Kahuku Wind Power

Habitat Conservation Plan

Applicant
Kahuku Wind Power LLC.
c/o First Wind
33 Lono Avenue
Suite 380
Kahului, HI 96732
Tel: (808) 873-0111

Prepared by
SWCA Environmental Consultants
201 Merchant Street, Suite 2310
Honolulu, HI 96813
Tel: (808) 548-7922

March 2010

Kahuku Wind Power

Habitat Conservation Plan

Applicant
Kahuku Wind Power LLC.
c/o First Wind
33 Lono Avenue
Suite 380
Kahului, HI 96732
Tel: (808) 873-0111

Prepared by
SWCA Environmental Consultants
201 Merchant Street, Suite 2310
Honolulu, HI 96813
Tel: (808) 548-7922

March 2010

TABLE OF CONTENTS

List of Figures

List of Tables

List of Appendices

1.0 INTRODUCTION AND PROJECT OVERVIEW

1.1 Summary

Kahuku Wind Power LLC (or the "Applicant") proposes to construct and operate a new 30-megawatt (MW), 12-turbine commercial wind energy generation facility in the Kahuku area on the northeastern portion of Oʻahu (Figure 1). The proposed project, known as Kahuku Wind Power, is situated on approximately 578 acres (234 ha) of privately owned land near the U.S. Army Kahuku Training Range. Kahuku Wind Power would supply wind-generated electricity to the Hawaiian Electric Company (HECO).

Kahuku Wind Power will consist of 12 Clipper 2.5-MW wind turbine generators (WTGs), an operations and maintenance building, one permanent unguyed meteorological (met) tower, three microwave towers (one on-site and two off-site), and an electrical substation (Figure 1, 2). Unpaved service roadways will also be created to connect the new WTGs to other project components. Up to three temporary guyed met towers will be also be erected for varying lengths of time prior to and during construction to gather meteorological data and for power-curve testing. A more detailed description of the proposed infrastructure for the project will be provided in the Environmental Assessment (EA) for Kahuku Wind Power.

It is anticipated that construction and operation of Kahuku Wind Power has the potential to result in the incidental take of seven federally listed threatened or endangered species: the Hawaiian stilt or aeʻo (*Himantopus mexicanus knudseni*), Hawaiian coot or ʻalae keʻokeʻo (*Fulica alai*), Hawaiian duck or koloa maoli (*Anas wyvilliana*), Hawaiian moorhen or ʻalae ʻula (*Gallinula chloropus sandvicensis*), Newell's shearwater or ʻaʻo (*Puffinus auricularis newelli*), Hawaiian petrel or ʻuaʻu (*Pterodroma sandwichensis*), and Hawaiian hoary bat or ʻopeʻapeʻa (*Lasiurus cinereus semotus*). One state-listed endangered species, the Hawaiian short-eared owl or pueo (*Asio flammeus sandichensis*), is also believed to have potential to collide with the proposed WTGs or other project infrastructure. No other listed, proposed, or candidate species have been found or are known or expected to be present in the project area.

These eight federally or state listed species are known to, or are considered to have potential to, fly in the vicinity of the project area and could be injured or killed if they collide with WTGs or other project components. Adjusted take estimates at Kahuku Wind Power for all listed species take into account both direct and indirect take. Direct take comprises individuals that are killed or injured colliding with WTGs, the permanent unguyed met tower, construction vehicles or equipment, or other project components. Indirect take considers that it is possible that listed adults that are killed or injured by project components could have been tending to eggs, nestlings, or dependent young. Thus, the loss of these adults would also lead to the loss of eggs or dependent young, which is attributable to the proposed project.

The Applicant is seeking an Incidental Take License (ITL) in accordance with Chapter 195-D, Hawaiʻi Revised Statutes. This permit is issued by the State Department of Land and Natural Resources (DLNR). This HCP supports the issuance of this permit, and describes how the Applicant will avoid, minimize, mitigate, and monitor the incidental take of threatened and endangered species that may occur during construction and operation of the proposed project. Additionally, the HCP outlines a monitoring protocol to determine the actual take of each species after the facility begins operating. Most importantly, this HCP incorporates adaptive management provisions to allow for modifications to the mitigation and monitoring measures as knowledge is gained during implementation.

This HCP is also intended to support a Biological Assessment (with mitigation) by the U. S. Fish and Wildlife Service (USFWS), to fulfill the requirements of the U. S. Department of Energy (DOE) for formal consultation pursuant to Section 7 of the Endangered Species Act (ESA). DOE is proposing to issue a loan guarantee to Kahuku Wind Power LLC to support construction of the proposed project and thus the proposed action is subject to compliance with Section 7 of the ESA. The USFWS has been consulted throughout the preparation of this document, and have participated in meetings with the state Division of Forestry and Wildlife (DLNR) and the Endangered Species Recovery Committee (ESRC).

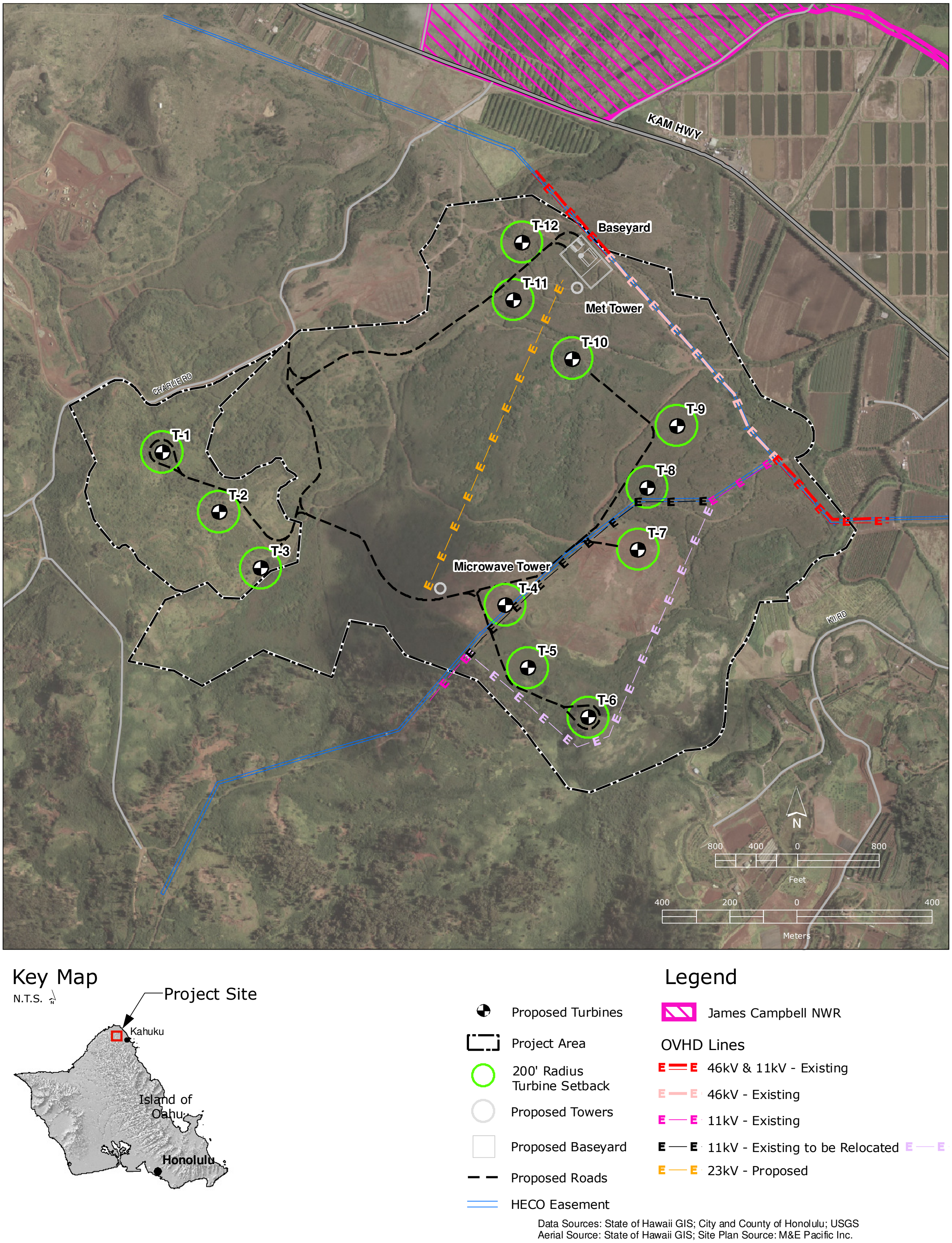

Figure 1. Kahuku Wind Power Location.

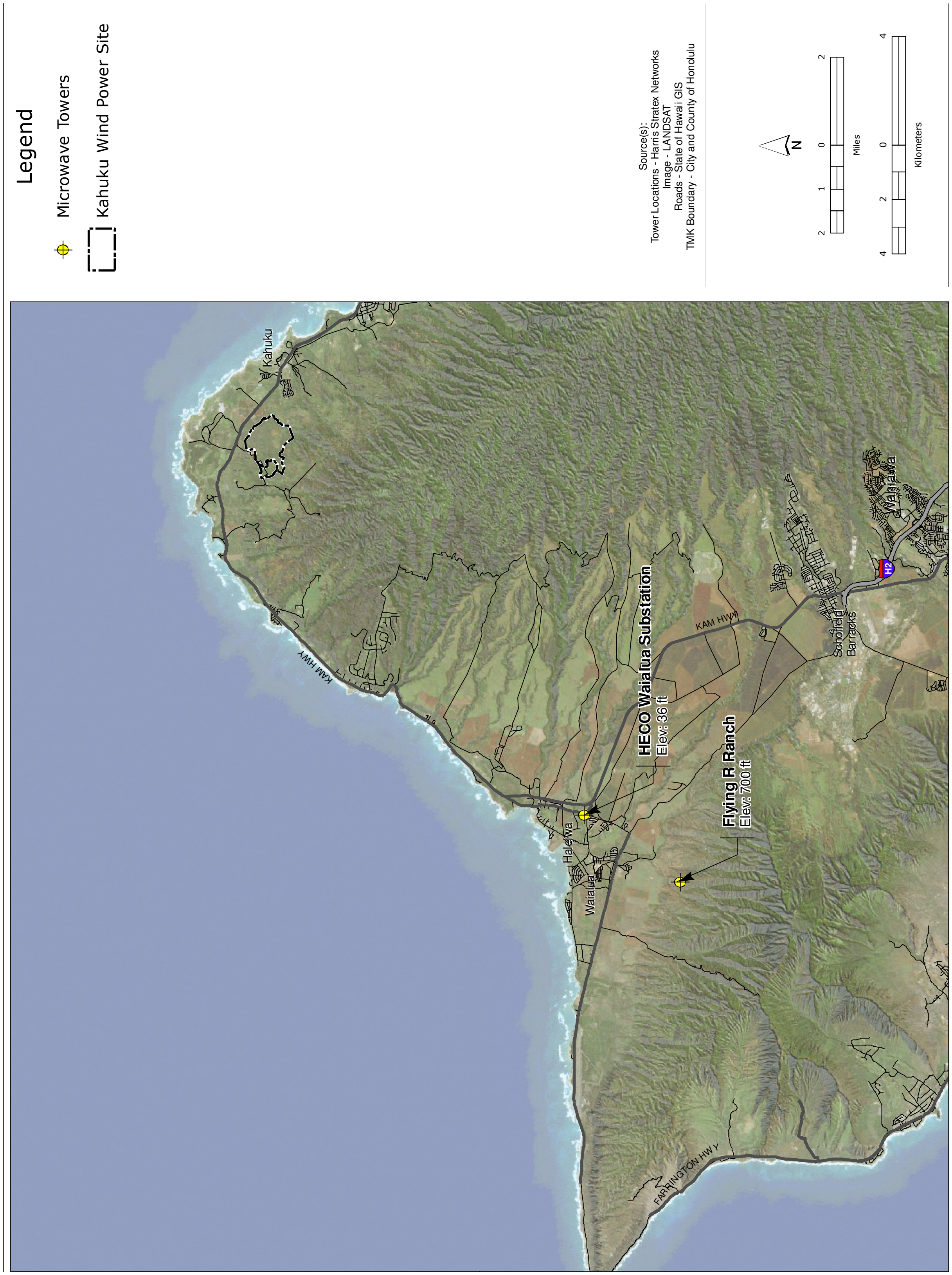

Figure 2. Location of Offsite Microwave Towers

1.2 Applicant Background

Kahuku Wind Power LLC is a subsidiary of First Wind, a Boston based wind energy generation firm. Kahuku Wind Power LLC was created for the express purpose of developing a new wind generation facility in Kahuku, O'ahu. The principals of First Wind are among the world's leading wind power developers with extensive experience in financing, constructing, operating, and managing large wind energy projects in America and worldwide. In North America, First Wind has a portfolio of over 3,000 MW of wind energy generation under development.

1.3 Regulatory Context

1.3.1 Endangered Species Act (16 U.S.C. 1531-1544)

Established in 1973, the Endangered Species Act (ESA) protects plants, fish, and wildlife that have been designated as threatened or endangered and conserves ecosystem in which the species depend. Candidate species, which may be listed in the near future, are not afforded protection under the ESA.

Section 7(a)(1) of the ESA directs all federal agencies to aid in the conservation of federally listed species. Section 7(a)(2) outlines procedures for federal agencies to follow when taking actions that may adversely affect federally listed species or designated critical habitats to ensure that the agencies are not undertaking, funding, permitting, or authorizing actions likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat. Kahuku Wind Power LLC is applying for a Department of Energy (DOE) loan guarantee to support the construction of the proposed project. The issuance of a DOE loan guarantee is a Federal action subject to compliance with Section 7 of the ESA.

1.3.2 National Environmental Policy Act (42 U.S.C. 4371 et seq.)

The National Environmental Policy Act (NEPA) of 1969 provides an interdisciplinary framework for Federal agencies to analyze and disclose the environmental impacts of their proposed actions and consider reasonable alternatives. The purpose of NEPA is to promote agency analysis and public disclosure of the environmental issues surrounding a proposed federal action in order to reach a decision that reflects NEPA's mandate to strive for harmony between human activity and the natural world. Although the requirements of the ESA and NEPA overlap considerably, the scope of NEPA exceeds the ESA by considering impacts of a federal action on other natural and human resources besides endangered and threatened species and their habitats.

The issuance of a loan guarantee by DOE is a Federal action subject to compliance with NEPA. If no significant impacts are identified during preparation of the EA, DOE will issue a Finding of No Significant Impact (FONSI); however, if potentially significant impacts are identified, DOE will prepare an Environmental Impact Statement (EIS). DOE is also using the NEPA process to assist in determining whether to issue a loan guarantee to Kahuku Wind Power LLC to support the proposed project.

1.3.3 Chapter 195D, Hawai'i Revised Statutes

The purpose of Chapter 195D of Hawai'i Revised Statutes (HRS) is "to insure the continued perpetuation of indigenous aquatic life, wildlife, and land plants, and their habitats for human enjoyment, for scientific purposes, and as members of ecosystems…" (§195D-1). Section 195D-4 states that any endangered or threatened species of fish or wildlife recognized by the ESA shall be so deemed by State statute. Like the ESA, the unauthorized "take" of such endangered or threatened species is prohibited [§195D-4(e)]. Under Section 195D-4(g), the Board of Land and Natural Resources (BLNR), after consultation with the State's ESRC, may issue a temporary Incidental Take License (subsequently referred to as an "ITL") to allow a take otherwise prohibited if the take is incidental to the carrying out of an otherwise lawful activity.

In order to qualify for an ITL, the following must occur:

- The Applicant minimizes and mitigates the impacts of the take to the maximum extent practicable (i.e., implements a Habitat Conservation Plan (HCP));
- The Applicant guarantees that adequate funding for the HCP will be provided;
- The Applicant posts a bond, provides an irrevocable letter of credit, insurance, or surety bond, or provides other similar financial tools, including depositing a sum of money in the endangered species trust fund created by §195D-31, or provides other means approved by BLNR, adequate to ensure monitoring of the species by the State and to ensure that the applicant takes all actions necessary to minimize and mitigate the impacts of the take;
- The plan increases the likelihood that the species will survive and recover;
- The plan takes into consideration the full range of the species on the island so that cumulative impacts associated with the take can be adequately assessed;
- The activity permitted and facilitated by the license to take a species does not involve the use of submerged lands, mining, or blasting;
- The cumulative impact of the activity, which is permitted and facilitated by the license, provides net environmental benefits; and
- The take is not likely to cause the loss of genetic representation of an affected population of any endangered, threatened, proposed, or candidate plant species.

Section 195D-21 outlines the requirements of HCPs, which are similar to those in federal regulations.[1] According to this section, HCPs submitted in support of an ITL application shall:

- Identify the geographic area encompassed by the plan; the ecosystems, natural communities, or habitat types within the plan area that are the focus of the plan; and the endangered, threatened, proposed, and candidate species known or reasonably expected to be present in those ecosystems, natural communities, or habitat types in the plan area;
- Describe the activities contemplated to be undertaken within the plan area with sufficient detail to allow the department to evaluate the impact of the activities on the particular ecosystems, natural communities, or habitat types within the plan area that are the focus of the plan;
- Identify the steps that will be taken to minimize and mitigate all negative impacts, including without limitation the impact of any authorized incidental take, with consideration of the full range of the species on the island so that cumulative impacts associated with the take can be adequately assessed; and the funding that will be available to implement those steps;
- Identify those measures or actions to be undertaken to protect, maintain, restore, or enhance the ecosystems, natural communities, or habitat types within the plan area; a schedule for implementation of the measures or actions; and an adequate funding source to ensure that the actions or measures, including monitoring, are undertaken in accordance with the schedule;
- Be consistent with the goals and objectives of any approved recovery plan for any endangered species or threatened species known or reasonably expected to occur in the ecosystems, natural communities, or habitat types in the plan area;
- Provide reasonable certainty that the ecosystems, natural communities, or habitat types will be maintained in the plan area, throughout the life of the plan, in sufficient quality, distribution, and extent to support within the plan area those species typically associated with

[1] Applicants that apply for a federal Incidental Take Permit (ITP) from the USFWS under Section 10(a)(1)(B) of the ESA are required to prepare a Habitat Conservation Plan (HCP).

the ecosystems, natural communities, or habitat types, including any endangered, threatened, proposed, and candidate species known or reasonably expected to be present in the ecosystems, natural communities, or habitat types within the plan area;

- Contain objective, measurable goals, the achievement of which will contribute significantly to the protection, maintenance, restoration, or enhancement of the ecosystems, natural communities, or habitat types; time frames within which the goals are to be achieved; provisions for monitoring (such as field sampling techniques), including periodic monitoring by representatives of the department or the ESRC, or both; and provisions for evaluating progress in achieving the goals quantitatively and qualitatively; and

- Provide for an adaptive management strategy that specifies the actions to be taken periodically if the plan is not achieving its goals.

In addition to the above requirements, all HCPs and their actions authorized under the plan should be designed to result in an overall net benefit to the threatened and endangered species in Hawai‘i (Section 195D-30).

Section 195D-25 provides for the creation of the ESRC, which is composed of biological experts, representatives of relevant Federal and State agencies (i.e. USFWS, USGS, DLNR), and appropriate governmental and non-governmental members to serve as a consultant to the DLNR and the BLNR on matters relating to endangered, threatened, proposed, and candidate species. ESRC reviews all applications for HCPs and makes recommendations to the DLNR and the BLNR on whether they should be approved, amended, or rejected.

Following preparation of the plan, the proposed plan and the application must be made available for public review and comment no less than 60 days prior to approval. BLNR may approve the plan if: *(A) The plan will further the purposes of this chapter by protecting, maintaining, restoring, or enhancing identified ecosystems, natural communities, or habitat types upon which endangered, threatened, proposed, or candidate species depend within the area covered by the plan; (B) The plan will increase the likelihood of recovery of the endangered or threatened species that are the focus of the plan; and (C) The plan satisfies all the requirements of this chapter* [§195D-21].

If it is approved, participants in the plan shall submit an annual report to the department within 90 days of each fiscal year ending June 30, that includes a description of activities and accomplishments, analysis of the problems and issues encountered in meeting or failing to meet the objectives set forth in the HCP, areas needing technical advice, status of funding, and plans and management objectives for the next fiscal year (§195D-21).

1.3.4 Chapter 343, Hawai‘i Revised Statutes

Chapter 343, Hawaii Revised Statutes (Environmental Impact Statements) was developed "to establish a system of environmental review which will ensure that environmental concerns are given appropriate consideration in decision making along with economic and technical considerations" (§343-1, HRS). Kahuku Wind Power LLC will comply with Chapter 343 for any actions conducted under this Habitat Conservation Plan as required by law.

1.3.5 Migratory Bird Treaty Act (16 U.S.C. 703-712)

All native migratory birds of the United States are protected under the Migratory Bird Treaty Act (MBTA) of 1918, as amended (16 U.S.C. 703-712 *et. seq.*). This act states that 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. "Take" is defined as "to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect (16 U.S.C. 703-712)." No process for authorizing incidental take of MBTA protected birds or providing permits is described in the MBTA (USFWS and NMFS 1996). However, USFWS will not refer the incidental take of any such ESA-listed migratory bird for prosecution under the MBTA, provided that the incidental take statement within the biological opinion includes the following language: "The Fish and Wildlife Service will not refer the incidental take of any migratory bird or bald eagle for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. §§ 703-712), or the Bald and Golden Eagle Protection Act of 1940, as amended (16 U.S.C. §§ 668-668d), if such take is in compliance with the terms and conditions (including amount and/or number) specified herein." Other MBTA-protected birds that are not protected by the ESA, and that may be adversely affected by the proposed wind facility, will not be covered by any take authorization.

To avoid and minimize impacts to MBTA-protected species, Kahuku Wind Power LLC has incorporated design and operational features based on the USFWS Interim Guidance on Avoiding and Minimizing Impacts to Wildlife from Wind Turbines (USFWS 2003). These guidelines contain materials to assist in evaluating possible wind power sites, wind turbine design and location, and pre- and post-construction research to identify and/or assess potential impacts to wildlife. Specific measures that have been adopted by Kahuku Wind Power to avoid and minimize the potential for impacts to MBTA-protected species are detailed in Table 5-1.

1.3.6 National Historic Preservation Act (16 U.S.C. 470-470b, 470c-470n)

The National Historic Preservation Act of 1966 (NHPA) is the primary federal law protecting cultural, historic, Native American, and Native Hawaiian resources. Section 106 of the NHPA (36 CFR 800) requires federal agencies to assess and determine the potential effects of their proposed undertakings on prehistoric and historic resources (e.g. sites, buildings, structures, and objects) and to develop measures to avoid or mitigate any adverse effects. Detailed requirements for complying with NHPA are addressed in regulations promulgated by the Advisory Council on Historic Preservation (ACHP) under 36 CFR 800.

As Kahuku Wind Power LLC is receiving financial assistance from a federal agency (DOE) via their loan guarantee program, the proposed project is considered an "undertaking" covered by the ACHP and must comply with Section 106 of the NHPA. Accordingly, DOE must consult with the ACHP, the State Historic Preservation Officer (SHPO), affected Tribes, the Applicant, and other interested parties, and make a good-faith effort to consider and incorporate their comments into project planning. In consultation with SHPO, a roughly 230 ac (93 ha) area of potential effects (APE)[1] was decided upon for the proposed project (Rechtman 2009). The DOE is currently evaluating the effects of the proposed project on historic and cultural resources and this evaluation will then be sent to SHPO for concurrence. The potential impacts on prehistoric and historic resources are discussed in detail in the EA.

1.4 Project Description

1.4.1 Project History

First Wind has secured rights to the approximately 578 ac (234 ha) that comprise the project area from Continental Pacific, LLC, a large agricultural developer (Tax Map Key 5-6-005:007 and 5-6-5:014). Approximately 70 ac (28 ha) of the project area is leased from Continental Pacific, LLC and the remainder was purchased in May 2007. The Kahuku region was identified in a statewide energy resource assessment as one of O'ahu's three most productive locations for wind generation (Global Energy Concepts LLC 2006). Three previous wind power projects operated in the area in the 1980s and 1990s and have since been dismantled.

Various biological surveys and monitoring activities related to the preparation of this HCP have been conducted on-site. Radar and audio-visual studies for endangered seabirds were conducted in Fall 2007 and Summer 2008 (Day and Cooper 2008). On-site avian sampling was conducted bi-monthly between March 2007 and December 2008. Nocturnal visual sampling for native bats were conducted at various locations on the site from October 2007 to December 2008 and audio sampling for bats began on the project area in April 2008 and is still ongoing. Botanical assessments were conducted by

[1] Section 800.16(d) of the ACHP regulations requires agencies to determine the area of potential effects (APE), defined as "the geographic area or areas within which an undertaking may directly or indirectly cause changes in the character or use of historic properties, if any such properties exist."

Hobdy in April 2007 and July 2009 (Hodby 2007, 2009), and wetland assessments were conducted by SWCA in June and October 2008 (SWCA 2008).

Three temporary met towers were installed on the property in October 2007 in order to collect wind resource data. Two met towers were dismantled in early December 2008 and currently only one temporary met tower remains on the project area. The project was granted two Conditional Use Permit-Minors by the City and County of Honolulu's Department of Planning and Permitting in January 2008 and November 2009. Applications for grading and building permits have been submitted. A Power Purchase Agreement was finalized with HECO in July 2009. An Interconnect Requirements Study (IRS) with HECO is ongoing.

1.4.2 Project Design and Components

The Kahuku Wind Power wind energy generation facility would consist of 12 Clipper 2.5-MW WTGs, each turbine pad approximately 1.78 ac (0.72 ha) in size. Each turbine site would consist of a pad-mounted transformer, power distribution panel, turbine tower, and gravel access drive and buffer area. An additional 1.30 ac (0.53 ha) surrounding each turbine site would be temporarily disturbed during construction and revegetated following completion of the turbine components. The towers proposed for the project are approximately 262 ft (80 m) in height. The proposed rotor blades are approximately 153 ft (47 m) in length. Thus, the maximum height of the turbines from tower base to highest blade tip would be 420 ft (128 m). The turbines would be arranged in four arrays consisting of three in each row (Figure 1). Prior to construction, three temporary met towers will be present on site for a period of up to four months for power-curve testing[1] and dismantled prior to the erection of the turbines. All temporary met towers are guyed. One permanent unguyed 262 ft (80 m) tall met tower would be erected during construction and remain for the duration of the project. This permanent met tower will have a concrete foundation approximately 625 ft^2 (58 m^2) in area.

The proposed project would include construction of a fenced base yard, which would contain three structures – the operations and maintenance (O&M) building, Battery Energy Storage System (BESS) enclosure, and the electrical substation. The single-story O&M building would house operation personnel, wind generating facility controls, and maintenance equipment and spare parts. This building would be 7,000 ft^2 (650 m^2) and have a maximum height of 29 ft (8.8 m). The electrical substation would feed electricity into an existing HECO electrical transmission line and would consist of a control building, 34-kilovolt (KV) column/recloser, transformer, and an "A" frame circuit breaker. The proposed BESS enclosure would be built immediately adjacent to the substation and consist of a 10,675 ft^2 (992 m^2) building roughly 25 ft (7.6 m) high to house the components of the BESS and the HECO Control Room.

The proposed project would involve building three new microwave towers in separate locations to provide secure high-speed communications between Kahuku Wind Power and HECO's system on O'ahu. One of the three towers would be built on-site for transmitting data, control, and protective relaying functions to the HECO substations. This tower would be approximately 30 ft (9.1 m) tall and built on a concrete foundation approximately 144 ft^2 (13.5 m^2) in area.

Two other microwave towers would be erected off-site (Figure 2). One tower would be located at the HECO Waialua Substation in Haleiwa at 66-011 Waialua Beach Road in a rural residential area in Haleiwa. This site is roughly 11.1 mi (17.8 km) from the Kahuku project area. This tower would be approximately 60 ft (18 m) in height and built on a concrete foundation approximately 169 ft^2 (16 m^2) in area. The second new microwave tower would be located on agricultural land at "Flying R Ranch" in Waialua. This site is owned by Waialua Ranch Partners. The Flying R Ranch site is located 13.6 mi (21.9 km) southwest of the Kahuku project area and 2.6 mi (4.2 km) southwest of the Waialua. The height of the Flying R Ranch tower would be approximately 40 ft (12 m). Similar to the Waialua microwave tower, this tower would be built on a 169 ft^2 concrete foundation. Approximately 1,000 linear ft (305 m) of overhead cable, supported on wooden poles approximately 50 ft (15 m) high, would be required to transmit electricity from the nearest existing HECO electrical distribution line to

[1] Power curve testing is a process by which the future performance of individual turbines is predicted by correlating the overall wind measurements at the site over a year or more, to temporary met towers erected at specific turbine sites for a shorter time period, usually on the order of 2-4 months.

the proposed Flying R Ranch microwave tower. This overhead line will be installed, owned and maintained by HECO. Once the installation both microwave towers is completed, HECO will assume the ownership and maintenance of both off-site microwave towers.

Electrical power generated by the WTGs would be transformed and collected through a network of underground and overhead collection circuits. The underground collection cables would total approximately 11,000 linear ft (3,353 m) and would be buried in trenches approximately 3.0 ft (0.9 m) wide and 4.0 ft (1.2 m) deep and backfilled to finish grade. Disturbed areas would be revegetated following excavation and burying of cables.

The overhead segment of the collection system would bring electrical output from the furthest six WTGs to the substation. This segment is overhead rather than underground because of the difficult terrain of the area and the presence of Kalaeokahipa Gulch, which is subject to discretionary U.S. Army Corps of Engineers jurisdiction (see Section 3.4 for details). The overhead cable would be approximately 3,000 linear ft (914 m) and would be supported on approximately 15 new wooden utility poles roughly 45 ft (14 m) in height (Figure 1).

No new transmission lines would be constructed as part of the project; however, HECO would relocate an existing 11-kV electrical distribution line toward the southwestern boundary of the project area to accommodate construction of the WTGs (Figure 1). This existing line is 2,937 linear ft (895 m) long and the relocated line will be 4,217 linear ft (1,286 m) long, approximately 1,280 linear ft (390 m) longer than the existing line. Similar to the existing line, the relocated line will be supported on wooden poles. The relocation of the distribution line would be cleared of vegetation to a width of approximately 15 ft (4.5 m).. All existing transmission lines and distribution lines (including the relocated line) will be owned and maintained by HECO. The collection lines for the WTGs mentioned in the previous paragraph will be owned and maintained by Kahuku Wind Power LLC.

A more detailed description of the project components is provided in the EA.

1.4.3 Purpose and Need for Kahuku Wind Power Project

The purpose of the proposed Kahuku Wind Power project is to reduce the island's dependency on imported fossil fuels by providing an alternative energy source on O'ahu that is renewable. The Hawaiian Islands are largely dependent on imported petroleum, with over 90% of its energy needs supplied from fossil fuels brought from outside of the state (Global Energy Concepts LLC 2006, Rocky Mountain Institute 2008). Approximately $2 billion to $3 billion worth of oil is imported to the state annually (S.B. 2474, S.D. 3, H.D. 2). O'ahu in particular consumes the vast majority of the state's electricity, but generates little electricity from renewable sources. Furthermore, fossil fuel pricing has historically been volatile; fuel prices are subject to fluctuation based on supply and demand conditions, as well as political concerns that can affect the long-term availability of world supply. Reducing the proportion of energy that comes from fossil fuel would also buffer the system from the energy cost fluctuations that accompany volatile oil prices.

In an effort to reduce imports and oil consumption, the State developed Hawai'i's Renewable Portfolio Standards (S.B. 2474, S.D. 3, H.D. 2) and HRS §269-92, which established renewable energy portfolio standards for Hawai'i's electric utilities. According to the renewable portfolio standards established in HRS §269-92, each electric utility company that sells electricity for consumption in the State shall establish a renewable portfolio standard of:

(1) 10% of its net electricity sales by December 31, 2010;
(2) 15% of its net electricity sales by December 31, 2015; and
(3) 20% of its net electricity sales by December 31, 2020.

In January 2008, the State of Hawai'i and the U.S. DOE signed an agreement to establish the Hawai'i Clean Energy Initiative (HCEI), which strives to have 70 % clean, renewable energy for electricity and transportation by 2030. This goal has the potential of reducing Hawai'i's current crude oil consumption by 72% (State of Hawai'i and USDOE 2008).

In order to meet the goals of energy independence and sustainability, renewable energy alternatives need to be developed in Hawai'i. Several wind energy facilities are already operating in the state and new facilities are currently being proposed (Table 1-1). The proposed Kahuku Wind Power project will help the state move toward these goals.

Table 0-1-1. Existing and potential wind energy facilities throughout Hawai'i.

