided into daytime (7:00 am to 10:00 pm) and nighttime (10:00 pm to 7:00 am) periods to show diurnal variation at each MP. The following subsections present results by MP. Table 9 provides the broadband dBA L_{eq} tabular results of the baseline monitoring survey at integer wind speeds, which is consistent with the limits prescribed in HAR 11-46, which are also given in dBA L_{eq}. The subsections that follow provide 1/3-octave band data results in dB L_{eq} for use with the LFN DEFRA limits.

Table 9. Baseline Monitoring Results at Integer Wind Speeds

Monitoring Position*	Time of Day	dBA L_{eq} by Wind Speed (m/s)								
		Calm	3	4	5	6	7	8	9	10+
LT-1	7AM-10PM	40	45	47	50	50	49	51	52	55
	10PM-7AM	N/A***	43	43	44	47	48	49	50	52
LT-2	7AM-10PM	46	41	45	50	47	46	47	46	48
	10PM-7AM	47	51	42	46	48	46	44	47	45
LT-3	7AM-10PM	42	45	45	44	46	45	45	45	49
	10PM-7AM	44	44	43	40	42	43	43	45	45

Note: *short-term measurements were conducted for 30-minute periods which do not include all operational wind speed conditions. **Vehicle pass-by events removed. ***No "calm" time periods during monitoring.

Monitoring Position: LT-1

LT-1 was located within the Project site along the northwest Project site limits 68m from the Project's proposed WTG #1 and 327m from the nearest existing Kahuku Wind Farm WTG. Deployment occurred on April 23, 2012 at approximately 10:00 AM during sunny and warm (77°F) weather conditions. The elevation at LT-1 is approximately 20 m above sea level (ASL). Noise sources observed during deployment included the existing Kahuku Wind Farm, wind interacting with vegetation, helicopter and fixed-wing aircraft flyovers, and nearby agricultural activities involving small combustion engine equipment. LT-1 included the two sound level meters, one LD831 and one Norsonic 140 for redundancy. Redundancy was desirable at this location because Tetra Tech wanted to collect sound data generated from the existing Kahuku Wind Farm. At the

Kahuku Wind Farm, all but one of that wind energy development's WTGs were operating. Via informal conversations with maintenance personal it was learned by Tetra Tech's scientists that typically one Kahuku Wind Farm WTG is down at any given time for maintenance. Therefore, this operational scenario for the Kahuku Wind Farm is considered "typical". During deployment and retrieval of the monitoring equipment it was observed that the existing WTGs nearest to the Project were all operating. During the course of the survey the Norsonic 140 experienced technical issues; however, these issues did not prevent collection of a statistically significant dataset that is appropriate for establishing baseline conditions. Figure 3 presents a photograph of the two sound level meters deployed relative to the existing Kahuku Wind Farm from the viewpoint of the Project's site limit. Figure 4 provides the time history and Figure 5 provides the regression analyses of ambient sound levels during daytime and nighttime monitoring periods. Figure 6 provides the 1/3-octave band spectral data at cut-in (3 m/s) and maximum rotational (8 m/s) wind speeds relative to the threshold of human hearing. None of the infrasound levels monitored were above the threshold of human hearing. Table 10 provides the 1/3-octave band monitoring results spanning the frequencies from 4Hz to 5000 Hz.

Figure 3. Photo of LT-1

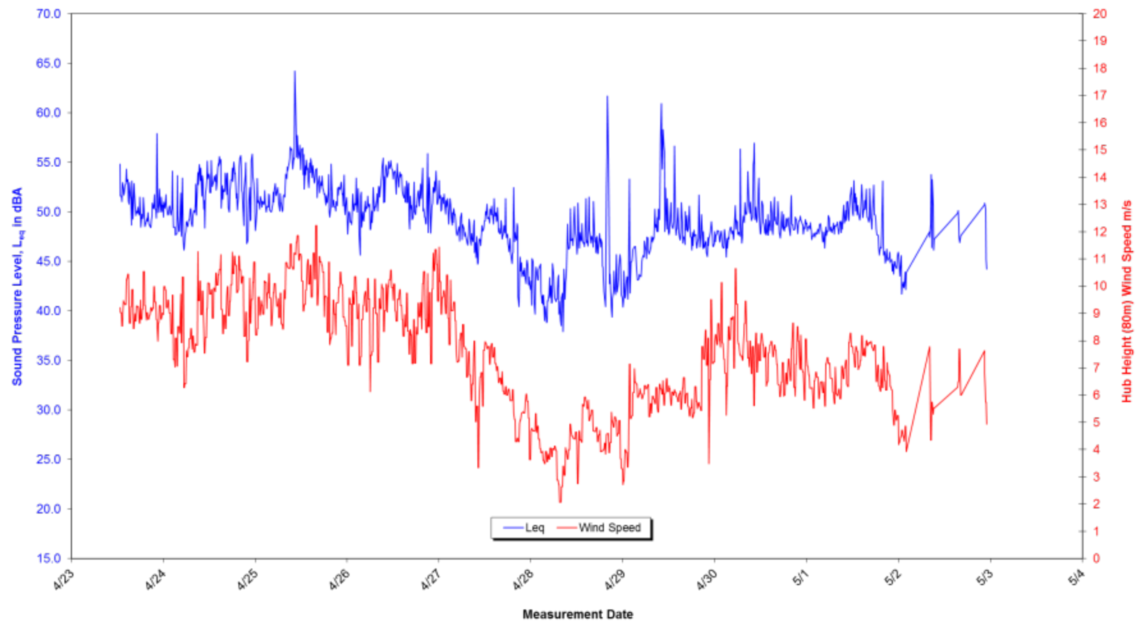


Figure 4. LT-1 Time History Plot

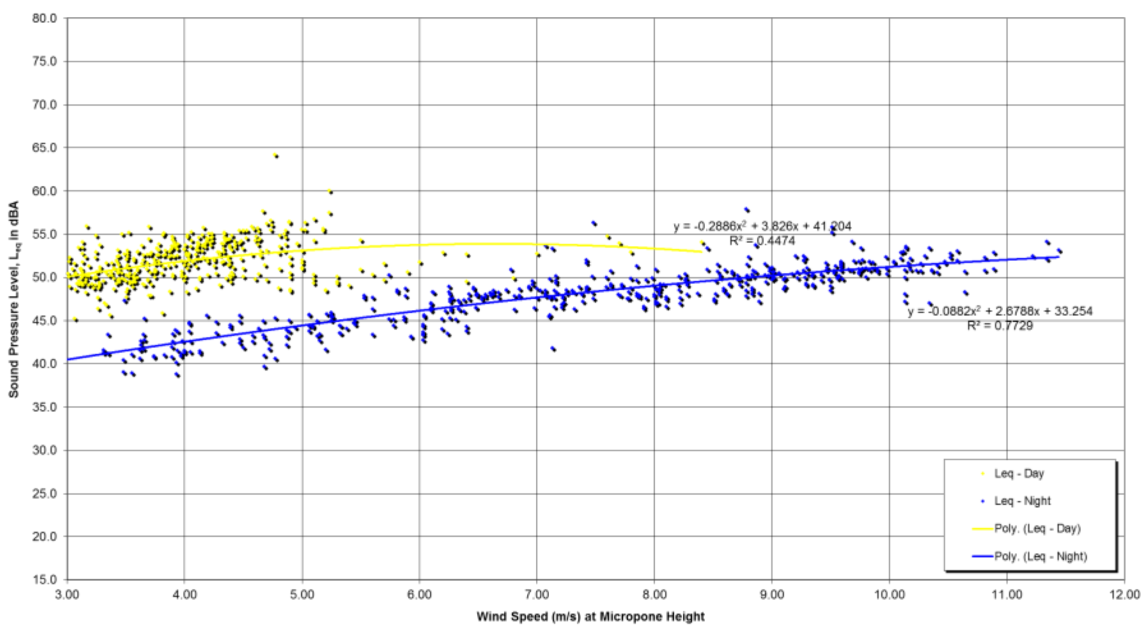


Figure 5. LT-1 Regression Analysis

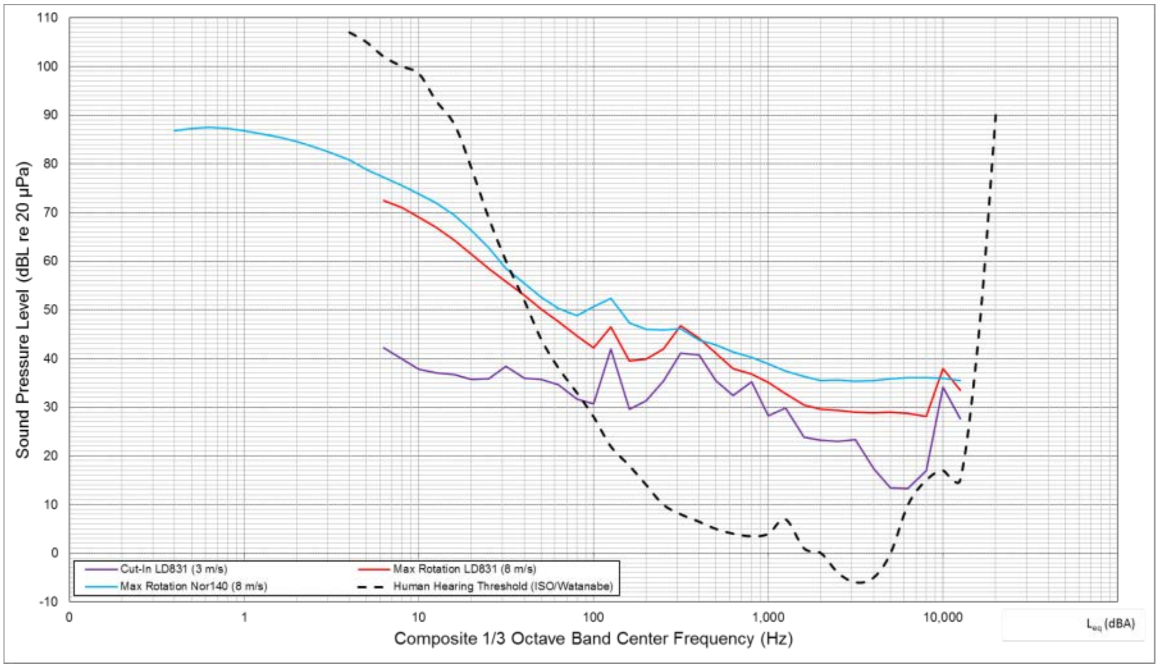


Figure 6. LT-1 1/3-Octave Band Spectral Plot

Table 10. LT-1 1/3-Octave Band Baseline Monitoring Results at Integer Wind Speeds

Frequency Range	1/3-Octave Band (Hz)	dBA L_{eq} by Wind Speed (m/s)							
		3	4	5	6	7	8	9	10
Infrasound	4.0*	-	-	-	74	77	81	82	85
	5.0*	-	-	-	72	75	79	80	83
	6.3	60	60	64	69	71	73	74	75
	8.0	58	58	62	67	70	72	73	74
	10.0	55	56	59	65	68	70	71	72
	12.5	52	53	56	62	66	68	69	71
	16.0	49	50	53	59	63	65	67	69
Low Frequencies	20.0	50	51	52	57	60	63	65	66
	25.0	49	47	48	53	57	60	62	64
	31.5	44	45	48	51	54	57	59	61
	40.0	43	43	45	49	51	54	57	59
	50.0	44	45	45	47	49	52	54	56
	63.0	42	41	42	45	46	49	51	53
	80.0	43	40	40	44	44	47	48	50
	100	41	39	39	43	42	44	46	48
	125	44	45	46	47	47	48	48	48
	160	39	39	38	43	40	42	43	44
	200	37	38	37	43	40	42	42	42
Selected Mid Frequencies	250	38	40	41	42	42	43	44	44
	315	41	43	45	47	47	46	47	47
	400	41	42	43	45	45	44	44	44
	500	38	39	40	42	42	42	41	41
	630	34	35	37	40	38	39	39	39
	800	36	37	37	40	38	38	38	38
	1000	31	32	33	37	36	36	37	37
	1250	30	31	32	35	34	35	35	35
	1600	26	28	29	33	32	32	33	34
	2000	27	28	28	32	31	32	32	33

Table 10. LT-1 1/3-Octave Band Baseline Monitoring Results at Integer Wind Speeds

Frequency Range	1/3-Octave Band (Hz)	dBA L_{eq} by Wind Speed (m/s)							
		3	4	5	6	7	8	9	10
	2500	28	28	27	31	31	32	32	34
	3150	28	27	26	30	31	32	32	34
	4000	22	24	23	29	30	32	33	34
	5000	20	23	23	29	30	32	33	35
Note: *Data monitored using Norsonic 140. All other data monitored with Larson Davis 831									

Monitoring Position: LT-2

LT-2 was located within the Project site along the north central Project site limits 496m from the Project's proposed WTG #6 and 1,674m from the nearest existing Kahuku Wind Farm WTG. The location of LT-2 was chosen to represent a cluster of single-family housing 204m north. Deployment occurred on April 23, 2012 at approximately 11:10 AM during sunny and warm (80°F) weather conditions. The elevation at LT-2 is approximately 5m ASL. Sound sources observed during deployment included the light wind interacting with vegetation, distant agricultural equipment, helicopter and fixed-wing aircraft flyovers, and periodic wildlife including insects and stray dogs. The area is relatively sheltered from wind being surrounded by a tree line separating it from other agricultural lands to the south and the residential area to the north. The location is also slightly lower in elevation than the houses in the nearby development which are 34m ASL. Monitoring at LT-2 was accomplished using a LD831 which operated for the entire two week monitoring period providing a statistically significant dataset appropriate for establishing baseline conditions. Figure 7 presents a photograph of the two sound level meters deployed taken in the direction of the residential development. Figure 8 provides the time history and Figure 9 provides the regression analyses of ambient sound levels during daytime and nighttime monitoring periods. As the time history and regression analysis shows there is little variation in sound level when hub height wind speeds are elevated which confirms that the area is relatively sheltered from the wind. Short-term monitoring in the neighborhood was necessary to ascertain wind effects at the slightly higher elevation which was accomplished via ST-2. Figure 10 provides the 1/3-octave band spectral data at cut-in (3 m/s) and maximum rotational (8 m/s) wind speeds relative to the threshold of human hearing. None of the infrasound levels monitored were above the threshold of human hearing. Table 11 provides the 1/3-octave band monitoring results spanning the frequencies from 6.3Hz to 5000 Hz.

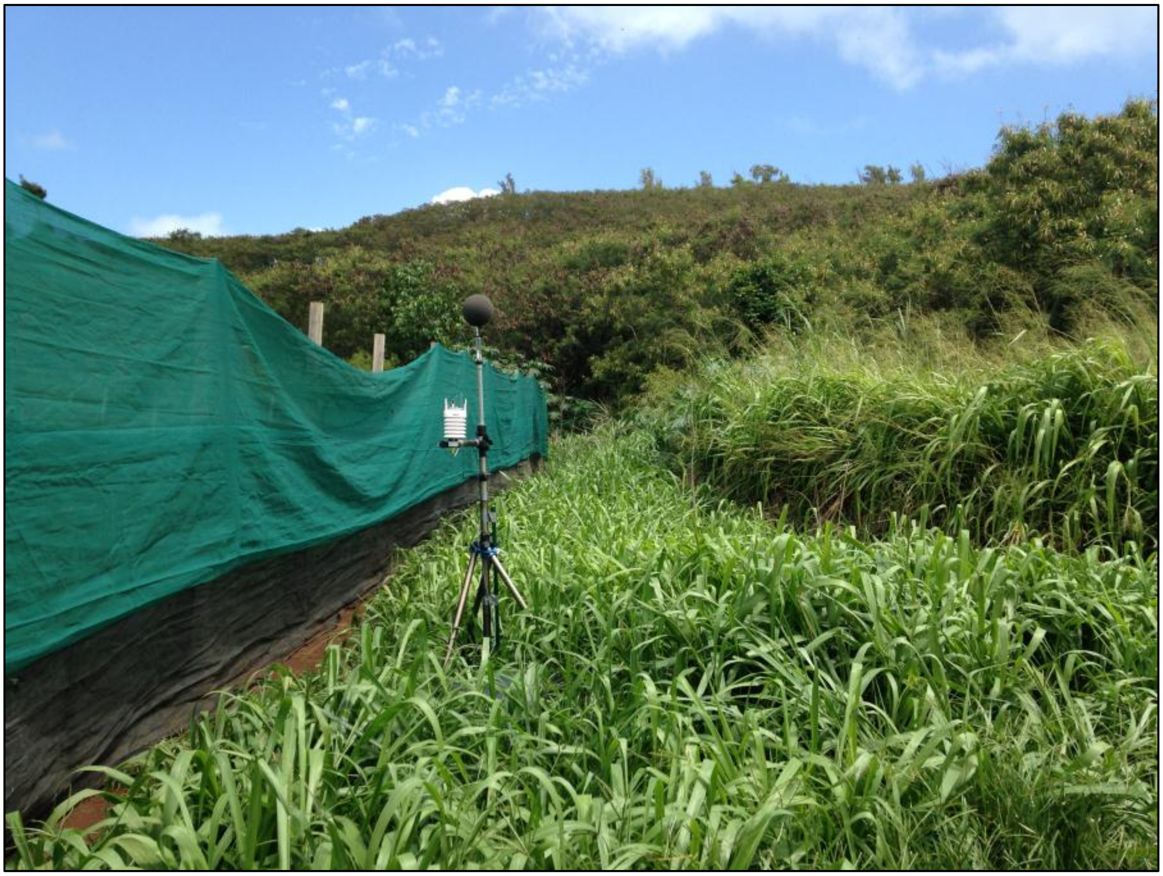


Figure 7. Photo of LT-2

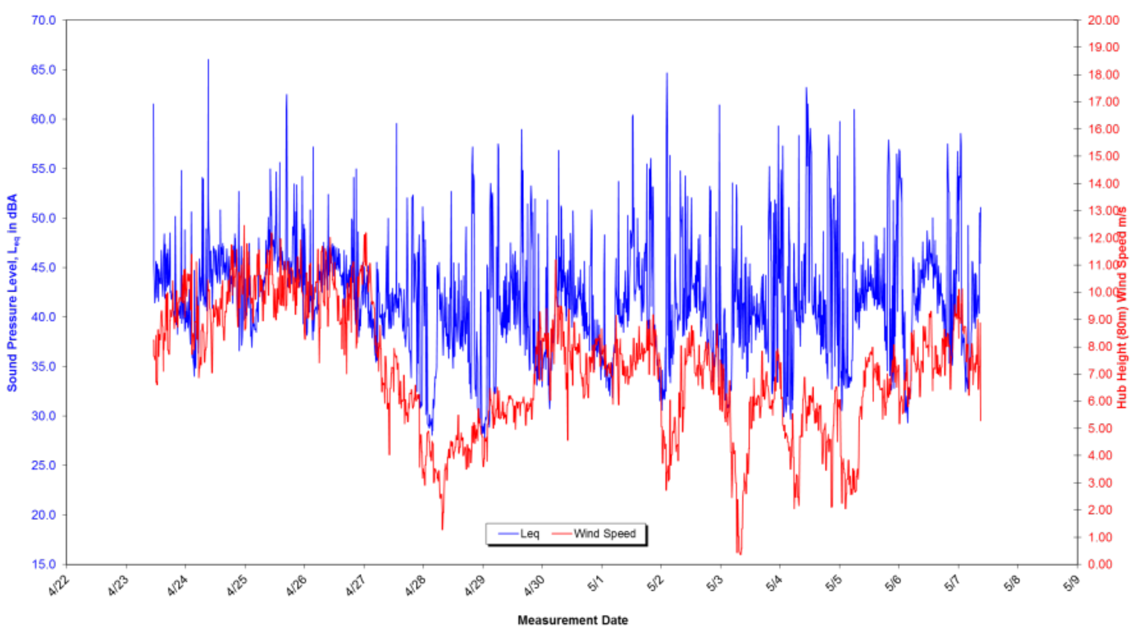


Figure 8. LT-2 Time History Plot

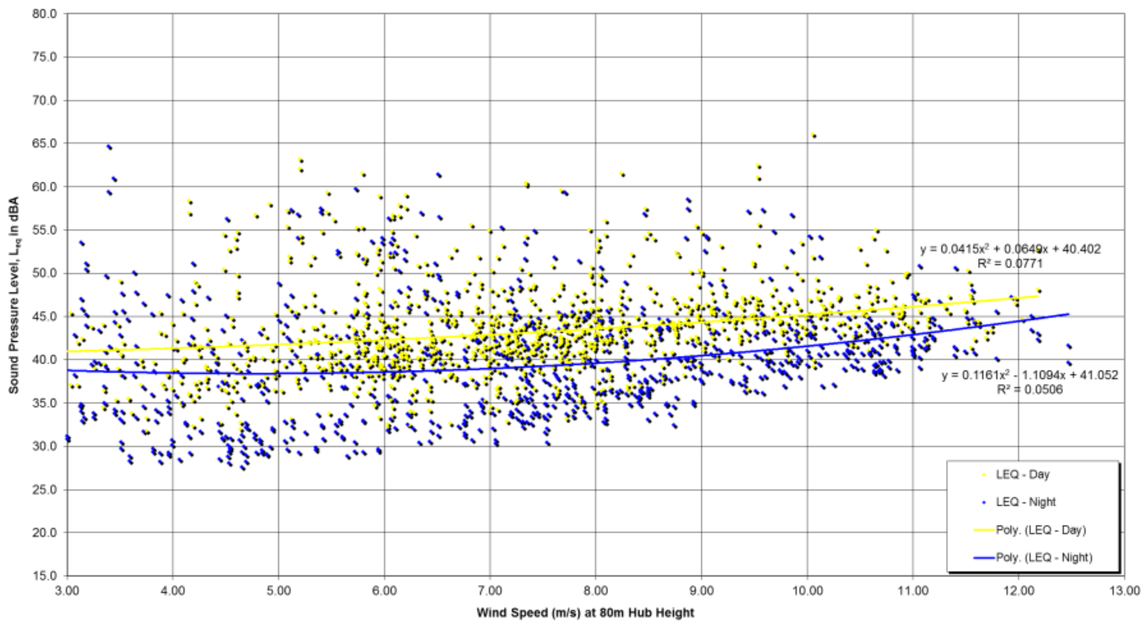


Figure 9. LT-2 Regression Analysis

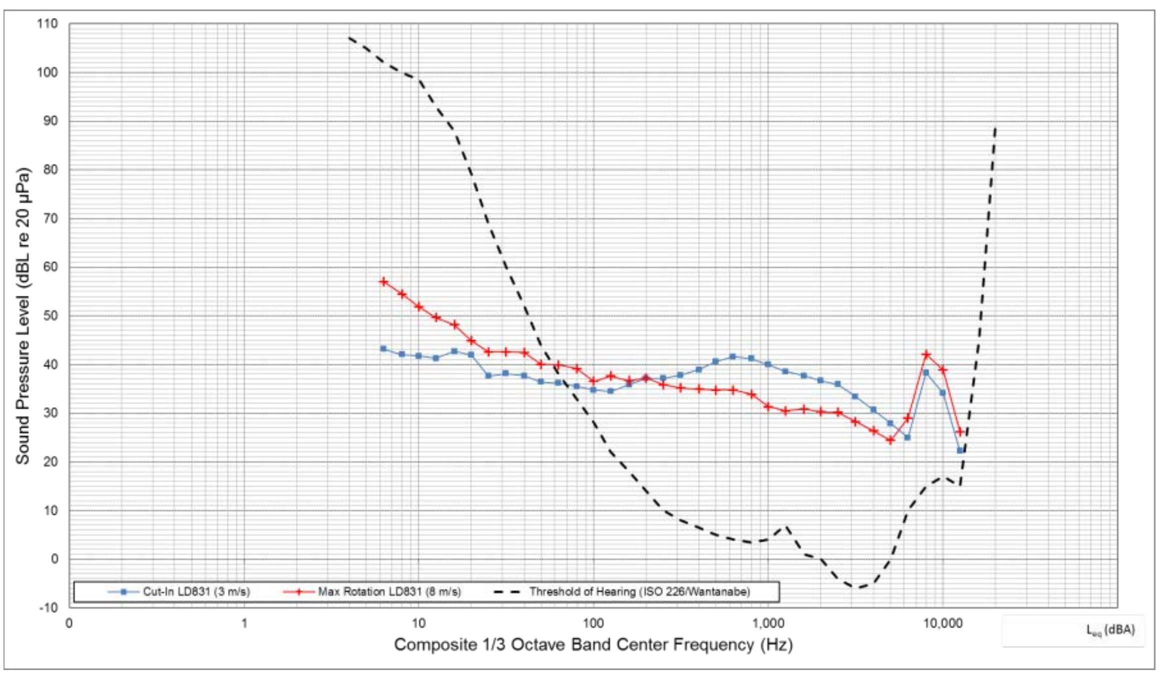


Figure 10. LT-2 1/3-Octave Band Spectral Plot

Table 11. LT-2 1/3-Octave Band Baseline Monitoring Results at Integer Wind Speeds

Frequency Range	1/3-Octave Band (Hz)	dBA L_{eq} by Wind Speed (m/s)							
		3	4	5	6	7	8	9	10
Infrasound	4.0*	-	-	-	-	-	-	-	-
	5.0*	-	-	-	-	-	-	-	-
	6.3	43	47	50	54	56	57	59	60
	8.0	42	45	48	51	54	54	57	58
	10.0	42	43	46	49	51	52	54	55
	12.5	41	43	44	47	49	50	52	52
	16.0	43	46	45	47	48	48	50	51
Low Frequencies	20.0	42	39	40	43	44	45	46	48
	25.0	38	37	39	42	43	43	44	45
	31.5	38	40	41	44	44	43	44	45
	40.0	38	36	39	44	46	42	45	45
	50.0	36	36	39	43	43	40	41	43
	63.0	36	35	41	44	43	40	40	46
	80.0	36	32	43	44	42	39	41	47
	100	35	31	39	41	40	37	38	42
	125	34	32	35	43	42	38	38	40
	160	36	32	36	37	36	37	38	39
	200	37	32	37	37	37	37	38	40
Selected Mid Frequencies	250	37	32	38	37	36	36	37	38
	315	38	31	37	35	35	35	36	37
	400	39	29	37	36	35	35	35	37
	500	41	30	37	36	36	35	36	36
	630	42	30	37	36	35	35	36	36
	800	41	29	37	36	34	34	34	35
	1000	40	27	35	34	32	31	32	36
	1250	39	27	33	32	30	30	31	33
	1600	38	30	34	31	30	31	32	37
	2000	37	29	34	32	30	30	33	35
	2500	36	29	37	33	30	30	34	37
	3150	33	24	34	31	28	28	30	35
	4000	31	22	31	28	26	26	28	32
	5000	28	19	29	26	24	24	28	27

Note: *The LD831 has a functional monitoring limit of 6.3Hz lower frequencies were not monitored at LT-2.