Facility Name	Operator	Energy Generated	Island
Lalamilo Wind Farm	Hawaii Electric Light Company	1.2 MW	Hawai'i
Pakini Nui	Tawhiri Power, LLC	20.5 MW	Hawai'i
Upolu Point	Hawi Renewable Development	10.5 MW	Hawai'i
Kaheawa Wind Power (KWP)	First Wind	30 MW	Maui
Auwahi Wind Project *	Sempra Generation	21 MW	Maui
Kaheawa Wind Power (KWP) II *	First Wind	21 MW	Maui
Kahuku Wind Power *	First Wind	30 MW	O'ahu
Kawailoa Wind Power *	First Wind	50 – 70MW	O'ahu
Na Pua Makani	Oahu Wind PowerPartners LLC	25 MW	O'ahu
Ikaika Wind Power I *	First Wind	50 MW	Moloka'i
Ikaika Wind Power II *	First Wind	200 MW	Moloka'i
Unknown *	Castle & Cooke	200 MW	Lāna'i
Kauai Wind Power *	First Wind	10.5 -15 MW	Kaua'i
* = Potential wind farm Source: http://hawaii.gov/dbedt/info/energy/renewable/wind;http://www.firstwind.com/projects/#hi.			

Furthermore, reducing the consumption of fossil fuel for energy generation would also benefit the environment in a number of ways. The most important of these is the reduction in air pollutant emissions associated with the combustion of fossil fuels, such as carbon dioxide (CO_2), sulfur dioxide (SO_2), and nitrogen oxides (NO_X). These gases are known to contribute to various undesirable environmental effects including global warming and acid rain. Additionally it has been shown that these gases are detrimental to human health and the health of other living organisms. Wind energy technology also reduces water use (U.S. Department of Wind Energy 2008). Additional emission reductions will stem from the elimination of the need to transport petroleum fuels from distant ports to the island.

1.5 List of Preparers

This HCP was prepared by Ling Ong, Ph.D, Paul Sunby, B.S., Tiffany Thair, (M.S. Candidate), Ryan Taira, B.A., Michelle Christy, Ph.D and John Ford, M.S. of SWCA Environmental Consultants. Reviewers include Dave Cowan, Greg Spencer and Robert Roy of First Wind, and the input and guidance provided by Dr. Paula Hartzell and Scott Fretz of DLNR, James Kwon of USFWS, as well as members of the ESRC is gratefully acknowledged.

2.0 DESCRIPTION OF HABITAT CONSERVATION PLAN

2.1 Purpose

The construction and operation of the Kahuku Wind Power wind energy generation facility could potentially adversely impact seven federally listed species and one state listed species that are known or presumed to fly in the vicinity of the project area. These species have the potential to collide with the stationary towers, or be struck by the rotors, resulting in injury or mortality. These species also may collide with guy wires supporting any of the temporary met towers, with the one permanent unguyed met tower, with microwave towers, with the overhead collection lines or relocated distribution line, or may also be harmed during construction or operation activities by the operation of vehicles or heavy equipment. Of the eight species, seven are birds- the threatened Newell's (Townsend's) shearwater or ‘a‘o, and the endangered Hawaiian duck or koloa maoli, Hawaiian stilt or ae‘o, Hawaiian coot or ‘alae ke‘oke‘o, Hawaiian common moorhen or ‘alae ‘ula, Hawaiian petrel or ‘ua‘u, and the state-endangered Hawaiian short-eared owl or pueo. The eighth species is a mammal, the endangered Hawaiian hoary bat or ‘ope‘ape‘a.

These species are protected under the ESA, as amended, or as a state-listed species in the case of the Hawaiian short-eared owl. Because of the documented presence of these species near the proposed facility and the anticipated take in connection with a construction and operation of the proposed project, the Applicant has filed an application for an ITL pursuant to HRS Chapter 195-D. This HCP has been prepared to fulfill application requirements for these permits. Upon issuance of the ITL, the Applicant will be authorized for the incidental take of a limited number of individuals of these eight species in connection with the otherwise lawful construction and operation of the proposed Kahuku Wind Power facility.

The purpose of this HCP also includes the following:

1. To make the most supportable determinations as to the potential impact that the wind energy generation facility could have on each of these listed species;
2. To discuss alternatives to the proposed facility and its design, in terms of these impacts;
3. To propose appropriate efforts to minimize, mitigate, and monitor these potential impacts to the maximum extent practicable;
4. To ensure funding for the completion of these efforts; and
5. To provide for adaptive management and adjustment of the above measures as determined during implementation of the HCP.

2.2 Scope and Term

This HCP seeks to offset the potential impact of the proposed wind energy generation facility on the listed species with measures that protect and provide a net benefit to these species island-wide and statewide. The Applicant anticipates a 20-year project life, throughout which this HCP would be in effect. With monitoring and review by the USFWS and DLNR, the provisions for adaptive management will allow mitigation of project impacts to be adjusted appropriately. Accordingly, this HCP includes provisions for post-construction monitoring and adaptive management to allow flexibility and responsiveness to new information over the life of the project. Monitoring and adaptive management will be coordinated with USFWS and DLNR.

3.0 ENVIRONMENTAL SETTING

3.1 Location, Vicinity, & Climate

The proposed Kahuku Wind Power facility is located on approximately 578 ac (234 ha) in the community of Kahuku in the Koʻolauloa District on the northeastern portion of Oʻahu (TMK 5-6-5:7 and 5-6-005:014). The project area is accessed by Charlie Road via Kamehameha Highway. It is bounded on the east by pasture and agricultural lands along the Kamehameha Highway and on the west and south by agricultural land owned by the State of Hawaiʻi. The north and northwestern portion abuts a ti plantation and a training facility for the Union of Operating Engineers. The southwest portion of the project area is bordered by federal land including the U.S. Army Kahuku Training Range (Figure 1).

Notable nearby land uses include the Turtle Bay Resort, located about 1.4 mi (2.3 km) northwest of the project area, and the Kuilima Wastewater Treatment Plant, located about 1.0 mi (1.6 km) northwest of the project area. In addition, the Kiʻi Unit of the James Campbell National Wildlife Refuge (NWR) is located makai (seaward) of the property about a mile away below Kamehameha Highway. The NWR consists of two wetland units roughly 2.0 miles (3.2 km) apart: the Kiʻi Unit (126 ac or 51 ha) and the Punamano Unit (134 ac or 54 ha). An expansion area was added to the refuge boundary in 2006 to join the existing units. Land will be acquired as funds become available; upon completion the NWR would total approximately 1,100 ac (445 ha). Both the James Campbell NWR and the Kuilima Wastewater Treatment Plant support four federally endangered waterbirds.

Local climatic conditions at the site are characteristic of lowland areas on the windward side of Oʻahu, with relatively constant temperatures and persistent northeast tradewinds. Annual temperatures range from approximately 68.9 to 80.8°F (20.5 to 27.1°C) and annual precipitation is between 37.88 and 40.86 inches (96.2 and 103.8 cm) (NOAA 2002, DBEDT 2007). Due to its location on the northern corner of Oʻahu, Kahuku is considered a high wind energy site (Lau and Mink 2006). Northeasterly trade winds are present nearly 90 % of the year in Kahuku and the southerly Kona winds are present approximately 10 % of the year (Smith, Young & Assoc. 1990).

3.2 Topography and Geology

The topography of Oʻahu is characterized by broad central valleys in the interior portions and tall, steep slopes on the coastal areas as a result of erosion from wind, rain, and sea (Moore 1964, Polhemus 2007). The site is located on a plateau above various low coastal terraces (Hunt and DeCarlo 2000). Inland of the plateau, the land slopes upward into hills and gullies (Hobdy 2007). The topography of the project area consists of incised hillsides that generally increase in elevation to the west. Elevation of the project area ranges from approximately 40 ft (12 m) above mean sea level on the eastern edge to approximately 525 ft (161 m) on the western side. The average elevation is roughly 218 ft (67 m). No significant topographic features are present on-site, although intermittent gulches and gullies formed by agriculture and soil excavation are apparent. Two of these gulches are named, Ohiaʻai Gulch and Kalaeokahipa Gulch.

Oʻahu, the third largest island in the Hawaiian archipelago, was created by several geological processes. These include shield-building volcanism, subsidence, weathering, erosion, sedimentation, and rejuvenated volcanism (Hunt 1996). Oʻahu is mostly composed of the heavily eroded remnants of two large Pliocene shield volcanoes - Waiʻanae and Koʻolau (Juvik and Juvik 1998). The extinct Koʻolau Volcano, which formed about 2.2 to 2.5 million years ago, is comprised of shield lavas, referred to as Koʻolau Basalt, as well as rejuvenated stages, termed the Honolulu Volcanics (Juvik and Juvik 1998, Lau and Mink 2006).

The proposed project is located at the foot of the Koʻolau Mountains, which were created by the Koʻolau Volcano. Eroded shield volcanoes, such as the Koʻolau Volcano, typically have dike complexes of basaltic material associated with active rift zones that extend vertically into the lava flows, inhibiting normal groundwater flow (Hunt 1996). The majority of the project area is underlain by Koʻolau Basalt lava flows ranging from 1.8 to 3 million year old. Older dune deposits, as well as lagoon and reef deposits (limestone and mudstone), are present near the makai boundary of the property.

Exposed coral reef escarpments formed in the northern portion of the project area during a time when the ocean stand was at a higher level. The coral reef escarpments are pocked with shallow overhangs and small caves due to erosion. Consultation meetings and presentations with the public highlighted the rich history of these escarpments. In response to community concerns, Kahuku Wind Power LLC has committed to preserve the coral bluff areas located on the project area, as well as to document the moʻolelo (stories, legends) concerning these areas. Sixty foot (18 m) buffer areas will be placed around these coral escarpment areas.

3.3 Soils

Various soil types developed throughout the Island of Oʻahu as the basaltic lavas and volcanic ash from the volcanoes weathered and decomposed (Juvik and Juvik 1998). Soils on the Island of Oʻahu were classified and defined by the U.S. Department of Agriculture (USDA) Soil Conservation Service and Natural Resource Conservation Service (NRCS) (Foote et al. 1972). Soil types and features identified by the NRCS on-site are summarized in Table 3-1.

Table 3-1. Soil types within the Kahuku Wind Power project area.

Soil Type	Slopes	Key Characteristics	Site Coverage
Paumalu silty clay	8-15%	Permeability moderately rapid; runoff slow to medium; erosion slight to moderate	19.26%
Lahaina silty clay	3-7%	Permeability moderate; runoff: slow; erosion slight.	17.43%
Lahaina silty clay	7-15%	Permeability moderate; runoff medium; erosion moderate.	16.53%
Coral Outcrop		--	11.46%
Paumalu silty clay	3-8%	Permeability moderately rapid; runoff slow; erosion slight	10.14%
Paumalu-badland complex		Permeability moderately rapid; runoff medium to rapid; erosion moderate to severe.	5.55%
Paumalu silty clay	15-25%	Permeability moderately rapid; runoff medium; erosion moderate.	4.68%
Paumalu silty clay	25-40%	Permeability moderately rapid; runoff medium to rapid; erosion moderate to severe.	3.78%
Kaena clay	6-12%	Permeability slow; runoff: slow to medium; erosion slight to moderate.	3.60%
Kemoo-badland complex		Permeability moderate/moderately rapid; runoff medium to rapid; erosion moderate to severe.	1.77%
Kaena very stony clay	10-35%	Permeability slow; runoff medium to rapid; erosion moderate to severe.	1.30%
Kemoo silty clay	12-20%	Permeability moderate/moderately rapid; runoff medium; erosion moderate.	1.24%
Haleiwa silty clay	2-6%	Permeability moderate; runoff slow; erosion slight.	0.81%
Waialua silty clay	3-8%	Permeability moderate; runoff: slow; erosion slight.	0.79%
Kaena stony clay	6-12%	Permeability slow; runoff slow to medium; erosion slight to moderate.	0.60%
Water > 40 ac		--	0.48%
Paumalu silty clay	40-70%	Permeability moderately rapid; runoff rapid; erosion severe.	0.31%
Waialua silty clay	0-3%	Permeability moderate; runoff: slow; erosion slight.	0.21%
Kemoo silty clay	6-12%	Permeability moderate/moderately rapid; runoff medium; erosion: slight to moderate.	0.06%
Source: Foote et al. (1972).			

Soils on-site generally consist of well-drained silty clay soils that developed in old alluvium and colluvium derived from basic igneous rock. Only a thin layer of friable, red soil material can be found within the cracks, crevices, and depressions of the coral outcrop. A narrow strip of alluvial sand and gravel underlies a portion of the property, roughly bisecting the middle of the project area. Large areas of the property are devoid of topsoil due to erosion associated with past land uses, such as sugar cultivation, grazing, and soil excavation. Between 1987 and 1991, approximately 47 ac (19 ha) of soil was excavated from portions of the site for use as fill material for the Arnold Palmer Golf Course at the Turtle Bay Resort (Belt Collins Hawaii Ltd. 2007).

3.4 Hydrology, Drainage, and Water Resources

3.4.1 Surface water

Hydrologic processes in Hawai�much are often highly dependent on the climatic and geological features of the area. For example, stream flow is influenced by rainfall and wind patterns. The majority of the perennial streams on O‘ahu (84%) are located in the Ko‘olau Mountains because the prevailing trade wind patterns produce a larger amount of precipitation compared to the leeward side (Polhemus 2007). Permeable underlying rock may also cause some streams on O‘ahu to have lengthy dry reaches under natural conditions. Streams in the Kahuku area are considered to be naturally intermittent (Polhemus et al. 1992) and are typically short and steep, with permeable upland soils creating rapid infiltration into the Ko‘olau aquifer.

Three intermittent streams occur on portions of the property. Ohia‘ai Gulch drains along the eastern boundary of the property, Kalaeokahipa transverse the northwestern portion, and an unnamed headwater tributary to James Campbell NWR parallels Nudist Camp Road, which is makai of Kamehameha Highway (Figure 3). Various other drainage gulches occur on the lowland area makai of the proposed Kahuku Wind Power facility.

Naturally occurring wetlands are situated along the coastal Kahuku plain. The James Campbell NWR is composed of two lowland marsh and pond complexes. The Ki‘i Unit is a remnant of a formerly larger marsh that has been drastically modified by agriculture. Seven ponds occur within the unit and the primary water source is an artesian well. The Punamano Unit of the refuge consists of a north and south pond that are intermittently connected and naturally fed by rainfall, springs, and seepage (USFWS 2002).

In the late 1970s, the USFWS Division of Ecological Services biologists used orthophoto quadrangle maps and spot field checks to map wetlands in Hawai‘i as a part of the National Wetlands Inventory (NWI) Program according to the Cowardin et al. (1979) classification system. According to the USFWS definition, three wetlands occur within the project area; Ohia‘ai Gulch/Ki‘i Ditch, Kalaeokahipa Gulch, and an unnamed headwater tributary to James Campbell NWR (paralleling Nudist Camp Road). All of these were described by USFWS as being palustrine, forested, broad-leafed evergreen, seasonal (PFO3C) wetlands. In addition, the lower reach of Ohia‘ai Gulch/Ki‘i Ditch, outside of the project boundary, is classified as palustrine, emergent, persistent, seasonally flooded, excavated (PEM1Cx).

SWCA biologists conducted a wetland assessment in the project area to identify any wetlands or other waters subject to U.S. Army Corps of Engineers (Corps) jurisdiction under Section 404 of the Clean Water Act. No permanent surface water is present in the project area, and no wetlands meeting the three established criteria of hydrophytic vegetation, hydric soils, and water regime were found to occur within the property boundaries (SWCA 2008). Small areas of standing water have been observed to occur on site and remain for several days after a period of heavy rains. These areas of standing water are located in a low-lying pasture where topsoil had been excavated historically. They do not exhibit the necessary soils or vegetation characteristics to be regulated as wetlands. Two intermittent gulches that cross the site, Ohia‘ai Gulch (along the eastern boundary) and Kalaeokahipa Gulch (across the northwestern portion), are subject to discretionary Corps jurisdiction because of their “significant nexus” to the waters at the James Campbell NWR (Figure 3) (J. Anamizu, pers. comm.). Thus, activities involving the discharge of dredge and fill materials into these waters would require a permit from the Corps.

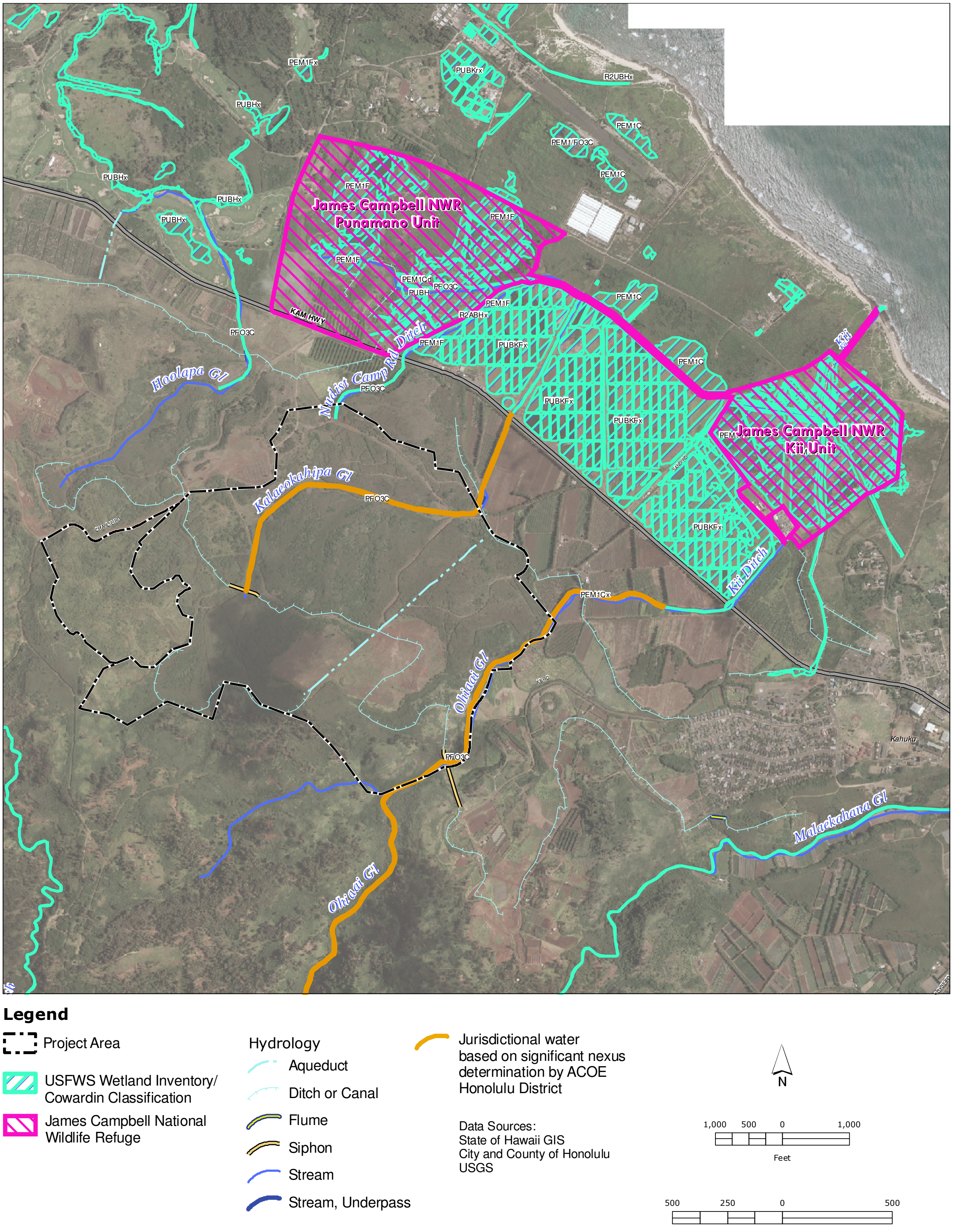

Figure 3. Jurisdictional Waters.

3.4.2 Flooding

The Flood Insurance Rate Maps (FIRM) prepared by the Federal Emergency Management Agency's National Flood Insurance Program depicts flood hazard areas through the state. The maps classify land into four zones depending on the expectation of flood inundation. The project area is entirely located in Flood Zone D where analysis of flood hazards has not been conducted and flood hazards are undetermined.

Surface water generally drains from the southwest to northeast on the Kahuku Wind Power project area (Belt Collins Hawaii Ltd. 2007). Areas of standing water after heavy rainfall have been observed on the property. In order to reduce the risk for waterbirds, Kahuku Wind Power intends to grade these areas during construction to improve drainage and prevent standing water from collecting after heavy rain.

3.4.3 Groundwater

O'ahu has a vast amount of groundwater, which supplies most of the domestic water supply (Macdonald and Abbot 1970, Lau and Mink 2006). Groundwater in Kahuku is part of the Ko'olauloa Aquifer system of the Windward Aquifer sector that extends from Punalu'u Valley to Kahuku Point (Mink 1982). This aquifer primarily occurs as a basal freshwater lens in the dike-free Ko'olau Basalt and overlying unconsolidated and consolidated sedimentary deposits. Salinity is less than 250 milligrams per liter chloride [mg/l Cl^-]. It is currently used for drinking water, but has a high vulnerability to contamination (Belt Collins Hawaii Ltd. 2007a).

Depth to groundwater on-site is estimated to range from approximately 20 to 400 ft (6 to 122 m) below ground surface (Belt Collins Hawaii Ltd. 2007). Regionally, groundwater moves from the volcanic-rock aquifers into the overlying sedimentary deposits and eventually discharges to the ocean. The precise direction of groundwater flow beneath the property is not known (Belt Collins Hawaii Ltd. 2007). Mean annual groundwater recharge in the Ko'olau region due to rainfall infiltration is approximately 3.8 million gallons per day (mgd); however, ground water flow through the area is anticipated to be higher due to inflow from the adjacent dike complex (Miller et al. 1999).

3.5 Environmental Contaminants

A Phase I Environmental Site Assessment (Phase I) was conducted for the Kahuku Wind Power project area by Belt Collins Hawaii Ltd. (2007) to identify potential hazardous substances and environmental contaminants. This assessment consisted of a site reconnaissance, review of appropriate federal and State regulatory lists and databases, review of maps/photographs, and interviews with past and present owners.

The Phase I did not reveal evidence of recognized environmental contaminants or hazardous conditions on the property; however, there was insufficient information on several past on-site activities that are likely to have used petroleum products and/or hazardous substances. These activities include sugar cane and pineapple cultivation, earth moving, and military activities (Belt Collins Hawaii Ltd. 2007).

Operation of the facility will require the use of several materials that require special handling and storage (e.g., mineral oil, hydraulic oil, waste oil, and cleaner/degreaser). More detailed information on these materials will be provided in the EA.

3.6 Land Use Designations

Under The State Land Use Law (Act 187), Hawai'i Revised Statute (HRS) Chapter 205, all lands and waters in the State are classified into four districts: Agriculture, Rural, Conservation, and Urban. Conservation Districts, under the jurisdiction of DLNR, are further divided into five subzones: Protective, Limited, Resource, General and Special (Hawai'i Administrative Rules, Title 13, Chapter 5). The State of Hawai'i Land Use District Boundaries are governed by the City and County Land Use

Ordinance. The proposed project area and surrounding areas are designated as an Agricultural by the State of Hawaiʻi Land Use District Boundaries Map (Figure 4).

Lands mauka of the project area are zoned as Conservation and are owned by the federal government (Kahuku Military Training Area). Further inland, the state owns more Conservation district land (Pupukea-Paumalu Forest Reserve). The subzone designation for both of these areas is Resource. Lands across Kamehameha Highway from the project area, including the James Campbell NWR, are defined as Conservation land and are subzoned General (Figure 4).

The Oʻahu General Plan is a comprehensive document with objectives and policies to address the physical, social, economic, and environmental concerns affecting the City and County of Honolulu. The City and County of Honolulu is further divided into eight regional areas that are guided by Development Plans or Sustainable Communities Plans (SCPs). Kahuku is located in the Koʻolau Loa Sustainable Community Plan area. The Koʻolau Loa SCP (DPP 1999) is one of eight geographically oriented plans intended to guide public policy, investment, and decision-making through 2020. In cooperation of the Oʻahu General Plan, this plan provides a policy context for land use, budgetary actions, and decisions made by the private sector. Land use maps within the Koʻolau Loa SCP depict the area as Agriculture (DPP 1999). An update of the Koʻolau Loa SCP is currently in progress.

In addition, land use is dictated by zoning ordinances from the City and County. The City and County of Honolulu zoning ordinance defines the area as AG-1 Restricted Agricultural District. This designation is intended to preserve "important agricultural lands" for agricultural functions such as the production of food, feed, forage, fiber crops, and horticultural plants (City and County of Honolulu, Land Use Ordinance, Chapter 21). A wind farm is permitted in this zoning area with a Conditional Use Permit (CUP) (City and County of Honolulu, Land Use Ordinance, Chapter 21, Section 5.700). Adjoining land is also zoned AG-1 Restricted or AG-2 General. AG-2 applies to agricultural lands with a minimum lot size of 2 acres (0.81 ha).

More information on land use policies and plans are provided in the EA.

3.7 Flora

3.7.1 Flora Within the Project Area

Botanical surveys of the Kahuku Wind Power project area were conducted by Robert Hobdy in April 2007 and July 2009 (Appendix 1 and 11). Hobdy walked a series of routes throughout the property and more intensively examined areas most likely to support native or rare plants (e.g., gullies or rocky outcrops). A supplemental wetland plant survey was conducted by SWCA botanists in June 2008. Approximately 128 plant species were recorded during the survey by Hobdy in 2007 and an additional four species were found during the later survey by SWCA (2008). In 2009, Hobdy recorded approximately 99 plant species in a 68.5 ac (27.7 ha) area within the project area. No state or federally listed endangered, threatened, or candidate plant species, nor species considered rare throughout the Hawaiian Islands, were found in the project area by Hobdy or SWCA.

The majority of the project area (about 80%) is covered with dense brush or trees and the abundant and common plants are non-native to the Hawaiian Islands. In general, vegetated areas are mostly comprised of dense koa haole (*Leucaena leucocephala*) trees with a mix of grasses and herbaceous plants in the understory. Cocklebur (*Xanthium strumarium*), allspice (*Pimenta dioica*), sourgrass (*Digitaria insularis*), kolomona (*Senna surratnesis*), pitted beardgrass (*Bothriochloa pertusa*), Chinese violet (*Asystasia gangetica*), Christmas berry (*Schinus terebinthifolius*), parasol leaf tree (*Macaranga tanarius*), common beggarticks (*Bidens alba*), sourbush (*Pluchea carolinensis*), lantana (*Lantana camara*), Jamaica vervain (*Stachytarpheta jamaicensis*), and pea aubergine (*Solanum torvum*) are some of the other common species through the area. A comparatively large clearing is present in the southwest portion of the project area where topsoil was removed for use on the aforementioned golf course, and other smaller open areas are scattered throughout.

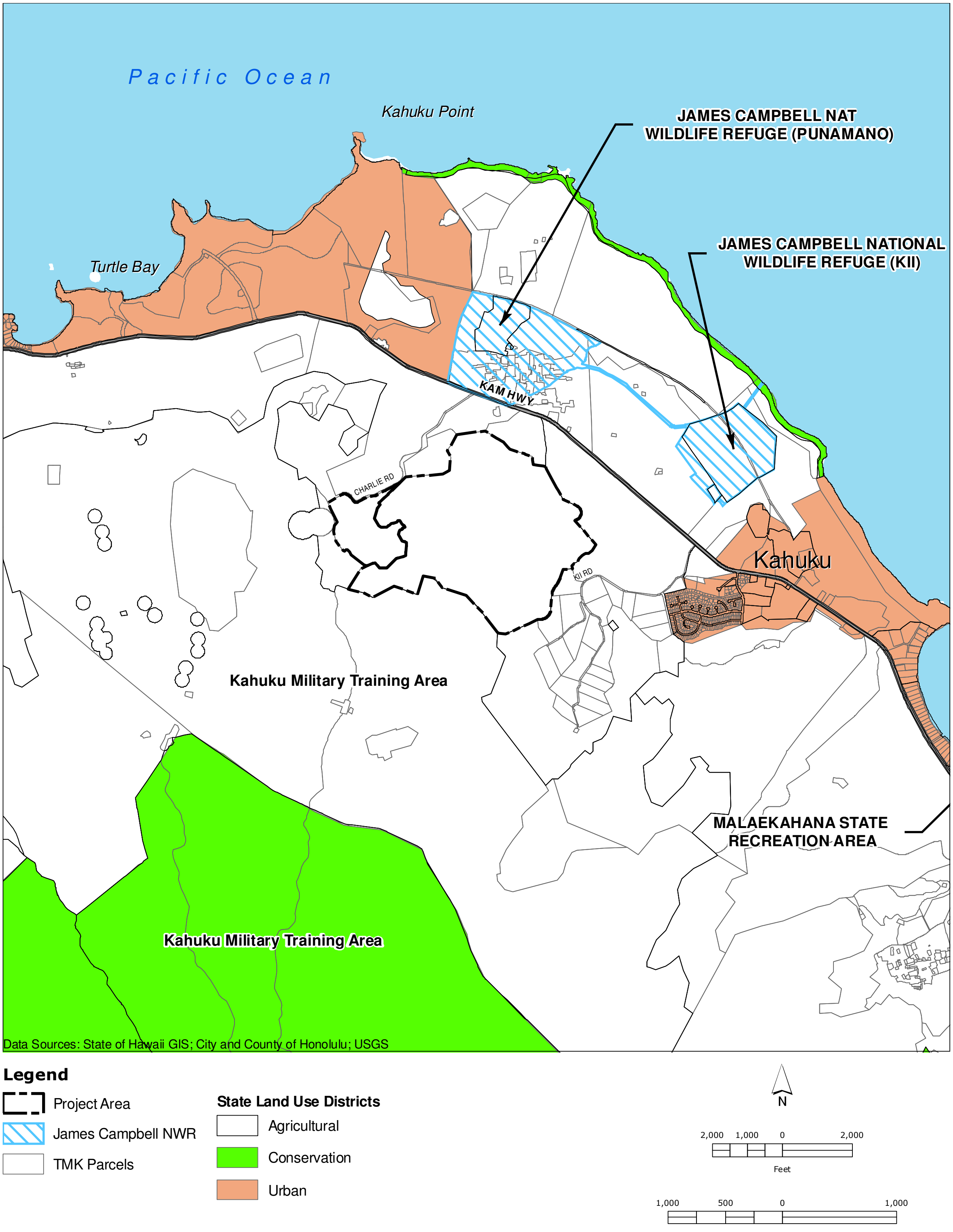

Figure 4. State of Hawai`i Land Use Boundaries Map.

Few native plant species exist on-site as a result of topsoil disturbance from sugar production and cattle grazing. Native species are generally located on rocky outcrops and on exposed ridge tops in the upper portion of the property (SWCA 2008). Of the 12 native plants that occur in the project area, only three are endemic to the Hawaiian Islands – ʻakia (*Wikstroemia oahuensis*), niʻaniʻau (*Nephrolepis exaltata* subsp. *hawaiiensis*), and kīlau (*Pteridium aquilinum* var. *decompositum*). Table 3-2 lists other native plant species recorded in the project area by Hobdy (2007, 2009) and SWCA (2008).

Table 3-2. Native Hawaiian plants observed in the project area.

Scientific Name	Common, Hawaiian Name(s)	Status[1]	Abundance[2]
FERNS AND FERN ALLIES			
DENNSTAEDTIACEAE			
Pteridium aquilinum (L.) Kuhn var. *decompositum* (Gaudich.) R.M. Tryon	kīlau	E	rare
LINDSAEACEAE			
Sphenomeris chinensis (L.) Maxon	palaʻā	I	rare
NEPHROLEPIDACEAE			
Nephrolepis exaltata (L.) Schott subsp. *hawaiiensis* W.H.Wagner	niʻaniʻau	E	rare
MONOCOTS			
POACEAE			
Chrysopogon aciculatus (Retz.) Trin.	piʻi piʻi	I	uncommon
Heteropogon contortus (L.) P. Beauv. ex Roem. & Schult.	pili	I	uncommon
DICOTS			
MENISPERMACEAE			
Cocculus orbiculatus (L.) DC	huehue	I	X
PIPERACEAE			
Peperomia blanda Kunth var floribunda (Miq.) H.Huber	ʻalaʻala wai nui	I	rare
PLUMBAGINACEAE			
Plumbago zeylanica L.	ʻilieʻe	I	rare
ROSACEAE			
Osteomeles anthyllidifolia (Sm.) Lindl.	ʻūlei	I	rare
SOLANACEAE			
Solanum americanum Mill.	popolo	I	rare
STERCULIACEAE			
Waltheria indica L.	ʻuhaloa	I	uncommon
THYMELAEACEAE			
Wikstroemia oahuensis (A. Gray) Rock	ʻakia	E	uncommon

(1) E= endemic (native only to Hawaiʻi); I= indigenous (native to Hawaiʻi and elsewhere).
(2) Common= widely scatted throughout the project area or locally abundant; uncommon= scattered sparsely throughout the project area or occurring in a few small patches; rare= only a few isolated individuals at the project area; X = observed by SWCA, but abundance not recorded.

Following construction, Kahuku Wind Power LLC intends to improve the project area using suitable ground cover. Where practical, native species can be used to stabilize bank slopes along any constructed access roads or cut and fill slopes within the project area. Hodby (2007) suggested that the more resilient native species, such as ʻūlei, ʻakia, and ʻilieʻe, might be considered for out-planting. The Applicant has had significant success implementing a native plant re-establishment program at the Kaheawa Wind Power (KWP) facility on Maui (First Wind and Kaheawa Wind Power 2008). Although native species may be re-introduced where feasible, the primary goal of the revegetation would be to immediately stabilize soil and prevent erosion following construction.

3.7.2 Flora at Off-site Microwave Tower Locations

The Waialua Substation tower would be located in a fenced area that is completely paved or covered in gravel. Landscaped areas are present outside of the fenced area.

SWCA conducted a botanical survey of the Flying R Ranch off-site microwave tower site in December 2009. No state or federally listed endangered, threatened, or candidate plant species were observed during the survey, nor were any species considered rare throughout the Hawaiian Islands (T. Thair/SWCA, personal observation). The area is dominated by non-native species including Java plum (*Syzygium cumini*), Guinea grass (*Urochloa maxima*), and maile honohono (*Ageratum conyzoides*). Only one native species (*Dodonea viscosa*) was observed in the vicinity, roughly 85 ft (26 m) from where the microwave tower foundation would be constructed. A complete list of the plant species documented at the Flying R Ranch site is included in Appendix 12.

Vegetation that would be disturbed at the off-site microwave tower sites consists of non-native species common throughout Oʻahu and the main Hawaiian Islands. Due to the overall lack of native plant species at the off-site microwave tower sites, there would be no impacts to flora as a result of construction or operation of the two towers.

3.8 Wildlife

3.8.1 Wildlife Within and Around the Project Area

Wildlife occurring on or flying over the project area has been investigated by Kahuku Wind Power LLC and its consultants through avian point count surveys, nocturnal radar surveys, and the use of night vision equipment and bat detection devices. To our knowledge, no other wildlife surveys have been conducted on-site. The methodology and results of these wildlife investigations are discussed below.

Avian point count surveys were conducted between October 2007 and December 2008 for a total of 65.3 observation hours. Point count surveys were conducted by Kahuku Wind Power LLC from October 2007 to May 2008, and by SWCA from June 2008 to December 2008. Ten point count stations were established on the site (Figure 5) and four to eight point count stations were surveyed during each session. Sessions were conducted in the morning (0600 – 1000 h), afternoon (1000 – 1400 h) and evening (1400 – 1800 h). Each point count lasted 20 minutes per station. Three point counts were also conducted at adjacent wetlands located 1,640 to 3,280 ft (500 to 1,000 m) makai of the Kahuku Wind Power project area to describe the flight activity of endangered Hawaiian waterbirds due to the few observations recorded at the established on-site point count locations. This was an effort to gain a better understanding of the activity patterns of the endangered species covered by the HCP, particularly those known to occur at the nearby James Campbell NWR (the Hawaiian stilt, Hawaiian coot, Hawaiian duck and Hawaiian moorhen), as well as to document the arrival and activity patterns of non-listed migratory bird species.

All passerines, owls (Strigiformes) and doves (Columbiformes) within a 656-ft (200 m) radius of the count location were recorded. Bird species aurally detected within 200 m radius were also recorded. Waterbirds and seabirds, which are larger and more visible, were recorded to within a 1,312-ft (400 m) radius of the count station. Data recorded during surveys included time of day, bird species, size of flock, flight direction, flight altitude, distance of bird from observer, habitat, location (on-site or off-site), and sex and age of bird, if possible. Single occurrences of birds detected during surveys, whether individuals or flocks, are hereafter referred to in this document as “flights.” Weather variables recorded were wind speed, wind direction, cloud cover, visibility, and precipitation. Mammals observed incidental to the bird surveys were also recorded during each point count survey.

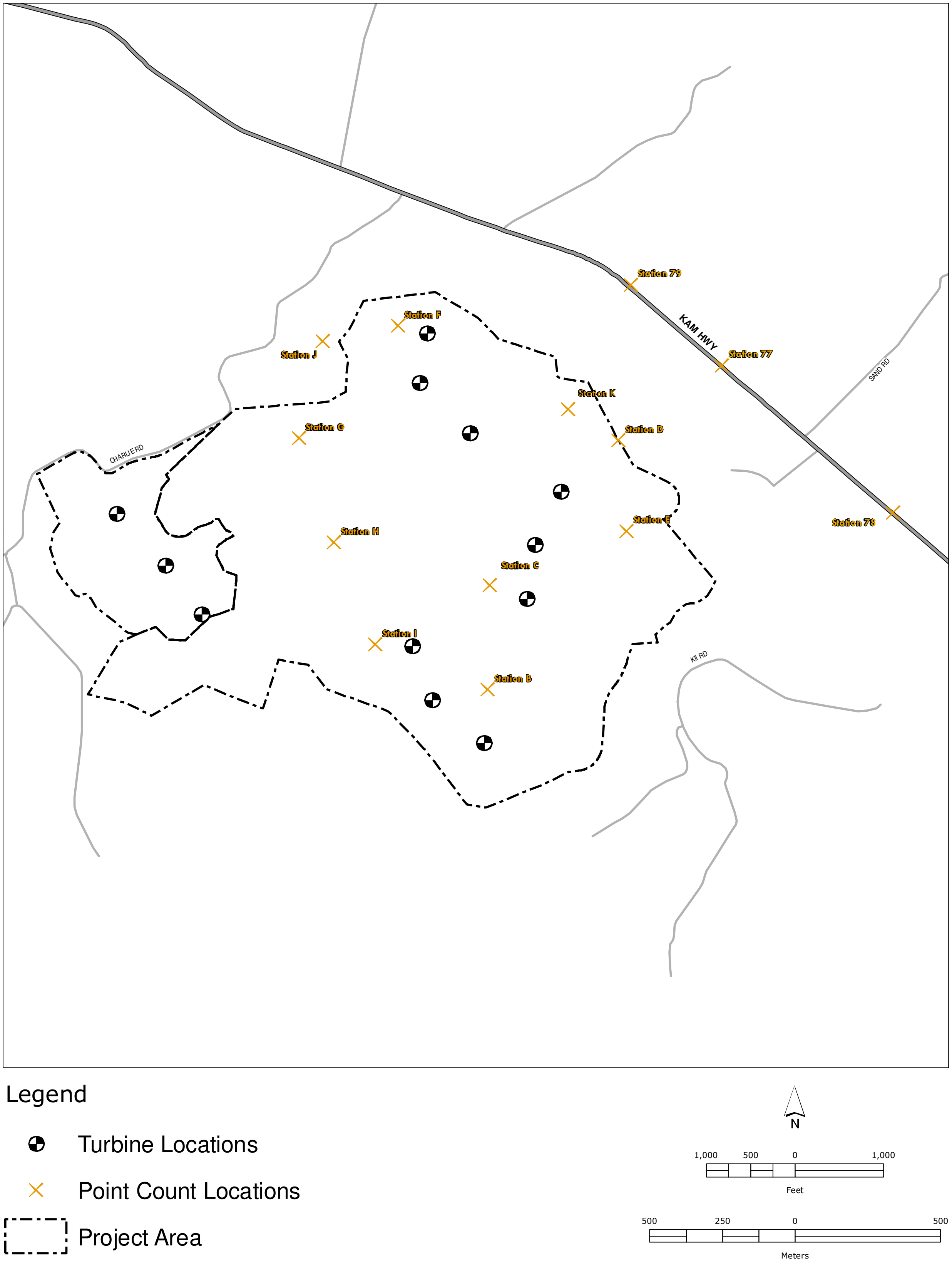

Figure 5. Bird Point Count Stations.

A total of 23 bird species were observed during the point count surveys on and adjacent to the Kahuku Wind Power project area, 19 of which are introduced species. *Anas* ducks that may have been the endangered Hawaiian Duck were observed flying over a portion of the site during the point count surveys. However, Hawaiian ducks on O'ahu have hybridized with feral mallards (*Anas platyrhynchos*) and the exact genetic identity of *Anas* ducks on O'ahu has been questioned. Details on the Hawaiian duck and the hybridization issue are discussed in Section 3.8.4.3.

Anas ducks were also detected at the points surveyed in wetlands adjacent to the project area, as were some Hawaiian stilts and Hawaiian coots. One adult female Hawaiian stilt carcass was found beneath a temporary met tower within the project area, but necropsy results have indicated that the bird was emaciated with a high parasite load and collision with the met tower was not considered the cause of death (K. Swindle, pers. comm.). No Hawaiian moorhens were detected during the point count surveys, although this species is known to occur at the James Campbell NWR. The Hawaiian short-eared owl, which is listed by the state as endangered on O'ahu, is also known to occur at James Campbell NWR.

Nocturnal radar surveys were conducted on site in summer 2007 (five evenings, 1800-2100 h, October 16-20) and fall 2008 (eight evenings, 1800-2100h, and mornings, 0400-600h from 1-8 July) in an effort to identify seabirds that may potentially transit the Kahuku Wind Power project area during crepuscular and night periods. The fall surveys coincide with the Hawaiian petrel and Newell's shearwater fledgling periods and the summer surveys coincide with the incubation periods for both species.

Birds documented on-site or flying over the Kahuku Wind Power project area during the radar surveys that were not detected on point count surveys included probable Newell's shearwater, Hawaiian short-eared owl, and barn owl (*Tyto alba*). Criteria used to establish the detection of shearwaters/petrels were based on identifying targets on radar flying at airspeeds greater than 30 mi/h, of the appropriate size, flying inland or seaward only (not parallel to shore) and exhibiting directional flight. As discussed in Section 3.8.4.1, timing of radar detections was used to tentatively identify these birds as Newell's shearwaters rather than Hawaiian petrels. The Hawaiian short-eared owl was heard by the radar technicians and the barn owl visually sighted and identified. Hawaiian short-eared owl is discussed in Section 3.8.4.7.

Table 3-3 identifies all birds detected during the point count and radar surveys. Included in this table are scientific and common names of each species as standardized by the American Ornithologists' Union, biogeographical status of each species throughout Hawai'i, federal listing status, indication of whether the observed species is protected by the MBTA, and indication of whether the species was detected on-site, off-site, or both.

Other non-listed bird species observed on or flying over the Kahuku Wind Power project area that are protected under the MBTA include the barn owl, great frigatebird (*Fregata minor*), cattle egret (*Bubulcus ibis*), Pacific golden-plover (*Pluvialis fulva*), ruddy turnstone (*Arenaria interpres*), northern cardinal (*Cardinalis cardinalis*), and house finch (*Carpodacus mexicanus*). However, the cattle egret, barn owl, northern cardinal, and house finch, while resident on the island, are non-native. Other non-listed birds protected by the MBTA that were detected at points in the adjacent wetlands, but not on the Kahuku Wind Power project area, include wandering tattler (*Heteroscelus incanus*) and sanderling (*Calidris alba*). Migratory shorebirds were first detected in fall in September and last detected in spring in May.

Nocturnal visual surveys were also conducted twice a month from October 2007 to December2008 for a total of 18 observation hours. Four to eight point counts were surveyed for 20 minutes each field session. The point count locations used were the same as bird point count locations. Night vision goggles (Kerif ITT PVS-7 F5001 Series) and infra-red spotlights (Brinkmann Q-beam Max Million III) were used and provided ability to detect bats out to a distance of 100 ft (30 m) from the observer. No bats were detected visually during these observations.

Table 3-3. Birds detected on and adjacent to Kahuku Wind Power project area during point count and radar surveys.

Scientific Name	Common Name	Status[1]	Protection		Observed[2]	
			ESA/ State	MBTA	On-Site	Adjacent Wetlands
Puffinus auricularis newelli	Newell's shearwater[3]	E	T	X	X (F)	
Fregata minor	great frigatebird	I		X	X (F)	X
Bubulcus ibis	cattle egret	NN		X	X	X
Anas sp.	Hawaiian (?) duck hybrid			X	X (F)	X
Himantopus mexicanus knudseni	Hawaiian stilt, ae'o	E	E		*	X
Fulica alai	Hawaiian coot	E	E	X		X
Phasianus colchicus	ring-necked pheasant	NN			X	X
Pluvialis fulva	Pacific golden-plover	V		X	X	X
Arenaria interpres	ruddy turnstone	V		X	X	X
Heteroscelus incanus	wandering tattler	V		X		X
Calidris alba	sanderling	V		X		X
Streptopelia chinensis	spotted dove	NN			X	X
Geopelia striata	zebra dove	NN			X	X
Tyto alba	barn owl	NN		X	X	
Asio flammeus sandwichensis	Hawaiian short-eared owl	E	X[4]	X	X	
Pycnonotus cafer	red-vented bulbul	NN			X	X
Pycnonotus jocosus	red-whiskered bulbul	NN			X	
Cettia diphone	Japanese bush warbler	NN			X	
Copsychus malabaricus	white-rumped shama	NN			X	
Acridotheres tristis	common mynah	NN			X	X
Zosterops japonicus	Japanese white-eye	NN			X	
Cardinalis cardinalis	northern cardinal	NN		X	X	
Paroaria coronata	red-crested cardinal	NN			X	X
Carpodacus mexicanus	house finch	NN		X	X	X
Passer domesticus	house sparrow	NN			X	X
Estrilda astrild	common waxbill	NN			X	X
Padda oryzivora	*Java sparrow*	NN			X	
Lonchura cantans	African silverbill	NN			X	
Lonchura punctulata	nutmeg mannikin	NN			X	
Lonchura malacca	chestnut munia	NN			X	

[1] E = endemic; I = indigenous, V = visitor; NN = non-native permanent resident
[2] X = Detected during surveys; F = only detected flying over site; * downed bird collected
[3] Identification inferred from interpretation and timing of radar data
[4] Endangered for the State of Hawaii only

Three to five Anabat detectors (Titley Electronics, NSW, Australia) were deployed at various locations at Kahuku Wind Power beginning April 2008 to present (Figure 6). Anabat detectors were moved monthly to new locations if no bat calls were detected during the previous month. A low but consistent level of bat activity was recorded at Anabat detectors throughout the year with a slight increase in activity from June to September (see Appendix 4 and section 3.8.4.8). In July 2008, one bat was visually detected flying during the previously discussed radar surveys.

3.8.2 Non-Listed Wildlife Species

In addition to federally and state listed species, the vegetation in the project area provides habitat to other endemic, indigenous, and non-native birds, migratory species, and several introduced mammals. Key avian species (i.e. waterbirds and seabirds) that occur in the vicinity of the project area are discussed below.

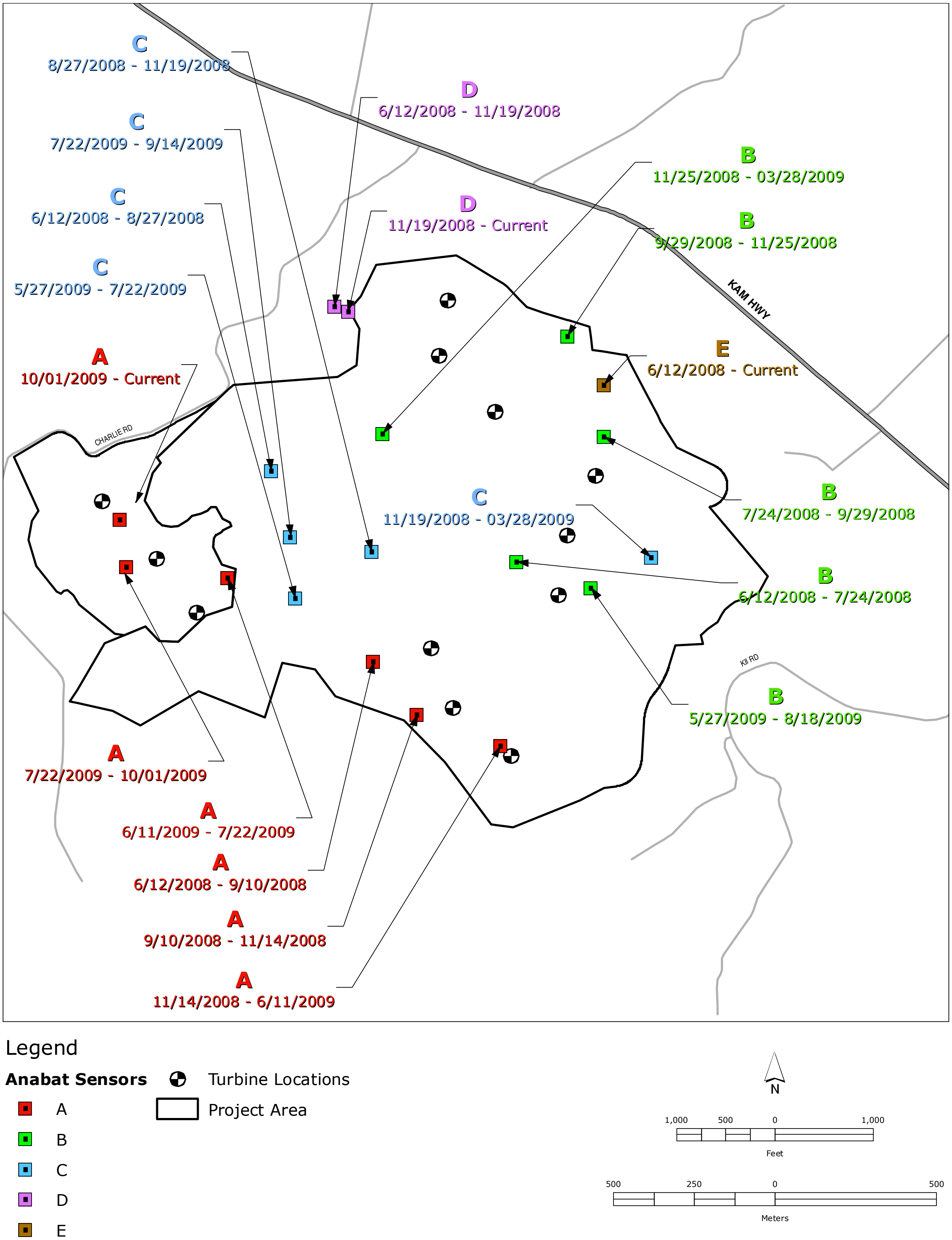

Figure 6. Anabat Sensor Locations and Dates of Deployment.

3.8.2.1 Herons and Egrets

The indigenous black-crowned night-heron (*Nycticorax nycticorax*) is a cosmopolitan species resident on the main Hawaiian Islands (Pratt et al. 1987, Hawaii Audubon Society 2005). The black-crowned night-heron was identified as a species of "Moderate Concern" in *The North American Waterbird Conservation Plan* (Kushlan et al. 2002). Populations of species given this designation are declining with moderate threats or distribution, stable with known or potential threats and moderate to restricted distributions, or are relatively small with relatively restricted distributions. In Hawai'i, this species is considered a nuisance by aquaculture farmers. A concentration of this species occurs at the Ki'i Unit of the James Campbell NWR because of the abundance of potential prey (e.g., crustaceans, insects, fish, and frogs) at the NWR and within nearby aquaculture farms (Mitchell at el. 2005). Between 2001 and 2006, an average of 13 birds were recorded per month at the Ki'i Unit (USFWS, unpubl. data). No black-crowned night-heron were observed at Kahuku Wind Power during any of the avian surveys and they are not expected to occur on the site owing to a lack of suitable wetland habitat. Potential exists for individuals of this species to occasionally fly over the project area, especially the lower elevation makai portions.

The cattle egret was introduced to Hawai'i from Florida for insect control in the mid 20th century and has become a widespread species across the main Hawaiian Islands. This species was identified as "Not Currently At Risk" in *The North American Waterbird Conservation Plan* (Kushlan et al. 2002). On O'ahu, large concentrations of this species can be found at Pearl Harbor, Kaneohe Bay, and Kahuku. Cattle egrets eat a wide variety of prey including insects, spiders, frogs, prawns, mice, crayfish, and the young of native waterbirds (Pratt et al. 1987, Telfair 1994, Robinson et al. 1999, Brisbin et al. 2002, Engilis et al. 2002, Hawaii Audubon Society 2005, USFWS 2005a). Cattle egrets were observed regularly during the avian surveys at Kahuku Wind Power and accounted for approximately 17% (5.36 flocks/hr/point count) of all flights observed on site.

3.8.2.2 Seabirds

The indigenous wedge-tailed shearwater (*Puffinus pacificus*) is common throughout the tropical and subtropical Pacific and Indian Oceans. Worldwide, over one million breeding pairs are believed to occur. The species was identified as of "Low Concern" in *The North American Waterbird Conservation Plan* (Kushlan et al. 2002). Populations of species designated of "Low Concern" are either stable with moderate threats and distribution, or are increasing or stable, but with known or potential threats and moderate to restricted distributions. The species is considered of least concern in the Pacific because of its wide distribution and population size (USFWS 2005b).

Over a quarter of the population of this species (275,000 pairs) breeds in the Hawaiian Islands (Whitton 1997, USFWS 2005b). On O'ahu, wedge-tailed shearwaters are known to nest at Ka'ena Point, Mokapu Peninsula, Kupikipikio Point, Mālaekahana State Recreation Area, and the Kahuku Golf Course. Wedge-tailed shearwaters also nest at five offshore State Seabird Sanctuaries around O'ahu (Moku'auia, Kīhewamoku, Pulemoku, Kukuiho'olua, and Mokuālai) (Smith et al. 2002, Mitchell et al. 2005). To date, no wedge-tailed shearwaters have been seen flying over the Kahuku Wind Power project area. Wedge-tailed shearwaters typically excavate ground burrows for nesting, but will also nest on the ground surface (USFWS 2005b). The main threats to wedge-tailed shearwaters nesting on O'ahu are predation by introduced mammalian predators and human disturbance by trampling burrows (Mitchell et al. 2005). Young birds are also threatened by urban lighting. On the northern tip of O'ahu, young shearwaters have been observed flying into lights while leaving their colonies in the late fall. A wedge-tailed shearwater rescue plan has been developed by the Turtle Bay Resort in the case that downed birds are found on resort grounds (Kusao & Kurahashi, Inc. 2003).

Laysan albatross (*Diomedea immutabilis*) have consistently been observed during bird surveys conducted by USFWS makai of the Kahuku Wind Power project area at the Ki'i Unit of the James Campbell NWR (USFWS, unpubl. data). This species is considered of "High Concern" by the *Regional Seabird Conservation Plan* (USFWS 2005b) and *The North American Waterbird Conservation Plan* (Kushlan et al. 2002). Populations of species identified as "High Concern" are known or thought to be declining and have some other known or potential threats.

Approximately 93% of the breeding pairs of Laysan albatross occur on Midway and Laysan Islands. Some albatrosses are known to nest at Ka'ena Point and have attempted to nest at Dillingham Airfield, Kahuku Golf Course, and the Marine Corps Base Hawai'i in Kaneohe on O'ahu (USFWS 2005b). In the past, Laysan albatross have also attempted unsuccessfully to nest at Kahuku Point (VanderWerf, pers. comm.). This species typically nests on beaches and other low grounds generally near the ocean.

To date, no Laysan albatross have been seen flying over the Kahuku Wind Power project area. Potential for Laysan albatross to fly over the site appears to be extremely low because this species nests near water and otherwise stays at sea.

3.8.2.3 Other Birds

For centuries, migratory ducks, geese, and other waterfowl have wintered on the Hawaiian Islands. Table 3-4 provides a list of migratory waterfowl that have been observed utilizing the James Campbell NWR. The indicated fulvous whistling-duck (*Dendrocygna bicolor*) established a small temporary breeding population at the refuge (Pratt et al. 1987, Hawaii Audubon Society 2005), but was last observed in December 2001 (USFWS 2002).

James Campbell NWR is also an important wintering ground for shorebirds in the Hawaiian Islands (Engilis and Naughton 2004). Shorebirds primarily utilize wetlands and tidal flats; however, estuaries, grasslands, uplands, beaches, golf courses, and even urban rooftops are important habitats for some species (Engilis and Naughton 2004). O'ahu offers the most diverse shorebird habitat of all the Hawaiian Islands. Threats to shorebirds in the Pacific region include habitat loss (urban, industrial, military, agricultural, recreational development), invasive plants, non-native animals (predation, disease, competition), human disturbance, and environmental contaminants (Engilis and Naughton 2004). Species of shorebirds that have been observed at James Campbell NWR are listed in Table 3-5.

Table 3-4. Migratory waterfowl observed on the nearby James Campbell NWR.

Scientific Name	Common Name
Dendrocygna bicolor	fulvous whistling-duck
Anser albifrons	greater white-fronted goose
Chen caerulescens	snow goose
Branta bernicla	black brant
Branta canadensis	Canada goose
Anas crecca	green-winged teal
Anas platyrhynchos	mallard
Anas acuta	northern pintail
Anas querquedula	garganey
Anas discors	blue-winged teal
Anas cyanoptera	cinnamon teal
Anas clypeata	Northern shoveler
Anas strepera	gadwall
Anas penelope	Eurasian wigeon
Anas americana	American wigeon
Aythya valisineria	canvasback
Aythya americana	redhead
Aythya collaris	ring-necked duck
Aythya fuligula	tufted duck
Aythya marila	greater scaup
Aythya affinis	lesser scaup
Netta peposaca	rosy-billed pochard
Bucephala albeola	bufflehead
Mergus merganser	common merganser
Source: USFWS, unpublished.	

The USFWS developed the *U.S. Pacific Islands Regional Shorebird Conservation Plan* over concerns of declining shorebird populations and loss of habitat (Engilis and Naughton 2004). This plan identifies three shorebird species of primary importance in Hawaiʻi: the Hawaiian stilt, Pacific golden-plover, and bristle-thighed curlew (*Numenius tahitiensis*). The only permanent resident shorebird, the Hawaiian stilt, is discussed in Section 3.8.4.4. The other two species are of primary importance because Hawaiʻi supports a substantial amount of Pacific golden-plovers during the winter (an estimated 15,000 to 20,000 individuals) and the bristle-thighed curlew is the only migratory species that winters exclusively in the Pacific. The wandering tattler is considered a species of importance and the ruddy turnstone is a species of secondary importance (Engilis and Naughton 2004).

Pacific golden-plover and ruddy turnstone are the only shorebirds that were detected utilizing the project area during the avian surveys conducted by Kahuku Wind Power LLC and SWCA. Data suggests that these birds arrive in the vicinity of the project area in September and leave in May. Pacific golden-plovers were seen in flight more often than ruddy turnstones (0.57 vs 0.02 flights/hr/point count), and only Pacific golden-plovers were recorded at flight altitudes that fall within the rotor swept zone of the proposed turbines.

Table 3-5. Migratory shorebirds observed on the nearby James Campbell NWR.

Scientific Name	Common Name
Pluvialis squatarola	black-bellied plover
Pluvialis fulva	Pacific golden-plover
Charadrius semipalmatus	semipalmated plover
Charadrius vociferus	killdeer
Himantopus mexicanus knudseni	Hawaiian stilt
Actitis maclaria	spotted sandpiper
Tringa solitaria	solitary sandpiper
Heteroscelus brevipes	gray-tailed tattler
Heteorscelus incanus	wandering tattler
Tringa melanoleuca	greater yellowlegs
Tringa flavipes	lesser yellowlegs
Numenius phaeopus	whimbrel
Numenius tahitiensis	bristle-thighed curlew
Limosa limosa	black-tailed godwit
Limosa fedoa	marbled godwit
Arenaria interpres	ruddy turnstone
Calidris canutus	red knot
Calidris alba	sanderling
Calidris pusilla	semipalmated sandpiper
Calidris mauri	Western sandpiper
Calidris ruficollis	red-necked stint
Calidris minutilla	least sandpiper
Calidris fuscicollis	white-rumped sandpiper
Calidris bairdii	Baird's sandpiper
Calidris melanotos	pectoral sandpiper
Calidris acuminata	sharp-tailed sandpiper
Calidris alpina	dunlin
Calidris ferruginea	curlew sandpiper
Calidris himantopus	stilt sandpiper
Tryngites subruficollis	buff-breasted sandpiper
Philomachus pugnax	ruff
Limnodromus griseus	short-billed dowitcher
Limnodromus scolopaceus	long-billed dowitcher
Gallinago sp.	snipe
Phalaropus tricolor	Wilson's phalarope
Phalaropus fulicaria	red phalarope
Source: USFWS, unpublished.	

3.8.2.4 Mammals

The Hawaiian hoary bat is the only terrestrial mammal native to Hawai'i; this species is discussed in Section 3.8.4.8. Non-native mammals observed on the Kahuku Wind Power project area incidental to the avian surveys include small Indian mongoose (*Herpestes javanicus*), domestic cow (*Bos taurus*), horse (*Equus caballus*), feral pig (*Sus scrofa*), feral cat (*Felis catus*) and dog (*Canis lupus familiaris*). Although not seen during the surveys, it is also anticipated that rats (*Rattus* sp.) and house mice (*Mus musculus*) occur on the Kahuku Wind Power project area.

3.8.3 Wildlife at Off-site Microwave Tower Locations

Based on general observations, birds that frequent the Waialua Substation site were non-native species common to altered rural environments on O'ahu. These include zebra dove, spotted dove, rock pigeon (*Columba livia*), common myna, Japanese white-eye, red-vented bulbul, red-whiskered bulbul, house finch, common waxbill, house sparrow, and Java sparrow (L. Ong/SWCA, pers. obs.). Domestic dogs and cats were also observed and mice and rats would be expected.

Non-native birds are also common at the Flying R Ranch site. These include the common myna, zebra dove, spotted dove, Japanese white-eye, house finch, red-vented bulbul, Japanese bush warbler, peacock, red crested cardinal, Erckel's francolin (*Francolinus erckelii*), and, while not observed, barn owl (L. Ong/SWCA, pers. obs.). Cattle and horses were observed in the vicinity and mice and rats would be expected.

3.8.4 Listed Wildlife Species

No federally listed endangered, threatened, or candidate species are known to reside on the Kahuku Wind Power project area and no portion of the site has been designated as critical habitat for any listed species. The endangered Hawaiian hoary bat has been documented flying over the project area and low bat activity has been recorded on the acoustic bat detectors. Several federally listed endangered and threatened bird species occur regularly on adjacent properties and individuals of these species may occasionally transit through the airspace of the proposed Kahuku Wind Power facility. One state listed endangered species, the Hawaiian short-eared owl, is known to occur on the Kahuku Wind Power project area.

The proposed WTGs, on-site and off-site microwave towers, met tower, overhead collection lines and relocated distribution line associated with the Kahuku Wind Power project would potentially present collision hazards to the listed bird and bat species. These species may also collide with the two off-site microwave towers. Lighting these standing structures pursuant to Federal Aviation Adminstration (FAA) regulations may increase the risk of avian collisions (USFWS 2007). Table 3-6 lists the federally and state listed species with potential to be adversely impacted by operation of the Kahuku Wind Power project and for which federal or state authorization of incidental take is being sought.

Four of the species listed in Table 3-6, the Hawaiian duck, Hawaiian coot, Hawaiian moorhen, and Hawaiian stilt, require wetlands for their survival (USFWS 2005a). The loss and degradation of coastal wetlands, as a result of coastal development and runoff, has been a significant factor in the decline of these birds in Hawai'i. Between 1780 and 1980, the area of coastal wetland habitat in the main Hawaiian Islands declined by 31% (Evans et al. 1994). Coastal wetlands were filled for commercial, residential, and resort developments and drained for agriculture. Predation by introduced animals, disease, and environmental contaminants have also contributed to the population decline of Hawai'i's endangered waterbirds. Furthermore, invasive plants, such as mangroves and grasses, have encroached on wetlands and altered natural processes (Evans et al. 1994, USFWS 2005a).

No critical habitat has been designated for any of Hawai'i's endangered waterbirds (USFWS 2005a). The general recovery objectives for the endangered waterbirds, as described in the *Second Draft Recovery Plan for Hawaiian Waterbirds* (2005a), are the following: stabilize or increase populations to greater than 2,000 individuals per species; establish multiple self-sustaining breeding populations throughout their historic ranges; protect and manage core and supporting wetlands statewide;

eliminate or control the threat of introduced predators, diseases, and contaminants; and remove the island-wide threat of the Hawaiian duck hybridizing with feral mallards.

All four of these waterbirds are known to occur regularly in the Ki'i Unit of the James Campbell NWR, which lies nearby the proposed Kahuku Wind Power facility. Of these four species, only possible Hawaiian ducks have been observed flying over the Kahuku Wind Power project area during the avian surveys conducted by First Wind and SWCA. Newell's shearwaters were detected flying over the Kahuku Wind Power site during nocturnal radar surveys. No Hawaiian petrels, which also may fly inland at night, were detected during the radar surveys, but it is believed possible that individuals of this species may occasionally fly over the Kahuku Wind Power project area. Hawaiian short-eared owls were heard on-site by the radar technicians. Detailed information on the eight species identified in Table 3-6 is provided below.

Table 3-6. Federally or state listed species with potential to be impacted by the Kahuku Wind Power project.