Monitoring Position: LT-3

LT-3 was located within the Project site along the northeastern Project site limits 221m from the Project's proposed WTG #10 and 2,197m from the nearest existing Kahuku Wind Farm WTG. The location of LT-3 was chosen to represent the Kahuku Elementary and High Schools as well as residential areas adjacent to them which are approximately 230m north. Deployment occurred on April 23, 2012 at approximately 11:40 AM during sunny and warm (80°F) weather conditions. The elevation at LT-3 is approximately two meters ASL. Sound sources observed during deployment included the light wind interacting with vegetation, distant agricultural equipment, helicopter and fixed-wing aircraft flyovers, and periodic wildlife including insects. Like LT-2 the area is relatively sheltered from wind being surrounded by a tree line separating it from other agricultural lands to the south and the schools/residential area to the north. The location is also slightly lower in elevation than the schools/residential area which are five meters ASL. Monitoring at LT-3 was accomplished using a Norsonic 140 which operated for the entire two week monitoring period providing a statistically significant dataset appropriate for establishing baseline conditions. Figure

11 presents a photograph of the two sound level meters deployed taken in the direction of the residential development. Figure 12 provides the time history and Figure 13 provides the regression analyses of ambient sound levels during daytime and nighttime monitoring periods. As the time history and regression analysis shows there is little variation in sound level when hub height wind speeds are elevated which confirms that the area is relatively sheltered from the wind. Short-term monitoring in the neighborhood was necessary to ascertain wind effects at the slightly higher elevation which was accomplished via ST-3. Figure 14 provides the 1/3-octave band spectral data at cut-in (3 m/s) and maximum rotational (8 m/s) wind speeds relative to the threshold of human hearing. None of the infrasound levels monitored were above the threshold of human hearing. Table 12 provides the 1/3-octave band monitoring results spanning the frequencies from 6.3Hz to 5000 Hz.

Figure 11. Photo of LT-3

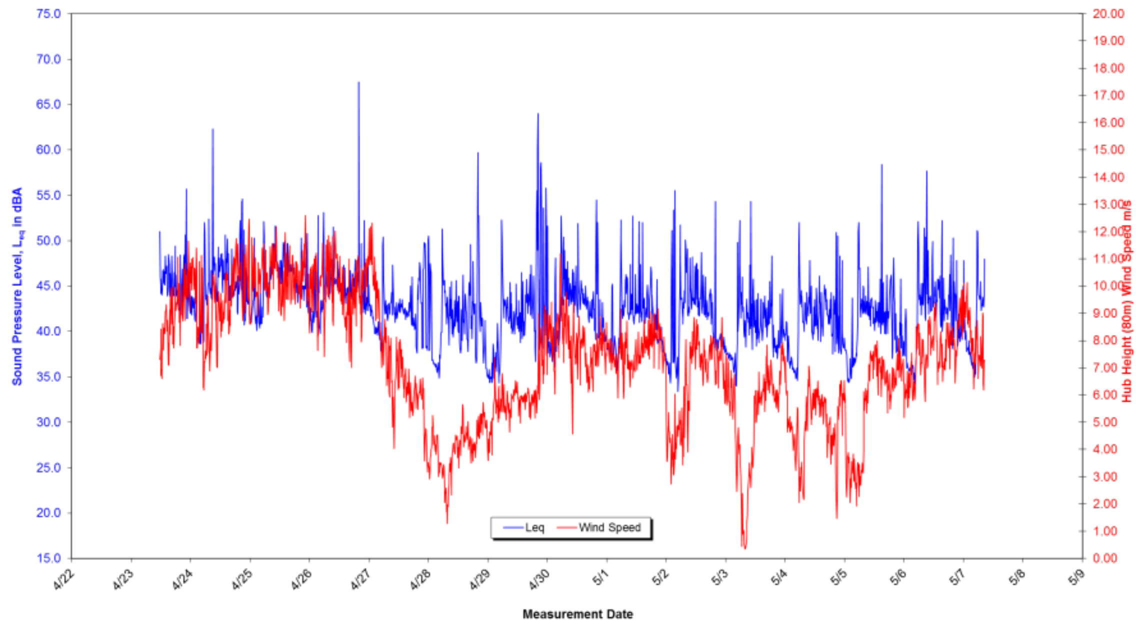


Figure 12. LT-3 Time History Plot

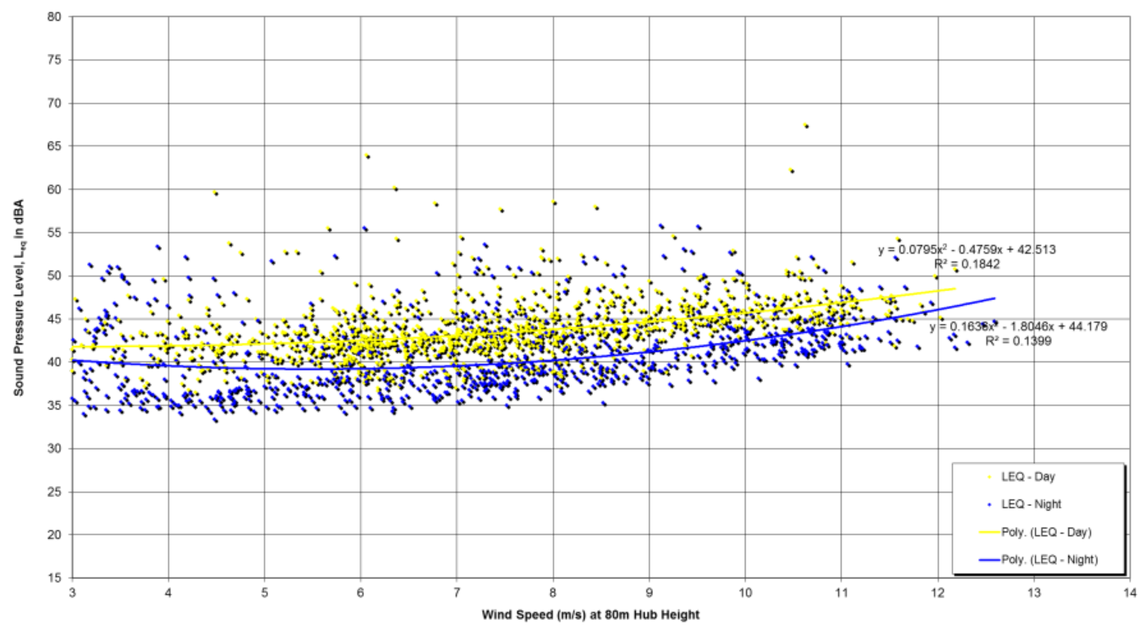


Figure 13. LT-3 Regression Analysis

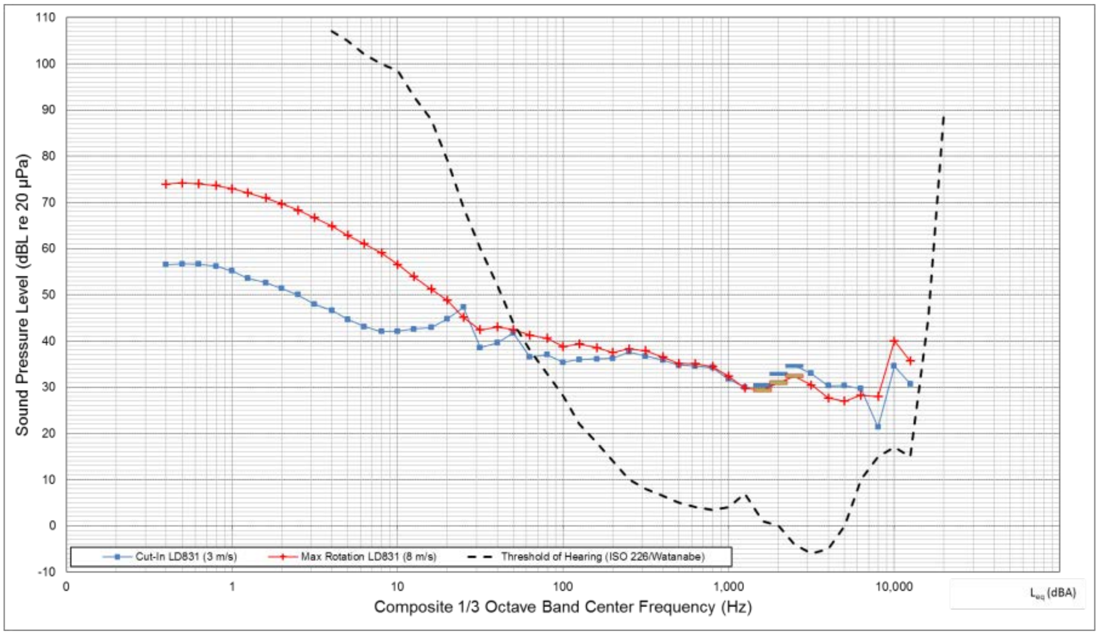


Figure 14. LT-3 1/3-Octave Band Spectral Plot

Table 12. LT-3 1/3-Octave Band Baseline Monitoring Results at Integer Wind Speeds

Frequency Range	1/3-Octave Band (Hz)	dBA L_{eq} by Wind Speed (m/s)							
		3	4	5	6	7	8	9	10
Infrasound	4.0	47	53	56	60	62	65	69	71
	5.0	45	51	54	58	60	63	67	69
	6.3	43	49	52	56	58	61	65	67
	8.0	42	47	50	54	56	59	64	66
	10.0	42	45	47	51	53	57	61	64
	12.5	43	43	45	48	51	54	59	61
	16.0	43	43	44	47	48	51	56	58
Low Frequencies	20.0	45	43	43	46	47	49	53	55
	25.0	47	39	39	41	46	45	49	52
	31.5	39	38	39	40	42	42	46	48
	40.0	40	39	39	41	42	43	45	46
	50.0	42	38	36	39	42	42	44	44
	63.0	37	37	38	37	44	41	43	44
	80.0	37	35	37	38	43	41	42	42
	100	35	34	35	35	41	39	40	41
	125	36	33	33	35	40	39	40	41
	160	36	34	34	36	38	39	40	41
	200	36	33	33	35	38	38	39	41
Selected Mid Frequencies	250	38	34	34	36	38	38	40	42
	315	37	34	34	36	38	38	39	40
	400	36	33	33	35	37	37	37	39
	500	35	32	32	33	36	35	36	38
	630	35	32	31	33	36	35	36	37
	800	34	32	30	32	35	34	35	37
	1000	32	30	28	30	32	32	34	36
	1250	30	28	26	28	30	30	32	34
	1600	30	28	27	28	29	29	31	32
	2000	33	31	29	30	31	31	32	32
	2500	35	33	31	32	32	32	33	35

Table 12. LT-3 1/3-Octave Band Baseline Monitoring Results at Integer Wind Speeds

Frequency Range	1/3-Octave Band (Hz)	dBA L_{eq} by Wind Speed (m/s)							
		3	4	5	6	7	8	9	10
	3150	33	31	29	31	31	30	31	33
	4000	30	28	25	26	28	28	29	33
	5000	30	28	25	24	27	27	29	30

Monitoring Position: ST-1

The ST-1 measurement was conducted on April 23, 2014 from 5:00PM to 5:30PM along public ROW near leased Hawaii Department of Agriculture (DOA) parcels that have single-family residences. The measurement was conducted to capture monitoring data at these residences where long-term equipment deployment was not allowed. Data collected at ST-1 are meant to provide additional information to characterize the DOA parcels that are located closest to the existing Kahuku Wind Farm. A daytime measurement was conducted at ST-1 with observed sound sources including the existing WTGs at the Kahuku Wind Farm, wind interacting with vegetation, periodic aircraft flyovers, and periodic small combustion engine agricultural equipment. Traffic noise along the Kamehameha Highway was not audible during the measurement or was masked by other sounds including the existing WTGs. Figure 15 provides the 1/3-octave band spectral data for the monitoring period which included hub height wind speeds of 10 m/s. At no time were infrasound levels of sufficient strength to be above the threshold of human hearing.

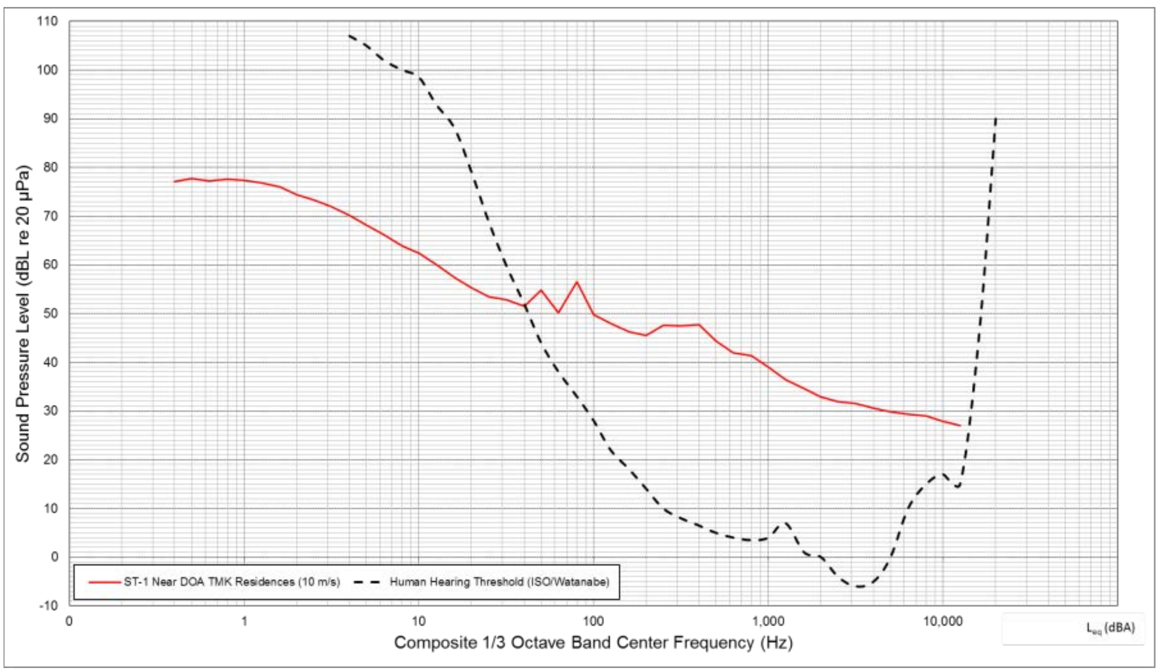


Figure 15. ST-1 1/3-Octave Band Spectral Plot

Monitoring Position: ST-2

The ST-2 measurement was conducted on April 22, 2014 from 2:05PM to 2:35PM along public ROW in the southwest portion of a relatively densely populated housing development referred to as the "Mauka Village". The measurement was conducted to capture monitoring data at these residences where long-term equipment deployment was not allowed. ST-2 is meant to provide additional support data to characterize ambient conditions at these residences which are also represented by LT-2. A daytime measurement was conducted at ST-2 with observed sound sources including the roadway traffic, wind interacting with structures, dogs periodically barking during set up of the meter, people conversing, and periodic helicopter and fixed-wing aircraft flyovers. Figure 16 provides the 1/3-octave band spectral data for the monitoring period which included hub height wind speeds of 10 m/s. At no time were infrasound levels of sufficient strength to be above the threshold of human hearing.

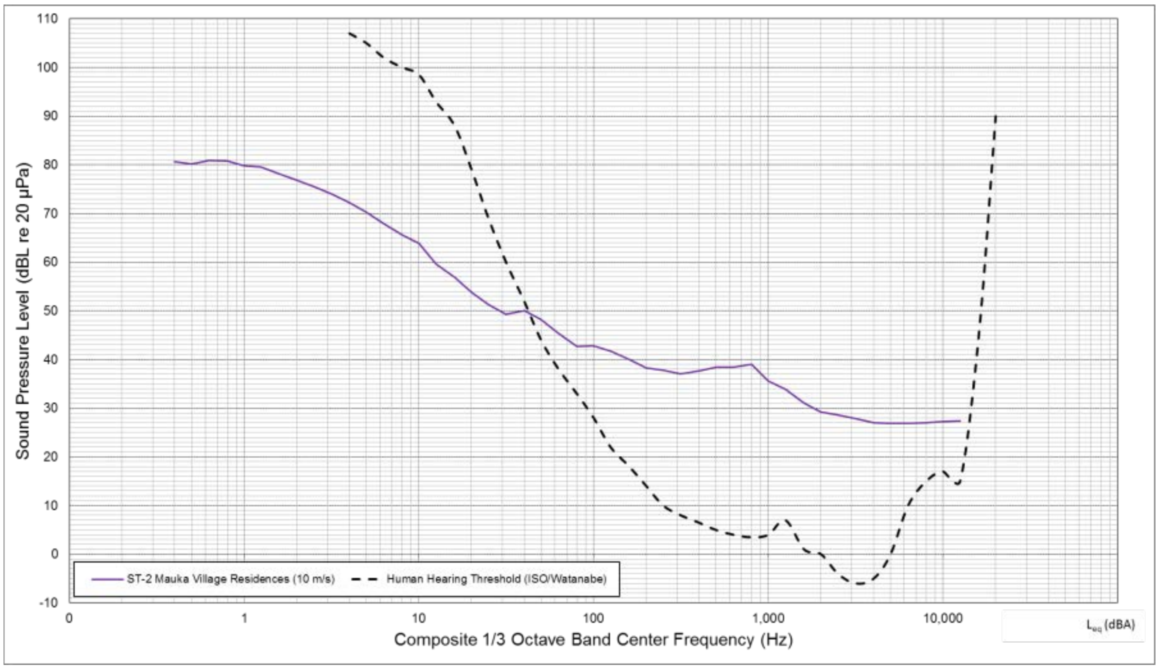


Figure 16. ST-2 1/3-Octave Band Spectral Plot

Monitoring Position: ST-3

Measurements at ST-3 were conducted on April 22, 2014 along public ROW adjacent to the northwest fence line of the Kahuku Elementary School and are representative of the acoustic environment of the schools and residences nearby which are also included in the "Mauka Village". The measurement was conducted to capture monitoring data where long-term equipment deployment was not allowed. ST-3 is meant to provide additional support data to characterize ambient conditions at the schools and residences which are also represented by LT-3. A daytime measurement was conducted from 2:45PM to 3:15PM and a nighttime measurement was conducted from 11:02PM to 11:32PM. Observed daytime sound sources included local roadway traffic, wind interacting with structures and vegetation, distant yard maintenance, people conversing, and periodic helicopter and fixed-wing aircraft flyovers. Nighttime observations included periodic traffic, people conversing at nearby residences, wind interacting with structures and vegetation, and minimal insect noise. Hub height wind speeds during the daytime measurement were 11 m/s and were 9 m/s at night. Figure 17 provides the 1/3-octave band spectral data for the daytime and nighttime monitoring periods. At no time were infrasound levels of sufficient strength to be above the threshold of human hearing.