Scientific Name	Common, Hawaiian Name(s)	Date Listed	Status[1]
Birds			
Puffinus auricularis newelli	Newell's shearwater, ʻaʻo	10/28/1975	T
Pterodroma sandwichensis	Hawaiian petrel, uaʻu	3/11/1967	E
Anas wyvilliana	Hawaiian duck, koloa maoli	3/11/1967	E
Himantopus mexicanus knudseni	Hawaiian stilt, aeʻo	10/13/1970	E
Fulica alai	Hawaiian coot, ʻala ekeʻokeʻo	10/13/1970	E
Gallinula chloropus sandvicensis	Hawaiian moorhen, ʻalae ʻula	3/11/1967	E
Asio flammeus sandwichensis	Hawaiian short-eared owl, pueo	--	SE
Mammals			
Lasiurus cinereus semotus	Hawaiian hoary bat, ʻopeʻapeʻa	10/13/1970	E
1) E = federally endangered; T = federally threatened; SE = state endangered			

3.8.4.1 Newell's Shearwater

<u>Population, Biology, and Distribution of the Newell's Shearwater</u>

The Newell's shearwater is an endemic Hawaiian sub-species of the nominate species, Townsend's shearwater (*Puffinus a. auricularis*) of the eastern Pacific. The Newell's shearwater is considered "Highly Imperiled" in the *Regional Seabird Conservation Plan* (USFWS 2005b) and the *North American Waterbird Conservation Plan* (Kushlan et al. 2002). Species identified as "Highly Imperiled" have suffered significant population declines and have either low populations or some other high risk factor.

The most recent population estimate of Newell's shearwater was approximately 84,000 birds, with a possible range of 57,000 to 115,000 birds (Ainley et al. 1997). Radar studies on Kauaʻi showed a 63% decrease in detections of shearwaters between 1993 and 2001 (Day et al. 2003a). The largest breeding population of Newell's shearwater occurs on Kauaʻi (Telfer et al. 1987, Day and Cooper 1995, Ainley et al. 1995, 1997, Day et al. 2003). Breeding also occurs on Hawaiʻi Island (Reynolds and Richotte 1997, Reynolds et al. 1997, Day et al. 2003a) and almost certainly occurs on Molokaʻi (Pratt 1988, Day and Cooper 2002). Recent radar studies suggest the species may also nest on Oʻahu (Day and Cooper 2008). On Maui, radar studies and visual and auditory surveys conducted over the past decade suggest that one or more small breeding colonies are present in the West Maui Mountains in the upper portions of Kahakuloa Valley (Spencer, pers. comm.).

Newell's shearwaters typically nest on steep slopes vegetated by uluhe fern (*Dicranopteris linearis*) undergrowth and scattered ʻōhiʻa (*Metrosideros polymorpha*) trees. Currently, most Newell's shearwater colonies are found from 525 to 3,900 ft (160 to 1,200 m) above mean sea level, often in isolated locations and/or on slopes greater than 65 degrees (Ainley et al. 1997). The birds nest in short burrows excavated into crumbly volcanic rock and ground, usually under dense vegetation and at the base of trees. A single egg is laid in the burrow and one adult bird incubates the egg while the second adult goes to sea to feed. Once the chick has hatched and is large enough to withstand the cool temperatures of the mountains, both parents go to sea and return daily to feed the chick. Newell's shearwaters arrive at and leave their burrows during darkness and birds are seldom seen near land during daylight hours. During the day, adults remain either in their burrows or at sea some distance from land.

First breeding occurs at approximately six years of age, after which breeding pairs produce one egg per year. A high rate of non-breeding is found among experienced adults that occupy breeding colonies during the summer breeding season, similar to some other seabird species (Ainley et al. 2001). No specific data exist on longevity for this species, but other shearwaters may reach 30 years of age or more (Bradley et al. 1989, del Hoyo et al. 1992).

The Newell's shearwater breeding season begins in April, when birds return to prospect for nest sites. A pre-laying exodus follows in late April and possibly May; egg-laying begins in the first two weeks of June and likely continues through the early part of July. Pairs produce one egg, and the average incubation period is thought to be approximately 51 days (Telfer 1986). The fledging period is approximately 90 days, and most fledging takes place in October and November, with a few birds still fledging into December (SOS Data).

The flight of the Newell's shearwater is characterized by rapid beats interspersed with glides, although beats tend to be fewer in high winds. The birds avoid flying with tailwinds because it decreases control. Over land, ground speed of the species has been measured to average 38 mph or 61 kph (Ainley et al. 1997). The wingbeat pattern of Newell's shearwater is somewhat similar to that of Hawaiian petrel.

<u>Current Threats to the Newell's Shearwater</u>

Declines in Newell's shearwater populations are attributed to loss of nesting habitat, predation by introduced mammals (mongoose, feral cats, rats, and feral pigs) at nesting sites, and fallout of juvenile birds associated with disorientation from urban lighting (Ainley et al. 1997, Mitchell et al. 2005, Hays and Conant 2007).

No Newell's shearwater fatalities have been recorded at KWP in the time since the Federal Incidental Take Permit and State ITL were issued in January 2006 (Kaheawa Wind Power LLC 2008a, 2008b).

<u>Occurrence of Newell's Shearwater in the Project Area and Off-site Microwave towers</u>

Day and Cooper (2008) conducted surveillance radar and audiovisual sampling at the Kahuku Wind Power project area in fall 2007 and summer 2008. These surveys found an extremely low number of targets exhibiting flight speeds and flight patterns that fit the "shearwater/petrel" category. Based on surveys conducted on other islands, Newell's shearwaters move to the interior portions of the islands starting about 30 min after sunset, while Hawaiian petrel movements begin at sunset to about 60 min after sunset (Day et al. 2003b). Over five nights of sampling in fall 2007, two petrels or shearwaters were detected flying inland over the Kahuku Wind Power project area toward the Koʻolau Range and two were detected flying seaward over the site from the Koʻolau Range. No petrels or shearwaters were detected flying inland during seven nights of sampling in summer 2008, while seven petrels and/or shearwaters were recorded flying seaward.

No visual identification of these birds was possible, but Day and Cooper (2008) suggested that the individuals were likely Newell's shearwaters and not Hawaiian petrels since all targets were recorded after complete darkness. While the uppermost elevation of the site reaches the lower elevational limit for known nesting by this shearwater, no evidence was obtained to suggest that these birds could be nesting on-site.

As indicated, the Newell's shearwater has not been confirmed as a nesting species on Oʻahu. Assuming the detected birds were Newell's shearwaters, then their observed behavior of flying to and from the Koʻolau Range suggests strongly that at least a small number of these birds are breeding or prospecting in these mountains. Because of the few detections obtained during the Day and Cooper study and lack of radar studies from adjacent lands, it is not known whether the Kahuku Wind Power project area lies within the primary corridor used by these few birds as they move between their nesting areas and the ocean. Observations of Newell's shearwaters in the Hawaiian Islands indicate that approximately 65% of shearwaters will fly at or below turbine height (Day and Cooper 2008).

No radar studies were conducted at the off-site microwave tower sites because the low heights of the towers (60ft or less) and their small profiles would present minimal collision risk to shearwaters. It is expected that Newell's shearwater individuals could occasionally transit over the off-site microwave tower sites, but at much higher altitudes than the towers themselves (average flight height estimated at 627 ± 82 ft or 191 ± 25 m).

3.8.4.2 Hawaiian Petrel

<u>Population, Biology, and Distribution of the Hawaiian Petrel</u>

The Hawaiian petrel was once abundant on all main Hawaiian Islands except Ni'ihau (Mitchell et al. 2005). The population was most recently estimated to be approximately 20,000, with 4,000 to 5,000 breeding pairs (Mitchell et al. 2005). Today, Hawaiian petrels continue to breed in high-elevation colonies on Maui, Hawai'i, Kaua'i and Lāna'i (Richardson and Woodside 1954, Simons and Hodges 1998, Telfer et al. 1987, DLNR unpublished data 2006, 2007). Radar studies conducted in 2002 also suggest that breeding may occur on Moloka'i (Day and Cooper 2002). Breeding is no longer thought to occur on O'ahu (Harrison 1990).

Survey work at a recently re-discovered Hawaiian petrel colony on Lāna'i, that had been previously thought to be extirpated, indicates that thousands of birds are present, rather than hundreds of birds as first surmised, and that the size of the breeding colony approaches that at Haleakalā, Maui, where as many as 1,000 pairs have been thought to nest annually (Mitchell et al. 2005, Tetra Tech EC, Inc., June 2008). Radar counts of petrels on the perimeter of Maui and recent colony detections by KWP researchers suggest that the Maui population may be much higher than the 1,000 pairs previously estimated (Cooper and Day 2003).

Hawaiian petrels are nocturnal and subsist primarily on squid, fish, and crustaceans caught near the sea surface. On Kaua'i, Hawaiian petrels move from the sea to the interior portions of the island between sunset and about 60 min after sunset (Day et al. 2003b). Unlike shearwaters, Hawaiian petrels are not known to dive or swim below the surface (Pitman 1986). Foraging may take place thousands of kilometers from their home islands during both breeding and non-breeding seasons (Spear et al. 1995). Recent studies conducted using satellites and transmitters attached to Hawaiian petrels have shown that they can range across more than 6,200 miles (10,000 km) during two-week foraging expeditions (Adams 2008).

Hawaiian petrels are active in their nesting colonies for about eight months each year. The birds are long-lived (ca. 30 years) and return to the same nesting burrows each year between March and April. Present-day Hawaiian petrel colonies are typically located at high elevations above 8,200 ft (2,500 m). The types of habitats used for nesting are very diverse and range from xeric habitats with little or no vegetation, such as at Haleakalā National Park on Maui, to wet forests dominated by 'ōhi'a with uluhe understory as those found on Kaua'i (Mitchell et al. 2005). Females lay only one egg per year, which is incubated alternately by both parents for approximately 55 days. Eggs hatch in June or July, after which both adults fly to sea to feed and return to feed the nestling. The fledged young depart for sea in October and November. Adult birds do not breed until age six and may not breed every year, but pre-breeding and non-breeding birds nevertheless return to the colony each year to socialize.

<u>Current Threats to the Hawaiian Petrel</u>

The most serious land-based threat to the species is predation of eggs and young in the breeding colonies by introduced mammalian predators such as small Indian mongoose, feral cats, pigs, dogs, and rats. Owls have also been documented as predators of fledglings (Hodges and Nagata 2001). Population modeling by Simons (1984) suggested that this species could face extinction in a few decades if predation is not controlled. Intensive trapping and habitat protection has helped to improve nesting and fledging success (Ainley et al. 1997). Hodges and Nagata (2001) found that nesting activity (signs of burrow activity) in sites protected from predators on Haleakalā ranged from 37.25 to 78.13% while nesting activity in unprotected sites ranged from 23.08 to 88.17%. Nesting success (proportion of active burrows that showed signs of fledging chicks) in protected sites ranged from 16.97 to 50.00%, while nesting success in unprotected sites ranges from 0.00 to 44.00% (Hodges and Nagata 2001).

Ungulates can indirectly affect nesting seabirds by overgrazing and trampling vegetation, as well as facilitating erosion. Climatic events such as El Niño can also impact the reproductive success of seabirds (Hodges and Nagata 2001). Other threats include occasional mortality from collisions with power lines, fences, and other structures near breeding sites or attraction to bright lights. In addition, juvenile birds are sometimes grounded when they become disoriented by lights on their nocturnal first flight from inland breeding sites to the ocean. A few, mostly juvenile, Hawaiian petrels have landed in brightly lit areas at scattered locations on Maui most years. The problem is much smaller than the one involving Newell's shearwaters (see prevous section), and Simons and Hodges (1998) conclude that it is probably not a threat to remaining populations. Hawaiian petrels are known to occasionally collide with tall buildings, towers, powerlines, and other structures while flying at night between their nesting colonies and the ocean (Federal Register 2004).

<u>Occurrence of the Hawaiian Petrel in the Project Area and Off-site Microwave Towers</u>

As discussed in the previous section, several birds that were either Newell's shearwaters or Hawaiian petrels were detected by radar flying over the Kahuku Wind Power project area. No visual identification of these birds was possible, but Day and Cooper (2008) suggested that the individuals were likely Newell's shearwaters and not Hawaiian petrels since all targets were recorded after complete darkness. However, because of a lack of definitive identification of these birds, it is considered possible that a small number of Hawaiian petrels could occasionally fly over the Kahuku Wind Power project area during their nesting season (March through September). Hawaiian petrels fly at higher altitudes than Newell's shearwater on average (191 ± 25 m vs 125± 4 m, Cooper and Day 2003) and would be less likely to collide with the wind turbines and blades than Newell shearwater.

No radar studies were conducted at the off-site microwave tower sites because the low heights of the towers (60ft or less) and their small profiles would present minimal collision risk to petrels. It is expected that Hawaiian petrel individuals could occasionally transit over the off-site microwave tower sites, but at much higher altitudes than the towers themselves (average flight height estimated at 410 ± 13 ft or 125± 4 m, Cooper and Day 2003).

3.8.4.3 Hawaiian Duck

<u>Population, Biology, and Distribution of the Hawaiian Duck</u>

The Hawaiian duck is a non-migratory species endemic to the Hawaiian Islands, and the only endemic duck extant in the main Hawaiian Islands (Uyehara et al. 2008). The Hawaiian duck is a small, mottled brown duck with emerald green to blue patches on their wings (speculums). Males are typically larger, have distinctive dark brown chevrons on the breast feathers, an olive-colored bill, and bright orange feet. Females are slightly smaller and lighter in color (Evans et al. 1994, USFWS 2005a). Compared to feral mallard ducks, Hawaiian ducks are more secretive and about 20 to 30% smaller (Uyehara et al. 2007).

The historical range of the Hawaiian duck includes all the main Hawaiian Islands, except for the Islands of Lāna'i and Kaho'olawe. Hawaiian duck are strong flyers and usually fly at low altitudes. Intra-island movement has been recorded, where they may move between ephemeral wetlands or disperse to montane areas during the breeding season (Engilis et al. 2002). Hawaiian ducks also fly inter-island and have been documented to fly regularly between Ni'ihau and Kaua'i in response to above-normal precipitation and the flooding and drying of Ni'ihau's ephemeral wetlands (USFWS 2005a). Hawaiian duck occur in aquatic habitats up to an altitude of 10,000 ft (3,048 m) in elevation (Uyehara et al. 2007). The only naturally occurring population of Hawaiian duck exists on Kaua'i, with reintroduced populations on O'ahu, Hawai'i, and Maui (Pratt et al. 1987, Engilis et al. 2002, Hawaii Audubon Society 2005).

Hawaiian ducks are closely related to mallards (Browne et al. 1993). Due to this close genetic relationship, Hawaiian ducks will readily hybridize with mallards and allozyme data indicate there has been extensive hybridization between Hawaiian duck and feral mallards on O'ahu, with the near disappearance of Hawaiian duck alleles from the population on the island (Browne et al. 1993, Engilis pers. comm.). Uyehara et al. (2007) found a predominance of hybrids on O'ahu and samples collected by Browne et al. (1993) from ducks and eggs at the Ki'i Unit of the James Campbell NWR found mallard genotypes. In 2005, a peak count of 141 Hawaiian duck x mallard hybrids were recorded on the Ki'i Unit of the James Campbell NWR (USFWS unpub). Populations on Maui are also suspected to largely consist of Hawaiian duck x mallard hybrids. Estimated Hawaiian duck hybrid counts on these islands are 300 and 50 birds, respectively (Engilis et al. 2002, USFWS 2005a). The current wild population of pure Hawaiian ducks is estimated at approximately 2,200 birds. Approximately 200 pure individuals occur on the Island of Hawai'i and the remainder reside on Kaua'i. Because of similarities between the species, it can be difficult to distinguish between pure Hawaiian ducks, feral hen mallards, and hybrids during field studies.

Habitat types utilized by the Hawaiian duck include natural and man-made lowland wetlands, flooded grasslands, river valleys, mountain streams, montane pools, forest swamplands, aquaculture ponds, and agricultural areas (Engilis et al. 2002, Hawaii Audubon Society 2005, USFWS 2005a). The James Campbell NWR provides suitable habitat for foraging, resting, pair formation, and breeding (Engilis et al. 2002). No suitable habitat for Hawaiian duck occurs on the Kahuku Wind Power project area.

Breeding occurs year-round, although the majority of nesting occurs from March through June. The peak breeding season on Kaua'i Island occurs between December and May and the peak on Hawai'i Island occurs from April to June (Uyehara et al. 2008). Nests are placed in dense shoreline vegetation of small ponds, streams, ditches, and reservoirs (Engilis et al. 2002). Types of vegetation associated with nesting sites of Hawaiian duck include grasses, rhizominous ferns, and shrubs (Engilis et al. 2002). The diet of Hawaiian ducks consists of aquatic invertebrates, aquatic plants, seeds, grains, green algae, aquatic mollusks, crustaceans, and tadpoles (Engilis et al. 2002, USFWS 2005a).

Current Threats to the Hawaiian Duck

Hybridization with mallards is the largest threat to the Hawaiian duck. Reintroduction of pure Hawaiian ducks to O'ahu is being contemplated, although in order for pure Hawaiian ducks to continue to exist on O'ahu following reintroduction, the removal of all hybrids and the elimination of all sources of feral mallard ducks will need to occur (Engilis et al. 2002). James Campbell NWR in Kahuku is expected to play a key role in any future reintroduction of pure Hawaiian ducks to O'ahu (USFWS 2005a, Kwon pers. comm.). At present it is uncertain when reintroduction would occur, but it is possible that reintroduction could occur during the 20-year life of the proposed project.

In addition to hydridization concerns, Hawaiian ducks are predated by mongoose, feral cats, feral dogs, and possibly rats (Engilis et al. 2002). Black-crowned night-herons, largemouth bass (*Micropterus salmoides*), and bullfrogs have been observed to take ducklings (Engilis et al. 2002). Avian diseases are another threat to Hawaiian ducks, with outbreaks of avian botulism (*Clostridium botulinum*) occurring annually throughout the state. In 1983, cases of adult and duckling mortality on O'ahu were attributed to aspergillosis and salmonella (Engilis et al. 2002). As stated previously, the loss and degradation of coastal wetlands have been a significant factor in the decline of these birds in Hawai'i.

Little is known about the interaction of Hawaiian ducks with wind turbines. Studies of wind energy facilities located in proximity to wetlands and coastal areas in other parts of the United States and the world have shown that waterfowl and shorebirds have some of the lowest collision mortality rates at these types of facilities, suggesting that these types of birds are among the best at recognizing and avoiding wind turbines (e.g., Koford et al. 2004, Jain 2005, Carothers 2008). In support of these findings, systematic and ancillary observations of nēnē or Hawaiian goose (*Branta sandvicensis*) in flight at the Kaheawa Wind Power facility on Maui indicate this species is capable of exhibiting deliberate avoidance of wind turbines under prevailing conditions (Kaheawa Wind Power 2008).

Occurrence of the Hawaiian Duck in the Project Area and Off-site Microwave Towers

Ducks resembling Hawaiian ducks (but likely to be hybrids) have been seen flying over the lower elevation eastern portion of the Kahuku Wind Power project area on three occasions during point count surveys and one incidental observation (SWCA and First Wind 2008). These individuals were not observed landing on the site. More recently, a pair of ducks that resembled Hawaiian ducks was observed on-site following a period of heavy rain in a flooded depression in the area where topsoil had been excavated historically (L. Ong/SWCA pers. obs.). Hawaiian duck-like ducks flying over the nearby wetlands have been observed up to heights of approximately 200 ft (60 m). Thus, while flying over the Kahuku Wind Power project area, ducks may be vulnerable to colliding with the WTGs, turbine blades, and met towers. The estimated passage rate of Hawaiian duck-like ducks over the Kahuku Wind Power project area is 0.003 birds/ha/hr or 8.0 birds/day for the entire site (SWCA and First Wind 2008).

Due to the residential nature of the environment at the HECO Waialua substation microwave tower (asphalt roads, traffic, close proximity to houses), no waterbirds are expected to utilize the site. No habitat suitable for waterbirds occurs at the microwave tower site at Flying R Ranch as well, which consists of non-native forest with no nearby water features. Thus no Hawaiian ducks are expected to be near the vicinity of either off-site microwave tower.

Because of hybridization with feral mallards, it is questionable whether the Hawaiian duck-like ducks present on O‘ahu are protected under Section 9 of the ESA. However, at the request of the USFWS, the Applicant has agreed to consider the Hawaiian duck-like ducks present in the general project vicinity as if they were pure Hawaiian ducks. Consequently, the Applicant is offering to provide mitigation to compensate for the loss of any Hawaiian duck-like ducks resulting from construction and operation of the Kahuku Wind Power project.

3.8.4.4 Hawaiian Stilt

Population, Biology, and Distribution of the Hawaiian Stilt

The Hawaiian stilt is a non-migratory endemic subspecies of the black-necked stilt (*Himantopus mexicanus mexicanus*). The black-necked stilt occurs in the western and southern portions of North America, southward through Central America, West Indies, to southern South America and also the Hawaiian Archipelago (Robinson et al. 1999). Hawaiian stilt and black-necked stilt are part of a superspecies complex of stilts found in various parts of the world (Pratt et al. 1987, Robinson et al. 1999). The *U.S. Pacific Islands Regional Shorebird Conservation Plan* considers the Hawaiian stilt as highly imperiled because of its low population level (Engilis and Naughton 2004). Over the past 25 years, the Hawaiian stilt population has shown a general upward trend statewide. Annual summer and winter counts have shown variability from year to year. This fluctuation can be attributed to winter rainfall and variation in reproductive success (Engilis and Pratt 1993, USFWS 2005a). The state population size has recently fluctuated between 1,200 to 1,500 individuals with a five-year average of 1,350 birds (USFWS 2005a). Adult and juvenile dispersal has been observed both intra- and inter-island within the state (Reed et al. 1998).

O‘ahu supports the largest number of stilts in the state, with an estimated 35 to 50% of the population residing on the island. Some of the largest concentrations can be found at the James Campbell NWR, Kahuku aquaculture ponds, Pearl Harbor NWR, and Nu‘upia Ponds in Kaneohe (USFWS 2005a). The Ki‘i Unit of the James Campbell NWR, and the Waiawa Unit and Pond 2 of the Honouliuli Unit of the Pearl Harbor NWR are the most productive stilt habitats, with birds numbering near 100 or above during survey counts (USFWS 2002, USFWS unpubl. data). Hatching success of stilt nests has been greater than 80% in the Ki‘i Unit, but chick mortality rates are high (USFWS 2002).

Hawaiian stilts favor open wetland habitats with minimal vegetative cover and water depths of less than 9.4 inches (24 cm), as well as tidal mudflats (Robinson et al. 1999). Stilts feed on small fish, crabs, polychaete worms, terrestrial and aquatic insects, and tadpoles (Robinson et al. 1999, Rauzon and Drigot 2002). Hawaiian stilts tend to be opportunistic users of ephemeral wetlands to exploit the seasonal abundance of food (Berger 1972, USFWS 2005a). Hawaiian stilts nest from mid-February through late August with variable peak nesting from year to year (Robinson et al. 1999). Nesting sites for stilts consist of simple scrapes on low relief islands within and/or adjacent to ponds. Clutch size averages four eggs (Hawaii Audubon Society 2005, USFWS 2005a).

Current Threats to the Hawaiian Stilt

The most important causes of decline of the Hawaiian stilt and other Hawaiian waterbirds is the loss of wetland habitat and predation by introduced animals. Barn owls and the endemic Hawaiian short-eared owl are known predators of adult stilts and possibly their young (Robinson et al. 1999, USFWS 2005a). Known predators of eggs, nestlings, and/or young stilts include small Indian mongoose, feral cat, rats, feral and domestic dogs, black-crowned night-heron, cattle egret, common mynah, ruddy turnstone, laughing gull (*Larus atricilla*), American bullfrog (*Rana catesbeiana*), and large fish (Robinson et al. 1999, USFWS 2005a). A study conducted at the Ki'i Unit of the James Campbell NWR between 2004 and 2005 attributed 45% of stilt chick losses to bullfrog predation over the two breeding periods (USFWS unpubl. data). The Ki'i Unit has on-going control programs for mongoose, feral cats, rats, cane toads (*Bufo marinus*), and bullfrogs (Silbernagle, pers. comm.). Other factors that have contributed to population declines in Hawaiian stilts include altered hydrology, alteration of habitat by invasive non-native plants, disease, and possibly environmental contaminants (USFWS 2005a). Although the Hawaiian stilt is considered imperiled, it is believed to have high recovery potential with a moderate degree of threat.

Little is known about the interaction of black-necked stilt with turbines in the United States. One black-necked stilt was reported at the Altamont Pass Wind Resource Area from 2005-2007 (Altamont Pass Avian Monitoring Team 2008). The annual adjusted fatality per turbine was 0.00193 stilt per turbine. In general, low mortality of waterbirds has been documented at wind turbines situated coastally, like the proposed Kahuku Wind Power project, despite the presence of high numbers of waterbirds in the vicinity (Kingsley and Whittam 2007, Carothers 2008). Many studies of coastal-wind energy facilities have shown that waterbirds and shorebirds are among the birds most wary of turbines and that these birds readily learn to avoid the turbines over time (Carothers 2008).

Occurrence of the Hawaiian Stilt in the Project Area and Off-site Microwave Towers

No suitable habitat for Hawaiian stilt occurs on the Kahuku Wind Power project area. No Hawaiian stilts were seen flying over the proposed Kahuku Wind Power facility during the avian point count surveys conducted by Kahuku Wind Power LLC and SWCA, although one downed individual was found incidentally on the site next to a temporary met tower. Post-mortem results by USFWS veterinarians indicated that the bird was emaciated and carried a heavy parasite load. As there were no broken bones or abrasions to indicate a collision with the met tower or guy wires, the bird was determined to likely have died of natural causes. However, since the carcass was found at the base of the met tower, the final cause of death was declared indeterminate and not attributed to the met tower (K. Swindle, pers. comm.). Because of the known dispersal capabilities of these birds and their regular occurrence at the nearby Ki'i Unit of James Campbell NWR, it is expected that individual stilts can fly over the Kahuku Wind Power project area on a very irregular basis while moving between wetlands or islands.

Due to the residential nature of the environment at the HECO Waialua substation microwave tower (asphalt roads, traffic, close proximity to houses), no waterbirds are expected to utilize the site. No habitat suitable for waterbirds occurs at the microwave tower site at Flying R Ranch as well, which consists of non-native forest with no nearby water features. Thus no Hawaiian stilts are expected to be near the vicinity of either off-site microwave tower.

3.8.4.5 Hawaiian Coot

Population, Biology, and Distribution of the Hawaiian Coot

The Hawaiian coot is an endangered species endemic to the main Hawaiian Islands, except Kaho'olawe. The Hawaiian coot is non-migratory and believed to have originated from migrant American coots (*Fulica americana*) that strayed from North America. The species is an occasional vagrant to the northwestern Hawaiian Islands west to Kure Atoll (Pratt et al. 1987, Brisbin et al. 2002).

The population of Hawaiian coot has fluctuated between 2,000 and 4,000 birds. Of this total, roughly 80% occur on O'ahu, Maui, and Kaua'i (Engilis and Pratt 1993, USFWS 2005a). The O'ahu population fluctuates between approximately 500 to 1,000 birds. Hawaiian coots occur regularly in the Ki'i Unit of the James Campbell NWR, with peak counts in 2005 and 2006 reaching nearly 350 birds (USFWS 2002, USFWS 2005a, USFWS unpubl. data). Population fluctuations in these areas are attributed to seasonal rainfall and variation in reproductive success. Inter-island dispersal has been noted and is presumably influenced by seasonal rainfall patterns and food abundance (USFWS 2005a).

Coots are usually found on the coastal plain of islands and prefer freshwater ponds or wetlands, brackish wetlands, and man-made impoundments. They prefer open water that is less than 11.8 inches (30 cm) deep for foraging. Preferred nesting habitat has open water with emergent aquatic vegetation or heavy stands of grass (Schwartz and Schwartz 1949, Brisbin et al. 2002, USFWS 2005a). Nesting occurs mostly from March though September, with opportunistic nesting occurring year round depending on rainfall. Hawaiian coots will construct floating nests of aquatic vegetation, semi-floating nests attached to emergent vegetation or nests in clumps of wetland vegetation (Brisbin et al. 2002, USFWS 2005a). False nests are also sometimes constructed and used for resting or as brooding platforms (USFWS 2005a). Coots feed on seeds, roots, and leaves of aquatic and terrestrial plants, freshwater snails, crustaceans, tadpoles of bullfrogs and marine toads, small fish, and aquatic and terrestrial insects (Schwartz and Schwartz 1949, Brisbin et al. 2002).

Current Threats to the Hawaiian Coot

The USFWS *Second Draft Recovery Plan for Hawaiian Waterbirds* (2005a) lists the Hawaiian coot as having high potential for recovery and a low degree of threats (USFWS 2005a). Introduced feral cats, feral and domestic dogs, and mongoose are the main predators of adult and young Hawaiian coots (Brisbin et al. 2002, Winter 2003). Other predators of young coots include black-crowned night-heron, cattle egret, and large fish. Coots are susceptible to avian botulism outbreaks in the Hawaiian Islands (Brisbin et al. 2002). Wetland loss and degradation has also been noted as contributing to the decline of this species, as stated previously. Low numbers of American coot fatalities have been reported at two wind facilities in California and Minnesota, although in these cases standing or ponded water within the project area was an attractant (Erickson et al. 2001).

Occurrence of the Hawaiian Coot in the Project Area and Off-site Microwave Towers

No Hawaiian coots were observed in flight at the Kahuku Wind Power project area during the year-long avian point count survey. However, Hawaiian coots are known to disperse between islands, so there is potential for coots to occasionally fly over the lower elevations of Kahuku Wind Power project area if moving between wetlands or islands. No suitable habitat for Hawaiian coot occurs on the Kahuku Wind Power project area.

Due to the residential nature of the environment at the HECO Waialua substation microwave tower (asphalt roads, traffic, close proximity to houses), no waterbirds are expected to utilize the site. No habitat suitable for waterbirds occurs at the microwave tower site at Flying R Ranch as well, which consists of non-native forest with no nearby water features. Thus no Hawaiian coots are expected to be near the vicinity of either off-site microwave tower.

3.8.4.6 Hawaiian Moorhen

Population, Biology, and Distribution of the Hawaiian Moorhen

The Hawaiian moorhen is an endemic, non-migratory subspecies of the cosmopolitan common moorhen (*Gallinula chloropus*). It is believed that the subspecies originated through colonization of Hawai'i by stray North American migrants (USFWS 2005a). Originally occurring on all the main Hawaiian Islands (excluding Lāna'i and Kaho'olawe), Hawaiian moorhen is currently limited to regular occurrence on the Islands of Kaua'i and O'ahu (Hawaii Audubon Society 2005, USFWS 2005a). A population was reintroduced to Moloka'i in 1983, but no individuals remain on the island today.

Hawaiian moorhen are very secretive; thus, population estimates and long-term population trends are difficult to approximate (Engilis and Pratt 1993, Hawaii Audubon Society 2005, USFWS 2005a). The population of Hawaiian moorhen appears to be stable, with an average annual total of 314 birds estimated between 1977 and 2002. Approximately half of this population occurs on O'ahu. Seasonal fluctuations in population have been recorded, although this is believed to be an artifact of sparser vegetation allowing greater visibility in fields in winter than in summer (USFWS 2005a). In 2006, a peak of over 90 moorhen was recorded at the Ki'i Unit of the James Campbell NWR (USFWS unpubl. data).

In Hawai'i, moorhen largely depend on agricultural and aquaculture habitats. They prefer freshwater marshes, taro patches, reservoirs, wet pastures, lotus fields, and reedy margins of water courses. The habitats in which they occur are generally below 410 ft (125 m) in elevation (Pratt et al. 1987, Engilis and Pratt 1993, Hawaii Audubon Society 2005, USFWS 2005a). According to the *Second Draft Recovery Plan for Hawaiian Waterbirds* (2005a), the key components of moorhen habitat are: 1) dense stands of emergent vegetation near open water; 2) slightly emergent vegetation mats; and 3) shallow, freshwater areas. No such habitat is present on the Kahuku Wind Power project area.

Hawaiian moorhens will nest on open ground and wet meadows, as well as on banks of waterways and in emergent vegetation over water (Bannor and Kiviat 2002). Typically, nesting areas have standing water less than 24 inches (60 cm) deep. Nesting occurs year-round with the majority of nesting activity occurring from March through August (Bannor and Kiviat 2002, USFWS 2002). Timing of nesting by the Hawaiian moorhen is dependent on water levels and growth of suitable emergent vegetation (USFWS 2002).

Although the specific diet of the Hawaiian moorhen is not known, it is presumed the birds are opportunistic feeders (USFWS 2005a). Moorhens are very closely related to coots, and it is presumed that the diet of Hawaiian moorhens is generally similar to that described above for Hawaiian coot.

<u>Current Threats to the Hawaiian Moorhen</u>

As previously stated, coastal wetland loss and degradation as a result of commercial, residential, and resort developments have been identified as a key threat to the Hawaiian moorhen (Evans et al. 1994, USFWS 2005a). Feral cats, feral and domestic dogs, mongoose, and bullfrogs are known predators of Hawaiian moorhen. Black-crowned night-herons and rats are also as possible predators (Byrd and Zeillemaker 1981, Bannor and Kiviat 2002, USFWS 2005a). The Hawaiian moorhen is highly susceptible to disturbance by humans and introduced predators (Bannor and Kiviat 2002). The moorhen is considered to have a high potential for recovery with a moderate degree of threats (USFWS 2005a).

Hawaiian moorhen however are considered to be at low risk from wind farms because there have only been a few published reports of the closely related common moorhen colliding with turbines in Europe (Ireland, Percival 2003) and Netherlands (Hotker et al. 2006) and none in the United States. This is despite the fact that common moorhen are frequently found around wind turbines located near wetlands. However, one study in Spain lists the common moorhen at "some" collision risk with power lines due to their flight performance and also records one instance of mortality due to collision (Janss 2000).

<u>Occurrence of the Hawaiian Moorhen in the Project Are and Off-site Microwave Towers a</u>

No Hawaiian moorhens were detected during the year of avian point count surveys on the Kahuku Wind Power project area or on adjacent wetlands, although the birds are known to occur regularly at the Ki'i Unit of James Campbell NWR. This lack of detection is likely because moorhens rarely fly, but typically remain within or close to dense vegetation. However, as colonization of Hawai'i by moorhens does attest, members of the species are able to fly considerable distances when they so desire. It is very unlikely that Hawaiian moorhens regularly fly over the Kahuku Wind Power project area; however, given their ability to fly and their regular occurrence at the nearby Ki'i Unit of James Campbell NWR, it is possible that individual Hawaiian moorhens will very occasionally fly over the site, especially the lower elevation eastern portion nearest the adjacent wetlands.

Due to the residential nature of the environment at the HECO Waialua substation microwave tower (asphalt roads, traffic, close proximity to houses), no waterbirds are expected to utilize the site. No habitat suitable for waterbirds occurs at the microwave tower site at Flying R Ranch as well, which consists of non-native forest with no nearby water features. Thus no Hawaiian moorhens are expected to be near the vicinity of either off-site microwave tower.

3.8.4.7 Hawaiian Short-eared Owl

Population, Biology, and Distribution of the Hawaiian Short-eared Owl

The Hawaiian short-eared owl is an endemic subspecies of the nearly cosmopolitan short-eared owl (*Asio flammeus*). This is the only extant owl native to Hawai'i and is found on all the main islands from sea level to 8,000 ft (2,450 m). The Hawaiian short-eared owl is listed by the State of Hawai'i as endangered on the Island of O'ahu.

Unlike most owls, Hawaiian short-eared owls are active during the day (Mostello 1996, Mitchell et al. 2005), though nocturnal or crepuscular activity has also been documented (Mostello 1996). Hawaiian short-eared owls are commonly seen hovering or soaring over open areas (Mitchell et al. 2005).

No surveys have been conducted to date to estimate the population size of Hawaiian short-eared owl. The species was widespread at the end of the 19^{th} century, but numbers are thought to be declining (Mostello 1996, Mitchell et al. 2005).

Hawaiian short-eared owl occupy a variety of habitats, including wet and dry forests, but are most common in open habitats such as grasslands, shrublands, and montane parklands, including urban areas and those actively managed for conservation (Mitchell et al. 2005). Evidence indicates the owls became established on Hawai'i in relatively recent history, with their population likely tied to the introduction of Polynesian rats (*Rattus exulans*) to the islands by Polynesians.

Pellet analyses indicate that rodents, birds, and insects, respectively are their most common prey items of Hawaiian short-eared owls (Snetsinger et al. 1994, Mostello 1996). Birds depredated by Hawaiian short-eared owl have included passerines, seabirds, and shorebirds (Snetsinger et al. 1994, Mostello 1996, Mounce 2008). The Hawaiian short-eared owl relies more heavily on birds and insects than its continental relatives (Snetsinger et al. 1994), likely because of the low rodent diversity of the Hawaiian Islands (Mostello 1996).

Hawaiian short-eared owls nest on the ground. Little is known about their breeding biology, but nests have been found throughout the year. Nests are constructed by females and consist of simple scrapes in the ground lined with grasses and feather down. Females perform all incubating and brooding, while males feed females and defend nests. The young may leave the nest on foot before they are able to fly and depend on their parents for approximately two months (Mitchell et al. 2005).

Current Threats to the Hawaiian Short-eared Owl

Loss and degradation of habitat, predation by introduced mammals, and disease threaten the Hawaiian short-eared owl. Hawaiian short-eared owls appear particularly sensitive to habitat loss and fragmentation. Ground nesting birds are more susceptible to the increased predation pressure that is typical within fragmented habitats and near rural developments (Wiggins et al. 2006). These nesting habits make them increasingly vulnerable to predation by rats, cats, and the small Indian mongoose (Mostello 1996, Mitchell et al. 2005).

Some mortality of Hawaiian short-eared owls on Kaua'i has been attributed to "sick owl syndrome," which may be caused by pesticide poisoning or food shortages. They may be vulnerable to the ingestion of poisoned rodents. However, in the one study on mortality that has been conducted, no evidence was found that organochlorine, organophosphorus, or carbamate pesticides caused mortality in Hawaiian short-eared owls (Thierry and Hale 1996). Other causes of death on Maui, O'ahu, and Kaua'i have been attributed to trauma (apparently vehicular collisions), emaciation, and infectious disease (pasteurellosis) (Thierry and Hale 1996). However, persistence of these owls in lowland, non-native and rangeland habitats suggests that they may be less vulnerable to extinction than other native birds. This is likely because they may be resistant to avian malaria and avian pox (Mitchell et al. 2005), and because they are opportunistic predators that feed on a wide range of small animals.

Little information is available on the impacts of wind facilities on owls. However, four fatalities of short-eared owl (*Asio flammeus flammeus*) have been recorded at McBride Lake, Alberta, Canada, Foote Creek Rim, Wyoming, Nine Canyon, Wyoming, and Altamont Wind Resource Area, California (Kingsley and Whittam 2007). Hawaiian short-eared owls are present year-round and observed regularly in the vicinity of the Kaheawa Wind Power facility on Maui, with no fatalities reported in approximately 3.5 years of operation. In the vicinity of turbines, most observations of Hawaiian short-eared owl have been below the rotor swept zone of the turbines and thus their susceptibility to collision appears to be low (Spencer, pers. comm.). At Wolfe Island, Ontario, it was observed that short-eared owls were most vulnerable to colliding with turbine blades during predator avoidance and during aerial flight displays (Stantec Consulting Ltd. 2007). Short-eared owl on O'ahu have no aerial predators and thus may only be vulnerable to colliding with turbines during flight displays.

Occurrence of the Hawaiian Short-eared Owl in the Project Area and Off-site Microwave Towers

Hawaiian short-eared owls were only detected once at the Kahuku Wind Power project area during the 15-month long avian point count surveys conducted by First Wind and SWCA. One Hawaiian short-eared owl was heard on-site in July 2008 by personnel conducting the radar survey for seabirds. Because these owls are active during daytime and crepuscular periods, it seems probable that they would have been detected more frequently during the avian point counts if resident on-site. Therefore, it seems that Hawaiian short-eared owl is most likely an irregular visitor to the Kahuku Wind Power project area.

No Hawaiian short-eared owls were seen during the wildlife surveys at either microwave tower site. Due to the residential nature of the environment at the HECO Waialua substation microwave tower (asphalt roads, traffic, close proximity to houses), no Hawaiian short-eared owls are expected to utilize this site. Hawaiian short-eared owls may occur at the Flying R Ranch microwave site due to suitable agricultural and forest habitat in the vicinity.

3.8.4.8 Hawaiian Hoary Bat

Population, Biology, and Distribution of the Hawaiian Hoary Bat

The Hawaiian hoary bat is the only native land mammal present in the Hawaiian archipelago. It is a sub-species of the hoary bat (*Lasiurus cinereus*), which occurs across much of North and South America. Both males and females have a wingspan of approximately 1 ft (0.3 m), although females are typically larger-bodied than males. Both sexes have a coat of brown and gray fur. Individual hairs are tipped or frosted with white (Mitchell et al. 2005).

The species has been recorded on Kaua'i, O'ahu, Moloka'i, Maui, and Hawai'i, but no historical population estimates or information exist for this subspecies. Population estimates for all islands in the state in the recent past have ranged from hundreds to a few thousand bats (Menard 2001). However, based on monitoring currently underway on the Island of Hawai'i, the population is estimated to possibly be as high as a hundred thousand bats on the Island of Hawai'i alone (Bonaccorso, pers. comm.). The Hawaiian hoary bat is believed to occur primarily below an elevation of 4,000 ft (1,220 m). This subspecies has been recorded between sea level and approximately 9,050 ft (2,760 m) in elevation on Maui, with most records occurring at or below approximately 2,060 ft (628 m) (USFWS 1998).

Hawaiian hoary bats roost in native and non-native vegetation from 3 to 29 ft (1 to 9 m) above ground level. They have been observed roosting in 'ōhi'a, hala (*Pandanus tectorius*), coconut palms (*Cocos nucifera*), kukui (*Aleurites moluccana*), kiawe (*Proscopis pallida*), avocado (*Persea americana*), mango (*Mangifera indica*), shower trees (*Cassia javanica*), pūkiawe (*Styphelia tameiameiae*), and fern clumps; they are also suspected to roost in eucalyptus (*Eucalyptus* spp.) and Sugi pine (*Cyrptomeria japonica*) stands. The species has been rarely observed using lava tubes, cracks in rocks, or man-made structures for roosting. While roosting during the day, Hawaiian hoary bat are solitary, although mothers and pups roost together (USFWS 1998).

Preliminary study of a small sample of Hawaiian hoary bats (n=18) on the Island of Hawaiʽi have estimated short-term (1-2 weeks) home range sizes of 104.8 ± 94.9 (SD) ac (42.4 ± 38.4 ha) with core areas of approximately 13.3 ± 13.6 (SD) ac (5.4 ± 5.5 ha, USGS, unpublished data). The size of home ranges and core areas varied widely between individuals. Core areas included feeding ranges that were actively defended, especially by males, against conspecifics. For some individuals, core areas included night roosts, but typically did not include day roosts. Roosting and feeding areas may be disjunct as the average long-axis (maximum length of home range) was 2.7 ± 2.9 (SD) mi (4.4 ± 4.6 km), with a maximum length of 11.1 mi (17.8 km), indicating that some individuals travelled long distances between roosting and feeding areas.

It is suspected that breeding primarily occurs between April and August. Lactating females have been documented from June to August, indicating that this is the period when non-volent young are most likely to be present. Breeding has only been documented on the Islands of Hawaiʽi and Kauaʽi (Baldwin 1950, Kepler and Scott 1990, Menard 2001). It is not known whether bats observed on other islands breed locally or only visit these islands during non-breeding periods. Seasonal changes in the abundance of Hawaiian hoary bat at locations of different elevations indicate that altitudinal migrations occur on the Island of Hawaiʽi. During the breeding period (April through August), Hawaiian hoary bat occurrences increase in the lowlands and decrease at high elevation habitats. Hawaiian hoary bat occurrences are especially low from June until August in high elevation areas. In the winter, especially during the post-lactation period in October, bat occurrences increase in high elevation areas and in the central highlands, possibly receiving bats from the lowlands (Menard 2001).

Hawaiian hoary bats feed on a variety of native and non-native night-flying insects, including moths, beetles, crickets, mosquitoes and termites (Whitaker and Tomich 1983). They appear to prefer moths ranging between 0.6 and 0.89 inches (16 to 20 mm) in size (Bellwood and Fullard 1984, Fullard 2001). Koa moths (*Scotorythra paludicola*), which are endemic to the Hawaiian islands and use koa (*Acacia koa*) as a host plant (Haines et al. 2009), are frequently targeted as a food source (Gorresen pers. comm.). Prey is located using echolocation. Water courses and edges (e.g., coastlines and forest/pasture boundaries) appear to be important foraging areas. In addition, the species is attracted to insects that congregate near lights (USFWS 1998, Mitchell et al. 2005). They begin foraging either just before or after sunset depending on the time of year (USFWS 1998, Mitchell et al. 2005).

<u>Current Threats to the Hawaiian Hoary Bat</u>

The availability of roosting sites is believed to be a major limitation in many bat species. Possible threats to the Hawaiian hoary bat include pesticides (either directly or by impacting prey species), predation, alteration of prey availability due to the introduction of non-native insects, and roost disturbance (USFWS 1998). Management of the Hawaiian hoary bat is also limited by a lack of information on key roosting and foraging areas, food habits, seasonal movements, and reliable population estimates (USFWS 1998).

In their North American range, hoary bats are known to be more susceptible to collision with wind turbines than most other bat species (Johnson et al*.* 2000, Erickson 2003, Johnson 2005). Most mortality has been detected during the fall migration period. Hoary bats in Hawaiʽi do not migrate in the traditional sense, although as indicated, some seasonal altitudinal movements occur. Currently, it is not known if Hawaiian hoary bats are equally susceptible to turbine collisions during their altitudinal migrations as hoary bats are during their migrations in the continental US. At the Kaheawa Wind Power facility, one Hawaiian hoary bat fatality was observed after three years of operation. This incident occurred in late September at an elevation of approximately 2750 ft (838 m) above sea level.

<u>Occurrence of the Hawaiian Hoary Bat in the Project Area and Off-site Microwave Towers</u>

Three to five Anabat detectors were deployed in various locations on the Kahuku Wind Power project area. Anabat detectors detect the presence of bats by recording ultrasonic sounds emitted by bats during echolocation. These studies are presently still on-going. Anabat detectors that did not detect bat calls after a month were moved to new locations to increase the area sampled at the project area.

Bat activity recorded by the Anabat detectors from April 2008 to April 2009 were at a rate of 0.0130 bat passes/detector/night or 0.016 bat call sequences/detector/night (see Appendix 4 for a full report). The year-long data suggests that bat activity may increase from June to September and are lowest or absent from December to February. The detection rates at Kahuku Wind Power are 40-fold lower than detection rates recorded at Hakalau Forest National Wildlife Refuge on the Island of Hawai‘i, (0.660 passes/detector/night, Bornaccorso, unpublished report). Bat activity at the Kahuku Wind Power project area was similar to the post-construction bat activity recorded at the Kaheawa Wind Power project, which had an activity rate of 0.014 bat call sequences/detector/night (Kaheawa Wind Power LLC 2009). One observed fatality has been recorded at the KWP facility after 3.5 years of project operation.

The actual number of bats represented by the detections made by the Anabat detectors on the Kahuku Wind Power site is not known. No bats were sighted at the Kahuku Wind Power project area during the nocturnal point count surveys conducted from October 2007 through December 2008. Day and Cooper (2008) visually observed one Hawaiian hoary bat on-site incidental to the seabird radar survey in July of 2008. Given these results, it is presumed that a very small number of Hawaiian hoary bats forage over the Kahuku Wind Power project area on a somewhat regular, though possibly seasonal, basis.

No surveys for Hawaiian hoary bats were conducted at either microwave tower site. As bats may forage in a wide variety of habitats, and may congregate near lights, bats may occur at either the HECO Waialua substation microwave tower site (rural) or the Flying R Ranch site (agricultural).

4.0 BIOLOGICAL GOALS AND OBJECTIVES

The final addendum to the *Handbook for Habitat Conservation Planning and Incidental Take Permitting Process* (USFWS 2000) is a five-point policy guidance for the HCP process. The addendum outlines the importance of defining biological goals. These broad, guiding principles clarify the purpose and direction of an HCP's operating conservation program. Biological objectives are also integral to the HCP process in order to achieve the different components of the biological goals. The objectives are more measurable than the goals and may include: species or habitat indicator, location, action, quantity/state, and timeframe needed to meet the objective (USFWS 2000).

Kahuku Wind Power LLC has met with local representatives of the USFWS and Hawai‘i DLNR to discuss potential adverse impacts to the eight listed species, measures to practicably minimize the potential for adverse impacts, and biological goals and objectives. Where the potential for impacts is unavoidable, this HCP provides means to minimize and mitigate any adverse impacts to the listed species that may occur, and to provide a net conservation benefit.

Based on ongoing surveys conducted on the project area, as well as records of species known to exist on the adjacent NWR, the proposed project is expected to directly or indirectly impact the flight space of eight federally or state listed species. The proposed wind energy facility in Kahuku is anticipated to directly or indirectly impact the listed individuals, but will have only minor, negligible, or indirect impacts on the amount or quality of terrestrial habitat for these species. For this reason, the goals and objectives of this HCP are species-based, rather than habitat-based.

Specific biological goals and objectives of this HCP are to:

- Minimize and mitigate, to the maximum extent practicable, the effects of take caused by the wind energy generation facility;
- Increase the knowledge and understanding of the eight federally and state listed species' occurrence and behavior in the project vicinity;
- Adhere to goals of the existing recovery plans for any of the eight listed species, considering the most recent updated information and goals; and
- Provide a net conservation benefit to each of the eight species.

5.0 ALTERNATIVES

Section 10(a)(2)(A)(iii) requires an HCP to describe what alternative actions to the proposed incidental taking of listed species were considered by the Applicant, and why those alternatives are not being utilized. The proposed project design (Proposed Action) and the need for the project is described in Section 1.4. Before evaluating the potential impacts of the proposed project, and before discussing measures to avoid and minimize potential impacts, it is helpful to understand how the project area and design were ultimately chosen over other possible alternatives.

5.1 No-Action ("No Build") Alternative

The "no-action" alternative is a "no build" alternative that would mean a commercial wind energy generation facility would not be constructed and operated by Kahuku Wind Power LLC at this location on O'ahu. Kahuku Wind Power LLC is a business entity created for this sole purpose, with a majority partner that is a leader in the wind power industry. Thus, a "no build" alternative is contrary to the Applicant's fundamental purpose and objective. The "no build" scenario also fails to serve the purpose, intent, and requirements of Act 95 (S.B. 2474, S.D. 3, H.D. 2, signed by Governor Linda Lingle on June 2, 2004), which establishes renewable energy portfolio standards for Hawai'i's electric utilities. Act 95 requires each electric utility to establish a renewable portfolio standard of 8% by the end of 2005, 10% by the end of 2010, 15% by the end of 2015, and 20% by the end of 2020. The "no build" alternative, then, does not support the State of Hawai'i's desire to develop viable renewable energy sources, or Kahuku Wind Power LLC's business plan to contribute to these goals.

The no-build scenario would result in no take and no change in the status of the listed species and no implementation of any mitigation measures. There would be no changes to the site or to existing habitats, nor any potential for collision with wind turbines or project infrastructure. However, without the proposed mitigation measures, there would be no contributions to recovery efforts, and no further study or habitat protection funded by the project. In view of the fact that these are expected to provide a net benefit to the species, the "no-build" scenario does not have any positive effect on the species.

Lastly, the "no build" scenario would maintain the status quo of O'ahu's electric energy production, its dependence on imported oil and the emissions thereof. The broad economic and environmental benefits of a commercial wind energy generation facility would be foregone.

5.2 Alternative Project Locations

To achieve the project goal and objective, it is necessary for the Applicant to place the facility in a location where the wind blows reliably, and to connect the facility to an existing electrical transmission system. Because it is not possible to erect wind turbines anywhere on O'ahu without creating some risk of collision with those turbines by some listed bird and bat species, no alternative was available to the Applicant that would meet the project goal and objective and also completely avoid the possibility of incidental take occurring as a result of operation of the wind turbines. Furthermore, no inter-island transmission lines exist, so, sites considered for the proposed project were limited to the Island of O'ahu.

The proposed project area was selected based on the existing needs for renewable energy in Hawai'i, evaluation of wind resources on O'ahu, and a thorough consideration of alternative sites in the area. While wind power is currently the most commercially viable utility-scale renewable energy resource, O'ahu's wind resources, topography, and high land values make developing wind energy projects on the island a challenge. A recent report on renewable resources in Hawai'i found that "with its high competition for land available for development and protected natural features, it is much more difficult to identify ideal sites for renewable energy projects on O'ahu than on the other Hawaiian Islands. The best potential combination of land available for wind development and a strong, proven wind resource is found in the Kahuku area" (Global Energy Concepts LLC, December 2006). Kahuku was the location of several previous wind energy projects in the 1980s and early 1990s and has a well-documented wind regime. The area also benefits from existing electrical transmission lines and a community that is largely familiar with, and supportive of, wind energy generation.

This study also identified two other sites on O‘ahu with reasonable potential for wind development, Ka‘ena Point to the west of Kahuku and Kahe Ridge to the south. Ka‘ena Point was ruled out in the study because it has limited transmission infrastructure and possesses important cultural significance and protected wildlife habitats. Ka‘ena Point also has one of the largest seabird colonies on the main Hawaiian Islands (DLNR 2007a). While none of the three nesting seabird species are endangered [Laysan albatross (*Phoebastria immutabilis*), wedge-tailed shearwater (*Puffinus pacificus*) and white-tailed tropicbird (*Phaethon lepturus*)], the construction of a wind facility close to large seasonal concentrations of these breeding seabirds is undesirable (see Table 5-1). Moreover, nine other species of seabirds, the native pueo, and numerous migratory birds are regularly seen in the area and may be vulnerable to collisions with the turbines and associated structures of the wind facility.

Kahe Ridge was previously proposed as the site of a wind facility by HECO, but the project was cancelled in 2005 when the Mayor of Honolulu announced that permits would not be issued for the project based on concerns expressed at public meetings. Consequently, both Ka‘ena Point and Kahe Ridge were discounted as potential sites for the proposed project.

Once Kahuku was identified as the most viable location for the proposed project, Kahuku Wind Power LLC evaluated undeveloped land in and around Kahuku proximate to existing transmission infrastructure as possible sites for the facility. A potential site in Pūpūkea-Paumalū, to the southwest of the proposed project area, was eliminated after it was determined that access to the site would be difficult, gaining site control for the amount of land necessary for a utility-scale wind energy project was improbable, and the site was bordered by a satellite communications facility on one side and a conservation trust on the other. Additionally, undeveloped lands to the west and south of this site are controlled by the U.S. Army and regularly used for aircraft maneuvering and parachute training exercises. After careful consideration and elimination of these alternate sites, Kahuku Wind Power LLC selected the proposed project area and purchased the property to facilitate the planning, permitting, and construction of Kahuku Wind Power.

5.3 Alternative Site Layouts

Kahuku Wind Power LLC determined the optimum configuration for the turbine layout based on a meteorological data collection and analysis of the wind resource of the property over 12 months. Wind turbines are sited where they will produce the most energy, given the area's wind resource and topography. The initial configuration contemplated a layout consisting of two parallel rows of turbines set perpendicular to a presumed northeasterly wind direction. However, after collecting and analyzing several months of on-site meteorological equipment data, it was discovered that the predominant wind direction is more easterly than expected, and Kahuku Wind Power LLC adjusted the layout of the turbines to maximize their production from this wind profile.

A study of the on-site meteorological conditions was performed concurrently with the avian surveys described in Section 3.0. Results from these surveys and the impact modeling described in Section 6.0 provided Kahuku Wind Power LLC with an expectation that the annual mortality rates of listed species with the proposed layout would be exceedingly low. Estimated mortality rates are on average from 0.03 to 0.4 individuals per species per year, so a great amount of rounding upward is required in order to describe expected annual mortality of listed species in terms of whole birds. Given these very low numbers and knowledge that risk of mortality cannot reach zero, Kahuku Wind Power LLC did not examine alternate turbine configurations with regard to their potential to further reduce potential for avian and bat collisions. The modeling performed for the project suggests that in an average year, no listed species should be killed as a result of collision with the proposed turbines.

5.4 Avoidance and Minimization Measures

The analysis of project design alternatives supports the conclusion that the Proposed Action is preferred when all impacts on the human and natural environment are considered. Because complete avoidance of risk to the listed species is impossible under the Proposed Action, the Applicant has incorporated several measures to avoid and minimize the risk of listed and other wildlife species that may be adversely impacted by the project, and to minimize impact on the human environment. These measures include, but are not necessarily limited to:

- Using "monopole" steel tubular turbine towers rather than lattice towers. Tubular towers are considerably more visible than lattice towers and should reduce collision risk;
- The use of an unguyed instead of a guyed permananet met tower for the project site
- Marking guy wires on temporary certification met towers (scheduled to be in place for approximately four months) with high visibility bird diverters made of spiraled PVC and twin 12 inch white poly vinyl marking tape to improve the visibility of the wires;
- Utilizing a rotor with a significantly slower rotational speed (9.6 – 15.5 rpm) compared to older designs (28.5 - 34 rpm). This increases the visibility of turbine blades during operation and decreases collision risk;
- Placing new power collection lines underground to the extent practicable to minimize the risk of collision with new wires. All overhead collection lines will be spaced according to Avian Power Line Interaction Committee (APLIC 1994) guidelines to prevent possible electrocution of the Hawaiian short-eared owl. The horizontal spacing will be at least 30 inches (75 cm, based on estimated wrist-to-wrist distance), the vertical spacing at least 15 inches (38 cm, head-to-foot length) with adequate spacing between the conductors. Any jumper wires will be insulated;
- Improving drainage in areas to eliminate the accumulation of standing water after a period of heavy rains to minimize potential of attracting waterbirds to the site;
- Where feasible, minimizing night-time construction activities to avoid the use of lighting that could attract seabirds and possibly bats;
- Refraining from clearing of trees for construction at the times of the year when non-volent Hawaiian hoary bats juveniles may be present on the project site (June to August);
- Use of minimal on-site lighting at buildings and using shielded fixtures that will be utilized only on infrequent occasions when workers are at the site at night;
- A speed limit of 10mph will be observed while driving on site, to minimize collision with species listed in the HCP, in the event they are found to be utilizing habitat on site or injured.

5.4.1 USFWS Guidelines

In recognition of the growing wind energy industry in the United States, the USFWS has prepared *"Interim Guidelines to Avoid and Minimize Wildlife Impacts from Wind Turbines"* (USFWS 2003) intended to minimize impacts to all wildlife including those covered under ESA and MTBA. The guidelines are not required by statute to be followed. Kahuku Wind Power LLC has complied with these guidelines to the maximum extent practicable with regards to site development, turbine design, and operations. Table 5-1 below lists the recommendations from the *Interim Guidelines* relating to site development and turbine design and operation and discusses how the Applicant plans to comply with these recommendations. It should be noted that these recommendations relate to all wildlife, whether or not they are protected under the ESA or MBTA, and the benefits of following these recommendations, where applicable, extend beyond the implementation of this HCP.

The USFWS Wind Turbine Guidelines Advisory Committee published a third round of recommendations in June 2009; however, according to the document, important policy, technical, and editorial issues were still being addressed in the June 2009 document during the publication of this HCP.

Table 5-1. Comparison of Kahuku Wind Power project design with the USFWS Interim Voluntary Guidelines for Wind Projects (USFWS 2003).

USFWS Interim Voluntary Guidelines Site Development Recommendations	Proposed Kahuku Wind Power Project
Avoid placing turbines in documented locations of any species of wildlife, fish, or plant protected under the Federal Endangered Species Act	No locations on O'ahu were identified that were unlikely to be visited by listed species and were deemed suitable to support a financially viable wind energy generation facility. On-site surveys indicate that the risk to listed species is low, as none of the documented species have been observed utilizing the site and only three (two bird species and one bat species) are known to transit over the site infrequently. The project will reduce risk to listed species as much as possible while achieving the basic project purpose.
Avoid locating turbines in known local bird migration pathways or in areas where birds are highly concentrated, unless mortality risk is low (e.g., birds present rarely enter the rotor-swept area). Examples of high concentration areas for birds are wetlands, State or Federal refuges, private duck clubs, staging areas, rookeries, leks, roosts, riparian areas along streams, and landfills. Avoid known daily movement flyways (e.g., between roosting and feeding areas) and areas with a high incidence of fog, mist, low cloud ceilings, and low visibility.	No wetlands occur on the project area. Site-specific surveys indicate that the project area is not located along any of the daily movement flyways used by wetland birds and is consistently a location of high visibility with high cloud ceilings.
Avoid placing turbines near known bat hibernation, breeding, and maternity/nursery colonies, in migration corridors, or in flight paths between colonies and feeding areas.	The project area has shown a very low level of bat activity. It is likely that only a few individuals, if any, use the project area.
Configure turbine locations to avoid areas or features of the landscape known to attract raptors (hawks, falcons, eagles, owls). For example, Golden Eagles, hawks, and falcons use cliff/rim edges extensively; setbacks from these edges may reduce mortality. Other examples include not locating turbines in a dip or pass in a ridge, or in or near prairie dog colonies.	The only likely raptor to be present on site is the Hawaiian short-eared owl or pueo, which has only been heard in the project area once during the 15 month long survey. All observations thus far have indicated that Kahuku Wind Power is not located at a site that is attractive to raptors.
Configure turbine arrays to avoid potential avian mortality where feasible. For example, group turbines rather than spreading them widely, and orient rows of turbines parallel to known bird movements, thereby decreasing the potential for bird strikes. Implement appropriate storm water management practices that do not create attractions for birds, and maintain contiguous habitat for area-sensitive species (e.g., Sage Grouse).	Turbines have been grouped as closely as feasible, given wind resource and terrain considerations. No water features will be constructed and on-site drainage will be maintained so as not to attract waterbirds.

USFWS Interim Voluntary Guidelines Site Development Recommendations	Proposed Kahuku Wind Power Project
Avoid fragmenting large, contiguous tracts of wildlife habitat. Where practical, place turbines on lands already altered or cultivated, and away from areas of intact and healthy native habitats. If not practical, select fragmented or degraded habitats over relatively intact areas.	The project area has been extensively grazed and cultivated in the past and does not contain any healthy native habitat.
Avoid placing turbines in habitat known to be occupied by prairie grouse or other species that exhibit extreme avoidance of vertical features and/or structural habitat fragmentation. In known prairie grouse habitat, avoid placing turbines within 5 miles of known leks (communal pair formation grounds).	Not applicable as no prairie grouse occur in Hawai‘i.
Minimize roads, fences, and other infrastructure. All infrastructure should be capable of withstanding periodic burning of vegetation, as natural fires or controlled burns are necessary for maintaining most prairie habitats.	The proposed access roads and infrastructure are designed to be the minimum necessary to construct and operate the project while observing good engineering and environmental design standards. No periodic burning is necessary at the project area.
Develop a habitat restoration plan for the proposed site that avoids or minimizes negative impacts on vulnerable wildlife while maintaining or enhancing habitat values for other species. For example, avoid attracting high densities of prey animals (rodents, rabbits, etc.) used by raptors.	Vegetation that will be removed from the site during construction will be replaced with appropriate vegetation to ensure stable cover. Some areas may be planted with native vegetation, providing additional habitat enhancement to a landscape dominated by alien vegetation.
Reduce availability of carrion by practicing responsible animal husbandry (removing carcasses, fencing out cattle, etc.) to avoid attracting Golden Eagles and other raptors.	This recommendation is not applicable to projects on O‘ahu.
Use tubular supports with pointed tops rather than lattice supports to minimize bird perching and nesting opportunities. Avoid placing external ladders and platforms on tubular towers to minimize perching and nesting. Avoid use of guy wires for turbine or meteorological tower supports. All existing guy wires should be marked with recommended bird deterrent devices (APLIC 1994).	Tubular towers will be utilized for the turbine towers. The towers will not have platforms or ladders. The only permanent met tower will be unguyed.

USFWS Interim Voluntary Guidelines Site Development Recommendations	Proposed Kahuku Wind Power Project
If taller turbines (top of the rotor-swept area is >199 feet above ground level) require lights for aviation safety, the minimum amount of pilot warning and obstruction avoidance lighting specified by the FAA should be used (FAA 2000). Unless otherwise requested by the FAA, only white strobe lights should be used at night, and these should be the minimum number, minimum intensity, and minimum number of flashes per minute (longest duration between flashes) allowable by the FAA. Solid red or pulsating red incandescent lights should not be used, as they appear to attract night-migrating birds at a much higher rate than white strobe lights.	A subset of turbines (eight of twelve) will be lit with medium intensity, red-pulsating, synchronized lights in accordance with FAA aviation safety guidance. Kahuku Wind Power will request the maximum flash interval to minimize lighting impact. White strobe lights do not conform to FAA guidance. On-site lighting will be minimal and shielded so as not to attract night-migrating birds.
Where the height of the rotor-swept area produces a high risk for wildlife, adjust tower height where feasible to reduce the risk of strikes.	Roughly 95-100% of the endangered waterbird species observed in the adjacent wetlands fly below the rotor swept zone of the chosen turbine (Appendix 4). The risk to seabirds is higher with 64% of all birds expected to fly at turbine height or lower; however, seabird traffic is extremely low over the site (Appendix 3).
Where feasible, place electric power lines underground or on the surface as insulated, shielded wire to avoid electrocution of birds. Use recommendations of the Avian Power Line Interaction Committee (APLIC 1994, 1996) for any required above-ground lines, transformers, or conductors.	This recommendation is being followed; new power lines will be placed underground whenever feasible. APLIC guidelines for overhead collection lines have been followed.
High seasonal concentrations of birds may cause problems in some areas. If, however, power generation is critical in these areas, an average of three years monitoring data (e.g., acoustic, radar, infrared, or observational) should be collected and used to determine peak use dates for specific sites. Where feasible, turbines should be shut down during periods when birds are highly concentrated at those sites.	This recommendation is not applicable as there were no observed seasonal concentrations of birds passing over the site. Though seabirds and ducks have been documented to pass through the project area, the passage rates are low compared to other locations in Hawai‘i. Results of on-going acoustic bat monitoring indicate low levels of bat activity in the project area.
When upgrading or retrofitting turbines, follow the above guidelines as closely as possible. If studies indicate high mortality at specific older turbines, retrofitting or relocating is highly recommended.	This recommendation is not applicable to the current project as it will be a new facility.