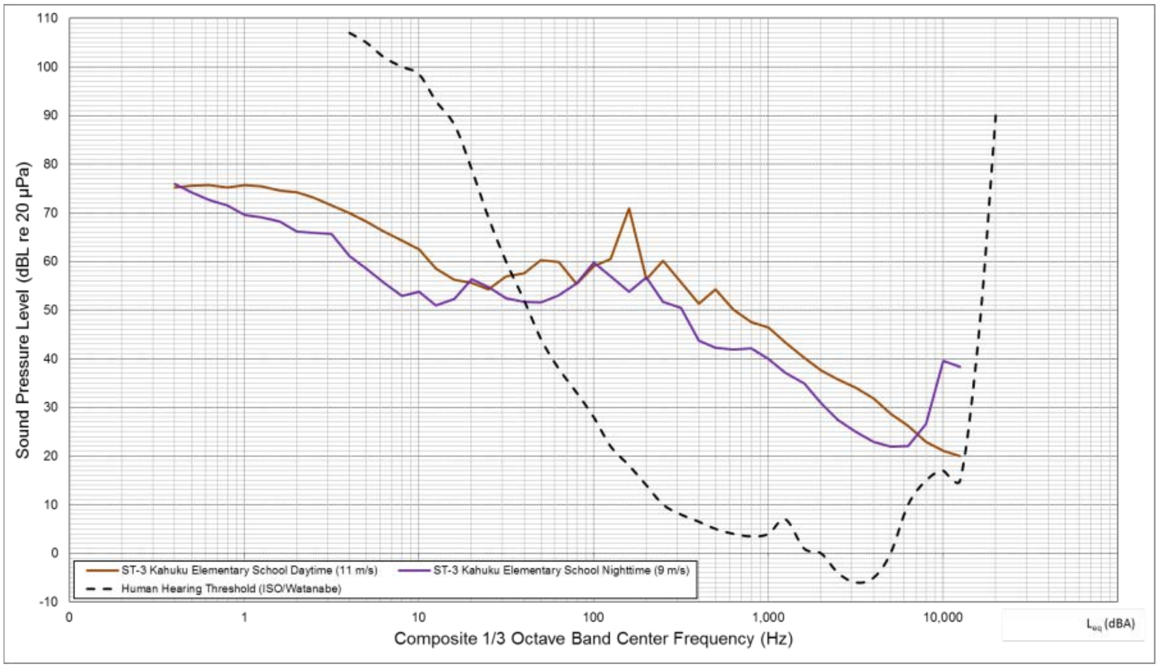


Figure 17. ST-3 1/3-Octave Band Spectral Plot

Monitoring Position: ST-4

Measurements at ST-4 were conducted on April 22, 2014 along limited public ROW near the Gunstock Ranch and are representative of the ranch and nearby rural residences located approximately one kilometer from the Project. The measurement was conducted to capture monitoring data where long-term equipment deployment was not allowed and to verify that long-term monitors at LT-2 and LT-3 are sufficiently representative of this area as well. A daytime measurement was conducted from 3:24PM to 4:03PM and a nighttime measurement was conducted from 10:26PM to 10:56PM. Because the landowners were in the process of locking the limited public access dirt road when field engineers arrived to conduct the nighttime measurement an alternate location was utilized at the entrance off of the Kamehameha Highway. Observed daytime sound sources included periodic local roadway traffic, traffic on the Kamehameha Highway, wind interacting vegetation, distant yard maintenance, people conversing, and periodic helicopter and fixed-wing aircraft flyovers. Nighttime observations included limited traffic on the Kamehameha Highway, wind interacting vegetation, and minimal insect noise. Hub height wind speeds during the daytime measurement were 11 m/s and were 9 m/s at night. Figure 18 provides the 1/3-octave band spectral data for the daytime and nighttime monitoring periods. At no time were infrasound levels of sufficient strength to be above the threshold of human hearing.

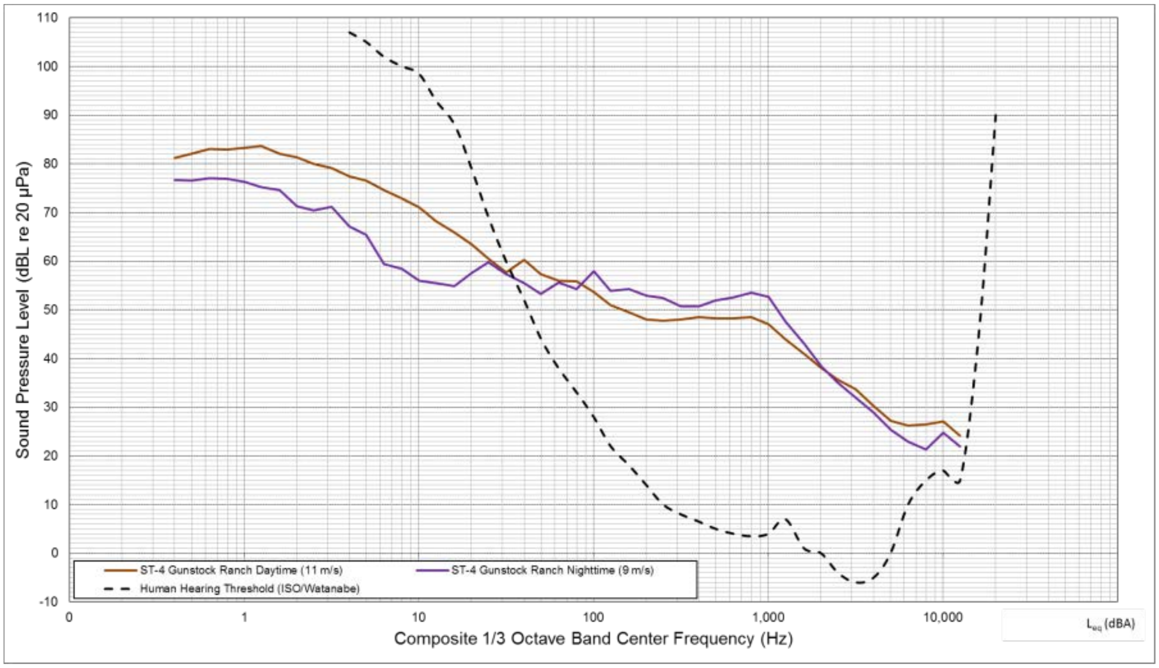


Figure 18. ST-4 1/3-Octave Band Spectral Plot

Monitoring Position: ST-5

Measurements at ST-5 were conducted on May 7, 2014 at the military entrance to the property which contains the Kahuku Wind Farm. The measurement was conducted to capture downwind sound levels from the Kahuku Wind Farm WTGs which are typically louder than in the upwind direction where the Project would be located. A daytime measurement was conducted from 10:00AM to 10:30AM and a nighttime measurement was conducted from 3:11AM to 3:41AM. Observed daytime sound sources included traffic on the Kamehameha Highway, the Kahuku Wind Farm WTGs, wind interacting vegetation, and periodic helicopter and fixed-wing aircraft flyovers. Nighttime observations included minimal traffic on the Kamehameha Highway, the Kahuku Wind Farm WTGs, wind interacting vegetation, and minimal insect noise. Hub height wind speeds during the daytime measurement were 5 m/s and were 6 m/s at night. The dominant sound source at night was from WTGs with the nearest WTG located 476m southwest. To characterize sound levels from just the WTGs to the extent possible was achieved by excluding one minute intervals which included a vehicle pass-by on the Kamehameha Highway. Figure 19 provides the 1/3-octave band spectral data for the daytime and nighttime monitoring periods as well as the nighttime period excluding vehicle pass-bys. At no time were infrasound levels of sufficient strength to be above the threshold of human hearing.

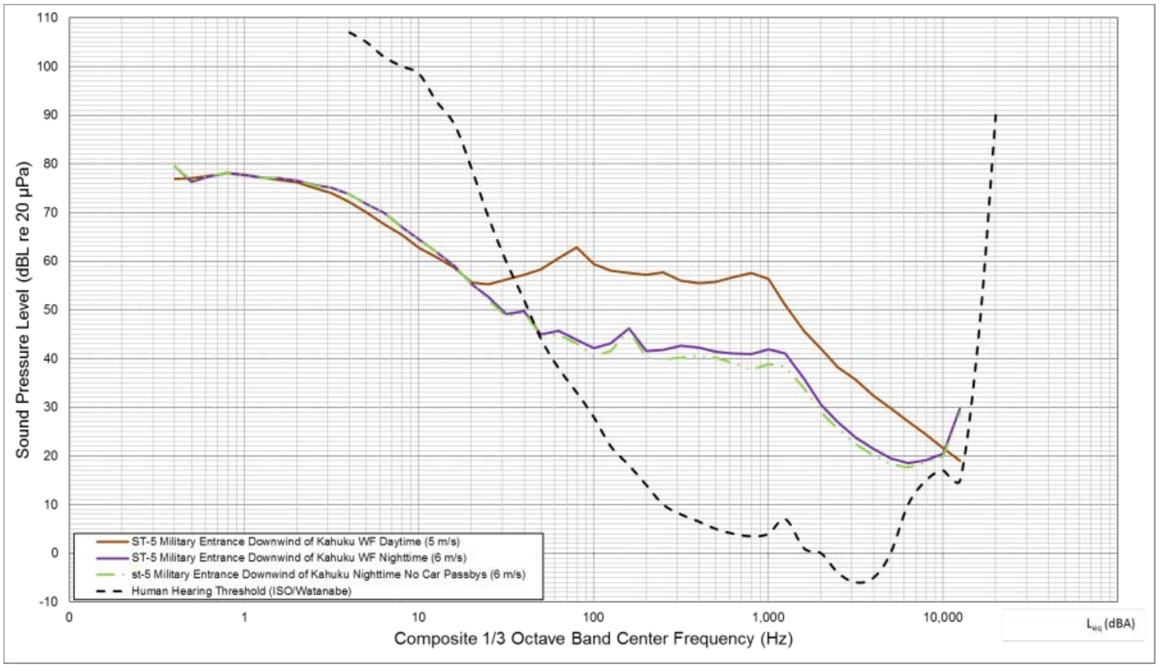


Figure 19. ST-5 1/3-Octave Band Spectral Plot

Monitoring Position: ST-6

The ST-6 measurement was conducted on May 7, 2014 3:54AM to 4:24AM along public ROW near leased DOA parcels that have single-family residences. The measurement was conducted to capture monitoring data at these residences where long-term equipment deployment was not allowed. ST-6 is meant to provide additional support data to characterize these DOA parcels that are located further from the existing Kahuku Wind Farm than those represented by ST-1. A nighttime measurement was conducted at ST-6 with observed sound sources including the existing WTGs at the Kahuku Wind Farm, wind interacting with vegetation, and limited insect noise. Traffic noise along the Kamehameha Highway was not audible during the measurement or was masked by other sounds including the existing WTGs. Figure 20 provides the 1/3-octave band spectral data for the monitoring period which included hub height wind speeds of 10 m/s. At no time were infrasound levels of sufficient strength to be above the threshold of human hearing.

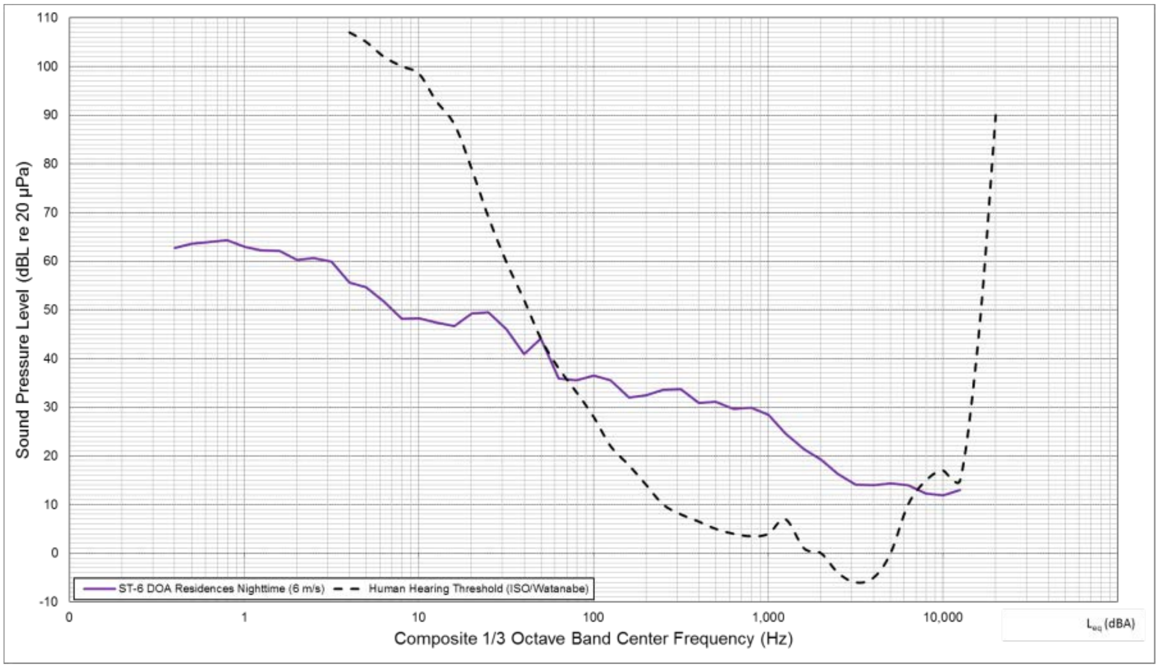


Figure 20. ST-6 1/3-Octave Band Spectral Plot

4.0 ACOUSTIC ANALYSIS METHODOLOGY

Each build alternative was evaluated for construction and operational noise impacts. The No Action Alternative, or Alternative 1, is not discussed here because there would be no noise, other than continued existing sound sources, associated with that alternative. There are two build alternatives under consideration, Alternative 2 (up to 25 MW), Alternative 2a (up to 29.7 MW) and Alternative 3 (up to 39 MW). Noise generated during Project construction and operation was evaluated at the property lines for each TMK per HAR 11-46 and at some of the closest sensitive receptors (i.e., residences) evaluated at outdoors at these structures. Sound levels were not predicted inside homes; however, it should be noted that studies have shown (FHWA 2011) that sound levels are generally 10 dB less inside structures with windows open, which may be common at residences near the Project. Project construction was assessed in a semi-qualitative manner using information available at this stage of the design process and using representative equipment information where necessary. The operational acoustic assessment was completed using DataKustic GmbH's CadnaA, the computer-aided noise abatement program (v 4.4.145).

CadnaA is a comprehensive 3-dimensional acoustic software model that conforms to the Organization for International Standardization (ISO) standard ISO 9613-2 "Attenuation of Sound during Propagation Outdoors." The engineering methods specified in this standard consist of full (1/1) octave band algorithms that incorporate geometric spreading due to wave divergence, reflection from surfaces, atmospheric absorption, screening by topography and obstacles, ground effects, source directivity, heights of both sources and receptors, seasonal foliage effects, and meteorological conditions.

Atmospheric absorption depends on temperature and humidity and is most important at higher frequencies. Over short distances, the effects of atmospheric absorption are minimal. The ISO 9613-2 calculation calculates attenuation for meteorological conditions favorable to propagation, i.e., downwind sound propagation or what might occur typically during a moderate atmospheric ground level inversion, which is assumed to be regulatory worst case. An average temperature of 24° Celsius (75° Fahrenheit) and relative humidity of 67 percent was assumed, based on available yearly climate information for the Project Area. While site-specific meteorological data was considered in the acoustic assessment, it is important to note that atmospheric attenuation is not strongly dependent on temperature. Though a physical impracticality, the ISO 9613-2 standard simulates omnidirectional downwind propagation and maximum WTG source directivities. For receivers located between discrete WTG locations or WTG groupings, the acoustic model may result in over-prediction in sound level at receivers.

In addition to geometrical divergence, attenuation factors (A) include topographical features, terrain coverage, and/or other natural or anthropogenic obstacles that can affect sound attenuation and result in acoustical screening. Topographical information was imported into the acoustic model using the official U.S. Geological Survey (USGS) digital elevation dataset to accurately represent terrain in three dimensions. Terrain conditions, vegetation type, ground cover, and the density and height of foliage can also influence the absorption that takes place when sound waves travel over land. A mixed ground absorption rate was assumed with semi-reflective value of G=0.5 to represent the average ground absorption of the Project Area. Due to land elevation variability in proximity to the Project, additional conservative factors for sound propagation in complex terrain were also taken into account. Sound attenuation through foliage and diffraction around and over existing anthropogenic structures such as buildings were ignored under all acoustic modeling scenarios.

4.1 Wind Turbine sound characteristics

There are two principal sound sources from an operating wind turbine: mechanical and aerodynamic sound. Mechanical sound is generated at the gearbox, generator, and cooling fan and is radiated from the surfaces of the nacelle and machinery enclosure and by openings in the nacelle casing. Aside from upset conditions that may result in abnormal mechanical noise emissions, the dominant noise generating component of utility scale wind turbines is aerodynamic.

Aerodynamic sound is related to air flow and the interaction with the tower structure and rotor blades when in motion and is the largest component of acoustic emissions for modern wind turbines. Sound originates from the flow of air around the air foils which is very strongly influenced by the tip speed of the blades. Tip speed is the speed of the tip of a rotor blade as it travels along the circumference of the rotor-swept area. The tip speed is directly related to the rotor size, which is fixed, and to the rotor rotational speed. The tip speed ratio is defined as the ratio of the speed of the tip of a rotating blade to the speed of the wind. Aerodynamic noise will vary primarily as a function of rotor rotational speed.

Air flow occurring across the blade produces turbulence at the surface boundary layer, which results in trailing edge boundary sound. Trailing edge sound is considered the principal aerodynamic noise source component of wind turbines. In addition to trailing edge, tip sound is created by vortex shedding as the blade tips pass through the air when in motion. Wind turbine manufacturers have instituted several measures to both reduce aerodynamic sound and increase power generation efficiency by reducing trailing edge and tip sound generation. Efforts to reduce aerodynamic sounds have included the use of upwind rotor designs, noise-reduced nacelle, variable speed operation resulting in lower tip speed ratios, and the use of specially modified rotor blades designed and fabricated to reduce trailing edge noise. Earlier wind turbine designs had the blades located downwind of the support structure. As the blades passed through the vortex shed behind the support tower, the blade would be momentarily displaced, resulting in a pressure pulse. This becomes the mechanism for the generation of excessive acoustic modulation and low frequency sound. The downwind rotor design is rarely used in modern utility-scale wind turbines that employ the now-standard upwind rotor design with blades upstream of the tower structure. This change in rotor location has greatly reduced many issues associated with the downwind design and resulted in a decrease of 10 dB or greater, which corresponds to a perceived decrease in loudness by a factor of two.

A somewhat unique acoustic characteristic of wind energy facilities is that the sound generated by each individual wind turbine will increase as the wind speed across the site increases, up to a certain maximum sound level reached at full rotation of the rotor blades (i.e., greater than approximately 8 meters per second [m/s]). All wind turbines under consideration for the Na Pua Makani Wind Farm are variable speed-type with sound predominantly determined by the aerodynamic broadband sound of the rotor blades, which is directly related to the circumferential or blade tip speed. Wind turbine sound is negligible when the rotor is at rest, increases as the rotor tip speed increases, and is generally constant once rated power output and full rotational speed is reached. As an offset, as wind speeds increase, the background ambient sound levels likely will continue to increase by the normal sound of wind blowing through trees and around buildings, resulting in acoustic masking effects. Aerodynamic noise is usually only perceived when the turbine rotor is moving and wind speeds are relatively low at ground level.

In order to assist project developers and acoustical engineers wind turbine manufacturers report WTG sound power levels at integer wind speeds referenced to the effective hub height, ranging from cut-in to full rated power per the International Electrotechnical Commission (IEC) 61400-11:2006 Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques. Table 13 presents a summary of sound power levels during normal mode operation. Sound power levels presented are inclusive of both mechanical and aerodynamic source components. The Vestas and Siemens specification present an expected warranty confidence interval (k-factor) of k=2 dB and k=1.5 dB, respectively. These k-factors were included in all acoustic modeling calculations and incorporates the uncertainty in independent sound power level measurements conducted, the applied probability level and standard deviation for test measurement reproducibility, and product variability. It is expected that the Vestas and Siemens WTGs installed would have similar sound profiles to what was used in the acoustic modeling analysis; however, it is possible that the final warranty sound data could vary slightly.

Table 13. Broadband Sound Power Levels (dBA) Reported in Accordance with IEC 61400-11

Wind Speed at Hub Height (AGL)	WTG Sound Power Level (LW) at Reference Wind Speed										
	7 mph (3 m/s)	9 mph (4 m/s)	11.2 mph (5 m/s)	13.4 mph (6 m/s)	15.9 mph (7 m/s)	17.9 mph (8 m/s)	20.1 mph (9 m/s)	22.4 mph (10 m/s)	24.6 mph (11 m/s)	26.8 mph (12 m/s)	29.1 mph (13 m/s)
Vestas V110-2.0	97.3	99.6	103.8	107.5	106.1	106.1	106.1	106.3	106.5	106.7	107
Siemens SWT 3.0-113	N/A	N/A	N/A	105	107.4	107.5	107.5	107.5	N/A	N/A	N/A
Siemens SWT 3.3-130	91.9	96.1	101.0	105.2	106.0	106.0	106.0	106.0	106.0	106.0	106.0
Source: Vestas 2013, Siemens 2013, Siemens 2015											

A summary of sound power levels during full rotation for each turbine by octave band center frequency are presented in Table 14.

Table 14. Representative Octave Band 1/1 Center Frequencies

Frequency (Hz)	Octave Band Sound Power Level (dBA)								Broadband (dBA)
	63	125	250	500	1000	2000	4000	8000	
Vestas V110-2.0	89.9	94.5	97.2	99.6	102.2	100.7	99.1	92.3	107.5
Siemens SWT 3.0-113	85.5	93.0	100.4	103.7	100.4	92.5	81.6	78.3	107.0
Siemens SWT 3.3-130	86.6	94.3	96.3	100.4	101.6	97.2	92.4	82.9	106.0
Source: Vestas 2013, Siemens 2013, Siemens 2015									

Predictions of WTG LFN and IS were conducted to identify potential impacts; however, these predictions are difficult for a number of reasons. For example, WTG manufacturers do not publish LFN and IS sound levels via their IEC 61400-11 testing reports; therefore, surrogate sound levels were needed to conduct the analysis. These surrogate values are the best available data, obtained from other published studies on Siemens WTGs. No data is known to exist on low LFN or IS source levels for Vestas wind turbines, but because the bulk of LFN and IS noise is a result of WTG blades the Siemens data is thought to be representative of the Vestas WTG as well. Additionally, attempts were made to scale the surrogate data to more closely match the Project WTG octave band spectra. Values used in the analysis of Project LFN and IS are given in Table 15.

Table 15. Representative Octave Band 1/1 LFN/IS Frequencies

Frequency (Hz)	Octave Band Sound Power Level (dBA)		
	8	16	31.5
Siemens SWT 3.0-113/SWT 3.3-130	59.8	73.7	84.8
Source: Scaled up from data in Epsilon 2010 using Siemens 2013 and 2015 sound power data.			

Another complication of LFN and IS prediction is that standard propagation modeling methodologies (e.g., ISO 9613-2) are not always appropriate because low frequency sounds attenuate at different rates with distance than the mid to high frequencies. Additionally, existing ambient LFN and IS are often already relatively high from the sounds of wind interacting with the environment vegetation or structures, vehicles on roadways, existing wind turbine noise from the

Kahuku Wind Farm, and ocean waves crashing on shore. However, comparisons were made to existing LFN and IS levels to ascertain the net increase, if any, with the Project.

4.2 Construction Noise

Construction noise analysis was evaluated for two Project build alternatives under consideration. Alternative 2 would implement two Vestas V110-2.0 and eight Siemens 3.0-113 WTGs. Alternative 2a would implement nine Siemens 3.3-130 WTGs. Alternative 3 would implement two Vestas V110-2.0 and 10 Siemens 3.0-113 WTGs.

4.2.1 Alternative 2

Construction of Alternative 2 would involve constructing of access roads, excavating and forming WTG foundations, works associated with preparing the site for crane-lifting, and actual WTG assembly and commissioning. Typically wind energy projects are constructed in four phases consisting of the following:

1. **Site Clearing:** The initial site mobilization phase includes the establishment of temporary site offices, workshops, stores, and other on-site facilities. Installation of erosion and sedimentation control measures will be completed as well as the preparation of initial haulage routes.
2. **Excavation:** This phase would begin with the excavation and formation of access roads and preparation of laydown areas. Excavation for the concrete WTG foundations would also be completed.
3. **Foundation Work**: Construction of the reinforced concrete WTG foundations would take place in addition to installation of the internal transmission network.
4. **Wind Turbine Installation**: Delivery of the WTG components would occur followed by their installation and commissioning.

Work on these construction activities is expected to overlap. It is likely that the WTGs would be erected in small groupings. Each grouping may undergo testing and commissioning prior to commencement of full commercial operation. Other construction activities include those for the supporting infrastructure such as the collection substation, maintenance building, and the overhead transmission lines. The construction of the Project may cause short-term but unavoidable noise impacts depending on the construction activity being performed and the distance to receiver. The sound levels resulting from construction activities vary significantly depending on several factors such as the type and age of equipment, the specific equipment manufacturer and model, the operations being performed, and the overall condition of the equipment and exhaust system mufflers. The list of construction equipment that may be used on the Project and estimates of near and far sound source levels are presented in Table 16.