6.0 POTENTIAL IMPACTS

Generation of electrical energy from wind is a renewable, clean, environmentally friendly technology. It reduces greenhouse gas emissions and water use in electricity generation. At the same time, the potential for wind energy turbines to adversely affect birds and bats is well-documented in the continental United States (e.g., Horn et al. 2008, Kunz et al. 2007, Kingsley and Whittam 2007, Kerlinger and Guarnaccia 2005, Erickson 2003, Johnson et al. 2003a, 2003b). In the State of Hawai�much 'i, wind-powered generation facilities are relatively new; thus, few wildlife monitoring impact studies have been conducted to document the direct or indirect impact of wind energy facilities on wildlife.

Kaheawa Wind Power, LLC has been conducting post-construction monitoring to document downed wildlife at the Kaheawa Pastures Wind Energy Generation Facility on Maui since operations began in June 2006 (First Wind and Kaheawa Wind Power 2008). This information offers some insight into the potential impacts of wind turbines on Hawaiian wildlife, as well as the accuracy of pre-operational estimated take values. Over the three and a half years of monitoring, Kaheawa Wind Power documented observed take of three listed species – a single adult Hawaiian petrel, three full-grown nēnē, and a single Hawaiian hoary bat (Kaheawa Wind Power, LLC 2009; Spencer, pers. comm.). These rates of take are all within the range predicted under the Baseline take scenario provided in the Kaheawa Wind Power HCP (Kaheawa Wind Power, LLC 2009; Spencer, pers. comm.). In addition, two ringed-necked pheasants have been found to have collided with the bases of the towers and one barn owl and a white-tailed tropic bird with turbine blades. Two feather piles of Eurasian skylarks have also been observed in the vicinity of the project, though well outside of the search plots (i.e., at a distance of more than the height of the turbines), suggesting that they may have been the caused by predation.

6.1 Impacts to Birds

Erickson et al. (2001) estimated that an average of 2.19 bird fatalities occur per wind turbine annually in the United States. This equated to an annual mortality of approximately 33,000 birds given the number of turbines in operation at the time (Erickson et al. 2001). Based on 12 wind projects in the U.S., the National Wind Coordinating Collaborative (2004) estimated an average annual avian fatality rate of 2.3 birds per turbine. Though avian fatality rates differ by region, projects in California presently account for the highest wind-related avian mortality in North America. Certain types of birds in certain settings seem to have a higher risk of collision with wind energy facilities than others. When abundant in open country, as in California, raptors (hawks, eagles, falcons and owls), have had comparatively high fatality rates, though passerines as a class generally comprise the majority of fatalities at wind facilities nationwide (Erickson et al. 2001, NWCC 2004, Kingsley and Whittam 2007). Although some impacts to avian species may occur as a result of habitat alteration and disturbance or operation of vehicles, most fatalities at wind facilities are attributed to collisions with wind turbine rotors, met towers, or guy wires (Kerlinger and Guarnaccia 2005).

Numbers of avian fatalities at wind energy facilities are very low compared to the numbers of fatalities resulting from some other human-related causes. Known sources of anthropogenic bird losses outside of wind energy sites include: lighted buildings, windows, communications towers, powerlines, smokestacks, vehicles, cat predation, pesticides, and hunting (Podolsky et al. 1998, Erickson et al. 2001, Martin and Padding 2002, Woodlot Alternatives, Inc. 2003, Federal Register 2004, Mineau 2005). Mortality from these other sources is many orders of magnitude higher than that which occurs at wind facilities.

The studies conducted to date at the Kaheawa Pastures Wind Energy Generation Facility suggest that avian mortality resulting from the proposed Kahuku project may occur at a lower rate than has occurred at facilities in the continental U.S. It is expected that individuals of non-listed bird species will occasionally be killed through collision with the proposed wind turbines and met towers. In general, potential exists for individuals of any of the bird species that have been identified in the project area (see Table 3-2) to collide with project components, although that potential seems greater for birds that regularly fly well above ground (e.g., cattle egret) than for those that usually remain low or concealed in vegetation (e.g., white-rumped shama).

6.2 Impacts to Bats

The number of bat fatalities at wind energy facilities has often exceeded the number of avian fatalities. Studies in the continental U.S. have shown that annual fatality rates vary by region with an average of 1.2 bat fatalities per turbine in the Pacific Northwest and Rocky Mountains, 1.7 bat fatalities per turbine (0.1 - 7.8 bats per turbine) in the Upper Midwest, and as much as 46.3 bat fatalities per turbine (range 15.54 – 69.6 bats per turbine) in certain areas of the eastern U.S. (Johnson 2005). Differences are likely due to differences in local habitat conditions and population sizes of the most susceptible species. Facilities studied in the eastern U.S. where fatalities are highest are primarily located along forested ridge tops as opposed to open areas, and where migratory tree-roosting species are most numerous. Geographic and topographic differences may also be factors. Most of the recorded bat fatalities in the U.S. (83.2%) are members of migratory tree-roosting species. Hoary bats (of which the Hawaiian hoary bat is a subspecies) are the most frequently (45.5%) recorded fatalities (Johnson 2005, Cryan and Brown 2007).

Available evidence indicates that bat mortality at continental U.S. wind facilities peaks in late summer and fall, coinciding with mating and migration. Increased bat fatalities also tend to occur during periods of low wind speed (< 13.5 mph or 6 m/s) and passing weather fronts (Arnett et al. 2008). In contrast, observed bat collision mortality during the breeding season is rare (Johnson et al. 2003b). Similar to birds, bats are also known to collide with high, man-made structures (Johnson 2005).

The high number of fatalities of migratory tree-roosting bats at wind energy facilities has stimulated a cooperative research effort to explore how and why bats contact turbines (Arnett et al. 2008). Several possible explanations have been generated. Research has suggested that some fatalities may result from mating behaviors that center on the tallest trees in a landscape (Cryan 2008). Some have suggested that some bats may be attracted to audible sound, ultrasound, and movement of wind turbine structures (Horn et al. 2008). However. research on the ultrasonic sound emissions of various turbines (of which the proposed Clipper 2.5-MW turbine was one) found that ultrasonic emissions attenuated at short distances from the turbine and there was no evidence of unusual ultrasonic emissions that would attract bats (Szewczak and Arnett 2006). Other theories speculate that migratory behavior, such as stopovers, are responsible for observed fatality rates (Johnson 2005, Cryan and Brown 2007) or that forest edges produced by access roads create favorable foraging habitat (Horn et al. 2008). Baerwald et al. (2008) documented that some bats killed at wind turbines suffered from barotraumas, i.e., pulmonary hemorrhaging caused by a rapid reduction in air-pressure, such as occurs behind moving turbine blades.

6.3 Estimating Project-related Impacts

Construction and operation of the Kahuku Wind Project would create the potential for federally and state-listed bird and bat species to collide with wind turbines, temporary and permanent met towers, and cranes used for construction of the turbines. The potential for each listed species to collide with these project components was identified based on the results of the on-site surveys discussed in Section 3.0 and the proposed project design. Fatality estimate models were developed that incorporated rates of species occurrence, observed flight heights, encounter rates with turbines and met towers, and considered ability of birds to avoid project components. Ability of birds to avoid turbines was then varied in the models to create a range of probabilities of mortality for each species on an annual basis. Range of expected mortality coincides with the amount of "direct take" expected from construction and operation of the Kahuku Wind Project.

In addition to "direct take," mortality of listed species resulting from collisions with project components can also result in "indirect take". For example, it is possible that adult birds killed through on-site collisions could have been tending to eggs, nestlings, or dependent fledglings, or adult bats could have been tending to dependent juveniles. The loss of these adults would then also lead to the loss of the eggs or dependent young. Loss of eggs or young would be "indirect take" attributable to the proposed project. Methods for determining indirect take are described in detail in section 6.3.2.

No direct or indirect take of listed species is expected to result from on-site habitat disturbances. The only listed species with potential to occur regularly "on the ground" in the project area are Hawaiian hoary bat, which have shown very low but regular activity rates on site and could theoretically roost in trees on the property, and Hawaiian short-eared owl, which may roost in low vegetation or nest on the ground within the property. Hawaiian hoary bats breed at low elevations, so it is possible dependent juvenile bats occur in the project area during the months of June to August. Likewise, the project area possibly does contain suitable nesting habitat for Hawaiian short-eared owl, though the occurrence of regular breeding on site is considered highly unlikely because of only one visual observation of a Hawaiian short-eared owl during the year-long avian surveys. Vegetation clearing for the project will be performed during times of year when Hawaiian hoary bats are not expected to be breeding in order to avoid potential for harm to non-volent juvenile bats. As Hawaiian short-eared owls breed year round, it is not possible to time clearing activities to avoid potential for conflict with nesting by this species. Vegetation clearing will be suspended within 300 ft (91 m) of any area where distraction displays, vocalizations, or other indications of nesting by adult Hawaiian short-eared owl are seen or heard, and resumed when it is apparent that the young have fledged or other confirmation that nesting is no longer occurring.

Estimated annual mortality resulting from the Kahuku Wind Project for each of the species addressed in this HCP is provided below. Also included for each species is an estimate of indirect take based on expected level of direct take. As discussed in Section 8.2 (Monitoring), the amount of direct take attributed to the project (total direct take) will be identified annually. Total direct take will be assessed using observed direct take (actual individuals found during post-construction monitoring) and an estimate of unobserved direct take based on searcher efficiency and scavenging trial results. This will account for individuals that may be killed by collision with project components but that are not found during the monitoring effort. It is generally accepted that some birds and bats killed through collision with wind turbines are not found by searchers for various reasons, including heavy vegetation cover and scavenging. The terms and equations discussed are presented below:

Total Direct Take = Observed Take + Unobserved Take

Adjusted Take = Total Direct Take + Indirect Take

"Total Direct Take" will be calculated based on an estimator approved by USFWS and DLNR such as the one proposed in Huso (2008), presented below:

$$\hat{m}_{ij} = \frac{c_{ij}}{\hat{r}_{ij}\hat{p}_{ij}\hat{e}_{ij}}$$

where

- $\mathbf{m_{ij}}$ estimated mortality
- $\mathbf{r_{ij}}$ estimated proportion of carcasses remaining after scavenging
- $\mathbf{e_{ij}}$ effective search interval
- $\mathbf{p_{ij}}$ estimated searcher efficiency
- $\mathbf{c_{ij}}$ Observed take

A detailed protocol of how monitoring will be performed at Kahuku Wind Power is provided in Section 8.2 and Appendix 7. A detailed protocol of how searcher efficiency and scavenging rates will be quantified during the post-construction monitoring effort is also provided in Appendix 7 and methods for calculating total direct take is presented in Appendix 9.

6.3.1 Take Levels

In addition to providing an estimate of direct and indirect take for each species covered by this HCP, each section below identifies the number of individuals of each species for which take authorization is sought through acquisition of a State of Hawai'i ITL. Because of a very low level of observed bird and bat activity at Kahuku Wind Power for the Covered Species in the HCP, the mortality modeling provides very low estimated rates of direct take. In order to account for the stochasticity of take over time, where take in any given year take may be higher or lower than the expected long-term average, 1-year, 5-year, and 20-year take limits are proposed (e.g., take for Species A could be authorized as three individuals in any given year but not more than five individuals total every 5 years and not more than ten individuals for 20 years). Short-term take limits (1-year and 5-year limits) also provide benchmarks for the monitoring of take and will enable mitigation efforts to be tailored to respond to more immediate events. Twenty-year limits, however, are believed to be a better reflection of the long-term amount of take expected. Exceeding the 5- or 20-year take limit would indicate that take has moved to a higher tier and would form the basis for consultation with DLNR and USFWS to implement adaptive management strategies.

Computed annual "total direct take" of each Covered Species will be classified as "Baseline," "Lower," and "Higher". "Baseline" total direct take is the amount requested to be authorized by the ITL. For each species, the annual **Baseline** level of take was estimated based on the expected average annual mortality identified through the modeling using the most reasonable expectations of avoidance for each species, rounded up to the nearest whole integer, and then adjusted to account for expected levels of unobserved direct take. For example, modeling suggests Newell's shearwater mortality will occur at an average rate of approximately 0.34 adults per year. To identify the annual Baseline level of take requested to be authorized, this was first rounded up to 1 adult per year (i.e., almost 3x). Then, based on assumptions concerning unobserved direct take, it was expected that the discovery of 1 shearwater mortality in a given year would lead to an assessment of total direct take for that year of 2 shearwaters. So, while the modeling suggests that shearwater mortality will occur at a rate of roughly one adult bird every three years, because it cannot be known if or in what years mortality will occur and because of assumptions concerning unobserved direct take, it is necessary to have the Baseline take authorization for Newell's shearwater allow the total direct take of a minimum of 2 adult birds in any given year. The 5-year and 20-year Baseline levels, being of a longer-term duration, however, more closely reflect the expected annual average mortalities.

The **Lower** rate for any species is the range of take that falls below the amount of take expected over any five-year period based on the annual average rate of expected take as estimated through modeling. For example, the expected take of shearwaters over a five-year period is 1.7 (because 0.34 shearwaters per year x 5 years = 1.7 shearwaters). Since finding one carcass will automatically result in a total direct take of more than one, the Lower rate of take identified for Newell's shearwater is required to be zero.

A **Higher** rate of take would be that which exceeds the authorized Baseline rate. As discussed, because of expected annual variability in actual rates of take, this HCP proposes that levels of take be authorized in one-year, 5-year, and 20-year Baseline limits. Any take occurring in excess of one of these term limits could be considered a "Higher" rate. However, it would be possible for take to occur so unevenly that take could qualify as "Higher" in one year and "Baseline" over the corresponding 5-year term. Therefore, Higher rates of take identified over 5-year and 20-year terms will be used to make adjustments to mitigation efforts because they will have incorporated some averaging of annual variability, while Higher rates measured over one-year terms will be used as "early warnings" that adjustments to mitigation efforts may become necessary and to spur investigation into why a Higher rate of take occurred and whether steps may be able to be taken to reduce future take. If post-construction monitoring indicates that take has exceeded the 5-year or 20-year Baseline take limit for any species, the Applicant would re-initiate consultation with DLNR and USFWS to implement adaptive management strategies.

6.3.2 Estimating Indirect Take

The amount of indirect take assigned to a fatality would be determined based on the presumed breeding status of the taken individual and potential productivity as discussed below. The estimates of indirect take derived in this section provide examples based on the best information currently available, which may change as new information emerges. Any new adjustments to indirect take will be done with the concurrence of USFWS and DLNR. Breeding status is assigned as follows:

1. Species with a defined breeding season (Newell's shearwater, Hawaiian petrel, Hawaiian stilt and Hawaiian hoary bat):

a. If an adult is found during breeding season, and if an estimate of the average breeding rate of the species (percent of adult population breeding in a given year) is available, the average population breeding rate will be used to determine the probability that the adult was breeding;
b. If an adult is found during breeding season, and if an estimated breeding rate is not available for the species, the adult will be assumed to have been breeding;
c. If an adult is found outside of the breeding season, the adult will be assumed to have been non-breeding;
d. Immatures will be assumed to be non-breeding regardless of season.
e. If age cannot be determined, an individual will be assumed to have been an adult of breeding age.

2. Species for which breeding occurs year-round but that have a peak to their breeding season (Hawaiian duck, Hawaiian coot and Hawaiian moorhen):
   a. If an adult is found during peak breeding season, the adult will be assumed to have been breeding;
   b. If an adult is found outside of peak breeding season, it will be assumed there was a 25% chance that the bird was actively breeding.

3. Hawaiian short-eared owl, which is believed to breed year-round with no known peak:
   a. A 16.67% chance of active breeding will be assumed for any adult owl found. This is based on expectation that a pair of owls produces one clutch per year and known length of the breeding period (length of incubation of 1 month plus 1 month of parental care of young till fledging; 2 months breeding / 12 months per year = 0.1666).

Potential productivity ranges widely amongst the species addressed in this HCP. Some species, such as Newell's shearwater and Hawaiian petrel, are expected to produce no more than one young per pair per year. Other species, such as Hawaiian duck, can lay clutches of a dozen eggs or more. While not all young hatched from a clutch of eggs can be expected to survive to fledging age much less adulthood, if an incubating female bird was to be killed by collision with a turbine, that fatality may be held indirectly responsible for the loss of the eggs that were viable at the time of collision. On the other hand, if a female was to be killed during the time it was tending to recently fledged young, a reasonable expectation would exist that the number of fledglings lost through loss of parental care would be fewer than the number of eggs in the original clutch because of expected natural losses to predation, disease, starvation, etc. that typically accrue through the breeding period.

The probability of some listed species colliding with a wind turbine also changes with time of year and/or breeding status. For example, Newell's shearwaters have potential to collide with turbines only during the breeding season because during non-breeding periods they remain at sea. Hawaiian hoary bats may preferentially reside at higher elevations during non-breeding periods. Waterbirds often become territorial during the breeding season and are likely less apt to wander away from nesting areas or brooding territories when tending to eggs or chicks, and so may be less susceptible to collisions when actively nesting. These factors were considered in developing how indirect take would be assessed to the proposed project.

Finally, assessments of indirect take must consider parental contributions to care of the eggs and/or young. Male Hawaiian hoary bats exhibit no role in raising of young, so death of a male bat through collision could not lead to indirect take. Males of some of the bird species do contribute significant effort to raising of young, so if a female of such a species were to be killed during the breeding season, the male of the pair may be capable of successfully raising some of their young, especially if the mortality were to occur when the young were closer to fledging age.

The amount of annual take requested to be authorized in the ITL for each species as identified below is divided into two categories. One category is the number of individuals requested to be authorized to be directly taken and the other consists of the number of individuals that will be assumed to be indirectly taken in terms of eggs, juveniles or fledglings. As described later, the number of individuals of a Covered Species for which take authorization is sought is greater than the number of individuals of that species actually expected to be taken. This is because the take modeling for most species resulted in identification of an average rate of take of less than one individual per year, whereas take authorizations must be presented in terms of whole individuals per year.

6.3.3 Seabirds (Petrels and Shearwaters)

Seabird mortality due to collisions with human-made objects, such as power lines, has been documented in Hawai'i on the Islands of Maui (Hodges 1994) and Kaua'i (Telfer et al. 1987, Cooper and Day 1998, Podolsky et al. 1998). At the Kaheawa Pastures Wind Energy Generation Facility on Maui, only a single seabird mortality (an adult Hawaiian petrel) has been observed since operations began in June 2006 (Kaheawa Wind Power, LLC 2008). Modeling of expected impacts to Newell's shearwater and Hawaiian petrel as identified below was performed by Day and Cooper (2008).

6.3.3.1 Newell's Shearwater

Impacts from Turbines and Met Towers

Based on the results of on-site surveys as discussed in Section 3.8.2.1, Day and Cooper (2008) estimated that direct take of Newell's shearwater at Kahuku Wind Power would range from approximately 0.00374 to 0.05643 shearwaters/turbine/year (based on 90-99% avoidance rates). This equates to an average annual fatality rate ranging between 0.04488 and 0.67716 shearwaters per year for all 12 turbines. The annual fatality rate due to collisions with met towers was expected to range between 0.001622 and 0.01622 shearwaters/tower (Day and Cooper 2008). Accordingly, the total estimated average fatality rate for the 12 turbines and one permanent met tower is projected to range between approximately 0.0465 – 0.6934 shearwaters/year. Observed fatality rates at existing projects suggest that petrels and shearwaters actually exhibit an avoidance rate approximating 95% or greater with respect to wind turbines and other tall objects in their airspace. The estimated average fatality rate at a 95% avoidance level for all 12 turbines and one met tower equates to approximately 0.34 shearwaters/year.

Impacts from Other Project Components

In addition to collisions with turbines and met towers, some limited potential exists for shearwaters to collide with cranes during the construction phase of the project. Cranes used during construction are typically comparable in height to the turbine towers (Kaheawa Wind Power, LLC 2006). However, the construction phase is expected to last less than six months, with cranes on-site for only three to four months. Given the brevity of the construction period and the low occurrence rate of the species, potential for Newell's shearwaters to collide with construction cranes is considered to be negligible.

Potential for shearwaters to collide with the on-site and off-site microwave towers, overhead collection lines, relocated distribution lines and utility poles also exists. All these structures are 60 ft tall or less. Studies have shown that only 1% of Newell's shearwaters (n = 688 birds; B. Cooper, pers. comm.) fly below 60 ft and of these individuals, the estimated collision avoidance rate is 97% (Day et al., In prep). Given that the seabird traffic rate on O'ahu is extremely low, the likelihood of a seabird flying at such low altitudes and colliding with the microwave towers, overhead collection lines, relocated distribution lines and utility poles related to the project is considered to be remote.

To our knowledge, no seabird mortality (or mortality of any other listed species) has been recorded at the existing Crown Castle tower near Flying R Ranch or at the Waialua Substation site, although we also are not aware that any systematic mortality monitoring has been conducted at these locations. Because the proposed Waialua Substation and Flying R Ranch towers would be located in areas with structures similar in height to the proposed microwave towers (utility poles, street pole, etc.) and associated overhead cables, the towers are not expected to create a significant collision hazard to any Covered Species if they should happen to transit the tower location.

Therefore, none of these structures were identified as a potential source of take of Newell's shearwater in the mortality modeling performed for the species and, thus, the amount of take requested to be authorized through the ITL is based solely on mortality expected to occur as a result of construction and operation of the WTGs and met towers.

However, if in the unlikely event a seabird mortality is found in the future and that mortality can be attributed to the on-site construction cranes, Kahuku Wind Power on-site or off-site microwave towers, associated overhead cables or utility poles Kahuku Wind Power LLC will mitigate for that loss at a level commensurate with any take recorded on-site and through the methods proposed in Section 7.3. After commissioning, the lease for both offsite microwave tower sites may be turned over from Kahuku Wind Power LLC to HECO. If so, any take responsibility (if any) associated with potential take at the off-site tower may be transferred as well. The transfer of responsibility would be determined in consultation with DLNR and USFWS.

Impacts from Project Related Activities

Some potential also exists for construction or maintenance vehicles to strike downed shearwaters (birds already injured by collision with turbines or towers) while traveling project roads. Project personnel will be trained to watch for downed shearwaters and other wildlife and speed limits (10 mph) will be emplaced and enforced to minimize potential for vehicular strikes to result in death of birds that otherwise might have been able to be rehabilitated. Despite this, it is assumed that day-to-day maintenance of the wind facility may very occasionally result in the fatality of a shearwater. This source of mortality does not result in an increase in the amount of direct take expected from the proposed project because these birds are accounted for in the mortality modeling.

Therefore, for this HCP, it is projected that take of Newell's shearwater as a result of collision with project-related components and vehicle strikes will occur at the average rate of 0.34 shearwaters/year.

Indirect Take and Take Limits

Adult birds are most likely to collide with turbines and associated structures while commuting between nesting and feeding grounds during incubation or chick feeding periods. This is generally the period of June through October. Potential also exists for shearwaters to collide with turbines in April, when scouting for nesting sites takes place. Newell's shearwaters are not expected to be flying across the project area at other times of year. Based on the above, an indirect take assessment would be applied to any adult shearwaters found directly taken during the period of 1 June through 31 October. Indirect take would not be assessed to adult shearwaters found at other times of year or applied to immature shearwaters. Little information is available for Newell's shearwaters on nestling growth rates and development or adult visitation rates. Therefore, it is assumed that care by both parents is necessary throughout the breeding season for a chick to fledge successfully. Indirect take would be applied at the rate of 0.46 chicks per adult. The calculation used to reach this number is presented in Table 6-1 below (life history data presented can be found in Appendix 5).

The DLNR and ESRC have recommended that annual take limits allow for at least one **observed** take a year. Because of assumptions concerning unobserved direct take, any one Newell's shearwater found to have collided with a project component in a year will lead to an assessment of total direct take for that year of greater than one that likely would be rounded up to two birds (based on expected results from take monitoring and subsequent adjustments for searcher efficiency and scavenging rates). While the second bird taken under this scenario would be assumed and, therefore, of unknown age or gender, for the purposes of this HCP it will be assumed that all birds taken through "unobserved direct take" will be of the same age and breeding status as the individual that was found. Consequently, the total direct take of two adult shearwaters in a year could result in an assessment of indirect take of up to 0.92 chicks, or essentially one chick, that year. Based on the above, the Applicant suggests the ITL should allow for a total direct take of two Newell's shearwaters and the indirect take of one chick per year of project operation.

Table 6-1. Calculation of indirect take for Newell's shearwater.

Newell's shearwater	Season	Average no. of chicks per pair (A)	Likelihood of breeding (B)	Parental contribution (C)	Indirect take (A*B*C)
Adult	Jun-Oct	1	0.46	1.0	0.46
Adult	Nov - May	--	0.00	--	0.00
Immature	All year	--	0.00	--	0.00

Actual expected rates of take and rates of take requested to be authorized by the Baseline ITL through the expected 20-year life of the project are summarized below. Also identified below are rates of take proposed to qualify as "Lower," and "Higher" for purposes of identifying when it would be appropriate or necessary to consider adaptive management practices. See section 6.3.1 for an explanation of the different take limits and take levels.

Expected Rate of Take		
Annual average	0.34 adults/immatures and 0.16 chicks	0.50 birds/year
20-year project life	7 adults/immatures and 4 chicks	
Requested ITL Authorization		
Baseline annual level of take	2 adults/immatures and 1 chick	3 birds/year
5-year limit of take	6 adults/immatures and 3 chicks	
20-year limit	8 adults/immatures and 4 chicks	
Higher Rate of Take		
One-year period	Total direct take of 3 – 4 adults/immatures and 1 – 2 chicks	
5-year period	Total direct take of 7 – 8 adults/immatures and 3 – 4 chicks	
20-year limit	Total direct take of 9 - 12 adults/immatures and 4 – 6 chicks	
Lower Rate of Take		
5-year period	Total direct take of 0 adults/immatures and 0 chicks	

The most recent population estimate of Newell's shearwater was approximately 84,000 birds, with a possible range of 57,000 to 115,000 birds (Ainley et al. 1997). However, radar studies and population modeling have indicated that the population of Newell's shearwater is likely on a decline especially on Kauaʻi (Ainley et al. 2001, Day et al. 2003). Declines in Newell's shearwater populations are attributed to loss of nesting habitat, predation by introduced mammals (mongoose, feral cats, rats, and feral pigs) at nesting sites, and fallout of juvenile birds associated with disorientation from urban lighting (Ainley et al. 1997, Mitchell et al. 2005, Hays and Conant 2007).

The expected loss of an average of 0.5 shearwater per year (0.34 adult shearwater and 0.16 chicks) is approximately 0.0005% to 0.001% of the estimated Newell's shearwater population. Given these very low percentages, it is considered extremely unlikely that take caused by the proposed project would result in significant adverse effects to Newell's shearwater at the population level.

However, rates of take at the Higher level may present a greater risk for the subset of the population that breeds on Oʻahu, which is poorly known but presumed small. Higher rates of take are expected to occur only in the unlikely event that less than 95 percent of the shearwaters passing over the site fail to detect and avoid the turbines and met towers (Day and Cooper 2008).

Predation by introduced mammals and downing due to urban lighting are considered the primary threats to the recovery of Newell's shearwater. Proposed mitigation measures (Section 7.0) are expected to more than offset the anticipated take and contribute to the species' recovery by providing a net conservation benefit, as required by State law. For this reason, no significant adverse impacts to the species' overall population, and no significant cumulative impacts to the species, are anticipated.

6.3.3.2 Hawaiian Petrel

No birds believed to be Hawaiian petrels were recorded flying over the site during the radar studies, and their documented numbers on O'ahu are very low (see section 3.8.2.2). Because no Hawaiian petrels were identified flying over the site, mortality modeling for this species would identify an expected rate of take of zero. Given the results of the radar studies and the very low number of petrels believed to occur on O'ahu, it does seem that the risk of the proposed project causing take of this species is very low, but not zero. Therefore, for the purpose of this HCP, it is assumed that the average annual direct take of adult Hawaiian petrel will be half that of Newell's shearwater (0.34 shearwaters/year), or 0.17 petrels/year. This estimate includes potential fatality caused by turbines, met towers, on-site and off-site microwave towers and overhead cables, utility poles and other associated structures, as well as mortality due to construction related fatalities and vehicular strikes.

After commissioning, the lease for both off-site microwave tower sites may be turned over from Kahuku Wind Power LLC to HECO. If so, any take responsibility (if any) associated with potential take at the off-site tower may be transferred as well. The transfer of responsibility would be determined in consultation with DLNR and USFWS).

As with Newell's shearwater, adult petrels have potential to collide with turbines and associated structures while commuting between nesting and feeding grounds during the pre-laying period (late February to April) and incubation or chick-feeding periods (May through October). Indirect take accounting for possible loss of eggs or chicks would be assessed to any direct take of Hawaiian petrels occurring during the breeding period of May through October, but would not be assessed if direct take of this species occurs during the pre-laying period or at other times of year. The risk of collision outside the pre-laying period or breeding season is considered minimal as these birds do not return to land during that time.

Potential for survival of a chick following a collision by one of its parents appears dependent upon the time at which the parent is lost. Both parents alternate incubating the egg (May-June), allowing one or the other to leave the colony to feed. Therefore, it is believed that both parents are essential for the successful hatching of the egg (Simons 1985). Both parents also contribute to the feeding of chicks. Chicks are fed 95% of all food they will receive from their parents within 90 days of hatching (Simons 1985). Because hatching generally occurs in late June, chicks should have received 95% of their food by the end of September. After this time, it is likely that many chicks could fledge successfully without further parental care as some chicks have been recorded as having been abandoned by their parents up to three weeks prior to fledging (Simons 1985). Consequently, it is considered probable that after September many chicks would be capable of fledging if subsequent care was provided by only one parent. Based on this, for the purposes of this HCP and assessing indirect take, it will be considered that both parents are essential to the survival of a Hawaiian petrel chick through September, but that a chick has a 50% chance of fledging successfully if adult take occurs in October.

Not all adult Hawaiian petrels visiting a nesting colony breed every year. Simons (1985) found that 11% of breeding-age females at nesting colonies were not breeding. Most non-breeding birds and failed breeders leave the colony for the season by mid-August (Simons 1985). Therefore, it appears there would be an 89% chance that an adult petrel taken from May through August was actually breeding, but nearly a 100% chance that birds taken in September or October would be tending to young. Based on the above life history parameters and as identified in Table 6-2 below, indirect take would be assessed at the rate of 0.89 chick per adult taken between May and August, 1.00 chick per adult taken in September, and 0.50 chick per adult taken in October (life history data presented can also be found in Appendix 5).

Table 6-2. Calculation of indirect take for Hawaiian petrel.

Hawaiian petrel	Season	Average no. of chicks per pair (A)	Likelihood of breeding (B)	Parental contribution (C)	Indirect take (A*B*C)
Adult	May-Aug	1	0.89	1.0	0.89
Adult	Sept	1	1.00	1.0	1.00
Adult	Oct	1	1.00	0.5	0.50
Adult	Nov - Apr	--	0.00	--	0.00
Immature	All year	--	0.00	--	0.00

Based on estimated rates of direct and indirect take, annual take of this species resulting from project operations is expected to average well less than one bird per year (0.17 adult/year + (maximum 1 chick/year x 0.17) = 0.34 bird/year). However, as for Newell's shearwater, the DLNR and ESRC have recommended that annual take limits allow for at least one **observed** take per year. Therefore, again because of assumptions concerning unobserved direct take, any one Hawaiian petrel found to have collided with a project component in a year will lead to an assessment of total direct take for that year of greater than one, with total direct take then likely to be rounded up to two birds. Birds taken through assessment of "unobserved direct take" will be assumed to have been adults lost during the breeding season.

The total direct take of two adults per year could result in an indirect take assessment of a maximum of two chicks. Consequently, the Applicant suggests the Baseline ITL should allow for a total direct take of two Hawaiian petrels and the indirect take of two chicks per year of project operation. Expected rates of take and rates of take requested to be authorized by the ITL through the expected 20-year life of the project are summarized below, along with rates of take considered to qualify as "Lower" and "Higher". See section 6.3.1 for an explanation of the different take limits and take levels.