Table 16. Alternative 2 Estimated L_{max} Sound Pressure Levels from Construction Equipment

Equipment*	Estimated Sound Pressure Level at 50 feet (dBA)	Estimated Sound Pressure Level at 2000 feet (dBA)
Forklift	80	48
Backhoe	80	48
Grader	85	53
Man basket	85	53
Dozer	83 - 88	51 - 56
Loader	83 - 88	51 - 56
Scissor Lift	85	53
Truck	84	52
Welder	73	41
Compressor	80	48
Concrete Pump	77	45

Sources: Federal Highway Administration, "Roadway Construction Noise Model User's Guide," Report FHWA-HEP-05-054 / DOT-VNTSC-FHWA-05-01, January 2006. Power Plant Construction Noise Guide, Bolt Beranek and Newman, Inc. 1977. Federal Highway Administration, "Procedures for Abatement of Highway Traffic Noise and Construction Noise." Code of Federal Regulations, Title 23, Part 772, 1992.

Sounds generated by construction activities would likely require a permit, to be obtained from the DOH, to allow for the operation of construction equipment that result in exceedances of the maximum permissible at property line locations. While the permit and permitting procedures do not limit the sound level generated at the construction site, time restrictions may be placed on time periods when the loudest construction activities are likely to occur, i.e. 7:00 a.m. and 7:00 p.m., Monday through Friday and between 9:00 a.m. and 6:00 p.m. on Saturday. The DOH would require reasonable and standard practices be employed to minimize the impact of noise resulting from construction activities. Provisions to conduct noise monitoring and community meetings may also be required, but will likely be deemed unnecessary given the remote location. The Project would proactively work with the community and attempt to resolve any complaints or concerns due to noise from construction by coordinating activities and informing the community of the timing of the expected construction noise at the closest NSRs to avoid conflicts, i.e., if blasting for foundation or removal of ledge or other potentially noisy activities are required during the construction period, nearby residents shall be notified in advance.

Construction activity would generate traffic having potential noise effects, such as trucks travelling to and from the site on public roads. Traffic noise is categorized into two categories: (1) the noise that will occur during the initial temporary traffic movements related to turbine delivery, haulage of components and remaining construction; and (2) maintenance and ongoing traffic from staff and contractors, which is expected to be minor. At the early stage of the construction phase, equipment and materials would be delivered to the site, such as hydraulic excavators and associated spreading and compacting equipment needed to form access roads and foundation platforms for each turbine. Once the access roads are constructed, equipment for lifting the towers and turbine components would arrive. Concrete would be mixed offsite and delivered to the Project site, rather than produced by an on-site concrete batch plant.

Federal laws prohibit state and local governments from regulating off-site sound levels generated by trucks and automobiles operating on a private site or public roadways. This federal regulatory preemption is specified in the Federal Noise Control Act of 1972 and in the Surface Transportation

Assistance Act of 1982, both of which prohibit states and local authorities from regulating the noise emitted by trucks engaged in interstate commerce, i.e., truck deliveries. A federal OSHA preemption also prohibits local and state governments from regulating safety signals on trucks and construction equipment. Alternative 2 construction would be coordinated with individual landowners regarding the operation of trucks, cars and other vehicles on private site access roadways as necessary to prevent the occurrences of unexpected noise resulting from construction and transport related vehicle movements.

4.2.2 Alternative 2a

Construction noise under Alternative 2a would be almost the same as Alternative 2, implementing an identical method of construction. The variation in construction noise between the two alternatives is a result of where construction would take place since the locations of WTGs are slightly different. Like Alternative 2, construction noise is likely to exceed HAR 11-46 limits at some TMKs in the Project Area and therefore a permit from the DOH would likely be required. Mitigation of construction noise would be the same for Alternative 2a as that for Alternative 2.Alternative 3

The first phase of construction of Alternative 3 would be identical to Alternative 2 and the second phase of Alternative 3 would use an identical method as that for the first phase of construction. The variation in construction noise between phases one and two of construction are a result of where construction would take place and that construction would occur at least two years later for the second phase. Like Alternative 2, construction noise is likely to exceed HAR 11-46 limits at some TMKs in the Project Area and therefore a permit from the DOH would likely be required. Mitigation of construction noise would be the same for Alternative 3 as that for Alternative 2.

4.3 Operational Noise

Operational noise analysis was conducted for the same two Project alternatives under consideration (e.g., Alternatives 2 and 3) and for the two WTG types under consideration.

4.3.1 Alternative 2

Operational noise with implementation of Alternative 2 would result from the WTGs and to a lesser extent the proposed substation 50 MVA transformer. Operational broadband (dBA) sound pressure levels were calculated assuming that all Alternative 2 WTGs would be operating continuously and concurrently at the highest manufacturer-rated sound level at the given operational condition. The sound energy was then summed to determine the equivalent continuous A-weighted downwind sound pressure level at a point of compliance with HAR 11-46, in this case the property or TMK limit. Calculations were completed along each property limit in the acoustic analysis area at a height of 5 ft (1.52 m) above ground (the approximate height of ears of a standing person). This is also the standard height at which testing for compliance with the State Community Noise Control Rule is completed. Table 17 presents the range of sound levels received at each TMK zoning class along the property line in the acoustic analysis area. These predictions demonstrate that compliance with HAR 11-46 is achieved since Project operational sound levels at the receiving property lines are at or below the controlling noise limit for each zone. Figure 21 provides a map of received sound levels in the acoustic analysis area for Alternative 2.

Table 17. Alternative 2 Range of Property Line Received Sound Levels by HAR 11-46 Zoning Class

HAR 11-46 Zoning Class	Controlling HAR 11-46 Zoning Limit (dBA L_{eq})	Range of Received Sound Levels dBA L_{eq}
Class A	45	8 – 44
Class B	50	38 – 41
Class A (Day Only)*	55	31 – 44
Class C	70	10 - 58
Note: *Class A (Day Only) uses include those at the area schools and golf course.		

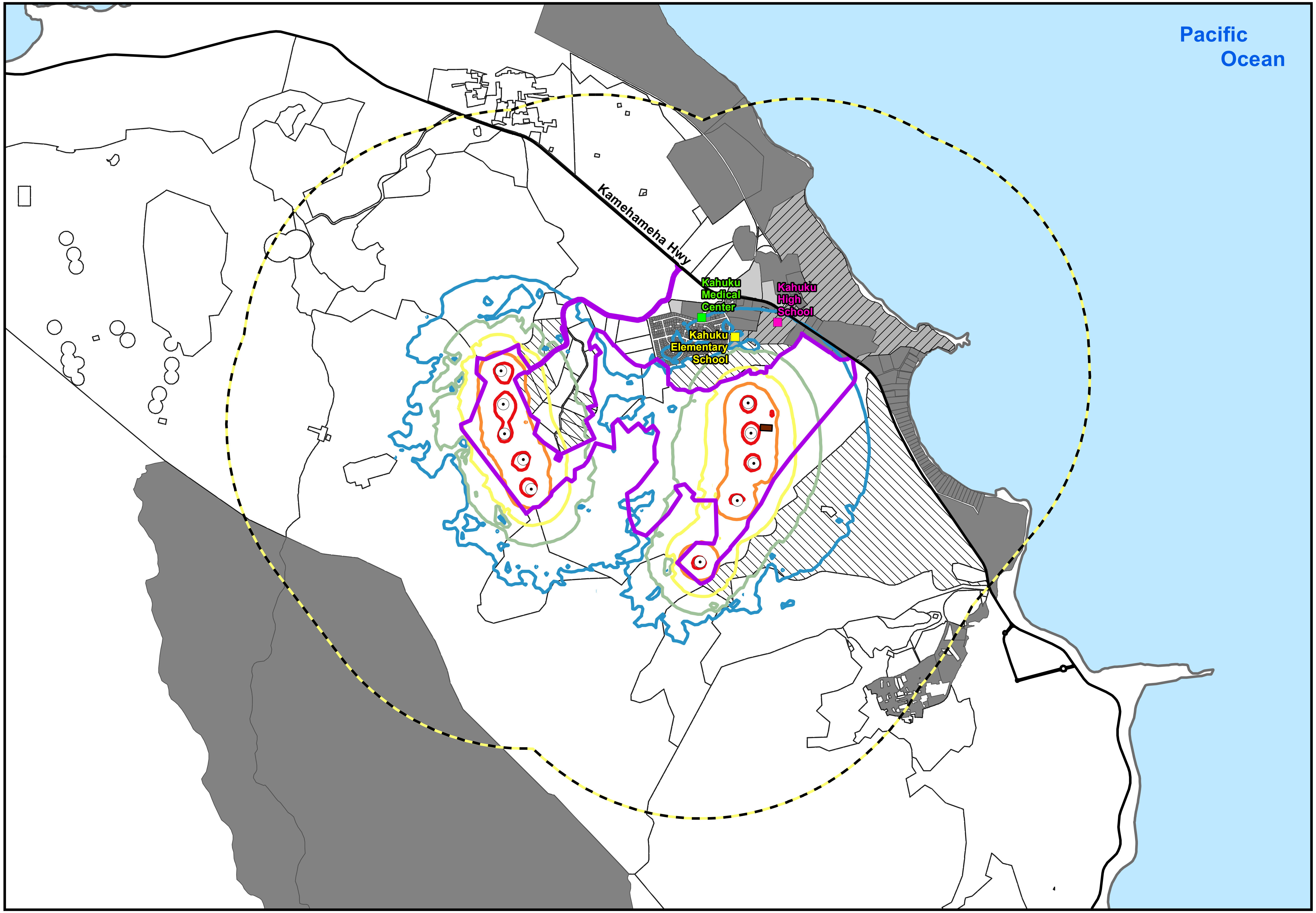
Figure 21

Na Pua Makani Wind Project

Alternative 2 Operational Sound Level Isopleths

Oahu, HI

December 2015



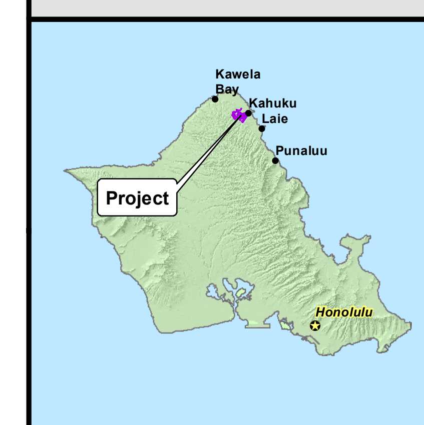
- Wind Farm Site Boundary
- Acoustic Study Area
- Collector Substation and Point of Interconnect
- Local Road
- Kahuku Elementary School
- Kahuku High School
- Kahuku Medical Center
- Potential Turbine Location

HAR Zone

- Class A (45 dBA Limit)
- Class A (55 dBA Limit) - Day Use Only
- Class B (50 dBA Limit)
- Class C (70 dBA Limit) - Has Residence
- Class C (70 dBA Limit) - No Residence or Project TMK

Sound Contour Range (dBA)

- 40
- 45
- 50
- 55
- 60



1:32,000 WGS84 UTM 4

0 0.5 1 2 3 4 5 Miles

Data Sources Champlin: project facilities / ESRI: roads / Hawaii Statewide GIS Program: TMK parcels / Tetra Tech: sound contours generated in CadnaA

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TETRA TECH

LFN/IS Predictions

As indicated in the regulatory environment description in this document (Section 2.0) there are no federal, state, or local regulations that stipulate LFN/IS noise level limits. Nevertheless, because the community has indicated concern via comments received during scoping, Champlin elected to analyze the contribution of predicted Project LFN/IS to existing LFN/IS levels in order to ascertain if there could be potential Project-related LFN/IS impacts. The first level of analysis utilized the WHO comparison guidance to identify locations where the predicted dBC was 10 dB greater than the predicted dBA. The next level of analysis was conducted at the nearest NSRs to the Project's WTGs, where the WHO guideline showed that received dBC were 10 dB higher than the predicted dBA to determine if LFN/IS would exceed the threshold of human hearing, the DEFRA limits, and/or the ANSI S12.9 Part 4 guidelines. The nearest residence is located approximately 673 feet (205 meters) a proposed WTG. Received LFN/IS are predicted to be 83 dB at 8 Hz and 76 dB at 16 Hz which are both well below the threshold of human hearing and the DEFRA limits but higher than the ANS S12.9 Part 4 guideline of 65 dB at 16 Hz. Monitored sound levels in this area would be similar to those monitored at positions LT-1 and ST-1 which shows that existing LFN/IS sound levels range from 69-76 dB at 8 Hz and 63-71 at 16 Hz, all below the threshold of human hearing, but at 16 Hz baseline sound levels are on average above the ANSI S12.9 Part 4. The Project would result in an increase in LFN/IS of but much of this would be masked by existing sound levels. Regardless, because it is unlikely that Project LFN/IS would be audible at these frequencies even the highest increases of LFN/IS would not result in an impact at the nearest residence. With regard to the 65 dB ANSI S12.9 Part 4 guideline, because the baseline sound levels are already above this threshold the likelihood of complaints is low given that Project LFN/IS would also be partially masked. Therefore, there is no anticipated LFN/IS impact from Alternative.

4.3.2 Alternative 2a

Operational noise with implementation of Alternative 2a would result from WTGs and to a lesser extent the proposed substation 50 MVA transformer. Additionally, the worst case LFN/IS noise levels would be the same under Alternative 2a as they are under Alternative 2 because the nearest residence is the same for the alternative being located 205 meters from the nearest proposed turbine. Refer to the Alternative 2 discussion of LFN/IS for results.

Operational broadband (dBA) sound pressure levels were calculated assuming that all Alternative 2a WTGs (a total of 9) would be operating continuously and concurrently at the maximum manufacturer-rated sound level at the given operational condition. The sound energy was then summed to determine the equivalent continuous A-weighted downwind sound pressure level at a point of compliance with HAR 11-46, in this case the property or TMK limit. Calculations were completed using receptor points along each property limit in the acoustic analysis area at a height of 5 ft (1.52 m) above ground (the approximate height of ears of a standing person). This is also the standard height at which testing for compliance with the State Community Noise Control Rule is completed. Table 18 presents the range of sound levels received at each TMK zoning class along the property line in the acoustic analysis area. Compliance with HAR 11-46 is achieved if Project operational sound levels at the receiving property line are at or below the controlling noise limit for each zone. Because sound levels for operation of the Project are all below the controlling HAR 11-46 limit the Project is anticipated to be in compliance. Figure 22 is a map of received sound levels from operation of Alternative 2a.

Table 18. Alternative 2a Range of Property Line Received Sound Levels by HAR 11-46 Zoning Class

HAR 11-46 Zoning Class	Controlling HAR 11-46 Zoning Limit (dBA L_{eq})	Range of Received Sound Levels dBA L_{eq}
Class A	45	8 - 43
Class B	50	35 – 38
Class A (Day Only)*	55	27 – 43
Class C	70	8 - 56
Note: *Class A (Day Only) uses include those at the area schools and golf course.		

4.3.3 Alternative 3

Operational noise with implementation of Alternative 3 would result from WTGs and to a lesser extent the proposed substation 50 MVA transformer. Additionally, the worst case LFN/IS noise levels would be the same under Alternative 3 as they are under Alternative 2 because the nearest residence is the same for the alternative being located 205 meters from the nearest proposed turbine. Refer to the Alternative 2 discussion of LFN/IS for results.

Operational broadband (dBA) sound pressure levels were calculated assuming that all Alternative 3 WTGs (a total of 12) would be operating continuously and concurrently at the maximum manufacturer-rated sound level at the given operational condition. The sound energy was then summed to determine the equivalent continuous A-weighted downwind sound pressure level at a point of compliance with HAR 11-46, in this case the property or TMK limit. Calculations were completed using receptor points along each property limit in the acoustic analysis area at a height of 5 ft (1.52 m) above ground (the approximate height of ears of a standing person). This is also the standard height at which testing for compliance with the State Community Noise Control Rule is completed. Table 19 presents the range of sound levels received at each TMK zoning class along the property line in the acoustic analysis area. Compliance with HAR 11-46 is achieved if Project operational sound levels at the receiving property line are at or below the controlling noise limit for each zone. Because sound levels for operation of the Project are all below the controlling HAR 11-46 limit the Project is anticipated to be in compliance. Figure 23 is a map of operational noise isopleths for Alternative 3.

Table 19. Alternative 3 Range of Property Line Received Sound Levels by HAR 11-46 Zoning Class

HAR 11-46 Zoning Class	Controlling HAR 11-46 Zoning Limit (dBA L_{eq})	Range of Received Sound Levels dBA L_{eq}
Class A	45	8 – 44
Class B	50	38 – 41
Class A (Day Only)*	55	31 – 44
Class C	70	10 – 58
Note: *Class A (Day Only) uses include those at the area schools and golf course.		

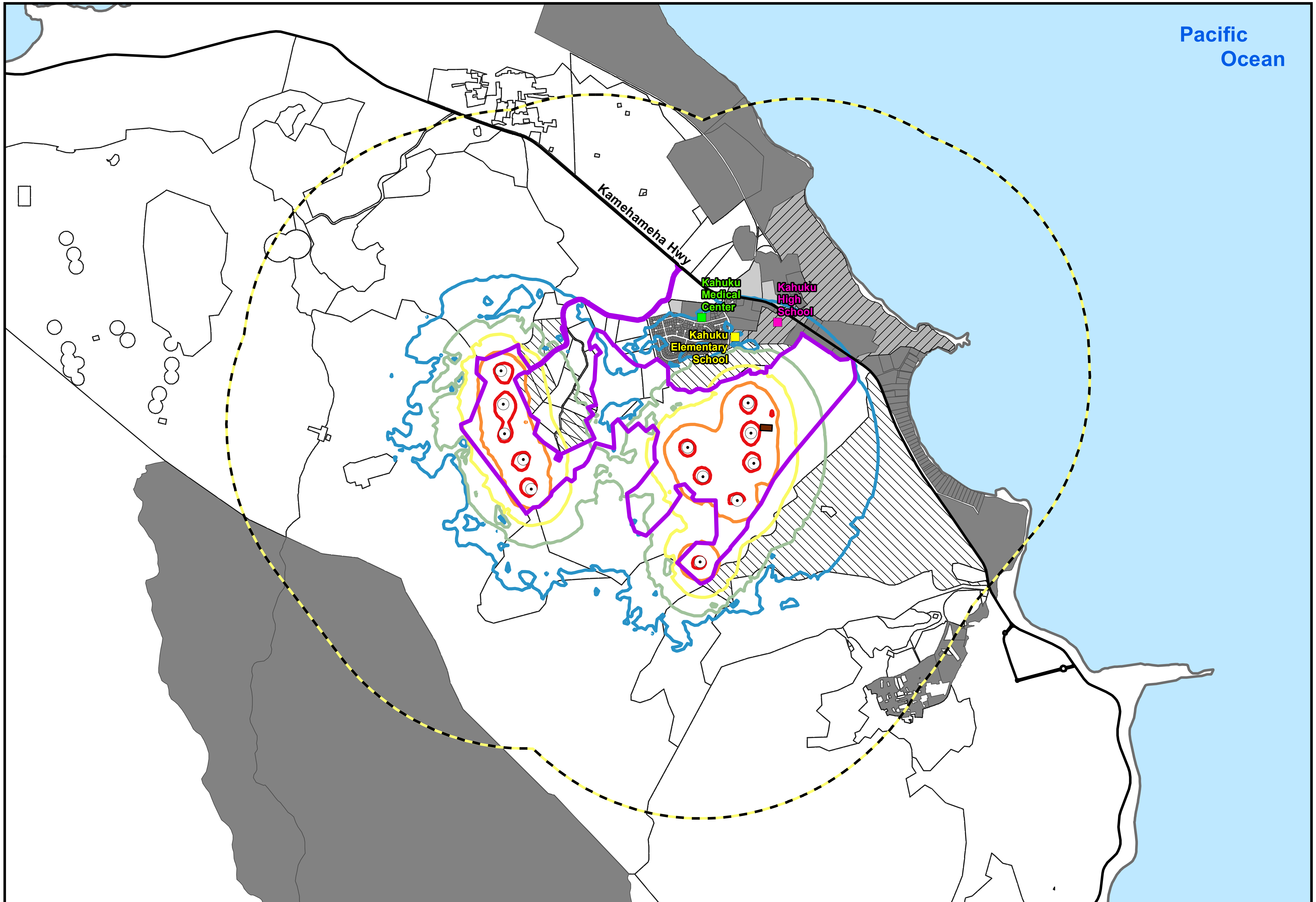


Figure 22

Na Pua Makani Wind Project

Alternative 3 Operational Sound Level Isopleths

Oahu, HI

December 2015

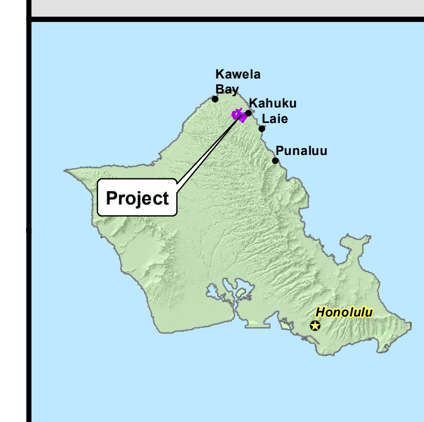
- Wind Farm Site Boundary
- Acoustic Study Area
- Collector Substation and Point of Interconnect
- Local Road
- Kahuku Elementary School
- Kahuku High School
- Kahuku Medical Center
- Potential Turbine Location

HAR Zone

- Class A (45 dBA Limit)
- Class A (55 dBA Limit) - Day Use Only
- Class B (50 dBA Limit)
- Class C (70 dBA Limit) - Has Residence
- Class C (70 dBA Limit) - No Residence or Project TMK

Sound Contour Range (dBA)

- 40
- 45
- 50
- 55
- 60



1:32,000 WGS84 UTM 4 — 0 0.5 1 2 3 4 5 Miles

Data Sources Champlin: project facilities / ESRI: roads / Hawaii Statewide GIS Program: TMK parcels / Tetra Tech: sound contours generated in CadnaA

P:\GIS_PROJECTS\Champlin_Wind\Na_Pua_Makani\MXDs\EIS\FEIS\Report_Figures\NoiseImpactAssessment\Champlin_NaPuaMakani_FEIS_Sound_Fig22_Alt3_11i17i_20151230.mxd - Last Saved 12/30/2015

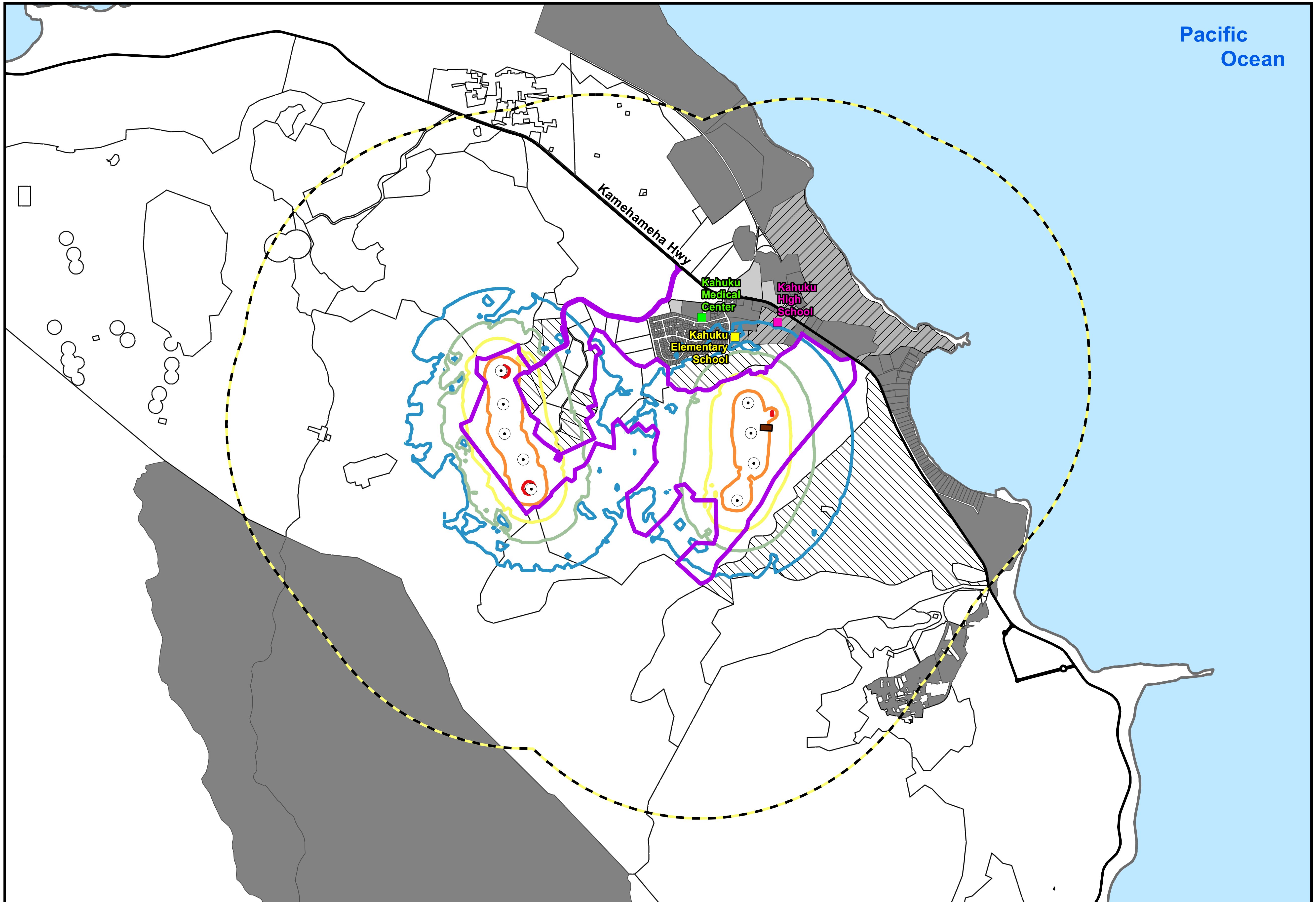
Figure 23

Na Pua Makani Wind Project

Alternative 2a Operational Sound Level Isopleths

Oahu, HI

December 2015



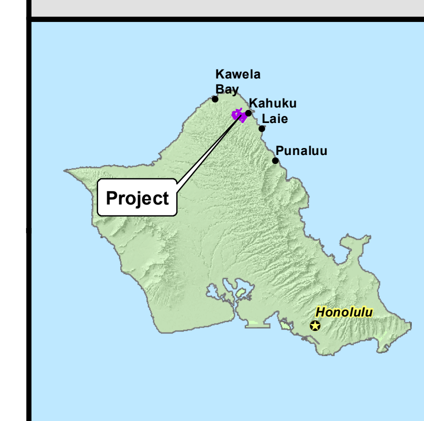
- Wind Farm Site Boundary
- Acoustic Study Area
- Collector Substation and Point of Interconnect
- Local Road
- Kahuku Elementary School
- Kahuku High School
- Kahuku Medical Center
- Potential Turbine Location

HAR Zone

- Class A (45 dBA Limit)
- Class A (55 dBA Limit) - Day Use Only
- Class B (50 dBA Limit)
- Class C (70 dBA Limit) - Has Residence
- Class C (70 dBA Limit) - No Residence or Project TMK

Sound Contour Range (dBA)

- 40
- 45
- 50
- 55
- 60



1:32,000 WGS84 UTM 4

0 0.5 1 2 3 4 5 Miles

Data Sources Champlin: project facilities / ESRI: roads / Hawaii Statewide GIS Program: TMK parcels / Tetra Tech: sound contours generated in CadnaA

TETRA TECH

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5.0 CONCLUSIONS

To conclude, Alternative 2 and Alternative 2a results in lower overall sound levels than Alternative 3 due to the smaller number of WTGs being constructed and operated. All Project Alternatives would be able to be constructed in compliance with HAR 11-46, but only if the construction contractor obtains a noise permit from DOH. Operationally neither Alternative is predicted to exceed the HAR 11-46 sound level limits, but all of the alternatives are predicted to increase sound levels in the acoustic analysis area by greater than 2 dBA at some Zone A or B TMKs, therefore operationally all of the Alternatives are similar although Alternative 3 results in slightly higher noise levels than Alternatives 2 and 2a. LFN/IS are not predicted to be a concern for the Project and are predicted to be below the threshold of human hearing. Additionally, there have been no known scientifically peer reviewed studies to date concluding a relationship between LFN and IS to health effects. Even so, the LFN/IS sound levels predicted with the Project are considered low level as they are below the threshold of human hearing and are not thought to pose a health risk to humans. Furthermore, monitored ambient LFN/IS levels would mask some of the Project LFN/IS further reducing the potential for public complaint. Nevertheless, to respond to potential future public concerns Champlin will implement a noise complaint resolution process. This process might include a post construction sound survey to ascertain the net increase, if any, in sound levels in the acoustic analysis area. Regardless, because there are no predicted operational noise impacts, mitigation of operational noise is not necessary.

6.0 REFERENCES

ANSI (American National Standards Institute).

2005 Quantities and Procedures for Description and Measurement of Environmental Sound – Part 4: Noise Assessment and Prediction of Long-Term Community Response.

Beranek, L.

1988 Noise and Vibration Control, Chapter 7 - Sound Propagation Outdoors. Institute of Noise Control Engineering, Washington, DC.

Bies and Hansen.

2003 Engineering Noise Control: Theory and Practice", Pages 554-555, Published by Taylor & Francis, 2003.

Bolt, Beranek and Newman, Inc.

1977 Power Plant Construction Noise Guide, prepared for the Empire State Electric Energy Research Corporation, Report No. 3321, 1977.

DataKustik GmbH.

2013 Computer-Aided Noise Abatement Model CadnaA, Version 4.3.143 Munich, Germany.

DEFRA (United Kingdom Department for Environment, Food, & Rural Affairs).

2005 Procedure for the Assessment of Low Frequency Noise Complaints. (Prepared by University of Salford, Contract no. NANR45)

Elliott, T. et al.

1998 Standard Handbook of Powerplant Engineering. McGraw-Hill: 1998, New York.

EPA (U.S. Environmental Protection Agency)

1971 Community Noise. NTID300.3 (N-96-01 IIA-231). Prepared by Wylie Laboratories.

1972 Noise Control Act of 1972 (42USC7641).

1978 Quiet Communities Act of 1978

FHWA (Federal Highway Administration).

2006 FHWA Roadway Construction Noise Model User's Guide, FHWA-HEP-05-054, January 2006.

2010 "Procedures for Abatement of Highway Traffic Noise and Construction Noise". Code of Federal Regulations, Title 23, Part 772, July 13, 2010.

General Electric

2013 Technical Documentation Wind Turbine Generator Systems 2.x-103 – 50 Hz and 60 Hz Product Acoustic Specifications

HDOH (Hawaii Department of Health).

1996 Chapter 46, Community Noise Control, Department of Health, State of Hawaii, Administrative Rules, Title 11, September 23, 1996.Hobdy, R.

IEC (International Electrotechnical Commission)

2005 International Standard IEC 61400-1, Wind Turbines Part 1: Design Requirements. IEC 61400-1:2005(E)

ISO (International Organization for Standardization).

1989 Standard ISO 9613-2 Acoustics – Attenuation of Sound during Propagation Outdoors. Part 2 General Method of Calculation. Geneva, Switzerland.

National Electrical Manufacturers Association

2000 NEMA Standards Publication No. TR 1-1993 (R2000) Transformers, Regulators and Reactors.

Siemens

2013 SWT-3.0-108 rev 1, Hub Height 79.5m Standard Acoustic Emission

2015 SWT-3.3-130 rev 0, Hub Heights 85, 115, 135 Standard Acoustic Emission

APPENDIX A Calibration Sheets

Certificate of Calibration and Conformance

This document certifies that the instrument referenced below meets published specifications per Procedure PRD-P263; ANSI S1.4-1983 (R 2006) Type 1; S1.4A-1985; S1.43-1997 Type 1; S1.11-2004 Octave Band Class 0; S1.25-1991; IEC 61672-2002 Class 1; 60651-2001 Type 1; 60804-2000 Type 1; 61260-2001 Class 0; 61252-2002.

Manufacturer:	Larson Davis	Temperature:	72.6	°F
Model Number:	831		22.56	°C
Serial Number:	3140	Rel. Humidity:	10.9	%
Customer:	TMS Rental	Pressure:	1004.1	mbars
Description:	Sound Level Meter		1004.1	hPa

Note: As Found / As Left: In Tolerance

Upon receipt for testing, this instrument was found to be:

Within the Stated tolerance of the manufacturer's specification

Calibration Date: 29-Jan-14 Calibration Due:

Calibration Standards Used:

Manufacturer	Model	Serial Number	Cal Due	Traceability No.
Larson Davis	LDSigGen/2239	0760/0109	4/12/2014	2012-161465

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at The Modal Shop and/or Larson Davis Corporate Headquarters. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

This calibration complies with ISO 17025 and ANSI Z540. The collective uncertainty of the Measurement Standard used does not exceed 25% of the applicable tolerance for each characteristic calibrated unless otherwise noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. Calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of The Modal Shop.

Technician: Wayne Underwood Signature:

THE MODAL SHOP INC. A PCB GROUP CO.

The Modal Shop, Inc.
3149 East Kemper Road
Cincinnati, OH 45241
Phone: (513) 351-9919
(800) 860-4867
www.modalshop.com

PRD-F242 revNR December 2, 2008 Page 1 of 1

PCB PIEZOTRONICS
A PCB GROUP COMPANY

Certificate of Calibration and Conformance

Certificate Number 2013-175223

Instrument Model 831, Serial Number 0001350, was calibrated on 10JUN2013. The instrument meets factory specifications per Procedure D0001.8310, ANSI S1.4-1983 (R 2006) Type 1; S1.4A-1985 ; S1.43-1997 Type 1; S1.11-2004 Octave Band Class 1; S1.25-1991; IEC 61672-2002 Class 1; 60651-2001 Type 1; 60804-2000 Type 1; 61260-2001 Class 1; 61252-2002.

Instrument found to be in calibration as received: YES
Date Calibrated: 10JUN2013
Calibration due: 10JUN2015

Calibration Standards Used

MANUFACTURER	MODEL	SERIAL NUMBER	INTERVAL	CAL. DUE	TRACEABILITY NO.
Stanford Research Systems	DS360	61746	12 Months	06JUL2013	61746-070612

Reference Standards are traceable to the National Institute of Standards and Technology (NIST)

Calibration Environmental Conditions

Temperature: 24 ° Centigrade Relative Humidity: 32 %

Affirmations

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the U.S. National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at Provo Engineering & Manufacturing Center. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

The collective uncertainty of the Measurement Standard used does not exceed 25% of the applicable tolerance for each characteristic calibrated unless otherwise noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. A one year calibration is recommended, however calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of the issuer.

"AS RECEIVED" data same as shipped data.
Tested with PRM831-010875

Signed: Ron Harris
Technician: Ron Harris

Page 1 of 1

Provo Engineering and Manufacturing Center, 1681 West 820 North, Provo, Utah 84601
Toll Free: 888.258.3222 Telephone: 716.926.8243 Fax: 716.926.8215
ISO 9001-2008 Certified

Scantek, Inc.
CALIBRATION LABORATORY
ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP®
NVLAP Lab Code: 200625-0

Calibration Certificate No.30716

Instrument: **Sound Level Meter**
Model: **140**
Manufacturer: **Norsonic**
Serial number: **1402796**
Tested with: **Microphone 1225 s/n 112883**
Preamplifier 1209 s/n 13442
Type (class): **1**
Customer: **Scantek, Inc.**
Tel/Fax: **410-290-7726 / 410-290-9167**

Date Calibrated: **3/3/2014** *Cal Due:* **3/4/2015**

Status:	**Received**	**Sent**
In tolerance:	X	X
Out of tolerance:		
See comments:		

Contains non-accredited tests: __Yes _X_ No
Calibration service: __ Basic _X_ Standard
Address: **6430 Dobbin Road, Suite C, Columbia, MD 21045**

Tested in accordance with the following procedures and standards:
Calibration of Sound Level Meters, Scantek Inc., Rev. 6/22/2012
SLM & Dosimeters – Acoustical Tests, Scantek Inc., Rev. 7/6/2011

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	31052	Oct 7, 2013	Scantek, Inc./ NVLAP	Oct 7, 2014
DS-360-SRS	Function Generator	33584	Sep 30, 2013	ACR Env./ A2LA	Sep 30, 2015
34401A-Agilent Technologies	Digital Voltmeter	US36120731	Sep 30, 2013	ACR Env. / A2LA	Sep 30, 2014
HM30-Thommen	Meteo Station	1040170/39633	Sep 30,2013	ACR Env./ A2LA	Sep 30, 2014
PC Program 1019 Norsonic	Calibration software	v.5.2	Validated Mar 2011	Scantek, Inc.	-
1251-Norsonic	Calibrator	30878	Nov 8, 2013	Scantek, Inc./ NVLAP	Nov 8, 2014

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK).

Environmental conditions:

Temperature (°C)	Barometric pressure (kPa)	Relative Humidity (%)
24.4 °C	101.260 kPa	34.1 %RH

Calibrated by:	Lydon Dawkins	**Authorized signatory:**	Mariana Buzduga
Signature	*Lydon Dawkins*	Signature	*[signature]*
Date	3/3/2014	Date	3/5/2014

Calibration Certificates or Test Reports shall not be reproduced, except in full, without written approval of the laboratory.
This Calibration Certificate or Test Reports shall not be used to claim product certification, approval or endorsement by NVLAP, NIST, or any agency of the federal government.
Document stored Z:\Calibration Lab\SLM 2014\Nor140_1402796_M1.doc

Page 1 of 2

Results summary: Device complies with following clauses of mentioned specifications:

CLAUSES [1] FROM IEC/ANSI STANDARDS REFERENCED IN PROCEDURES:	RESULT[2,3]	EXPANDED UNCERTAINTY (coverage factor 2) [dB]
CALIBRATION OF SOUND LEVEL METER - ANSI S1.4 CLAUSE 3.2	Passed	0.2
LEVEL LINEARITY TEST - ANSI S1.4-1983, CLAUSE 6.9 & 6.10	Passed	0.25
WEIGHTING NETWORK TEST: A NETWORK - ANSI S1.4-1983 CLAUSE 8.2.1	Passed	0.25
WEIGHTING NETWORK TEST: C NETWORK - ANSI S1.4-1983 CLAUSE 8.2.1	Passed	0.25
WEIGHTING NETWORK TEST: LINEAR NETWORK - ANSI S1.4-1983 CLAUSE 8.2.1	Passed	0.25
OVERLOAD DETECTOR TEST: A-NETWORK - ANSI S1.4-1983 CLAUSE 8.3.1	Passed	0.25
F/S/I/PEAK TEST: STEADY STATE RESPONSE - ANSI S1.4 1983 CLAUSE 6.4	Passed	0.25
FAST-SLOW TEST: OVERSHOOT TEST - ANSI S1.4 1983 CLAUSE 8.4.1	Passed	0.25
FAST-SLOW TEST: SINGLE SINE WAVE BURST - ANSI S1.4 1983 CLAUSE 8.4.1 & 8.4.3	Passed	0.25
IMPULSE TEST: CONTINUOUS SINE WAVE BURST - ANSI S1.4 1983 CLAUSE 8.4.3	Passed	0.25
IMPULSE TEST: SINGLE SINE WAVE BURST - ANSI S1.4 1983 CLAUSE 8.4.1 & 8.4.3	Passed	0.25
PEAK DETECTOR TEST, SINGLE SQUARE WAVE BURST - ANSI S1.4 1983 CLAUSE 8.4.4	Passed	0.25
RMS DETECTOR TEST: CREST FACTOR TEST - ANSI S1.4-1983 CLAUSE 8.4.2	Passed	0.25
RMS DETECTOR TEST: CONTINUOUS SINE WAVE BURST - ANSI S1.4-1983 CLAUSE 8.4.2	Passed	0.25
TIME AVERAGING TEST: AVERAGING FUNCTIONS - ANSI S1.43 CLAUSE 9.3.2	Passed	0.25
LINEARITY TEST - ANSI S1.43 CLAUSE 9.3.3	Passed	0.15
FILTER TEST 1/1OCTAVE: RELATIVE ATTENUATION - IEC 61260, CLAUSE 4.4 & #5.3	Passed	0.25
FILTER TEST 1/3OCTAVE: RELATIVE ATTENUATION - IEC 61260, CLAUSE 4.4 & #5.3	Passed	0.25
SUMMATION OF ACOUSTIC TESTS - ANSI S1.4 CLAUSE 5 USING ACTUATOR	Passed	0.2-0.5

1 The results of this calibration apply only to the instrument type with serial number identified in this report.

2 Parameters are certified at actual environmental conditions.

3 The tests marked with (*) are not covered by the current NVLAP accreditation.

Comments: The instrument was tested and met all specifications found in the referenced procedures.

Note: The instrument was tested for the parameters listed in the table above, using the test methods described in the listed standards. All tests were performed around the reference conditions. The test results were compared with the manufacturer's or with the standard's specifications, whichever are larger.
Compliance with any standard cannot be claimed based solely on the periodic tests.

Tests made with the following attachments to the instrument:

Microphone:	Norsonic 1225 s/n 112883 for acoustical test
Preamplifier:	Norsonic 1209 s/n 13442 for all tests
Other: line adaptor ADP005 (18pF) for electrical tests	
Accompanying acoustical calibrator:	none
Windscreen:	none

Measured Data: in Test Report # 30713 of 12 + 1 pages.

Place of Calibration: Scantek, Inc.
6430 Dobbin Road, Suite C
Columbia, MD 21045 USA

Ph/Fax: 410-290-7726/ -9167
callab@scantekinc.com

Document stored Z:\Calibration Lab\SLM 2014\Nor140_1402796_M1.doc

APPENDIX D
SHADOW FLICKER IMPACT ANALYSIS

Shadow Flicker Impact Analysis for the Na Pua Makani Wind Energy Project

Oahu, Hawaii

Prepared for

Na Pua Makani Power Partners, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

160 Federal Street – 3rd Floor

Boston, Massachusetts 02110

June 2014

Revised November 2014

Revised December 2015

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ATTACHMENT

Attachment A. Detailed Summary of WindPro Shadow Flicker Analysis Results

1.0 OVERVIEW

Na Pua Makani Power Partners, LLC (NPMPP), is proposing to develop the Na Pua Makani Wind Energy Project (Project) on Oahu, Hawaii (see Figure 1). The Project is undergoing environmental review under both the Hawaii Environmental Policy Act (HEPA) and the National Environmental Policy Act (NEPA). As part of this review, the Project is analyzing three alternatives: Alternative 1 – no action; Alternative 2 (the Proposed Action) – construction and operation of an up to approximately 25 MW Project consisting of up to 10 wind turbines; and Alternative 3 – construction and operation of a larger generation facility of up to 42 MW and consisting of up to 12 turbines. Tetra Tech has conducted a shadow flicker analysis for Project Alternatives 2 and 3 the results of which are provided in this report.

In response to public comments on the Draft EIS related to visual impacts and consideration of turbines with larger generating capacities (to reduce the total number of turbines), NPMPP reevaluated the proposed turbine locations and turbine models considered in the Draft EIS. Through this effort, NPMPP was able to reduce the maximum number of turbines needed to meet the target generating capacity for the Project. This modification takes advantage of recent technological advancements that have resulted in the availability of uprated versions of turbine models that are larger, more efficient, have increased generating capacity, and are better suited for the moderate to low wind conditions of the wind farm site than previous models. Accordingly, the updated shadow flicker impact analysis evaluates a Modified Proposed Action Option (Alternative 2A) along with the original project alternatives and turbine design, which incorporate updated turbine locations.

2.0 PROJECT COMPONENTS

NPMPP is currently considering turbine models from leading turbine manufacturers including Siemens, Vestas, GE and others. The turbine array could include a combination of models from a single manufacturer ranging in generating capacity and dimensions. For the purposes of impact analysis, Tetra Tech analyzed a turbine array that included the turbines with the tallest maximum blade tip height with the assumption that the tallest turbine would cast the furthest shadow and therefore potentially have the greatest effect. NPMPP will select the most appropriate turbines for the site-specific conditions of the wind farm prior to construction.

Three representative wind turbine models were selected to evaluate potential shadow flicker impacts. These models which represent the general range in dimensions of turbines that could be installed on site, have the following characteristics:

- **Vestas V110-2.0** - 3-blade 110-meter diameter rotor, with a hub height of 80 meters. Assumption that the 2.0-110 WT has a normal high rotor speed of approximately 14.9 rotations per minute (rpm) which translates to a blade pass frequency of 0.75 Hertz (Hz) which is less than 1 alternation per second.

- **Siemens SWT-3.0-113** - 3-blade 113-meter diameter rotor, with a hub height of 99.5 meters. Assumption that the 3.0-113 WT has a normal high rotor speed of approximately 14.7 rpm which translates to a blade pass frequency of 0.74 Hz (less than 1 alternation per second).
- **Siemens SWT-3.0-130** - 3-blade 130-meter diameter rotor, utilizing hub heights of 85, 115, and 135 meters, depending turbine location. The SWT 3.0-113 wind turbine has a normal high rotor speed of approximately 12.2 rpm which translates to a blade pass frequency of 0.61 Hz (less than 1 alternation per second).

Smaller turbine models (Vestas V110-2.0) may be considered for turbine locations 1 and 2 , and larger turbines (Siemens SWT-3.0-113) may be considered for locations 3 to 10 (or up to turbine location 12 for Alternative 3). The combination of turbine models and specific number of turbines under each alternative will be selected to ensure consistency with HECO grid requirements, onsite wind resources, and other Project-specific factors. The Alternative 2 design is based on construction of ten (10) turbines (numbers 1-5, and 8-12), and Alternative 3 design is based on the construction of all twelve (12) turbines (numbers 1-12). If Alternative 3 were selected, the project would be built in two phases, with the first phase build out of up to 10 turbines (up to approximately 25 MW), and the second phase builds out of the remaining turbines, for total of 12 turbines (up to approximately 42 MW).

The Modified Proposed Action Option (Alternative 2A) is based on the Siemens SWT 3.3-130 turbine model for all locations with a rotor diameter of 130 meters and hub heights of varying elevation (85 m, 115 m, and 135 m) depending on turbine location. A total of 9 turbines were assumed for the Modified Proposed Action Option.

3.0 SHADOW FLICKER BACKGROUND

A wind turbine's moving blades can cast a moving shadow on locations within a certain distance of a turbine. These moving shadows are called shadow flicker, and can be a temporary phenomenon experienced at nearby residences or public gathering places. The impact area depends on the time of year and day (which determine the sun's azimuth and altitude angles) and the wind turbine's physical characteristics (height, rotor diameter, blade width, and orientation of the rotor blades). Shadow flicker impact to surrounding properties generally occurs during low angle sunlight conditions, typically during sunrise and sunset times of the day. However, when the sun angle gets very low (less than 3 degrees), sunlight passes through more atmosphere and becomes too diffused to form a coherent shadow. Shadow flicker will not occur when the sun is obscured by clouds or fog, at night, or when the source turbine(s) are not operating. In addition, shadow flicker is only an issue when at least 20% of the sun's disc is covered by the turbine blades.

Shadow flicker intensity is defined as the difference in brightness at a given location in the presence and absence of a shadow. Shadow flicker intensity diminishes with greater receptor-to-turbine separation distance. Shadow flicker intensity for receptor-to-turbine distances beyond 2,500 meters (8,202 feet) is very low and generally considered imperceptible. In general, increasing proximity to turbines may make shadow flicker more noticeable, with the largest number of shadow flicker hours, along with greatest shadow flicker intensity, occurring nearest the wind turbines.