Expected Rate of Take

Annual average	0.17 adults/immatures and 0.17 chicks	0.34 birds/year
20-year project life	4 adults/immatures and 4 chicks	

Requested ITL Authorization

Baseline annual level of take	2 adults/immatures and 2 chicks	4 birds/year
5-year limit of take	4 adults/immatures and 4 chicks	
20-year limit	4 adults/immatures and 4 chicks	

Higher Rate of Take

One-year period	Total direct take of 3 - 4 adults/immatures and 3 – 4 chicks
5-year period	Total direct take of 5 – 6 adults/immatures and 5 – 6 chicks
20-year limit	Total direct take of 5 - 6 adults/immatures and 5 – 6 chicks

Lower Rate of Take

5-year period	Total direct take of 0 adults/immatures and 0 chicks

The current population of Hawaiian petrel is estimated to be approximately 20,000 birds, with 4,000 to 5,000 breeding pairs (Mitchell et al. 2005). The average rate of take of Hawaiian petrel is expected to be no more than 0.34 petrel/year (0.17 adult and 0.17 chick). This represents less than 0.009% of the estimated Hawaiian petrel breeding population and less than 0.002% of the estimated total population. Given these very low percentages, it is considered extremely unlikely that take of Hawaiian petrel caused by the proposed project would result in significant adverse effects to Hawaiian petrel at the population level.

Rates of take at the Higher level may present a greater risk for the subset of the population that breeds on O'ahu, which is poorly known but presumed small if present at all. However, higher take levels are considered very unlikely to occur since this species was not believed to have been recorded flying over the project area during the radar survey (Day and Cooper 2008). Thus, significant adverse effects to O'ahu populations of Hawaiian petrel are not expected.

Predation by introduced mammals and downing due to urban lighting are considered the primary threats to recovery of Hawaiian petrel. Proposed mitigation measures are expected to more than offset the anticipated take and contribute to the species' recovery by providing a net conservation benefit, as required by State law. For this reason, no significant adverse impacts to the species' overall populations, and no significant cumulative impacts to the species, are anticipated.

6.3.4 Hawaiian Waterbirds

6.3.4.1 Hawaiian Duck Hybrids

Impacts from Turbines and Met Towers

The estimated passage rate of Hawaiian duck hybrids over the Kahuku Wind Power project area is 0.0029 birds/ha/hr or 8.0 birds/day for the entire site (see section 3.8.2.3, Appendix 4). Modeling provides an estimated average fatality rate that ranges from 0.0004 to 0.0042 ducks/turbine/year (based on 90 – 99% avoidance rates). This equates to an average annual fatality rate ranging from 0.005 to 0.050 ducks/year for all 12 turbines. Average fatality caused by collision with the one permanent met tower is estimated to range from 0.00006 to 0.0006 ducks/year. Combined, the total estimated average fatality rate at Kahuku Wind Power for all 12 turbines and one met tower ranges from 0.001 - 0.051 ducks/year.

Low mortality of waterbirds has been documented at wind turbines situated coastally, like the proposed Kahuku Wind Power project, despite the presence of high numbers of waterbirds in the vicinity (Kingsley and Whittam 2007). Studies at wind energy facilities located in proximity to wetlands and coastal areas have shown that waterbirds and shorebirds are among the birds most wary of turbines and that these birds readily learn to avoid the turbines over time (Koford et al. 2004, Jain 2005, Carothers 2008). Avoidance behavior has also been documented by nēnē at the existing KWP facility on Maui (Kaheawa Wind Power 2008). Because of this, an avoidance rate of 95% (95% of the ducks approaching the turbines and met tower successfully avoid them) was used in the modeling to identify the expected average mortality rate of hybrid Hawaiian ducks resulting from proposed project operations. The estimated average rate of mortality at 95% avoidance is 0.026 ducks/year for all 12 turbines and the one met tower on site.

Passage rates of ducks over Kahuku Wind Power may temporarily increase due to events associated with extremely heavy rainfall (e.g. 5 inches of rain or more per day) which can occur every few years on O'ahu. These rains usually cause significant flooding in the northern portions of the island, where Kahuku Wind Power is situated. During one such event, some standing water was observed on site at Kahuku Wind Power and these features were noted to attract Hawaiian duck hybrids to the site for a short period of time (a few days). The observed ponding was in an area characterized as pasture area. In order to reduce the risk for waterbirds, Kahuku Wind Power intends to grade this area during construction to improve drainage and prevent standing water from collecting during such periods of heavy rain. The area in question is not a wetland or water as defined under state or federal laws and, given how rarely it holds water, does not provide resources regularly utilized by Hawaiian duck hybrids. Overall, we believe that minimizing the potential for collisions of listed waterbirds with project structures outweigh the significance in the loss of these small, ephemeral, and infrequently-used habitat areas.

Impacts from Other Project Components

Hawaiian duck hybrids frequently fly at altitudes that the microwave tower, overhead collection lines, relocated distribution lines and utility poles on-site would extend to (see Appendix 4). Therefore, potential for ducks to collide with these structures exists. However, as Hawaiian hybrid ducks are primarily diurnal, they are expected to easily avoid the microwave tower which would be highly visible during daylight hours. Observations of ducks conducted at nearby wetlands demonstrated that Hawaiian duck hybrids easily negotiated the overhead powerlines strung across the wetland habitat.

No ducks were observed to have any collisions or near-collisions with the overhead powerlines or utility poles (147 flocks observed, average of two birds per flock). Consequently, potential for hybrid Hawaiian ducks to collide with the microwave tower, overhead collection lines, relocated distribution lines and utility poles on-site to is considered to be negligible.

Some very limited and temporary potential risk would also exist for ducks to collide with cranes during the construction phase of the project. However, the cranes would be highly visible, and so should be readily avoided. In addition, as discussed for Newell's shearwater, the cranes are only expected to be present on-site for a brief period. Consequently, potential for hybrid Hawaiian ducks to collide with construction cranes is considered to be negligible.

No Hawaiian duck hybrids are expected to be present at either offsite microwave tower site.

Therefore, none of these structures were identified as a potential source of take of Hawaiian duck hybrids in the mortality modeling performed for the species and, thus, the amount of take requested to be authorized through the ITL is based solely on mortality expected to occur as a result of the operation of the WTGs and met towers.

However, if in the unlikely event a mortality is found in the future and that mortality can be attributed to the on-site construction cranes, Kahuku Wind Power on-site or off-site microwave towers, associated overhead cables or utility poles, Kahuku Wind Power LLC will mitigate for that loss at a level commensurate with any take recorded on-site and through the methods proposed in Section 7.4. After commissioning, the lease for both offsite microwave tower sites may be turned over from Kahuku Wind Power LLC to HECO. If so, any take responsibility (if any) associated with potential take at the off-site tower may be transferred as well. The transfer of responsibility would be determined in consultation with DLNR and USFWS).

<u>Impacts from Project-related Activities</u>

Some potential also exists for construction or maintenance vehicles to strike downed ducks (ducks already injured by collision with turbines or towers) while traveling project roads. Project personnel will be trained to watch for downed ducks and other wildlife and speed limits (10 mph) will be emplaced and enforced to minimize potential for vehicular strikes to result in death of ducks that otherwise might have been able to be rehabilitated. Despite this, it is assumed that day-to-day maintenance of the wind facility may occasionally result in the fatality of hybrid ducks. As discussed for Newell's shearwater, this potential source of mortality is accounted for in the collision mortality estimate and so does not result in an increase in the amount of take expected from the proposed project.

Therefore, for this HCP, it is projected that take of Hawaiian duck hybrids as a result of collision with project components and vehicle strikes will occur at the average rate of 0.02 ducks/year.

<u>Indirect Take and Take Limits</u>

It is assumed that adult ducks are most likely to collide with turbines and associated structures during non-breeding periods or toward the end of their breeding period when ducklings are larger and can be left unattended for longer periods of time. Breeding adults are expected to be much more likely to remain in their home ranges while incubating or attending to heavily dependent young, and so are not expected to fly over the Kahuku Wind Power site during those times. Hybrid Hawaiian ducks will breed year round, although a peak in breeding occurs from March to June.

For purposes of assessing indirect take, any adult hybrid Hawaiian duck mortality recorded during the months of March through June will be assumed to have been actively breeding. However, based on the previous paragraph, it will also be assumed that such ducks would have been tending to older ducklings, which likely would be fewer in number than original clutch size (studies indicate that average number of young produced per pair of Hawaiian ducks per nesting attempt is 1.225). It will be assumed that any ducks found from July through February will have had a 25% chance of having been breeding actively and tending to older ducklings. It is also assumed that death of a male adult will not to lead to indirect death of ducklings because the males do not provide any parental care for eggs or ducklings. Based on these assumptions, as indicated in Table 6-3 below, the amount of indirect take that would be assessed for each direct adult duck mortality ranges from 0.00 to 1.225 ducklings depending on time of year and gender of the fatality (life history data presented can be found in Appendix 5).

Table 6-3. Calculation of indirect take of the Hawaiian duck hybrid.

Hawaiian duck hybrid	Season	No. young per pair (A)	Likelihood of breeding (B)	Parental contribution (C)	Indirect (A*B*C)
Male	All year	1.225	0.25 - 1.00	0.00	0.00
Female	Peak breeding Mar-Jun	1.225	1.00	1.0	1.225
Female	Jul - Feb	1.225	0.25	1.00	0.31
Immature	All year	--	0.00	--	0.00

Because of previously discussed assumptions concerning unobserved direct take, any one hybrid Hawaiian duck found to have collided with a project component in a year will lead to an assessment of total direct take for that year of greater than one that likely would be rounded up to 2 ducks/year (based on expected results from take monitoring and subsequent adjustments for searcher efficiency and scavenging rates). While the second bird taken under this scenario would be assumed and, therefore, of unknown age or gender, for the purposes of this HCP it will be assumed that all hybrid Hawaiian ducks taken through "unobserved direct take" will be female adults with a 25% chance of having been in breeding condition. This is based on the information that hybrid Hawaiian ducks have one clutch a year, and are expected to be breeding three months of the year (a one-month incubation period followed by parental care for 2 months; 3 months breeding / 12 months per year = 0.25). Consequently, following the above table, indirect take will be assessed to ducks lost through "unobserved direct take" at the rate of 0.31 ducklings/duck (1.225 x 0.25 x 1.00 = 0.306).

The total direct take of 2 adults per year could result in an indirect take assessment of 0.31 to 1.535 ducklings per year, which is rounded here up to 2 ducklings per year. Consequently, while the chance of take occurring in any year appears to be exceptionally low, because of need to allow for assessment of unobserved direct take, the Applicant suggests the Baseline ITL should allow for a total direct take of 2 hybrid Hawaiian ducks and the indirect take of 2 ducklings in any year of project operation. Expected rates of take and rates of take requested to be authorized by the ITL through the expected 20-year life of the project are summarized below, along with rates of take considered to qualify as "Lower" and "Higher". Note that the level of take expected over the 20-year life of the project was derived by multiplying the expected annual average (0.2) by 20 and rounding up to the nearest whole integer (1). The requested 20-year take authorization is greater than 1 adult duck to not only allow for assessment of unobserved take, but to guard against possible future increases in the duck population altering their passage rate through the project area. Please see section 6.3.1 for an explanation of the different take limits and take levels.

Expected Rate of Take

Annual average	0.026 adults/immatures and 0.031 ducklings	
20-year project life	1 adult/immature and 1 duckling	

Requested ITL Authorization

Baseline level of take	2 adults/immatures and 2 ducklings	4 birds/year
5-year limit of take	6 adults/immatures and 6 ducklings	
20-year limit	8 adults/immatures and 8 ducklings	

Higher Rate of Take

One-year period	Total direct take of 3 - 4 adults/immatures 3 - 4 ducklings
5-year period	Total direct take of 7 - 8 adults/immatures and 7 – 8 ducklings
20-year period	Total direct take of 9 - 12 adults/immatures and 9 – 12 ducklings

Lower Rate of Take

5-year period	Total direct take of 0 adults/immatures and 0 ducklings

An estimated 300 hybrid Hawaiian ducks are present on O'ahu (Engilis et al. 2002, USFWS 2005a). The expected level of take over the 20-year life of the project is approximately one adult duck and one duckling being tended at the time of collision. Mortality realized at this very low rate is not expected to cause significant negative impacts to the O'ahu population of hybrid Hawaiian ducks. Regardless, because it is anticipated that all hybrid Hawaiian ducks on O'ahu will ultimately be removed/relocated to allow for the reintroduction of pure Hawaiian ducks, loss of hybrid ducks as a result of operation of the Kahuku Wind Project is not considered to be biologically significant or adverse.

6.3.4.2 Pure Hawaiian Ducks

The possibility of existence of genetically pure Hawaiian ducks on O'ahu is currently considered very remote (Engilis et al. 2002, USFWS 2005a, Engilis pers. comm.). However, as discussed, the USFWS is planning on James Campbell NWR playing a key role in the future reintroduction of pure Hawaiian ducks to O'ahu (USFWS 2005a, Kwon pers. comm.). At present it is uncertain when that will occur, but it is possible that reintroductions could occur during the 20-year life of the project. A Hawaiian duck/Hawaiian duck hybrid identification key is also being developed and this key will be used in the identification of downed ducks when available. If morphological features are inconclusive and there is reasonable uncertainty regarding the status of the duck incidentally taken, USFWS and DLNR may request the applicant conduct the appropriate genetic analysis.

As discussed in Section 3.8.2.3, the reintroduction of pure Hawaiian ducks would first require the removal of all hybrid Hawaiian ducks and feral mallards from O'ahu. If that were to occur during the life of the project, the potential for hybrid ducks to be killed through collision with project components as described above would be eliminated and replaced with potential for project operations to cause mortality of pure Hawaiian ducks. There likely would be some interval of time between eradication of the hybrid ducks and re-introduction of the pure ducks in which no potential existed for Hawaiian-type ducks to collide with the proposed turbines and met tower.

It is not known how many pure Hawaiian ducks would be released or what behavior patterns they would establish, so it is not possible at this time to estimate accurately an expected passage rate and model expected mortality rates. However, it does seem probable that the number of pure ducks released would be lower than the number of hybrid Hawaiian ducks currently present in the general project area, and that population of pure ducks would eventually build to approximate that of the current hybrid population. Consequently, it appears the potential for collisions would initially be lower than that expected for the hybrid ducks but could eventually match it. Given the low rate at which the hybrid ducks are expected to collide with project components and the degree to which that rate was rounded up to yield an annual rate of take of 1 duck/year, for the purposes of this HCP it is expected that rates of take of pure Hawaiian ducks would be similar to those identified above for hybrid Hawaiian ducks.

Should reintroduction of pure Hawaiian ducks occur during the lifetime of the project, the Applicant believes the same take authorizations and limits should be applied to the species as requested for the hybrid ducks above.

6.3.4.3 Hawaiian Stilt

Risk factors for Hawaiian stilt interacting with wind turbines and meteorological towers are poorly understood. As with Hawaiian petrel, no Hawaiian stilts were observed flying over the project area during the avian surveys. Consequently, modeling would result in an estimated take rate of zero because known stilt passage rate is zero. Because Hawaiian stilts occur regularly in the Kahuku area, it is considered that the project would create some risk of causing take of this species, however small. For the purposes of this HCP, the estimated rate of take of the Hawaiian stilt will be assumed to be the same as for Hawaiian duck hybrids, or an average of 0.026 stilts/year lost through interaction with turbines, met towers, on-site and off-site microwave towers and overhead cables, utility poles and other associated structures, as well as mortality due to construction related fatalities and vehicular strikes.

After commissioning, the lease for both off-site microwave tower sites may be turned over from Kahuku Wind Power LLC to HECO. If so, any take responsibility (if any) associated with potential take at the off-site tower may be transferred as well. The transfer of responsibility would be determined in consultation with DLNR and USFWS).

It is assumed that adult stilts are most likely to collide with turbines and associated structures during non-breeding periods or toward the end of their breeding period when chicks are larger and can be left unattended for longer periods of time. Hawaiian stilts are highly territorial during the breeding season (Robinson et al. 1999) and are much more likely to be defending their territories while incubating or attending to heavily dependent young, and so are not expected to fly over the Kahuku Wind Power site during those times. Hawaiian stilts breed from February to August.

For purposes of assessing indirect take, any adult Hawaiian stilt mortality recorded during the months of February through August will be assumed to have been actively breeding. However, based on the previous paragraph, it will also be assumed that such a stilt would have been tending to older chicks, which likely would be fewer in number than original clutch size (studies indicate that average clutch size is 4, while average number of fledglings produced per pair of Hawaiian stilts is 0.9). Stilt mortality that occurs outside the breeding season will be assumed to be of non-breeding birds and will not be assigned any indirect take. Since both sexes provide fairly equal amounts of parental care, the amount of indirect take assessed will be shared equally between males and females. Parents have not been documented to feed their chicks, thus at least half the brood is likely to survive even with the loss of one parent (Robinson et al. 1999). Based on these assumptions, as indicated in Table 6-4 below, the amount of indirect take assessed for each direct adult stilt mortality is 0.45 during the breeding season (life history data presented can be found in Appendix 5).

Table 6-4. Calculation of indirect take for the Hawaiian stilt.

Hawaiian Stilt	Season	Average no. of fledglings per pair (A)	Likelihood of breeding (B)	Parental contribution (C)	Indirect take (A*B*C)
Adult	Feb-Aug	0.9	1.00	0.5	0.45
Adult	Sep-Jan	--	0.00	--	0.00
Immature	All year	--	0.00	--	0.00

Because of previously discussed assumptions concerning unobserved direct take, any one Hawaiian stilt found to have collided with a project component in a year will lead to an assessment of total direct take for that year of greater than one that likely would be rounded up to 2 stilt/year (based on expected results from take monitoring and subsequent adjustments for searcher efficiency and scavenging rates). While the second bird taken under this scenario would be assumed and, therefore, of unknown age or gender, for the purposes of this HCP it will be assumed that all Hawaiian stilts taken through "unobserved direct take" will be adults. In addition, because stilt could be flying through the project area at any time of year, the likelihood of stilt being in breeding condition is assumed to be 16.67%. This is based on the information that Hawaiian stilts have one clutch a year, and are expected to be breeding two months of the year (a one month incubation period followed by parental care for one month; 2 months breeding / 12 months per year = 0.1666). Consequently, following the above table, indirect take will be assessed to stilts lost through "unobserved direct take" at the rate of 0.08 fledglings/stilt (0.9 x 0.1667 x 0.5 = 0.075).

The total direct take of 2 adults per year could result in an indirect take assessment of 0.53 fledglings per year, which is rounded here up to 1 fledgling per year. Consequently, the Applicant suggests the ITL should allow for a total direct take of 2 Hawaiian stilts and the indirect take of 1 fledgling in any year of project operation. Expected rates of take and rates of take requested to be authorized by the ITL through the expected 20-year life of the project are summarized below, along with rates of take considered to qualify as "Lower" and "Higher". As with Hawaiian duck, the expected level of take over 20 years was rounded up to the nearest whole integer and requested take authorizations allow for assessment of unobserved direct take and changes in Hawaiian stilt passage rates over time. Please see section 6.3.1 for an explanation of the different take limits and take levels.

Annual Expected Rate of Take		
Annual average	0.026 adults/immatures and 0.0012 fledglings	
20-year project life	1 adult/immature and 1 fledgling	
Requested ITL Authorization		
Baseline level of take	2 adults/immatures and 1 fledgling	3 birds/year
Five-year limit of take	6 adults/immatures and 3 fledglings	
20-year limit	8 adults/immatures and 4 fledglings	
Higher Rate of Take		
One-year period	Total direct take of 3 - 4 adults/immatures and 1 - 2 fledglings	
5-year period	Total direct take of 7 - 8 adults/immatures and 3 – 4 fledglings	
20-year limit	Total direct take of 9 – 12 adults/immatures and 5 – 6 fledglings	
Lower Rate of Take		
5-year period	Total direct take of 0 adults and 0 fledglings	

O'ahu supports 35-50% of the state's stilt population with approximately 450 to 700 birds present on the island. The take of stilts at the expected rate of one adult stilt and one fledgling over 20 years is not expected to significantly impact the population of the stilt on O'ahu. Moreover, the proposed mitigation (see section 7.3) is expected to more than offset the anticipated take and contribute to the species' recovery by providing a net conservation benefit, as required by State law. The mitigation is expected to be successful as the Hawaiian stilt is classified as a species with a high potential for recovery (USFWS 2005a) where the biological and limiting factors are well understood, the threats are understood and easily alleviated and intensive management is not needed or the known techniques have been documented with a high probability of success (USFWS 1983).

Levels of take under the Higher Take scenario may begin to impact the state population due to its small population numbers. This scenario however, is considered extremely unlikely to occur as Hawaiian stilts have not been seen flying overhead during avian surveys at Kahuku Wind Power and the baseline take estimate probably overestimates the amount of take that will actually occur. As stated above, mortality of waterbirds at wind farms has historically been low, despite the proximity of large populations of waterbirds near turbines. Waterbirds also learn to avoid turbines over time (Kingsley and Whittam 2007, Carothers 2008). The proposed mitigation for Higher Take levels is expected to more than offset the anticipated take and contribute to the species' recovery by providing a net conservation benefit, as required by State law. For these reasons, no adverse impacts to the species' overall population are anticipated.

6.3.4.4 Hawaiian Coot

As with Hawaiian stilt, the risk factors for Hawaiian coot interacting with wind turbines and met towers are poorly understood. A small number of fatalities of American coot have been reported at wind facilities in North America, although these involved projects where surface waters occurred within the project area (see section 3.8.2.5). No permanent surface water occurs within the Kahuku Wind Power site to serve as an attractant to Hawaiian coots, and no coots were observed flying through the site during the avian surveys. Consequently, as for Hawaiian petrel and Hawaiian stilt, mortality modeling for this species would result in a projected rate of take of zero. Because Hawaiian coots occur regularly in the Kahuku area and are known to make local and even inter-island movements, it seems the potential for take of this species occurring from the proposed project, while very low, is not zero. Therefore, as with Hawaiian stilt, for the purposes of the HCP, it will be assumed that the rate of take of Hawaiian coot will be the same as for hybrid Hawaiian ducks, or an average of 0.026 coots/year resulting from interactions with turbines, met towers, on-site and off-site microwave towers, associated overhead cables, utility poles and other associated structures, as well as mortality due to construction related fatalities and vehicular strikes.

After commissioning, the lease for both off-site microwave tower sites may be turned over from Kahuku Wind Power LLC to HECO. If so, any take responsibility (if any) associated with potential take at the off-site tower may be transferred as well. The transfer of responsibility would be determined in consultation with DLNR and USFWS).

It is assumed that adult coots are most likely to collide with turbines and associated structures during non-breeding periods when the birds could be making local or inter-island movements. Hawaiian coots are territorial during the breeding season (Polhemus and Smith 2005, Smith and Polhemus 2003) and are much more likely to be defending their territories while incubating or attending to heavily dependent young, and so are not expected to fly over the Kahuku Wind Power site during those times. Hawaiian coots have been documented to breed year round with the peak breeding period between March and September.

For purposes of assessing indirect take, any adult Hawaiian coot mortality recorded during the months of March through September will be assumed to have been actively breeding. However, as mentioned for other species, it is assumed that coots would not be flying at such distance from nesting locations unless their young were older and could be left alone for longer periods of time. Thus, for indirect take assessed to mortalities recorded from March to September, it will be assumed that such coots would have been tending to older chicks, which likely would be fewer in number than original clutch size (studies indicate that average number of fledglings produced per pair of Hawaiian coot is 0.9). It will be assumed that any coot found from October through February will have had a 25% chance of having been breeding actively and tending to older chicks. Since both sexes provide fairly equal parental care, the amount of indirect take assessed is equally shared between males and females. Older chicks are not fed but guided to food by their parents, thus at least half the brood is likely to survive even with the loss of one parent (Brisbin et al. 2002). Based on these assumptions, as indicated in Table 6-5 below, the amount of indirect take assessed for each direct adult coot mortality ranges from 0.11 to 0.45 chicks depending on the time of the year (life history data presented can be found in Appendix 5).

Table 6-5. Calculating indirect take for the Hawaiian coot.

Hawaiian coot	Season	No. chicks per pair (A)	Likelihood of breeding (B)	Parental contribution (C)	Indirect take (A*B*C)
Adult	Peak breeding Mar-Sept	0.9	1.00	0.5	0.450
Adult	Oct - Feb	0.9	0.25	0.5	0.113
Immature	All year	--	0.00	--	0.000

Because of previously discussed assumptions concerning unobserved direct take, any one Hawaiian coot found to have collided with a project component in a year will lead to an assessment of total direct take for that year of greater than one that likely would be rounded up to 2 coots/year (based on expected results from take monitoring and subsequent adjustments for searcher efficiency and scavenging rates). While the second bird taken under this scenario would be assumed and, therefore, of unknown age, for the purposes of this HCP it will be assumed that all Hawaiian coots taken through "unobserved direct take" will be adults. In addition, because coots could be flying through the project area at any time of year, the likelihood of coot being in breeding condition is assumed to be 33%. This is based on the information that Hawaiian coots have one clutch a year, and are expected to be breeding four months of the year (a one month incubation period followed by parental care for three months; 4 months breeding / 12 months per year = 0.33). Consequently, following the above table, indirect take will be assessed to chicks lost through "unobserved direct take" at the rate of 0.15 chicks/coot (0.9 x 0.33 x 0.5 = 0.15).

The total direct take of 2 adults per year could result in an indirect take assessment of 0.15 to 0.6 chicks per year, which is rounded here up to 1 chick per year. Consequently, the Applicant suggests the Baseline ITL should allow for a total direct take of 2 Hawaiian coots and the indirect take of 1 chick in any year of project operation. Expected rates of take and rates of take requested to be authorized by the ITL through the expected 20-year life of the project are summarized below, along with rates of take considered to qualify as "Lower" and "Higher". As with the hybrid Hawaiiian duck and Hawaiian stilt, the expected level of take over 20 years was rounded up to the nearest whole integer and requested take authorizations allow for assessment of unobserved direct take and changes in Hawaiian coot passage rates over time. Please see section 6.3.1 for an explanation of the different take limits and take levels.

Annual Expected Rate of Take		
Annual average	0.026 adults/immatures and 0.012 chicks	
20-year project life	1 adult/immature and 1 fledgling	
Requested ITL Authorization		
Baseline level of take	2 adults/immatures and 1 fledgling	3 birds/year
5-year limit of take	6 adults/immatures and 3 fledglings	
20-year limit	8 adults/immatures and 4 fledglings	
Higher Rate of Take		
One-year period	Total direct take of 3 - 4 adults/immatures and 2 fledglings	
5-year period	Total direct take of 7 - 8 adults/immatures and 3 – 4 fledglings	
20-year limit	Total direct take of 9 – 12 adults/immatures and 5 – 6 fledglings	
Lower Rate of Take		
5-year period	Total direct take of 0 adults and 0 fledglings	

O'ahu supports between 500 and 1,000 coots, or up to 33% of the state population. The expected loss of one adult coot and one fledgling over the life of the project, if realized, is not expected to have a significant impact on the population of the coot on O'ahu. Moreover, the proposed mitigation (see section 7.3) is expected to more than offset the anticipated take and contribute to the species' recovery by providing a net conservation benefit, as required by State law. The mitigation is expected to be successful as the Hawaiian coot is classified as a species with a high potential for recovery (USFWS 2005a) where the biological and limiting factors are well understood, the threats are understood and easily alleviated and intensive management is not needed or the known techniques have been documented with a high probability of success (USFWS 1983).

Levels of take under the Higher Take scenario may begin to impact the state population due to its small population numbers. This scenario however, is considered extremely unlikely to occur as Hawaiian coots have not been seen flying overhead during avian surveys at Kahuku Wind Power and the baseline take estimate probably overestimates the amount of take that will actually occur. As stated above, mortality of waterbirds at wind farms has historically been low, despite the proximity of large populations of waterbirds near turbines. Waterbirds also learn to avoid turbines over time (Kingsley and Whittam 2007, Carothers 2008). The proposed mitigation for Higher Take levels is expected to more than offset the anticipated take and contribute to the species' recovery by providing a net conservation benefit, as required by State law. For these reasons, no adverse impacts to the species' overall population are anticipated.

6.3.4.5 Hawaiian Moorhen

Hawaiian moorhens were never detected at Kahuku Wind Power during the 15-month long avian point count survey and are thought to be at very low risk of collision with turbines because of their sedentary habits (see section 8.3.2.6). For the same reasons discussed for Hawaiian stilt and Hawaiian coot, risk of collision by this species is not zero, and will be assumed to occur at the same

rate assumed for those species, or on an average of 0.02 moorhens/year as a result of collision with turbines, met towers, on-site and off-site microwave towers, associated overhead cables, utility poles and other associated structures, as well as mortality due to construction related fatalities and vehicular strikes.
After commissioning, the lease for both off-site microwave tower sites may be turned over from Kahuku Wind Power LLC to HECO. If so, any take responsibility (if any) associated with potential take at the off-site tower may be transferred as well. The transfer of responsibility would be determined in consultation with DLNR and USFWS).

Like Hawaiian coots, it is assumed that adult moorhens are most likely to collide with turbines and associated structures during non-breeding periods or, possibly, toward the end of their breeding period when chicks are larger and can be left unattended for longer periods of time. Hawaiian moorhen are territorial during the breeding season (Polhemus and Smith 2005, Smith and Polhemus 2003) and are much more likely to be defending their territories while incubating or attending to heavily dependent young, and so are not expected to fly over the Kahuku Wind Power site during those times. Hawaiian moorhen have been documented to breed year round with the peak breeding period between March to August.

For purposes of assessing indirect take, any adult Hawaiian moorhen mortality recorded during the months of March through August will be assumed to have been actively breeding. However, based on the previous paragraph, it will also be assumed that such moorhens would have been tending to older chicks, which likely would be fewer in number than original clutch size (studies indicate that average number of fledglings produced per pair of Hawaiian moorhens is 1.3). It will be assumed that any moorhen found from September through February will have had a 25% chance of having been breeding and tending to older chicks. Since both sexes provide fairly equal parental care, the amount of indirect take assessed is equally shared between males and females. Older chicks forage with adults, feeding themselves the majority of the time, thus at least half the brood is likely to survive even with the loss of one parent (Bannor and Kiviat 2002). Based on these assumptions, as indicated in Table 6-6 below, the amount of indirect take assessed for each direct adult moorhen mortality ranges from 0.16 to 0.65 fledglings depending on the time of the year (life history data presented can be found in Appendix 5).

Because of previously discussed assumptions concerning unobserved direct take, any one Hawaiian moorhen found to have collided with a project component in a year will lead to an assessment of total direct take for that year of greater than one that likely would be rounded up to 2 moorhens/year (based on expected results from take monitoring and subsequent adjustments for searcher efficiency and scavenging rates). While the second bird taken under this scenario would be assumed and, therefore, of unknown age, for the purposes of this HCP it will be assumed that all Hawaiian moorhens taken through "unobserved direct take" will be adults. In addition, because moorhens could be flying through the project area at any time of year, the likelihood of moorhens being in breeding condition is assumed to be 58%. This is based in the information that Hawaiian moorhens can have up to two clutches a year, and are expected to be breeding seven months of the year (two clutches at a one month incubation period followed by parental care for two and a half months; 3.5 months per clutch x 2 clutches / 12 months per year = 0.5833). Consequently, following the above table, indirect take will be assessed to chicks lost through "unobserved direct take" at the rate of 0.38 chicks/moorhen (1.3 x 0.58 x 0.5 = 0.38).

Table 6-6. Calculating indirect take for the Hawaiian moorhen.

Hawaiian moorhen	Season	Average no. of chicks per pair (A)	Likelihood of breeding (B)	Parental contribution (C)	Indirect take (A*B*C)
Adult	Peak Mar-Aug	1.3	1	0.5	0.65
Adult	Sept - Feb	1.3	0.25	0.5	0.1625
Immature	All year	--	0.00	--	0.00

The direct take of one adult will result in assessment of an indirect take of a maximum of 0.65 chick. Because of assumptions concerning unobserved direct take, the Applicant suggests the Baseline ITL should allow for a total direct take of 2 adults moorhens and the indirect take of 1.03 chicks, rounded up to 2 chicks, in any year of project operation. Expected rates of take and rates of take requested to be authorized by the ITL through the expected 20-year life of the project are summarized below, along with rates of take considered to qualify as "Lower" and "Higher". As with the duck, stilt, and coot, the expected level of take over 20 years was rounded up to the nearest whole integer and requested take authorizations allow for assessment of unobserved direct take and changes in Hawaiian moorhen passage rates over time. Please see section 6.3.1 for an explanation of the different take limits and take levels.