Shadow flicker frequency is related to the wind turbine’s rotor blade speed and the number of blades on the rotor. From a health standpoint, the low flicker frequencies associated with wind turbines, are harmless, and public concerns that flickering light from wind turbines can have negative health effects, such as triggering seizures in people with epilepsy are unfounded. Epilepsy Action (working name for the British Epilepsy Foundation) states that there is no evidence that wind turbines can cause seizures (Epilepsy Action 2008). However, they recommend that wind turbine flicker frequency be limited to 3 Hz. (For comparison, strobe lights used in discotheques have frequencies which range from about 3 Hz to 10 Hz (1 Hz = 1 flash per second). Since the proposed Project’s wind turbine blade pass frequency is approximately 0.74-0.8 Hz (less than 1 alternation per second), no negative health effects to individuals with photosensitive epilepsy are anticipated.

Shadow flicker impacts are not regulated in applicable state or federal law, and there is no permitting threshold with regard to hours per year of anticipated impacts to a receptor from a wind energy project. A threshold of 30 hours per year has been widely used in the industry as a target value in the absence of formal guidelines. This threshold originally came from German court case, where a judge found 30 hours of actual shadow flicker per year at a certain neighbor's property to be tolerable (WindPower 2003). The 30 hours per year threshold value has been widely used in the industry as a target value in the absence of formal guidelines. However, predicted shadow flicker greater than this threshold does not necessarily create a nuisance and is still well below concerns for impacts to health such as triggering epileptic seizers.

4.0 WINDPRO SHADOW FLICKER ANALYSIS

An analysis of potential shadow flicker impacts from the Project was conducted using the WindPro software package. The turbine array provided by NPMPP (layout dated December 4, 2015 for both the original Alternatives 2 and 3 and the Modified Proposed Action Option (Alternative 2A)), which includes up to twelve (12) turbine locations, was included in the analysis. The analysis evaluated the following three turbine scenarios:

- Alternative 2: Two (2) Vestas V110-2.0 plus eight (8) Siemens SWT-3.0-113 wind turbines
- Alternative 3: Two (2) Vestas V110-2.0 plus ten (10) Siemens SWT-3.0-113 wind turbines
- Alternative 2A: Nine (9) Siemens SWT-3.3-130 wind turbines

The WindPro analysis was conducted to determine shadow flicker impacts under realistic impact conditions (actual expected shadow). This analysis calculated the total amount of time (hours and minutes per year) that shadow flicker are expected to occur at receptors surrounding the project. The realistic impact condition scenario is based on the following assumptions:

- The elevation and position geometries of the wind turbines and surrounding receptors (potentially occupied residences). Elevations were determined using United States Geological Survey (USGS) digital elevation model (DEM) data. Positions geometries were determined using geographic information system (GIS) and referenced to Universal Transverse Mercator (UTM) Zone 4 (NAD83).

- The position of the sun and the incident sunlight relative to the wind turbine and receptors on a minute-by-minute basis over the course of a year.

- Historical sunshine availability (percent of total hours available). Historical sunshine rates for the area (as summarized by the National Climatic Data Center (NCDC 2008) for nearby Honolulu, Hawaii) used in this analysis are as follows:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
65%	68%	72%	70%	72%	74%	76%	77%	77%	70%	65%	63%

- Estimated wind turbine operations and orientation (based on approximately 4 years of wind data (4/7/09 – 6/27/13), including the wind speed and wind direction frequency distribution, measured at on-site meteorological towers).

- Receptor viewpoints (i.e., house windows) are conservatively assumed to always be directly facing turbine to sun line of sight (“greenhouse mode”).

WindPro incorporates terrain elevation contour information and the analysis accounts for terrain elevation differences. The sun’s path with respect to each turbine location is calculated by the software to determine the cast shadow paths every minute over a full year. Sun angles less than 3 degrees above the horizon were excluded, for the reasons identified earlier in this section. Since shadow flicker is only an issue when at least 20% of the sun disc is covered by the blades, WindPro uses blade width dimension data to calculate the maximum distance from the turbine where shadow flicker must be calculated. Beyond this distance, the turbine will not contribute to the shadow flicker impact.

It should be noted however, that WindPro provides a conservative estimate of shadow flicker as obstacles such as trees, haze, and visual obstructions (window facing, coverings) are not fully accounted for despite the likelihood of their reducing or eliminating shadow flicker impacts to receptors. A total of 737 receptor locations were identified within 2.5 kilometers of proposed Project turbines. A receptor in the model is defined as a 1 meter squared area (approximate size of a typical window), 1 meter (3.28 feet) aboveground level. Approximate eye level is set at 1.5 meters (4.94 feet). Figure 2 shows the receptor locations and proposed Project turbines location proposed for Alternatives 2, 3, and 2A.

5.0 SHADOW FLICKER ANALYSIS RESULTS

As expected, WindPro predicts that shadow flicker impacts will be greatest at locations nearer to the wind turbines. Figures 3, 4 and 5 describe the WindPro predicted shadow flicker impact areas for turbine Alternatives 2, 3, and 2A, respectively. Note that Alternative 1 in the associated Environmental Impact Statement is the No Action alternative, under which the Project would not be constructed. Therefore, it is not discussed further here.

Tables 1, 2, and 3 present the WindPro predicted shadow flicker impacts for the receptors with predicted annual shadow flicker impact greater than 30 hours per year, for each of the turbine alternatives modelled. Under Alternative 2 (the Proposed Action), 17 of the 737 receptors had expected shadow flicker impacts of more than 30 hours per year. The predicted shadow flicker impact at any receptor ranged from 0 to 244 hours and 9 minutes (Receptor 647) which is approximately 5.5 percent of the potential available daylight hours. Under Alternative 3 (larger generation wind project), 19 of the 737 receptors had expected shadow flicker impacts of more than 30 hours per year. The predicted shadow flicker impact at any receptor ranged from 0 hours to 393 hours 10 minutes per year (Receptor 647), which is approximately 8.9 percent of the potential available daylight hours. Under Alternative 2A (the Modified Proposed Action Option), 25 of the 737 receptors had expected shadow flicker impacts of more than 30 hours per year. The predicted shadow flicker impact at any receptor ranged from 0 to 258 hours and 19 minutes (Receptor 647), which is approximately 5.8 percent of the potential available daylight hours. A detailed WindPro shadow flicker analysis summary, for the full build-out scenario (Alternative 3) for each of the modeled receptor location, is provided in Attachment A.

Table 1. WindPro Predicted Shadow Flicker Impacts for Receptors with Maximum Expected Impacts – Turbine Alternative 2

Receptor ID	Shadow Hours per Year (expected) [hh:mm / year]	Receptor Status
647	244:09:00	Malaekahana (participating property); farm structure
609	123:24:00	Malaekahana (participating property); farm structure
595	122:38:00	Kahuku Agriculture Park; residence
607	121:50:00	Malaekahana (participating property); farm structure
608	107:01:00	Malaekahana (participating property); farm structure
610	90:55:00	Malaekahana (participating property); farm structure
600	85:43:00	Kahuku Agriculture Park; residence
599	69:28:00	Kahuku Agriculture Park; residence
602	61:38:00	Kahuku Agriculture Park; residence
594	57:43:00	Kahuku Agriculture Park; residence
743	55:58:00	Malaekahana (participating property); farm structure
593	52:00:00	Kahuku Agriculture Park; residence
601	51:56:00	Kahuku Agriculture Park; residence
648	49:05:00	Malaekahana (participating property); farm structure
450	46:26:00	Malaekahana (participating property); farm structure
645	43:48:00	Malaekahana (participating property); farm structure
452	32:58:00	Malaekahana (participating property); farm structure

Table 2. WindPro Predicted Shadow Flicker Impacts for Receptors with Maximum Expected Impacts – Turbine Alternative 3

Receptor ID	Shadow Hours per Year (expected) [hh:mm / year]	Receptor Status
647	393:10:00	Malaekahana (participating property); farm structure
648	286:46:00	Malaekahana (participating property); farm structure
607	160:05:00	Malaekahana (participating property); farm structure
608	135:29:00	Malaekahana (participating property); farm structure
609	130:46:00	Malaekahana (participating property); farm structure
595	127:13:00	Non Project Participant
645	108:39:00	Malaekahana (participating property); farm structure
610	104:16:00	Malaekahana (participating property); farm structure
600	95:38:00	Non Project Participant
599	77:03:00	Non Project Participant
602	68:30:00	Non Project Participant
646	64:56:00	Malaekahana (participating property); farm structure
594	60:34:00	Malaekahana (participating property); farm structure
742	55:58:00	Malaekahana (participating property); farm structure
450	55:19:00	Malaekahana (participating property); farm structure
593	52:00:00	Non Project Participant
601	51:57:00	Non Project Participant
452	32:59:00	Malaekahana (participating property); farm structure
431	31:35:00	Malaekahana (participating property); farm structure

Table 3. WindPro Predicted Shadow Flicker Impacts for Receptors with Maximum Expected Impacts – Turbine Alternative 2a

Receptor ID	Shadow Hours per Year (expected) [hh:mm / year]	Receptor Status
647	258:19:00	Malaekahana (participating property); farm structure
595	174:46:00	Non Project Participant
607	147:47:00	Malaekahana (participating property); farm structure
609	146:26:00	Malaekahana (participating property); farm structure
608	105:37:00	Malaekahana (participating property); farm structure
610	104:51:00	Malaekahana (participating property); farm structure
600	101:30:00	Non Project Participant
599	95:00:00	Non Project Participant
594	85:08:00	Non Project Participant
593	84:35:00	Non Project Participant
602	82:04:00	Non Project Participant
601	79:24:00	Non Project Participant
648	78:06:00	Malaekahana (participating property); farm structure
743	65:53:00	Malaekahana (participating property); farm structure
450	63:49:00	Malaekahana (participating property); farm structure
452	59:12:00	Malaekahana (participating property); farm structure
606	49:14:00	Malaekahana (participating property); farm structure
645	39:58:00	Malaekahana (participating property); farm structure
592	35:29:00	Non Project Participant
431	34:41:00	Malaekahana (participating property); farm structure
530	30:55:00	Non Project Participant

Table 3. WindPro Predicted Shadow Flicker Impacts for Receptors with Maximum Expected Impacts – Turbine Alternative 2a (continued)

Receptor ID	Shadow Hours per Year (expected) [hh:mm / year]	Receptor Status
531	30:46:00	Non Project Participant
529	30:41:00	Non Project Participant
532	30:27:00	Non Project Participant
528	30:10:00	Non Project Participant

The shadow flicker impact prediction statistics are summarized in Tables 4 through 6, for each of the turbine alternatives modeled.

Table 4. Statistical Summary of WindPro Predicted Shadow Flicker Impacts at Modeled Receptor Locations – Turbine Alternative 2

Cumulative Shadow Flicker Time (expected)	Number of Receptors
Total	737
= 0 Hours	490
> 0 Hours < 10 Hours	162
≥ 10 Hours < 20 Hours	60
≥ 20 Hours < 30 Hours	8
≥ 30 Hours	17

Table 5. Statistical Summary of WindPro Predicted Shadow Flicker Impacts at Modeled Receptor Locations – Turbine Alternative 3

Cumulative Shadow Flicker Time (expected)	Number of Receptors
Total	737
= 0 Hours	489
> 0 Hours < 10 Hours	162
≥ 10 Hours < 20 Hours	60
≥ 20 Hours < 30 Hours	7
≥ 30 Hours	19

Table 6. Statistical Summary of WindPro Predicted Shadow Flicker Impacts at Modeled Receptor Locations – Turbine Alternative 2a

Cumulative Shadow Flicker Time (expected)	Number of Receptors
Total	737
= 0 Hours	537
> 0 Hours < 10 Hours	70
≥ 10 Hours < 20 Hours	75
≥ 20 Hours < 30 Hours	30
≥ 30 Hours	25

6.0 CONCLUSION

The analysis of potential shadow flicker impacts from the Project on nearby receptors shows that shadow flicker impacts for the large majority of receptors expected to be well within acceptable industry standard ranges for avoiding nuisance impacts. The analysis was deliberately conservative and actual shadow flicker is expected to occur for less than the modeled durations. The analysis assumes that the receptors all have a direct in-line view of the incoming shadow flicker sunlight and does not account for trees or other obstructions which may block sunlight. In reality, the windows of many houses will not face the sun directly for the key shadow flicker impact times.

Only 17 of the 737 receptors modeled had expected shadow flicker impacts of more than 30 hours per year under the Proposed Action. Of these 17 receptors, 10 are located within the Project boundary on the Malaekahana Hui West, LLC parcel which is leasing land to the Project developer. No federal, state, or local regulations regulate shadow flicker; however, the 30 hours per year threshold is an industry standard that has been widely adopted in the United States as a threshold to evaluate shadow flicker impacts. There would be no shadow flicker impacts (zero hours of shadow flicker time) at the Kahuku Elementary School, Kahuku High School, or Kahuku Medical Center.

Mitigation measures such as strategic vegetative screening and/or installation of curtains and blinds on the windows facing the turbine casting the shadows are effective and economically viable mitigation options that the Project could consider on an individual basis with landowners, if necessary.

7.0 REFERENCES

Epilepsy Action. 2008. British Epilepsy Association. https://www.epilepsy.org.uk/sites/epilepsy/files/info/references/B007.02%20Photosensitive%20epilepsy%20Mar%2012.pdf. Accessed 6/23/14

National Climatic Data Center (NCDC). 2008. Sunshine Average Percent of Possible. http://www.ncdc.noaa.gov/oa/climate/online/ccd/pctpos.txt. Accessed 3/1/10

WindPower. 2003. Danish Wind industry Association. Shadow Casting From Wind Turbines.http://guidedtour.windpower.org/en/tour/env/shadow/index.htm, Accessed 4/28/10

FIGURES

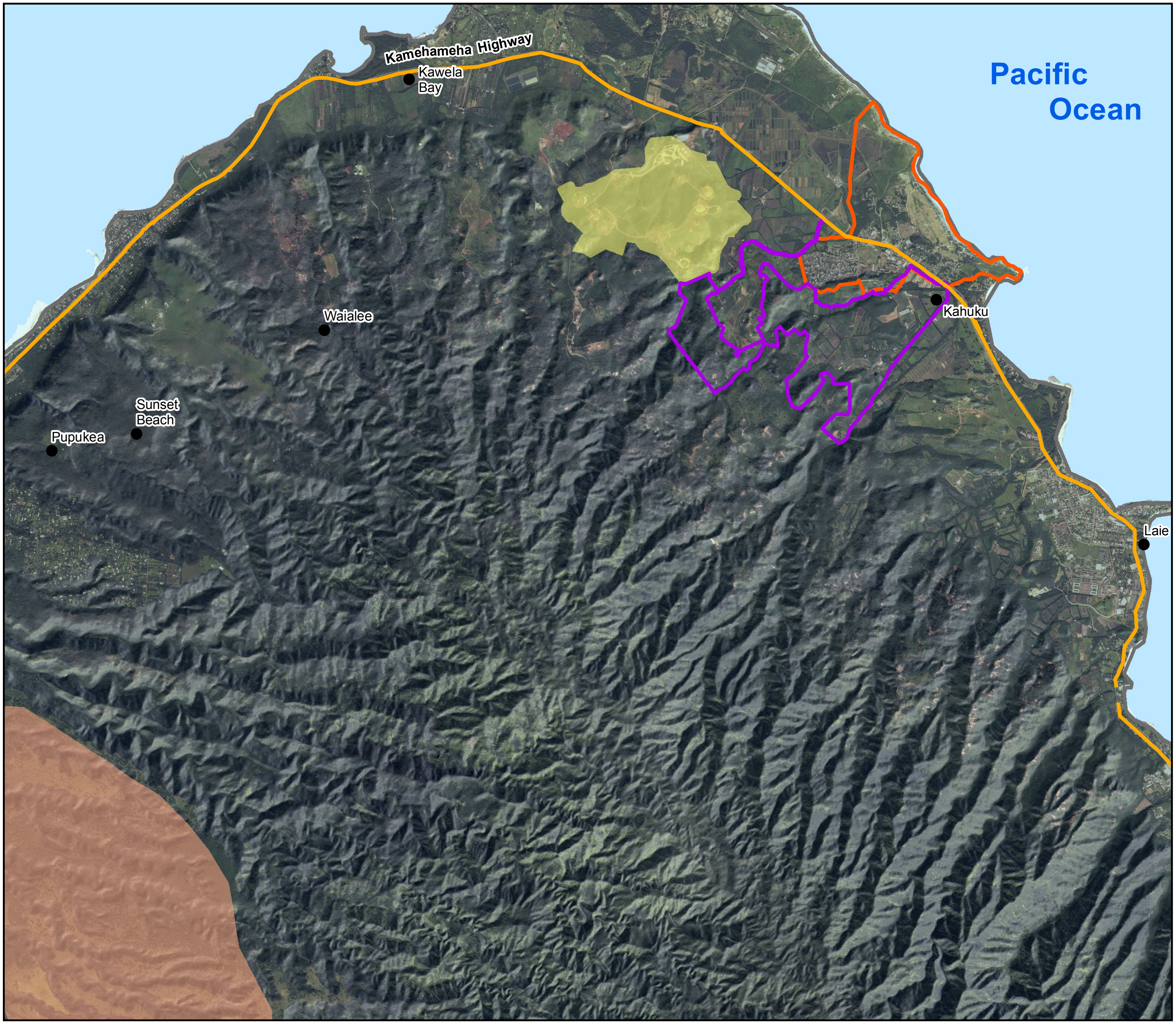
Figure 1

Na Pua Makani Wind Project

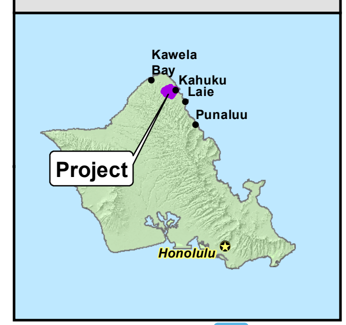
Vicinity Map

Oahu, HI

December 2015



Wind Farm Site
Kahuku Town
Kahuku Wind Farm (First Wind)
Kawailoa Wind Farm (First Wind)
State Highway
City/Town



1:65,000 WGS 1984 UTM 4

0 0.5 1 2 3 4 5 Miles

Data Sources Champlin: project facilities / ESRI: roads, cities / Hawaii Statewide GIS Program: city boundaries, vicinity wind projects, Kahuku training facility / USDA NAIP: aerial imagery

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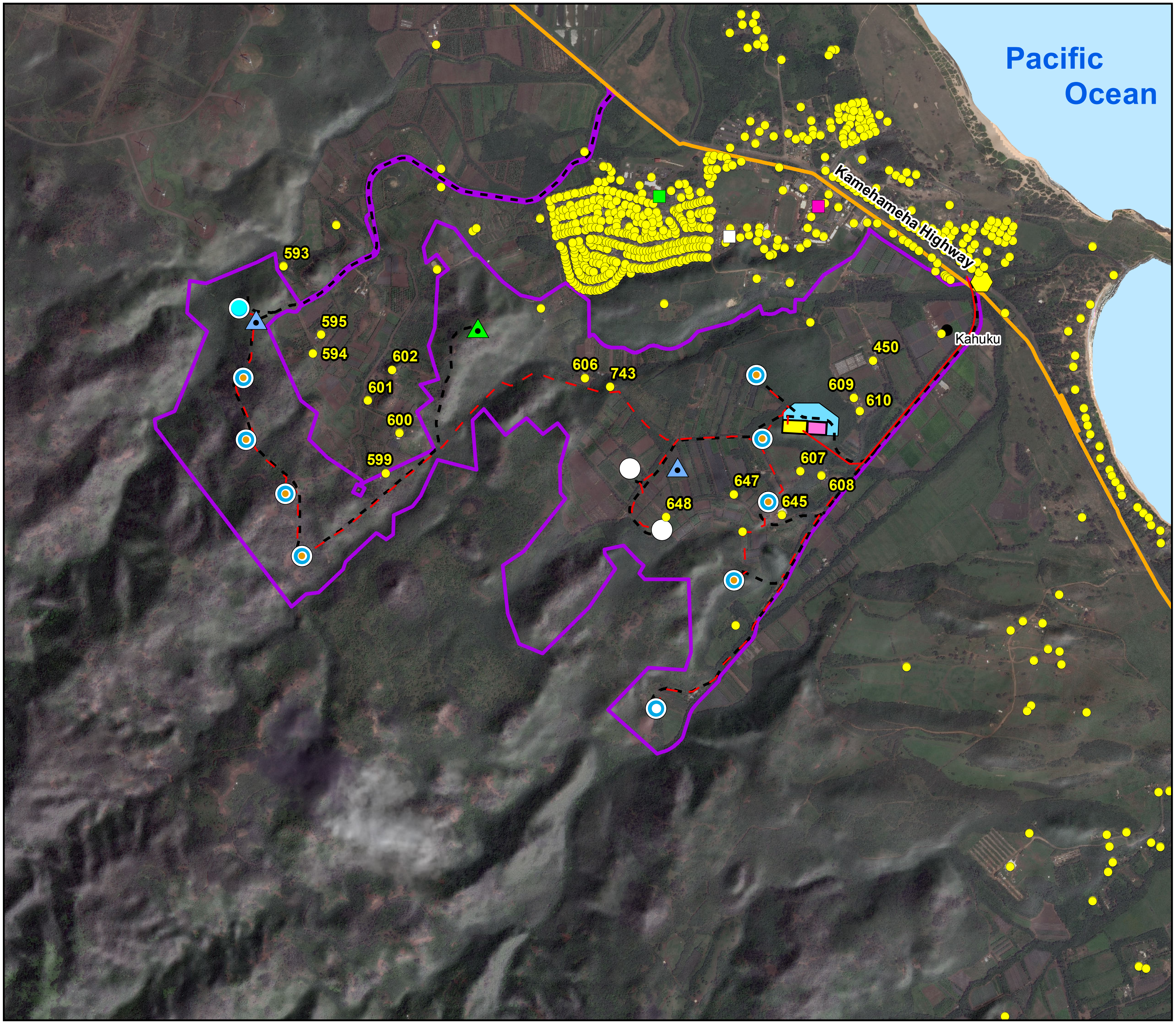
Figure 2

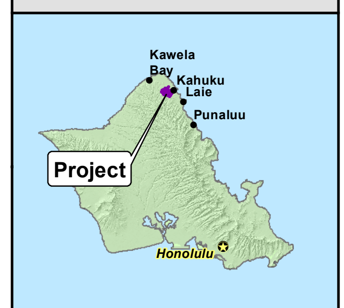
Na Pua Makani Wind Project

Wind Turbine and Receptor Locations

Oahu, HI
December 2015



- Wind Farm Site
- Sensitive Receptor
- Kahuku Elementary School
- Kahuku High School
- Kahuku Medical Center
- Permanent Met Tower
- Temporary Met Tower
- Alt 2a Potential Turbine Loc
- Alt 2 Potential Turbine Loc.
- Alt 3 Potential Turbine Loc.
- Line Tap Location
- Collector Substation and Point of Interconnect
- Laydown Area
- O&M Facility
- Transmission Line
- Collector Line
- Access Road
- City/Town
- State Highway



1:22,000 WGS 1984 UTM 4

0 0.25 0.5 1 Miles

Data Sources Champlin: project facilities / ESRI: roads / Tetra Tech: shadow flicker isopleths / DigitalGlobe: aerial imagery

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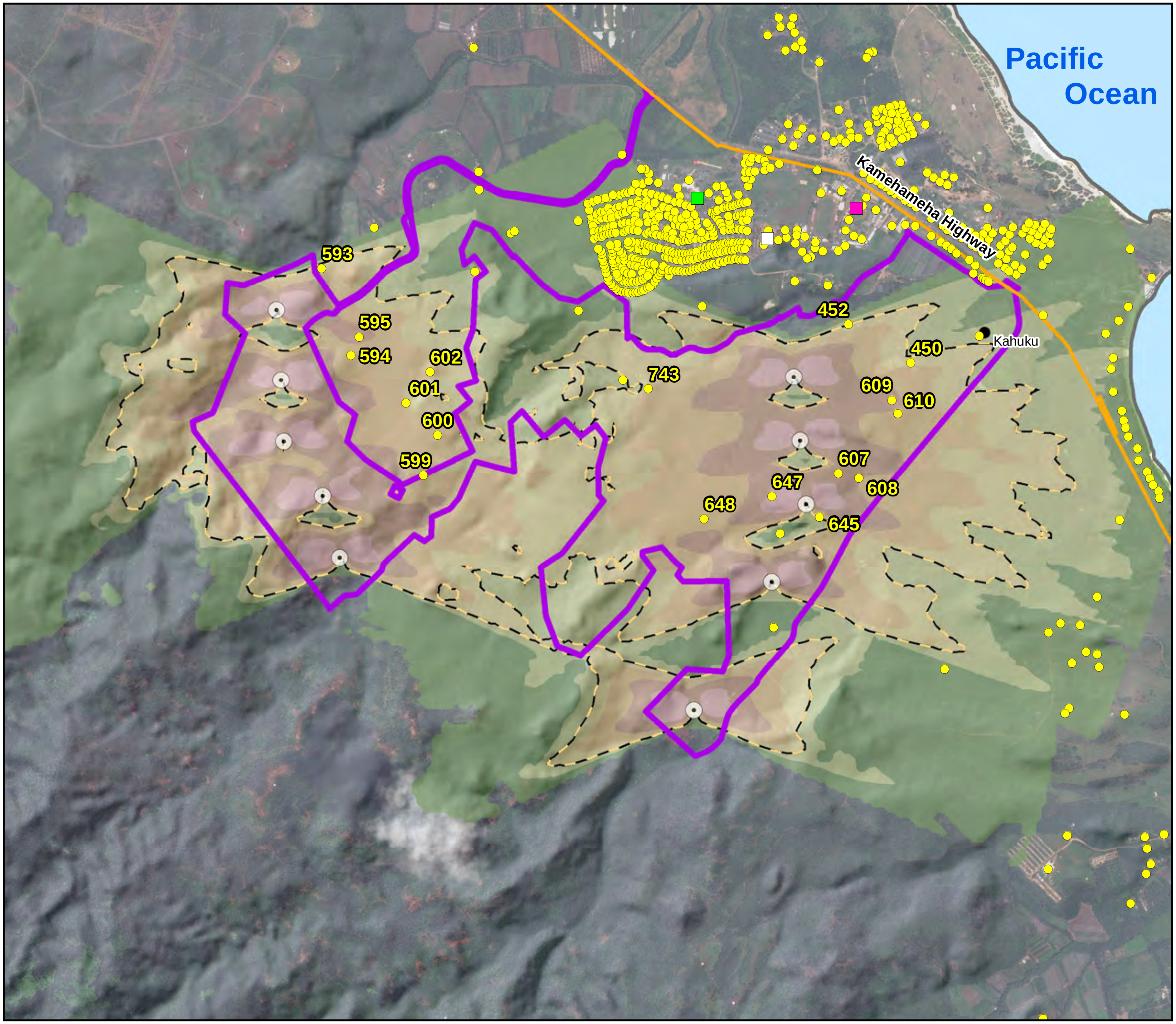


Figure 3

Na Pua Makani Wind Project

WindPro Expected Shadow Flicker Impact Areas Turbine Alternative 2

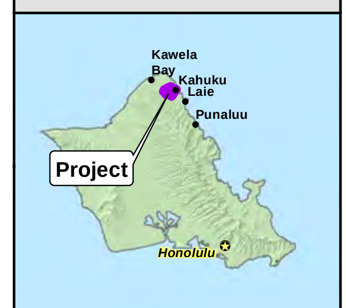
Oahu, HI
December 2015

- Sensitive Receptor *
- Kahuku Elementary School
- Kahuku High School
- Kahuku Medical Center
- Alt 2 Potential Turbine Loc.
- City/Town
- State Highway
- Wind Farm Site
- Shadow Flicker Boundary (30 hours per year)

Shadow Flicker (hours per year)

- 0 - 15
- 15 - 30
- 30 - 50
- 50 - 100
- 100 - 200
- > 200

* Only sensitive receptors with greater than 30 hours of shadow flicker per year labeled.



1:22,000 WGS 1984 UTM 4

0 0.25 0.5 1 Miles

Data Sources Champlin: project facilities / ESRI: roads / Tetra Tech: shadow flicker isopleths / DigitalGlobe: aerial imagery

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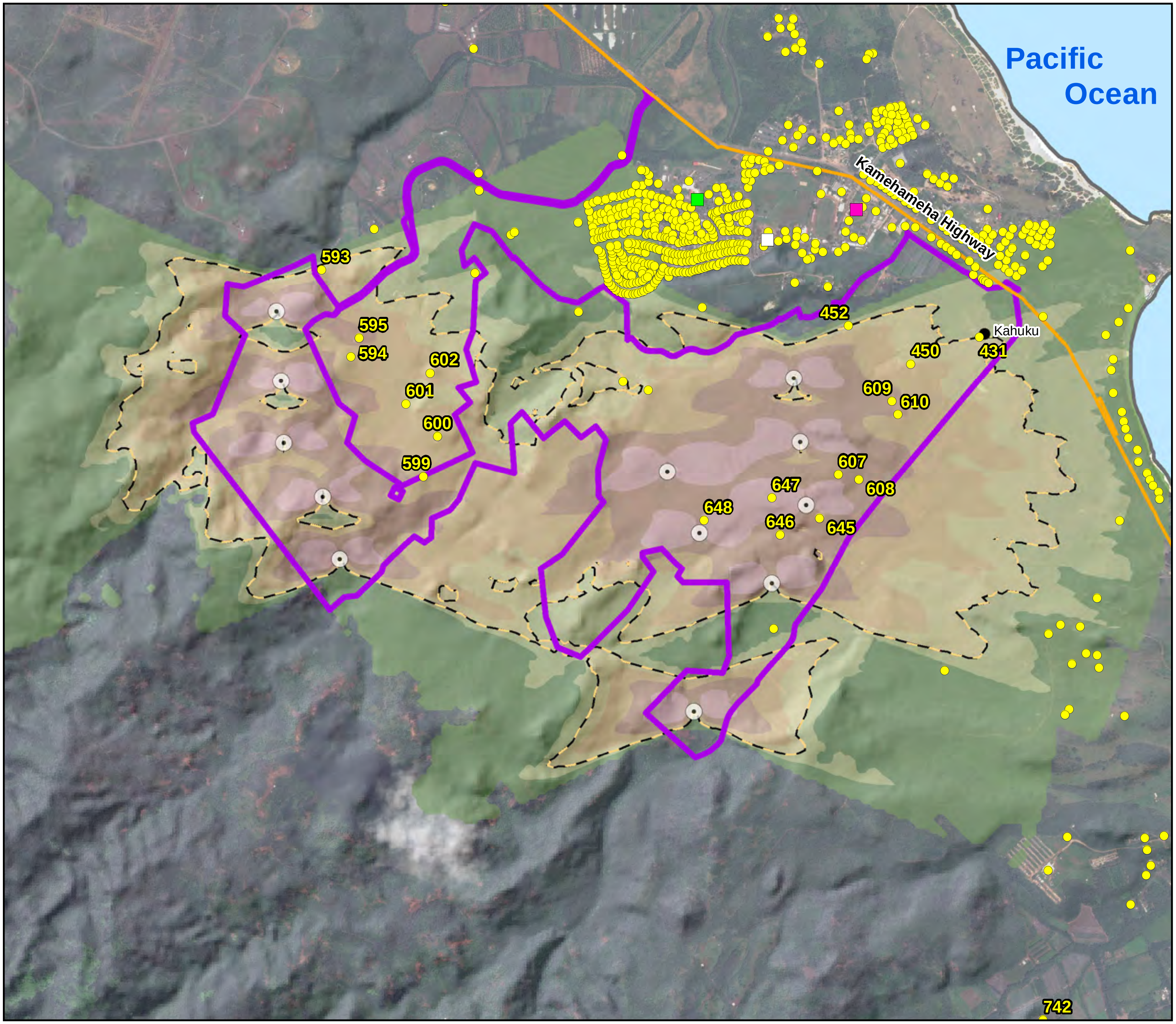
Figure 4

Na Pua Makani Wind Project

WindPro Expected Shadow Flicker Impact Areas Turbine Alternative 3

Oahu, HI
December 2015

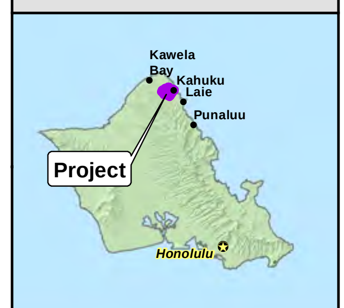


- Sensitive Receptor *
- Kahuku Elementary School
- Kahuku High School
- Kahuku Medical Center
- Alt 3 Potential Turbine Loc.
- City/Town
- State Highway
- Wind Farm Site
- Shadow Flicker Boundary (30 hours per year)

Shadow Flicker (hours per year)

- 0 - 15
- 15 - 30
- 30 - 50
- 50 - 100
- 100 - 200
- > 200

*** Only sensitive receptors with greater than 30 hours of shadow flicker per year labeled.**



N 1:22,000 WGS 1984 UTM 4

0 0.25 0.5 1 Miles

Data Sources Champlin: project facilities / ESRI: roads / Tetra Tech: shadow flicker isopleths / DigitalGlobe: aerial imagery

TETRA TECH

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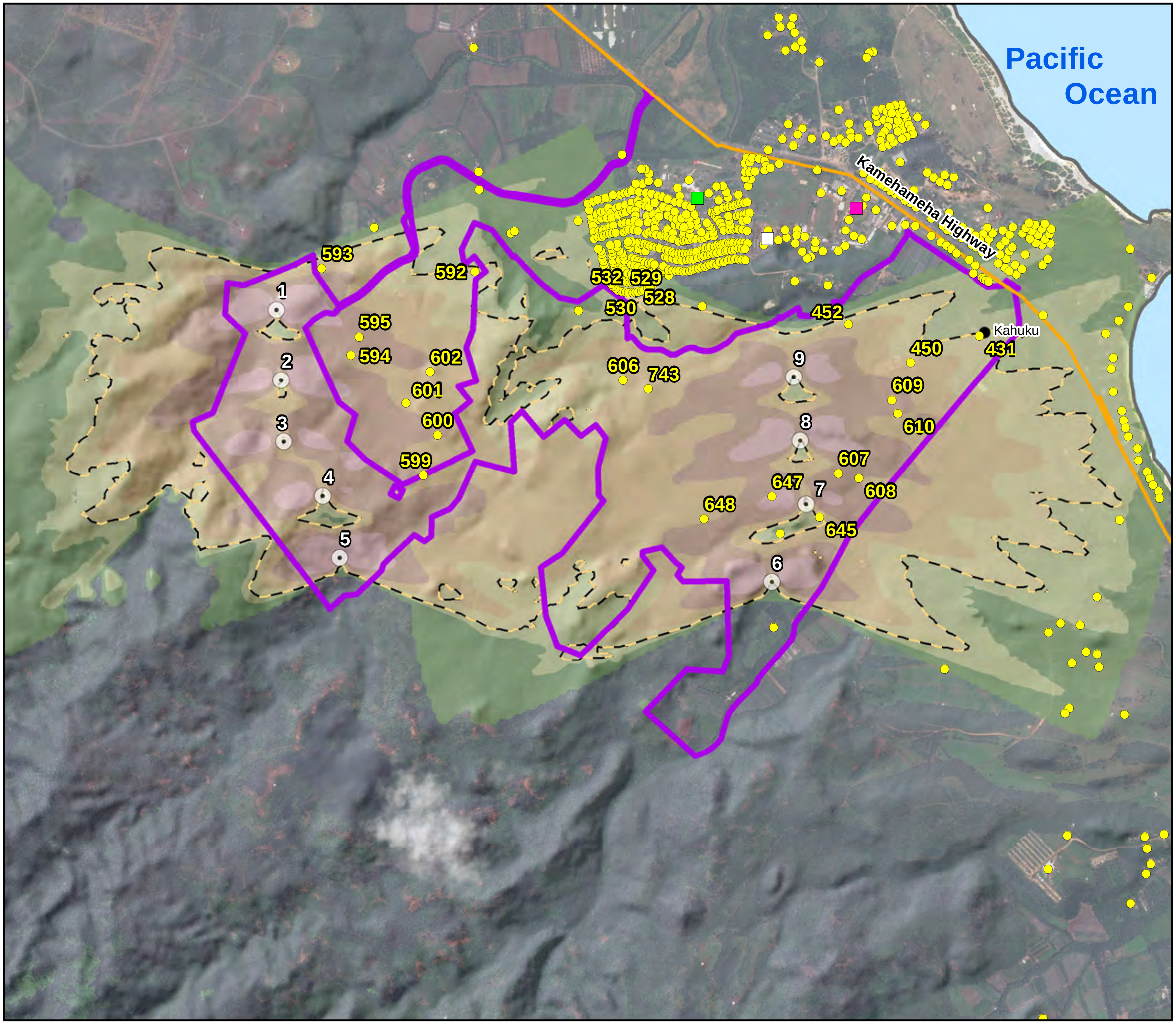


Figure 5

Na Pua Makani Wind Project

WindPro Expected Shadow Flicker Impact Areas Turbine Alternative 2a

Oahu, HI

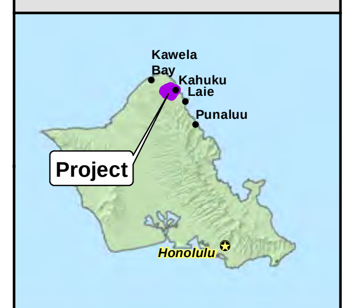
December 2015

- Sensitive Receptor *
- Kahuku Elementary School
- Kahuku High School
- Kahuku Medical Center
- Alt 2a Potential Turbine Loc.
- City/Town
- State Highway
- Wind Farm Site
- Shadow Flicker Boundary (30 hours per year)

Shadow Flicker (hours per year)

- 0 - 15
- 15 - 30
- 30 - 50
- 50 - 100
- 100 - 200
- > 200

* Only sensitive receptors with greater than 30 hours of shadow flicker per year labeled.



1:22,000 WGS 1984 UTM 4

0 0.25 0.5 1 Miles

Data Sources Champlin: project facilities / ESRI: roads / Tetra Tech: shadow flicker isopleths / DigitalGlobe: aerial imagery

TETRA TECH

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ATTACHMENT A.

Detailed Summary of WindPro Shadow Flicker Analysis Results

Na Pua Makani Energy Wind Project
WindPro Shadow Flicker Analysis Results Summary

Turbine Alternative 3

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (Hours per Year)
1	607,176	2,399,049	0:00:00
2	606,746	2,398,890	0:00:00
3	606,799	2,398,858	0:00:00
4	606,842	2,398,805	0:00:00
5	606,658	2,398,901	0:00:00
6	604,655	2,398,661	0:00:00
7	604,645	2,398,491	0:00:00
8	607,253	2,398,382	0:00:00
9	607,199	2,398,126	0:00:00
10	607,636	2,398,333	0:00:00
11	607,593	2,398,333	0:00:00
12	607,512	2,398,229	0:00:00
13	608,083	2,398,265	0:00:00
14	608,168	2,398,224	0:00:00
15	608,939	2,397,915	0:00:00
16	608,922	2,397,913	0:00:00
17	608,912	2,397,893	0:00:00
18	608,841	2,397,626	0:00:00
19	608,918	2,397,620	0:00:00
20	608,957	2,397,631	0:00:00
21	608,950	2,397,656	0:00:00
22	608,952	2,397,678	0:00:00
23	608,976	2,397,685	0:00:00
24	608,995	2,397,674	0:00:00
25	608,983	2,397,640	0:00:00
26	609,005	2,397,639	0:00:00
27	608,998	2,397,612	0:00:00
28	609,035	2,397,614	0:00:00
29	609,058	2,397,622	0:00:00
30	609,077	2,397,645	0:00:00
31	609,083	2,397,622	0:00:00
32	609,093	2,397,602	0:00:00
33	609,058	2,397,596	0:00:00
34	609,038	2,397,593	0:00:00
35	608,984	2,397,593	0:00:00
36	609,039	2,397,639	0:00:00
37	609,043	2,397,666	0:00:00
38	609,069	2,397,663	0:00:00
39	609,059	2,397,685	0:00:00
40	609,053	2,397,703	0:00:00
41	609,027	2,397,699	0:00:00
42	609,007	2,397,695	0:00:00
43	609,015	2,397,668	0:00:00
44	609,150	2,397,622	0:00:00
45	609,119	2,397,651	0:00:00
46	608,720	2,397,875	0:00:00
47	608,594	2,397,624	0:00:00

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (Hours per Year)
48	608,652	2,397,607	0:00:00
49	608,798	2,397,682	0:00:00
50	608,615	2,398,057	0:00:00
51	608,509	2,397,984	0:00:00
52	608,562	2,398,018	0:00:00
53	608,555	2,398,058	0:00:00
54	608,604	2,398,024	0:00:00
55	608,619	2,397,995	0:00:00
56	608,647	2,397,960	0:00:00
57	608,651	2,397,927	0:00:00
58	608,622	2,397,938	0:00:00
59	608,582	2,397,923	0:00:00
60	607,315	2,397,935	0:00:00
61	604,622	2,397,929	0:00:00
62	606,910	2,397,202	0:00:00
63	607,335	2,397,430	0:00:00
64	607,465	2,397,178	0:00:00
65	607,479	2,397,188	4:44:00
66	607,739	2,397,228	13:31:00
67	607,336	2,397,356	0:00:00
68	607,918	2,397,499	6:01:00
69	607,995	2,397,440	3:59:00
70	608,013	2,397,439	3:52:00
71	608,065	2,397,384	3:21:00
72	607,973	2,397,379	7:48:00
73	608,000	2,397,377	8:37:00
74	608,025	2,397,391	3:36:00
75	608,028	2,397,420	3:39:00
76	608,190	2,397,397	2:50:00
77	608,143	2,397,364	2:56:00
78	608,207	2,397,343	2:42:00
79	608,153	2,397,330	2:53:00
80	607,891	2,397,180	8:46:00
81	607,883	2,397,210	9:34:00
82	607,870	2,397,204	9:45:00
83	607,879	2,397,178	8:59:00
84	607,868	2,397,176	9:11:00
85	607,856	2,397,174	9:25:00
86	607,843	2,397,170	9:30:00
87	607,833	2,397,166	9:42:00
88	607,820	2,397,165	10:02:00
89	607,804	2,397,157	10:15:00
90	607,802	2,397,185	11:15:00
91	607,824	2,397,190	10:34:00
92	607,839	2,397,193	10:20:00
93	607,855	2,397,196	9:55:00
94	607,798	2,397,209	13:31:00
95	607,794	2,397,227	13:44:00
96	607,817	2,397,233	13:23:00
97	607,833	2,397,239	13:11:00
98	607,856	2,397,240	12:40:00
99	607,875	2,397,242	12:07:00
100	607,872	2,397,264	12:33:00

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (Hours per Year)
101	607,862	2,397,283	11:51:00
102	607,847	2,397,266	12:33:00
103	607,832	2,397,266	12:21:00
104	607,816	2,397,257	12:45:00
105	607,793	2,397,248	12:59:00
106	607,783	2,397,274	11:02:00
107	607,778	2,397,301	8:28:00
108	607,800	2,397,309	8:29:00
109	607,817	2,397,315	8:30:00
110	607,833	2,397,317	8:51:00
111	607,850	2,397,323	8:46:00
112	607,865	2,397,326	8:59:00
113	607,880	2,397,332	8:49:00
114	607,897	2,397,332	9:26:00
115	607,910	2,397,336	9:22:00
116	607,926	2,397,342	9:16:00
117	607,942	2,397,343	9:37:00
118	607,957	2,397,349	9:33:00
119	607,987	2,397,346	10:05:00
120	608,014	2,397,343	10:25:00
121	608,036	2,397,339	10:25:00
122	608,062	2,397,329	3:15:00
123	608,082	2,397,325	3:08:00
124	608,104	2,397,317	3:06:00
125	608,133	2,397,307	2:54:00
126	608,154	2,397,303	2:50:00
127	608,176	2,397,293	2:44:00
128	608,198	2,397,289	2:39:00
129	607,923	2,397,182	8:13:00
130	607,934	2,397,190	8:11:00
131	607,946	2,397,193	7:59:00
132	607,965	2,397,192	7:43:00
133	607,981	2,397,188	7:22:00
134	607,987	2,397,219	7:43:00
135	607,968	2,397,228	8:15:00
136	607,948	2,397,221	8:32:00
137	607,930	2,397,221	8:47:00
138	607,915	2,397,217	9:06:00
139	607,972	2,397,251	8:35:00
140	607,971	2,397,270	9:25:00
141	607,903	2,397,255	11:39:00
142	607,922	2,397,262	11:18:00
143	607,932	2,397,265	10:56:00
144	607,953	2,397,273	10:27:00
145	607,956	2,397,305	11:22:00
146	607,931	2,397,293	11:33:00
147	607,909	2,397,289	11:52:00
148	607,894	2,397,282	12:03:00
149	607,981	2,397,308	11:01:00
150	607,987	2,397,293	10:30:00
151	608,016	2,397,177	6:57:00
152	608,028	2,397,181	6:47:00
153	608,040	2,397,178	6:42:00

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (Hours per Year)
154	608,055	2,397,172	6:25:00
155	608,050	2,397,196	6:39:00
156	608,054	2,397,231	6:56:00
157	608,044	2,397,254	7:23:00
158	608,022	2,397,222	7:10:00
159	608,012	2,397,288	8:55:00
160	608,016	2,397,309	10:19:00
161	608,049	2,397,301	8:18:00
162	608,028	2,397,284	8:16:00
163	608,018	2,397,248	7:39:00
164	608,131	2,397,268	2:53:00
165	608,139	2,397,236	2:47:00
166	608,131	2,397,214	2:50:00
167	608,122	2,397,239	2:55:00
168	608,103	2,397,250	3:00:00
169	608,110	2,397,278	3:00:00
170	608,085	2,397,286	3:05:00
171	608,069	2,397,266	7:08:00
172	608,069	2,397,248	6:54:00
173	608,049	2,397,212	6:45:00
174	608,102	2,397,195	6:08:00
175	608,096	2,397,183	6:09:00
176	608,076	2,397,168	6:15:00
177	608,093	2,397,167	6:03:00
178	608,102	2,397,164	6:00:00
179	608,113	2,397,158	5:57:00
180	608,124	2,397,155	2:52:00
181	608,124	2,397,178	2:50:00
182	608,148	2,397,144	2:46:00
183	608,167	2,397,147	2:45:00
184	608,176	2,397,152	2:39:00
185	608,190	2,397,153	2:38:00
186	608,202	2,397,157	2:35:00
187	608,216	2,397,157	2:33:00
188	608,194	2,397,174	2:35:00
189	608,167	2,397,170	2:42:00
190	608,169	2,397,184	2:41:00
191	608,194	2,397,196	2:36:00
192	608,221	2,397,211	2:29:00
193	608,219	2,397,233	2:31:00
194	608,211	2,397,254	2:36:00
195	608,191	2,397,233	2:38:00
196	608,194	2,397,214	2:34:00
197	608,169	2,397,204	2:41:00
198	608,153	2,397,209	2:47:00
199	608,159	2,397,240	2:44:00
200	608,178	2,397,256	2:39:00
201	607,821	2,397,116	4:24:00
202	607,870	2,397,131	4:06:00
203	607,897	2,397,137	8:10:00
204	607,973	2,397,141	7:14:00
205	607,957	2,397,145	7:29:00
206	607,942	2,397,145	7:41:00

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (Hours per Year)
207	607,942	2,397,131	7:32:00
208	607,952	2,397,120	7:21:00
209	607,973	2,397,116	7:09:00
210	607,985	2,397,115	6:57:00
211	607,998	2,397,108	6:46:00
212	608,012	2,397,105	6:37:00
213	608,071	2,397,116	6:05:00
214	608,057	2,397,120	6:14:00
215	608,044	2,397,125	6:25:00
216	608,032	2,397,128	6:33:00
217	608,022	2,397,131	6:36:00
218	608,009	2,397,135	6:49:00
219	607,996	2,397,135	6:54:00
220	607,985	2,397,141	7:06:00
221	608,096	2,397,111	5:58:00
222	608,108	2,397,107	5:50:00
223	608,124	2,397,102	5:42:00
224	608,239	2,397,158	2:29:00
225	608,253	2,397,162	2:26:00
226	608,267	2,397,168	0:00:00
227	608,290	2,397,166	0:00:00
228	608,289	2,397,180	0:00:00
229	608,280	2,397,196	0:00:00
230	608,272	2,397,207	0:00:00
231	608,263	2,397,219	0:00:00
232	608,239	2,397,182	2:32:00
233	608,282	2,397,262	0:00:00
234	608,294	2,397,251	0:00:00
235	608,302	2,397,242	0:00:00
236	608,309	2,397,232	0:00:00
237	608,317	2,397,221	0:00:00
238	608,325	2,397,205	0:00:00
239	608,332	2,397,190	0:00:00
240	608,354	2,397,191	0:00:00
241	608,368	2,397,194	0:00:00
242	608,381	2,397,195	0:00:00
243	608,393	2,397,193	0:00:00
244	608,408	2,397,193	0:00:00
245	608,426	2,397,187	0:00:00
246	608,357	2,397,209	0:00:00
247	608,353	2,397,228	0:00:00
248	608,350	2,397,247	0:00:00
249	608,383	2,397,248	0:00:00
250	608,397	2,397,250	0:00:00
251	608,411	2,397,255	0:00:00
252	608,423	2,397,258	0:00:00
253	608,436	2,397,260	0:00:00
254	608,408	2,397,229	0:00:00
255	608,427	2,397,233	0:00:00
256	608,300	2,397,268	0:00:00
257	608,306	2,397,273	0:00:00
258	608,330	2,397,281	0:00:00
259	608,346	2,397,284	0:00:00

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (Hours per Year)
260	608,354	2,397,286	0:00:00
261	608,366	2,397,289	0:00:00
262	608,378	2,397,293	0:00:00
263	608,390	2,397,297	0:00:00
264	608,400	2,397,301	0:00:00
265	608,413	2,397,301	0:00:00
266	608,426	2,397,305	0:00:00
267	608,270	2,397,341	0:00:00
268	608,311	2,397,313	0:00:00
269	608,348	2,397,323	0:00:00
270	608,341	2,397,346	0:00:00
271	608,327	2,397,370	0:00:00
272	608,302	2,397,368	0:00:00
273	608,391	2,397,335	0:00:00
274	608,235	2,397,107	2:30:00
275	608,246	2,397,112	2:28:00
276	608,256	2,397,118	2:25:00
277	608,270	2,397,119	0:00:00
278	608,278	2,397,122	0:00:00
279	608,294	2,397,124	0:00:00
280	608,305	2,397,131	0:00:00
281	608,316	2,397,131	0:00:00
282	608,325	2,397,136	0:00:00
283	608,337	2,397,137	0:00:00
284	608,352	2,397,139	0:00:00
285	608,361	2,397,141	0:00:00
286	608,371	2,397,141	0:00:00
287	608,389	2,397,139	0:00:00
288	608,402	2,397,139	0:00:00
289	608,415	2,397,140	0:00:00
290	608,428	2,397,138	0:00:00
291	608,508	2,397,151	0:00:00
292	608,511	2,397,189	0:00:00
293	608,493	2,397,131	0:00:00
294	608,425	2,397,485	0:00:00
295	608,417	2,397,464	0:00:00
296	608,437	2,397,466	0:00:00
297	608,446	2,397,485	0:00:00
298	608,474	2,397,481	0:00:00
299	608,497	2,397,475	0:00:00
300	608,503	2,397,453	0:00:00
301	608,496	2,397,436	0:00:00
302	608,521	2,397,445	0:00:00
303	608,556	2,397,461	0:00:00
304	608,429	2,397,370	0:00:00
305	608,441	2,397,398	0:00:00
306	608,419	2,397,403	0:00:00
307	608,419	2,397,428	0:00:00
308	608,436	2,397,428	0:00:00
309	608,457	2,397,429	0:00:00
310	608,631	2,397,581	0:00:00
311	608,570	2,397,562	0:00:00
312	608,512	2,397,517	0:00:00

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (Hours per Year)
313	608,614	2,397,534	0:00:00
314	608,688	2,397,564	0:00:00
315	608,552	2,397,151	0:00:00
316	608,587	2,397,161	0:00:00
317	608,581	2,397,192	0:00:00
318	608,630	2,397,192	0:00:00
319	608,628	2,397,170	0:00:00
320	608,622	2,397,137	0:00:00
321	608,661	2,397,166	0:00:00
322	608,702	2,397,118	0:00:00
323	608,704	2,397,143	0:00:00
324	608,726	2,397,343	0:00:00
325	608,711	2,397,436	0:00:00
326	608,972	2,397,575	0:00:00
327	608,969	2,397,556	0:00:00
328	608,977	2,397,531	0:00:00
329	609,004	2,397,540	0:00:00
330	609,023	2,397,549	0:00:00
331	609,009	2,397,567	0:00:00
332	609,101	2,397,582	0:00:00
333	609,075	2,397,572	0:00:00
334	609,055	2,397,564	0:00:00
335	609,048	2,397,469	0:00:00
336	609,114	2,397,284	0:00:00
337	609,091	2,397,303	0:00:00
338	609,105	2,397,353	0:00:00
339	609,069	2,397,313	0:00:00
340	609,050	2,397,332	0:00:00
341	609,026	2,397,340	0:00:00
342	609,010	2,397,352	0:00:00
343	608,990	2,397,366	0:00:00
344	608,972	2,397,378	0:00:00
345	608,952	2,397,393	0:00:00
346	608,928	2,397,399	0:00:00
347	608,968	2,397,427	0:00:00
348	608,923	2,397,596	0:00:00
349	608,846	2,397,590	0:00:00
350	608,849	2,397,569	0:00:00
351	608,805	2,397,563	0:00:00
352	608,827	2,397,548	0:00:00
353	608,778	2,397,551	0:00:00
354	608,897	2,397,480	0:00:00
355	608,878	2,397,567	0:00:00
356	608,747	2,397,575	0:00:00
357	608,899	2,397,424	0:00:00
358	608,826	2,397,191	0:00:00
359	608,840	2,397,235	0:00:00
360	608,870	2,397,274	0:00:00
361	608,896	2,397,291	0:00:00
362	608,950	2,397,274	0:00:00
363	608,810	2,397,352	0:00:00
364	608,911	2,397,326	0:00:00
365	609,014	2,397,209	0:00:00

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (Hours per Year)
366	609,069	2,397,213	0:00:00
367	608,861	2,397,168	0:00:00
368	608,892	2,397,155	0:00:00
369	608,796	2,397,108	0:00:00
370	608,825	2,397,128	0:00:00
371	609,109	2,397,209	0:00:00
372	609,175	2,397,168	0:00:00
373	609,214	2,397,142	0:00:00
374	609,236	2,397,129	0:00:00
375	609,257	2,397,114	0:00:00
376	609,358	2,397,122	0:00:00
377	609,339	2,397,134	0:00:00
378	609,300	2,397,159	0:00:00
379	609,282	2,397,172	0:00:00
380	609,261	2,397,186	0:00:00
381	609,240	2,397,194	0:00:00
382	609,221	2,397,211	0:00:00
383	609,175	2,397,239	0:00:00
384	609,248	2,397,262	0:00:00
385	609,158	2,397,426	0:00:00
386	609,185	2,397,405	0:00:00
387	609,210	2,397,389	0:00:00
388	609,229	2,397,416	0:00:00
389	609,267	2,397,407	0:00:00
390	609,240	2,397,375	0:00:00
391	609,404	2,397,283	0:00:00
392	609,383	2,397,100	0:00:00
393	609,398	2,397,129	0:00:00
394	609,409	2,397,157	0:00:00
395	609,424	2,397,180	0:00:00
396	609,402	2,397,202	0:00:00
397	609,386	2,397,177	0:00:00
398	609,373	2,397,153	0:00:00
399	609,333	2,397,186	0:00:00
400	609,354	2,397,170	0:00:00
401	609,302	2,397,204	0:00:00
402	609,491	2,397,105	0:00:00
403	609,505	2,397,123	0:00:00
404	609,476	2,397,149	0:00:00
405	609,457	2,397,128	0:00:00
406	609,466	2,397,191	0:00:00
407	609,494	2,397,175	0:00:00
408	609,599	2,397,139	0:00:00
409	609,575	2,397,157	0:00:00
410	609,546	2,397,178	0:00:00
411	609,506	2,397,204	0:00:00
412	609,572	2,397,221	0:00:00
413	609,559	2,397,200	0:00:00
414	609,583	2,397,188	0:00:00
415	609,597	2,397,213	0:00:00
416	609,637	2,397,218	0:00:00
417	609,663	2,397,196	0:00:00
418	609,655	2,397,177	0:00:00

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (Hours per Year)
419	609,623	2,397,196	0:00:00
420	609,609	2,397,172	0:00:00
421	609,636	2,397,156	0:00:00
422	609,660	2,397,138	0:00:00
423	609,626	2,397,131	0:00:00
424	609,984	2,397,115	9:07:00
425	610,071	2,396,998	4:48:00
426	609,976	2,396,880	13:59:00
427	609,885	2,396,770	19:36:00
428	609,937	2,396,822	16:23:00
429	609,914	2,396,671	20:20:00
430	609,629	2,396,844	10:27:00
431	609,370	2,396,760	24:31:00
432	609,330	2,397,070	0:00:00
433	609,353	2,397,048	0:00:00
434	609,346	2,397,014	0:00:00
435	609,382	2,396,998	0:00:00
436	609,388	2,396,991	0:00:00
437	609,396	2,396,987	0:00:00
438	609,407	2,396,981	0:00:00
439	609,446	2,397,055	0:00:00
440	609,474	2,397,039	0:00:00
441	609,492	2,397,024	0:00:00
442	609,522	2,397,010	5:48:00
443	609,543	2,397,033	2:35:00
444	609,516	2,397,050	0:00:00
445	609,454	2,397,092	0:00:00
446	609,480	2,397,074	0:00:00
447	609,556	2,397,093	0:00:00
448	609,648	2,397,073	4:08:00
449	609,628	2,397,049	7:03:00
450	609,092	2,396,651	69:22:00
451	609,278	2,397,098	0:00:00
452	608,838	2,396,807	0:00:00
453	608,620	2,396,984	0:00:00
454	608,753	2,396,967	0:00:00
455	608,733	2,397,108	0:00:00
456	608,685	2,397,083	0:00:00
457	608,671	2,397,078	0:00:00
458	608,649	2,397,105	0:00:00
459	608,134	2,397,097	5:33:00
460	608,147	2,397,097	2:47:00
461	608,159	2,397,096	2:44:00
462	608,172	2,397,096	2:42:00
463	608,185	2,397,096	2:37:00
464	608,196	2,397,097	2:37:00
465	608,210	2,397,102	2:35:00
466	608,220	2,397,104	2:33:00
467	608,093	2,397,084	5:57:00
468	608,104	2,397,080	5:49:00
469	608,123	2,397,075	5:40:00
470	608,142	2,397,071	5:29:00
471	608,162	2,397,068	2:43:00

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (Hours per Year)
472	608,180	2,397,070	2:39:00
473	608,194	2,397,074	2:38:00
474	608,206	2,397,074	2:35:00
475	608,224	2,397,080	2:31:00
476	608,242	2,397,085	2:27:00
477	608,251	2,397,088	2:25:00
478	608,265	2,397,091	0:00:00
479	608,277	2,397,096	0:00:00
480	608,289	2,397,098	0:00:00
481	608,304	2,397,100	0:00:00
482	608,319	2,397,104	0:00:00
483	608,339	2,397,108	0:00:00
484	608,348	2,397,111	0:00:00
485	608,362	2,397,112	0:00:00
486	608,375	2,397,115	0:00:00
487	608,390	2,397,116	0:00:00
488	608,403	2,397,114	0:00:00
489	608,417	2,397,113	0:00:00
490	608,007	2,396,948	17:43:00
491	608,021	2,396,958	15:43:00
492	608,031	2,396,963	14:07:00
493	608,042	2,396,971	3:23:00
494	608,050	2,396,983	3:19:00
495	608,059	2,396,995	3:14:00
496	608,069	2,397,008	3:11:00
497	608,076	2,397,020	3:08:00
498	608,082	2,397,030	3:03:00
499	608,085	2,397,044	3:02:00
500	608,107	2,397,029	3:01:00
501	608,107	2,397,006	3:01:00
502	608,122	2,397,028	2:55:00
503	608,137	2,397,025	2:52:00
504	608,151	2,397,026	2:47:00
505	608,167	2,397,024	2:47:00
506	608,179	2,397,024	2:44:00
507	608,193	2,397,025	2:36:00
508	608,205	2,397,029	2:39:00
509	608,215	2,397,032	2:39:00
510	608,229	2,397,034	2:35:00
511	608,239	2,397,038	2:29:00
512	608,254	2,397,041	2:27:00
513	608,264	2,397,046	2:25:00
514	608,275	2,397,049	0:00:00
515	608,288	2,397,053	0:00:00
516	608,304	2,397,050	0:00:00
517	608,315	2,397,061	0:00:00
518	608,332	2,397,061	0:00:00
519	608,347	2,397,068	0:00:00
520	608,362	2,397,071	0:00:00
521	608,376	2,397,072	0:00:00
522	608,393	2,397,071	0:00:00
523	608,405	2,397,071	0:00:00
524	608,418	2,397,069	0:00:00

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (Hours per Year)
525	608,243	2,396,881	12:32:00
526	607,997	2,396,944	18:22:00
527	607,983	2,396,940	18:57:00
528	607,971	2,396,938	19:00:00
529	607,962	2,396,936	18:57:00
530	607,944	2,396,936	18:44:00
531	607,933	2,396,938	18:33:00
532	607,917	2,396,940	18:06:00
533	607,902	2,396,944	17:36:00
534	607,892	2,396,952	17:25:00
535	607,881	2,396,963	17:08:00
536	607,872	2,396,971	16:52:00
537	607,862	2,396,984	16:25:00
538	607,860	2,396,998	15:52:00
539	607,852	2,397,017	14:39:00
540	607,848	2,397,035	13:17:00
541	607,844	2,397,050	11:58:00
542	607,841	2,397,064	10:18:00
543	607,838	2,397,076	8:46:00
544	607,835	2,397,095	6:05:00
545	607,832	2,397,107	4:22:00
546	607,875	2,397,115	4:04:00
547	607,878	2,397,103	4:03:00
548	607,878	2,397,088	4:03:00
549	607,880	2,397,069	10:25:00
550	607,883	2,397,057	12:00:00
551	607,887	2,397,043	9:54:00
552	607,889	2,397,029	12:08:00
553	607,895	2,397,014	13:47:00
554	607,903	2,396,999	14:59:00
555	607,913	2,396,988	15:47:00
556	607,924	2,396,982	16:05:00
557	607,939	2,396,979	16:08:00
558	607,952	2,396,979	15:47:00
559	607,963	2,396,982	14:52:00
560	607,977	2,396,983	13:57:00
561	607,989	2,396,987	12:28:00
562	608,001	2,396,992	10:33:00
563	608,012	2,397,000	7:56:00
564	608,022	2,397,007	5:29:00
565	608,030	2,397,019	3:17:00
566	608,038	2,397,028	3:15:00
567	607,897	2,397,124	3:56:00
568	607,906	2,397,108	7:56:00
569	607,917	2,397,096	7:43:00
570	607,924	2,397,084	7:32:00
571	607,909	2,397,072	7:40:00
572	607,926	2,397,069	7:32:00
573	607,913	2,397,051	6:29:00
574	607,919	2,397,038	8:20:00
575	607,927	2,397,026	9:56:00
576	607,940	2,397,016	10:43:00
577	607,956	2,397,012	10:14:00

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (Hours per Year)
578	607,956	2,397,077	7:15:00
579	607,969	2,397,075	7:05:00
580	607,982	2,397,069	6:53:00
581	607,999	2,397,065	6:44:00
582	608,010	2,397,059	6:38:00
583	608,026	2,397,058	6:25:00
584	608,038	2,397,057	6:23:00
585	608,049	2,397,051	6:15:00
586	607,954	2,397,051	7:06:00
587	607,969	2,397,047	7:02:00
588	607,983	2,397,044	3:31:00
589	608,002	2,397,033	3:26:00
590	608,000	2,397,020	4:43:00
591	607,741	2,396,863	9:24:00
592	607,319	2,397,021	25:00:00
593	606,695	2,397,034	48:35:00
594	606,815	2,396,680	73:02:00
595	606,848	2,396,756	117:35:00
597	605,003	2,396,363	0:00:00
598	604,988	2,396,317	0:00:00
599	607,110	2,396,193	74:33:00
600	607,166	2,396,356	99:18:00
601	607,038	2,396,488	57:31:00
602	607,137	2,396,614	66:02:00
606	607,921	2,396,580	21:14:00
607	608,797	2,396,201	161:37:00
608	608,881	2,396,182	133:20:00
609	609,014	2,396,499	153:57:00
610	609,038	2,396,445	176:45:00
611	609,906	2,396,627	18:36:00
612	609,914	2,396,533	17:14:00
613	609,957	2,396,417	15:32:00
614	609,949	2,396,456	15:47:00
615	609,964	2,396,387	15:26:00
616	609,975	2,396,351	15:25:00
617	610,013	2,396,303	14:43:00
618	610,016	2,396,254	14:58:00
619	610,063	2,396,182	14:11:00
620	610,053	2,396,207	14:09:00
621	610,609	2,395,774	0:00:00
622	610,597	2,395,775	0:00:00
623	610,574	2,395,777	0:00:00
624	610,457	2,395,755	0:00:00
625	610,479	2,395,821	0:00:00
626	610,506	2,395,807	0:00:00
627	610,544	2,395,798	0:00:00
628	610,214	2,396,012	3:49:00
629	610,223	2,395,981	3:57:00
630	610,261	2,395,960	3:44:00
631	610,263	2,395,909	3:39:00
632	610,345	2,395,901	0:00:00
633	610,359	2,395,857	0:00:00
634	610,376	2,395,848	0:00:00

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (Hours per Year)
635	610,391	2,395,840	0:00:00
636	610,167	2,396,054	4:14:00
637	610,191	2,396,030	4:02:00
638	610,077	2,396,156	14:06:00
639	610,098	2,396,130	13:39:00
640	610,103	2,396,102	14:21:00
641	609,941	2,396,013	20:10:00
642	609,849	2,395,699	11:56:00
645	608,721	2,396,023	108:01:00
646	608,561	2,395,956	64:58:00
647	608,527	2,396,107	411:55:00
648	608,251	2,396,015	307:25:00
649	608,534	2,395,574	0:00:00
650	609,229	2,395,405	6:33:00
651	609,781	2,395,584	11:26:00
652	609,804	2,395,476	5:03:00
653	609,850	2,395,467	4:34:00
654	609,857	2,395,415	4:57:00
655	609,747	2,395,430	6:11:00
656	609,701	2,395,591	8:37:00
657	609,652	2,395,554	6:09:00
658	610,560	2,395,693	0:00:00
659	610,768	2,394,779	0:00:00
660	610,746	2,394,763	0:00:00
661	610,793	2,394,760	0:00:00
662	610,584	2,395,156	0:00:00
663	610,547	2,395,134	0:00:00
664	610,573	2,395,126	0:00:00
665	610,584	2,395,101	0:00:00
666	610,676	2,394,967	0:00:00
667	610,640	2,394,959	0:00:00
668	610,617	2,394,959	0:00:00
669	610,595	2,394,986	0:00:00
670	610,298	2,394,900	0:00:00
671	610,253	2,394,896	0:00:00
672	609,961	2,395,220	0:00:00
673	609,719	2,395,226	5:02:00
674	609,735	2,395,247	7:56:00
675	609,650	2,394,592	0:00:00
676	609,728	2,394,729	0:00:00
677	610,042	2,394,722	0:00:00
678	610,122	2,394,732	0:00:00
679	610,053	2,394,675	0:00:00
680	610,067	2,394,611	0:00:00
681	609,985	2,394,452	0:00:00
682	610,048	2,394,572	0:00:00
683	610,260	2,394,673	0:00:00
684	610,223	2,394,691	0:00:00
685	610,514	2,394,718	0:00:00
686	610,548	2,394,725	0:00:00
687	610,598	2,394,739	0:00:00
688	610,815	2,394,732	0:00:00
689	610,823	2,394,712	0:00:00

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (Hours per Year)
690	610,799	2,394,689	0:00:00
691	610,781	2,394,704	0:00:00
692	610,760	2,394,740	0:00:00
693	610,717	2,394,580	0:00:00
694	610,746	2,394,589	0:00:00
695	610,767	2,394,607	0:00:00
696	610,768	2,394,584	0:00:00
697	610,761	2,394,562	0:00:00
698	610,723	2,394,543	0:00:00
699	610,740	2,394,523	0:00:00
700	610,758	2,394,640	0:00:00
701	610,731	2,394,632	0:00:00
702	610,704	2,394,624	0:00:00
703	610,670	2,394,648	0:00:00
704	610,687	2,394,656	0:00:00
705	610,719	2,394,664	0:00:00
706	610,746	2,394,672	0:00:00
707	610,706	2,394,687	0:00:00
708	610,738	2,394,698	0:00:00
709	610,678	2,394,683	0:00:00
710	610,651	2,394,674	0:00:00
711	610,623	2,394,674	0:00:00
712	610,614	2,394,706	0:00:00
713	610,646	2,394,708	0:00:00
714	610,669	2,394,716	0:00:00
715	610,707	2,394,728	0:00:00
716	610,639	2,394,592	0:00:00
717	610,619	2,394,584	0:00:00
718	610,596	2,394,577	0:00:00
719	610,578	2,394,564	0:00:00
720	610,553	2,394,550	0:00:00
721	610,535	2,394,541	0:00:00
722	610,516	2,394,529	0:00:00
723	610,504	2,394,506	0:00:00
724	610,523	2,394,473	0:00:00
725	610,551	2,394,482	0:00:00
726	610,541	2,394,342	0:00:00
727	610,533	2,394,374	0:00:00
728	610,525	2,394,394	0:00:00
729	610,514	2,394,426	0:00:00
730	610,545	2,394,450	0:00:00
731	610,565	2,394,428	0:00:00
732	610,584	2,394,432	0:00:00
733	610,604	2,394,437	0:00:00
734	610,613	2,394,409	0:00:00
735	610,592	2,394,405	0:00:00
736	610,563	2,394,400	0:00:00
737	610,631	2,394,417	0:00:00
738	610,660	2,394,427	0:00:00
739	610,172	2,394,187	0:00:00
740	610,203	2,394,179	0:00:00
741	609,656	2,393,882	0:00:00
742	609,629	2,393,983	0:00:00

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (Hours per Year)
743	608,022	2,396,545	38:06:00