Annual Expected Rate of Take		
Annual average	0.026 adults/immatures and 0.017 fledglings	
20-year project life	1 adults/immatures and 1 fledgling	
Requested ITL Authorization		
Baseline level of take	2 adults/immatures and 2 fledglings	4 birds/year
Five-year limit of take	6 adults/immatures and 4 fledglings	
20-year limit	8 adults/immatures and 6 chicks	
Higher Rate of Take		
One-year period	Total direct take of 3 - 4 adults/immatures and 2 – 3 fledglings	
5-year period	Total direct take of 7 - 8 adults/immatures and 4 – 6 fledglings	
20-year limit	Total direct take of 9 – 12 adults/immatures and 6 – 8 fledglings	
Lower Rate of Take		
5-year period	Total direct take of 0 adults/immatures and 0 fledglings	

Biannual waterbird surveys record an average of 341 moorhens throughout the state (USFWS 2005a). This average is likely an inaccurate estimate of true population size as common moorhens are secretive and difficult to census (USFWS 2005a). The expected loss of one adult Hawaiian moorhen and one fledgling over the 20-year project life is not expected to result in significant adverse effects to the sub-species at the population level. The proposed mitigation (see section 7.3) is expected to more than offset the anticipated take and contribute to the species' recovery by providing a net conservation benefit, as required by State law. The mitigation is expected to be successful as the moorhen is classified as a species with a high potential for recovery (USFWS 2005a), where the biological and limiting factors are well understood, the threats are understood and easily alleviated and intensive management is not needed or the known techniques have been documented with a high probability of success (USFWS 1983).

Levels of take in the range of the Higher Take scenario may begin to adversely impact the state population given its potentially small size. Take at this level, however, is considered extremely unlikely to be realized as Hawaiian moorhens have not been seen at Kahuku Wind Power and the Baseline take estimate seems to be a conservative overestimate. The behavior of Hawaiian moorhen also supports this supposition as moorhens are rarely seen flying, preferring to swim or walk (Bannor and Kiviat 2002). Moorhens in Hawaiʻi are highly sedentary (while migratory on continental North America) and no records of inter-island flights have been documented (Bannor and Kiviat 2002). Hawaiian moorhens however do disperse in spring to breed (Nagata 1993). The Applicant's proposed mitigation for the anticipated take will contribute to a greater understanding of the species' occurrence and status, which in turn will help guide future management and recovery efforts and should result in an overall net conservation benefit for the species. For these reasons, no adverse impacts to the species' overall population are anticipated.

<u>6.3.5 Hawaiian Short-eared Owl</u>

One Hawaiian short-eared owl was seen during the avian point count surveys conducted over 15 months at the Kahuku Wind Power project area. One Hawaiian short-eared owl was also heard in the project area in July 2008 during the seabird radar survey (see section 3.8.2.7). Post-construction monitoring data from North America suggest the species is generally not vulnerable to collision with wind turbines (see section 3.8.2.7).

Data on status of Hawaiian short-eared owl in the project area is too scant to enable a reasonable estimation of the mortality rate for this species that may result from completion of the proposed project. Observations of short-eared owls at the KWP facility suggest most generally fly low over the ground, preferring open pastures and grasslands away from most structures (Spencer pers. comm.). Potential for short-eared owls to collide with wind turbines seems it would be greatest when birds were performing aerial breeding displays or if the birds were needing to avoid some aerial predator. The paucity of observations of this species from the project area strongly suggests Hawaiian short-eared owls do not breed in or directly adjacent to the project area, so the probability of short-eared owls colliding with wind turbines while performing breeding displays appears to be exceedingly low. No potential aerial predators of Hawaiian short-eared owl occur on O‘ahu, so it also appears very unlikely that short-eared owls would collide with any of the proposed wind turbines for this reason.

Potential for short-eared owls to collide with on-site and off-site project components including the permanent, un-guyed met tower, microwave towers, overhead collection lines, relocated distribution lines, utility poles or cranes during the turbine construction period is considered negligible because these structures would be immobile and stationed in cleared sites. Thus, the towers, cranes and overhead cables should be readily visible to, and avoidable by, owls.

The expectation that short-eared owls are not likely to collide with project related structures, is supported by the results of post-construction monitoring and general observations made at the KWP facility on Maui. Short-eared owls are observed regularly at the KWP facility yet, as indicated above, no short-eared owl fatalities with any project components have been recorded after more than three and a half years of operation (Spencer pers. comm.). One carcass however was incidentally found under MECO transmission lines in 2009. The paucity of recorded fatalities at a site where the species occurs regularly and, hence, has greater exposure to collision hazards, suggests strongly that risk of collision at the Kahuku Wind Power facility would be very low given that the species has rarely been documented on the site.

All overhead collection lines will be spaced according to APLIC guidelines (see Section 5.3) and no electrocution related mortalities are expected.

Some potential exists for construction or maintenance vehicles to strike short-eared owls that may be hunting low over the project area. Project personnel will be educated regarding the possibility of owls flying low across project roadways or resting on the ground adjacent to roadways and speed limits (10 mph) will be emplaced and enforced on project roadways to minimize potential for vehicle strikes to harm short-eared owls.

Given the above information, it is possible that no Hawaiian short-eared owl fatalities will be realized during the life of the Kahuku Wind Power project. However, because the species is known to occur in the general vicinity of the project area at least on occasion, the risk of collision cannot therefore be considered zero. Given the on-site survey results and monitoring results from the KWP site on Maui, it seems reasonable to assume that the chance of the proposed project causing a short-eared owl fatality in any given year is well less than 1.0. For the purposes of this HCP, it is assumed that the proposed project will on average result in the loss of 0.33 Hawaiian short-eared owl/year.
This equates to one owl every three years and was chosen as a conservative estimate based on the findings at KWP where no short-eared owls have been lost to project operations after three years. This mortality rate includes loss due to interaction with turbines, met towers, on-site and off-site microwave towers and overhead cables, utility poles and other associated structures, as well as mortality due to construction related fatalities and vehicular strikes.

Adult owls have potential to collide with turbines or be struck by vehicles at any time of year and presumably regardless of breeding status. Hawaiian short-eared owls breed year round with no known peak breeding season. The average breeding period (from brooding to fledging) is two months long. Thus, at any given time the probability that an owl killed on-site was actively breeding would be 0.167 (2 months / 12 months per year = 0.1667). Because the owls breed year round, it will be assumed that any owl that might be killed could have been tending to a full clutch of eggs or a nest of newly hatched young. As males only provide food and females exclusively brood and feed young, the loss of either parent is likely to result in the loss of the entire brood. Consequently, as depicted in Table 6-7 below, the amount of indirect take that will be assessed for the direct take of any adult Hawaiian short-eared owl is 0.95 owlets (life history data presented can be found in Appendix 5).

Table 6-7. Calculating indirect take for the Hawaiian short-eared owl.

Hawaiian short-eared owl	Season	Average no. of owlets per pair (A)	Likelihood of breeding (B)	Parental contribution (C)	Indirect take (A*B*C)
Adult	All year	5.6	0.17	1.0	0.95
Immature	All year	--	0.00	--	0.00

As discussed, because of assumptions concerning unobserved direct take, any one Hawaiian short-eared owl found to have collided with a project component in a year will lead to an assessment of total direct take for that year of greater than one. Consequently, the Applicant suggests the ITL should allow for a total direct take of 2 adults or recently fledged Hawaiian short-eared owls per year of project operation.

The direct take of one adult owl will result in an assessment of indirect take of 0.95 owlets or essentially rounded to one owlet. Consequently, the Applicant suggests the Baseline ITL should also allow for the indirect take of 2 owlets/year, which would account for the amount of incidental take that would be assessed to the total direct take of 2 adults (2 x 0.95 = 1.9). Expected rates of take and rates of take requested to be authorized by the ITL through the expected 20-year life of the project are summarized below, along with rates of take considered to qualify as "Lower" and "Higher". The expected 20-year rate was derived by multiplying 0.33 owls/year by 20 years and rounding up to the nearest whole integer. The requested 20-year authorization was increased from 7 to 8 because it is expected that total direct take will always be assessed in multiples of two. Please see section 6.3.1 for an explanation of the different take limits and take levels.

Expected Rate of Take		
Annual average	0.33 adults/immatures and 0.31 owlets	0.64 birds/year
20-year project life	7 adults/immatures and 7 owlets	
Requested ITL Authorization		
Baseline level of take	2 adults/immatures and 2 owlets	4 birds/year
Five-year limit of take	6 adults/immatures and 6 owlets	
20-year limit	8 adults/immatures and 8 owlets	
Higher Rate of Take		
One-year period	Total direct take of 3 - 4 adults/immatures and 3 - 4 owlets	
5-year period	Total direct take of 7 - 8 adults/immatures and 7 – 8 owlets	
20-year period	Total direct take of 9 -12 adults/immatures and 9 – 12 owlets	
Lower Rate of Take		
5-year period	Total direct take of 0 adults and 0 owlets	

No population numbers for Hawaiian short-eared owl are available for the island of O'ahu or any of the other Hawaiian Islands. However, given the rate of assumed loss (0.33 adults and 0.31 owlets), it is unlikely that the proposed project would cause a significant impact on the Hawaiian short-eared owl population on O'ahu. The Applicant's proposed mitigation for the anticipated take (see section 7.4) will contribute to a greater understanding of the species' occurrence and status on O'ahu, which in turn will help guide future management and recovery efforts and should result in an overall net conservation benefit for the species.

Higher levels of take may impact the O'ahu population if its population is small, but such take would not be expected to affect the status of the species on other islands. However, realization of take at higher levels is considered extremely unlikely to occur because Hawaiian short-eared owl have been seen only once at the Kahuku Wind Power site over the course of 15 months of surveys, and given the results of the monitoring surveys performed at KWP on Maui. However, the proposed mitigation for the Higher take levels will contribute to a greater understanding of the species' occurrence and status, which in turn will help guide future management and recovery efforts and should result in an overall net conservation benefit for the species.

6.3.6 Hawaiian Hoary Bat

Based on surveys conducted to date, a low but consistent level of Hawaiian hoary bat activity occurs on site (Appendix 4). There has been one other confirmed sighting of a Hawaiian hoary bat at Pūpūkea on the North Shore of O‘ahu in 2002 (Menard pers. comm.). Monitoring suggests that bats may potentially occur in very low numbers year-round on site with some small increase in activity between June and September (see section 3.2.3.8 for detailed information on Hawaiian hoary bat altitudinal movements and bat activity on site). Post-construction monitoring at the KWP facility on Maui has demonstrated that bat activity there is also low. A single observed direct take has occurred at KWP after more than 3-years of post-construction monitoring.

Extensive monitoring of bat activity at existing wind farms has shown a strong positive relationship between the total number of bat passes/detector/night with the estimated total fatalities/turbine/year determined through observed fatalities (Kunz et al. 2007). Essentially, the number of bat fatalities/turbine/year is almost equivalent to the number of bat passes per night for each detector on site (see Table 6-8). The data on echolocation passes reported in these studies did not distinguish among species so it is not possible to know if the correlation between mortality and bat call rates holds for all species. Moreover, echolocation calls were recorded at different heights at some sites and only at ground level at others.

Unfortunately, the echolocation call data for the above studies were all collected after the wind energy facilities were constructed. It is unclear whether preconstruction bat pass data, such as is available for the Kahuku Wind Power site, can fairly be used to estimate operational fatality rates. Operational monitoring has shown relatively high bat mortality rates at some wind power sites where no bat activity was recorded during pre-construction surveys, suggesting that certain bat species, especially migratory tree (*Lasiurus*) bats, may be attracted to wind turbines (Kunz et al. 2007). Other research suggests that clearing for wind projects in wooded habitats can alter how and where bats hunt for food. As a result, pre-construction investigations of bat activity in wooded habitats may not provide an accurate prediction of where and how many bats will occur in the post-construction landscape.

Table 6-8. Fatality rates and bat activity indices at 5 wind-energy facilities on the mainland United States (from Kunz et al. 2007).

Study area	Dates of study[1]	Bat mortality (no./turbine/yr)	Bat activity (no./detector/night)	Detector nights	Source
Mountaineer, WV	31 Aug- 11 Sep 2004	38	38.2	33	E.B. Arnett, Bat Conservation International, unpubl. data
Buffalo Mountain, TN	1 Sep 2000- 30 Sep 2003	20.8	23.7	149	Fiedler 2004
Top of Iowa, IA	15 Mar-15 Dec 2003, 2004	10.2	34.9	42	Jain 2005
Buffalo Ridge, MN	15 Mar-15 Nov 2001, 2002	2.2	2.1	216	Johnson et al. 2004
Foote Creek Rim, WY	1 Nov 1998-31 Dec 2000	1.3	2.2	39	Gruver 2002

[1] Sample periods and duration of sampling varied among studies, with no fatality assessments conducted or bat activity monitored in winter months.

As discussed in Section 3.2.3.8, the Anabat remote data-loggers used on-site resulted in measurement of approximately 0.016 call sequences/detector/night or 0.010 bat passes/ detector/night. Take estimates for Hawaiian hoary bat for the Kahuku Wind Power project are calculated with the following assumptions:

1) that changes in landscape and construction of turbines do not attract bats to the area;
2) that post-construction bat activity remains the same as the measured pre-construction bat activity; and
3) the number of bat fatalities/turbine/year is equivalent to the number of bat passes/night for each detector on site (as shown by Kunz et al. 2007)

However, since the level of bat activity is already very low, the estimated take of bats per turbine is based on the number of call sequences per detector night, rather than the number of bat passes (Assumption 3) in order to give a more conservative fatality estimate. Based on these assumptions, the estimated average rate of take for the Kahuku Wind Power project is 0.016 bats/turbine/year. This equates to a total average take of 0.19 bats/year for all 12 turbines on the site. It therefore seems reasonable to assume that the average direct take will be much less than one bat per year for the entire project. Bat activity at the Kahuku Wind Power project area was similar to the post-construction bat activity recorded at the Kaheawa Wind Power project, which had an activity rate of 0.014 bat call sequences/detector/night (SWCA and First Wind 2008). One observed fatality has been recorded at the KWP facility after 3.5 years of project operation.

Potential for bats to collide with met towers on-site and off-site microwave towers and overhead cables, utility poles, other associated structures or cranes is considered to be negligible because they would be immobile and should be readily detectable by the bats through echolocation. While the guy wires on the temporary met towers may pose a somewhat greater threat to bats, bats while present at KWP on Maui, have not been found to have collided with the guyed met towers after three years of operation nor with any cranes during the construction phase of that project. No downed bats have been found during the weekly searches of the one guyed temporary met tower at the Kahuku Wind Power site. Weekly searches began in October 2008 and are ongoing. This search plot has been regularly mowed since April 2009. In addition, of 64 wind turbines studied at Mountaineer Wind Energy Center in the Appalachian plateau in West Virginia, bat fatalities were recorded at operating turbines, but not at a turbine that remained non-operational during the study period. This supports the expectation that presence of the stationary structures such as met tower and cranes should not result in bat fatalities (Kerns et al. 2005).

However, if in the unlikely event a bat mortality is found in the future and that mortality can be attributed to the on-site construction cranes, Kahuku Wind Power on-site or off-site microwave towers, associated overhead cables or utility poles, Kahuku Wind Power LLC will mitigate for that loss at a level commensurate with any take recorded on-site and through the methods proposed in Section 7.5.

After commissioning, the lease for both offsite microwave tower sites may be turned over from Kahuku Wind Power LLC to HECO. If so, any take responsibility (if any) associated with potential take at the off-site tower may be transferred as well. The transfer of responsibility would be determined in consultation with DLNR and USFWS.

Hoary bats are thought to move to higher elevations during the months of January through March (Menard 2001), and so may be less prevalent in the project area during those months. The limited bat activity data collected to date collected at Kahuku Wind Power also suggest that this may be occurring but not conclusively. However, as there is generally little information on hoary bats on O‘ahu, it is assumed that levels of bat activity on-site remain constant throughout the year. Consequently, adult bats are considered to have equal potential to collide with turbines throughout the year and regardless of breeding status.

Hawaiian hoary bats breed between April and August (Menard 2001). Females are solely responsible for the care and feeding of young, and twin pups are typically born each year, although single pups sometimes occur. To date, no breeding records for Hawaiian hoary bat exist for O‘ahu, however, any female bats directly taken from April through August will be examined and, if determined to be pregnant or lactating, indirect take will be assessed. No indirect take will be assessed for female bats found at other times of year, or for male or immature bats found at any time of year. The rate at which indirect take will be assessed for pregnant or lactating female bats found during the months of April through August is 1.8 juveniles per adult female as indicated in Table 6-9 below (life history data presented can be found in Appendix 5).

As indicated, the average rate of direct take of Hawaiian hoary bats expected as a result of project operations is 0.19 bats per year. Indirect take associated with this level of direct take would either be zero or 0.34 juveniles per year (0.19 x 1.8 = 0.34). This yields an expected average rate of take of less than 0.53 bats per year.

Table 6-9. Calculating indirect take for the Hawaiian hoary bat.

Hawaiian hoary bat	Season	Average no. of juveniles per pair (A)	Likelihood of breeding (B)	Parental contribution (C)	Indirect take (A*B*C)
Female	Apr-Aug Pregnant or lactating	1.8	1.0	1.00	1.80
Female	Sep-Mar	--	0.0	--	0.00
Male	All year	--	0.0	0.00	0.00
Immature	All year	--	0.0	--	0.00

As with the other species addressed in this HCP, the DLNR and ESRC have recommended that annual take limits allow for at least one **observed** take a year. Again, because of assumptions concerning unobserved direct take, any 1 Hawaiian hoary bat found to have collided with a project component in a year will lead to an assessment of total direct take for that year of greater than 1 likely to be rounded up to 4 bats (based on expected results from searcher efficiency and scavenging rates at Kahuku Wind Power). Existing literature on adjusting total direct take for bats suggest that a ratio of one observed take to three unobserved takes is not unreasonable and may be conservative (e.g. Arnett et al. 2005, Jain et al. 2007, Fiedler et al. 2007, First Wind and Kaheawa Wind Power 2008). While the other bats taken under this scenario would be assumed and, therefore, of unknown age or gender, for the purposes of this HCP it will be assumed that all Hawaiian hoary bats taken through "unobserved direct take" will be adults and will have a 50% chance of having been female (based on the sex ratio of males to females during the breeding season). In addition, because bats could be flying through the project area at any time of year, the likelihood of a bat being in breeding condition is assumed to be 33%. This is based in the information that Hawaiian hoary bats have one brood a year, and are expected to be breeding four months of the year (a three month gestation period followed by parental care for one month, NatureServe 2008). Consequently, following the above table, indirect take will be assessed to bats lost through "unobserved direct take" at the rate of 0.30 juveniles/bat (05. x 0.33 x 1.8 = 0.30).

Indirect take assessed to a total direct take of 4 bats could range up to 3 juveniles (1.80 + 0.30*3 = 2.7). Consequently, the Applicant suggests the Baseline ITL should allow for a total direct take of 4 adult or volent juvenile Hawaiian hoary bats and the indirect take of up to 3 dependent juvenile bats per year of project operation. Expected rates of take and rates of take requested to be authorized by the ITL through the expected 20-year life of the project are summarized below, along with rates of take considered to qualify as "Lower" and "Higher". Please see section 6.3.1 for an explanation of the different take limits and take levels.

Expected Rate of Take

Average	0.19 adults/immatures and 0.34 juveniles	0.54 bats/year
20-year project life	4 adults/immatures and 7 juveniles	

Requested ITL Authorization

Baseline annual level of take	4 adults/immatures and 3 juveniles	7 bats/year
Five-year limit of take	10 adults/immatures and 8 juveniles	
20-year limit	12 adults/immatures and 9 juveniles	

Higher Rate of Take

One-year period	Total direct take of 5 - 8 adults/immatures and 3 – 6 juveniles
5-year period	Total direct take of 11 -12 adults/immatures and 8 – 9 juveniles
20-year period	Total direct take of 13 - 18 adults/immatures and 9 - 14 juveniles

Lower Rate of Take

5-year period	Total direct take of 0 adults/immatures and 0 juveniles

No recent population estimates exist for Hawaiian hoary bat, though previous estimates have ranged from several hundreds to several thousands (Tomich 1969, Menard 2001). The bat population on the island of Hawaiʽi is estimated to be in the tens of thousands (Bonnacorso pers. comm.). The Recovery Plan for the Hawaiian Hoary Bat (USFWS 1998) states "since no accurate population estimates exist for this subspecies and because historical information regarding its past distribution is scant, the decline of the bat has been largely inferred." Although overall numbers of Hawaiian hoary bats are believed to be low, they are thought to occur in the greatest numbers on the island of Hawaiʽi and Kauaʽi (Menard 2001).

The identified baseline level of take is low and is considered unlikely to result in a significant impact on the overall population of the Hawaiian hoary bat. Higher levels of take may begin to impact the Oʽahu population, if the population is very small, but they would not likely impact the status of the species on other islands where populations are assumed to be more robust. The Applicant's proposed mitigation for the anticipated take (see section 7.5) will contribute to a greater understanding of the species' status on Oʽahu, which in turn will help guide future management and recovery efforts and should result in an overall net conservation benefit for the species.

6.4 Cumulative Impacts to Listed Species

No ESA Section10(a)(1)(B) permits for the Covered Species have been issued through an HCP on the Island of Oʽahu. However, take has been authorized through two Safe Harbor Agreements (SHAs) on Oʽahu (Table 6-10). Under a Safe Harbor Agreement, property owners voluntarily undertake management activities on their property to enhance, restore, or maintain habitat benefiting species listed under the ESA. These agreements assure property owners they will not be subjected to increased property use restrictions if their efforts attract listed species to their property or increase the numbers or distribution of listed species already on their property. The USFWS issues the applicant an "enhancement of survival" permit, which authorizes any necessary future incidental take through section 10 (a)(1)(A) of the ESA. Accordingly, all impacts associated with these take authorizations have been mitigated.

Table 6-10. Take Authorizations for the Covered Species on Oʽahu through Safe Harbor Agreements.

Applicant	Issued	Duration	Species	Location
Chevron SHA	09/23/2005	6 years	Hawaiian stilt Hawaiian coot	Kapolei, Oʽahu Island

The proposed adjacent Na Pua Makani wind facility project and Kawailoa project (Table 1-1) have the potential to result in incidental take of the Covered Species. Thus, there is a possibility of cumulative impacts to these species. However, it is expected that if approved, the impacts and mitigation for Na Pua Makani and Kawailoa will resemble those discussed for Kahuku Wind Power; the proposed mitigation for Kahuku Wind Power is expected to more than offset the anticipated take and provide a net benefit to the species.

At a broader scale, Kahuku Wind Power represents one of many projects that can be expected to occur on the Island of Oʽahu. Oʽahu has experienced increasing human population growth and real estate development, and will likely continue increasing in the future. Some of the causes of decline of the Covered Species (such as mammal predation, light disorientation, pesticide use, and loss of nesting or roosting habitats) may be on the increase due to this growth. Through mitigation, projects like Kahuku Wind Power are among the few that are implementing measures to provide a net benefit to the affected species. In general, it is assumed that future development projects will be conducted in compliance with all applicable local, State, and Federal environmental regulations.

6.4.1 Seabirds (Newell's Shearwater and Hawaiian Petrel)

Currently, there is no authorized take of Newell's shearwater or Hawaiian petrel in the immediate vicinity (or on Oʻahu). Take authorization for these species will likely be requested for Na Pua Makani and Kawailoa because these projects have the potential to result in incidental take of the species by colliding with WTGs and other project components. The proposed Kahuku Village would also result in slight increases in artificial nighttime lighting, which also has the potential to impact the seabirds.

The proposed mitigation measures described for two seabirds are expected to more than offset the anticipated take and contribute to the species' recovery by providing a net conservation benefit, as required by State law. With the low expected rate of take, the proposed mitigation measures are expected to produce a measurable net benefit in the form of a marginal increase in the species' population. Similar mitigation measures are expected for Na Pua Makani and Kawailoa. For this reason, no significant adverse impacts to the species' overall population, and no significant cumulative impacts to the species, are anticipated.

6.4.2 Waterbirds (Hawaiian Duck, Hawaiian Stilt, Hawaiian Coot, Hawaiian Moorhen)

Currently, there is no authorized take of the Hawaiian duck, Hawaiian stilt, Hawaiian coot, or Hawaiian moorhen in the immediate vicinity. Take authorization for these federally listed waterbirds will likely be requested for Na Pua Makani and Kawailoa because these projects have the potential to result in incidental take of these species by colliding with WTGs and other project components.

The most important causes of decline of the Hawaiian stilt and other Hawaiian waterbirds is the loss of wetland habitat and predation by introduced animals. Other factors that have contributed to population declines include altered hydrology, alteration of habitat by invasive nonnative plants, disease, and possibly environmental contaminants (USFWS 2005a). Development of the Kahuku Wind Power project will not increase losses due to these other causes. However, some of these causes (loss of wetlands and pesticide use) may be on the increase due to continued real estate development on Oʻahu, and will likely continue increasing in the future. Thus, the possibility of cumulative impacts in addition to the anticipated take at Kahuku Wind Power exists.

However, the proposed mitigation measures described for the federally listed waterbirds are expected to more than offset the anticipated take and contribute to the species' recovery by providing a net conservation benefit, as required by State law. With the low expected rate of take, the proposed mitigation measures are expected to produce a measurable net benefit in the form of a marginal increase in the species' population. Similar mitigation measures are expected for Na Pua Makani and Kawailoa. For this reason, no significant adverse impacts to the species' overall population, and no significant cumulative impacts to the federally listed waterbirds, are anticipated.

6.4.3 Hawaiian Short-eared Owl

Currently, there is no authorized take of the Hawaiian short-eared owls in the immediate vicinity (or on Oʻahu). However, take authorizations of this species will likely be requested for Na Pua Makani and Kawailoa.

Loss and degradation of habitat, predation by introduced mammals, and disease threaten Hawaiian short-eared owl. Hawaiian short-eared owls appear particularly sensitive to habitat loss and fragmentation, as they require relatively large tracts of grassland and are ground nesters. Ground nesters are more susceptible to the increased predation pressure that is typical within fragmented habitats and near rural developments (Wiggins et al. 2006). These nesting habits make them vulnerable to predation by rats, cats, and the small Indian mongoose (Mostello 1996, Mitchell et al. 2005). Trauma (apparently from vehicular collisions), emaciation and infectious disease (pasteurellosis) (Thierry and Hale 1996) also causes death of Hawaiian short-eared owls throughout the state. Thus, the possibility of cumulative impacts from these threats, in addition to the anticipated take at Kahuku Wind Power exists.

However, Kahuku Wind Power LLC has proposed mitigation measures for the species will contribute to a greater understanding of the species' occurrence and status, which in turn will help guide future management and recovery efforts and should result in an overall net conservation benefit for the species. Similar mitigation measures are expected for Na Pua Makani and Kawailoa. For this reason, no significant adverse impacts to the species' overall population are expected, and no significant cumulative impacts to the species, are anticipated.

6.4.4 Hawaiian Hoary Bat

Currently, there is no authorized take of the Hawaiian hoary bat in the immediate vicinity (or on O'ahu). However, take authorizations of this species will likely be requested for Na Pua Makani and Kawailoa.

Because the population of this species is not known, it is difficult to gauge whether the take of Hawaiian hoary bat will result in a significant impact on the overall population. Kahuku Wind Power LLC's proposed mitigation for the anticipated take of Hawaiian hoary bat will contribute restoration of native bat habitat, and should result in an overall net conservation benefit for the species. Similar mitigation measures are expected for Na Pua Makani and Kawailoa. Therefore, there is no anticipated cumulative impact to the Hawaiian hoary bat.

7.0 MITIGATION MEASURES

7.1 Selection of Mitigation Measures

Kahuku Wind Power has coordinated with biologists from USFWS, DLNR (Department of Land and Natural Resources – Division of Forestry and Wildlife), First Wind, and SWCA, and with members of the ESRC (Endangered Species Recovery Committee), to identify and select appropriate mitigation measures to compensate for the take of eight federally and/or state-listed species during operation of the Kahuku Wind Power project. The criteria used for determining the most appropriate mitigation measures are as follows:

1. The level of mitigation should (at least) be commensurate with the currently anticipated take;
2. Mitigation should be species-specific and, to the extent practicable, location or island specific;
3. Mitigation measures should be practicable and capable of being done given currently available technology and information;
4. Mitigation measures should have measurable goals and objectives that allow success to be assessed;
5. Flexibility to adjust to changes in the level of take according to new information during project operation is desirable;
6. Efforts that are consistent with or otherwise advance the strategies of the respective species' draft or approved recovery plans are desirable;
7. Mitigation measures that serve to directly "replace" individuals that may be taken (*e.g.*, by improving breeding success or adult and juvenile survival) are preferred, though efforts to improve the knowledge base for poorly documented species also have merit, particularly when the information to be gained can benefit future efforts to improve survival and productivity;
8. Off-site mitigation measures to protect breeding or nesting areas for birds, and roosting areas for bats, located on otherwise unprotected private land are preferred over those on public land, and sites on state land are preferred by USFWS over those on federal land;
9. Measures to decrease the level of take resulting from a private activity unrelated to the project are generally considered the responsibility of the other party and are not preferred as mitigation (*e.g.*, rescue/rehabilitation of downed seabirds outside the project area as a result of disorientation by outdoor lights not related to the proposed project); and
10. Alternate or supplemental mitigation measures should be identified for future implementation if the level of take is found to be higher (or lower) as a result of monitoring.

Federal- and/or state-listed species considered to have potential to be incidentally taken during operation of the Kahuku Wind Power project include the Newell's shearwater, Hawaiian petrel, Hawaiian duck (and, more likely, Hawaiian duck-mallard hybrids), Hawaiian stilt, Hawaiian coot, Hawaiian moorhen, Hawaiian short-eared owl, and Hawaiian hoary bat. The mitigation proposed to compensate for impacts to these species is based on anticipated levels of incidental take as determined through on-site surveys, modeling, and the results of post-construction monitoring conducted at other wind projects in Hawai'i and elsewhere in the United States.

Possible rates of incidental take for all species discussed in this document have been identified as "Baseline," "Lower," and "Higher." These take levels were previously defined in section 6.3.3.1. Initial yearly mitigation efforts are designed to compensate for take at the 20-year Baseline authorized take level. Later in the project, total adjusted take as estimated through post-construction monitoring will be used to determine which tier take is occurring at and the necessary levels of mitigation to be commensurate with the requested take of the required tier.

Depending on the species, mitigation is proposed to take the form of implementing measures intended to increase populations of the listed species or funding of studies intended to better understand status and distribution of the species on O'ahu in order to facilitate future state, federal, or private conservation and management efforts. Measures intended to increase population sizes will generally be aimed at decreasing predation pressure through exclusion or removal of predators from known breeding areas. Decreasing predation pressure is expected to increase adult and juvenile survival, leading to increased productivity, and thus compensate for any individuals that may be taken incidentally by the project.

It is possible that individuals of some waterbird and seabird species could be taken before mitigation measures have allowed for increases in productivity. This would result in a lag between the time of incidental take and intended replacement, possibly resulting in a loss of productivity by the species over that time. Therefore, the proposed levels of mitigation are also intended to compensate for loss of productivity by incidentally taken, sexually mature adult birds over a possible lag-period, which is the time from which the take occurs till the time an adult is protected from predation or the extra fledgling produced reaches adulthood. Conversely, it is also possible that mitigation measures would allow for increases in productivity by the Covered Species before any incidental take occurs, and credit would thus be accrued that could be used to offset future take.

For species with continuing mitigation efforts (e.g., annual predator control), mitigation will be adjusted to account for rates of take found to differ from Baseline levels. Because of expected annual variability in observed rates of take, no adjustments to Baseline levels of mitigation will be made to account for Higher rates of take unless the 5-year Baseline limit is exceeded, or for Lower rates of take until at least five years of fatality monitoring data have been collected. The Applicant will promptly coordinate with USFWS and DLNR if Higher rates of take are identified in order to implement adaptive management plans and adjust mitigation efforts accordingly. Sections 6.3.2 through 6.3.6 identify the rates of take that will be considered "Higher" for each species. A summary of mitigation efforts proposed by Kahuku Wind Power for the species addressed in this HCP is identified in Table 7-1 below and the proposed funding structure in Appendix 8.

Table 7-1. Mitigation measures for different tiers of proposed take.

Species	Proposed Mitigation by Measured Take Level		
	Lower	**Baseline**	**Higher**
Seabirds	Same as Baseline	Mitigation for Newell's shearwater and Hawaiian petrel at Makamakaʻole or other suitable seabird nesting sites on Maui or Kauai or elsewhere	Increased mitigation efforts at the same site or additional mitigation measures at one or more additional sites on Maui or Kauai or elsewhere
Waterbirds	Same as Baseline	Predator control and vegetation maintenance at Hamakua Marsh for 3 to 5 years; subsequent mitigation efforts to meet baseline requested take as required	Additional mitigation efforts at Hamakua Marsh or predator control and monitoring at additional wetlands
Hawaiian short-eared owl	Same as Baseline	Upfront contribution of $25,000 for research and rehabilitation and $25,000 up to a maximum of $50,000 for management as it becomes available	Additional funding of $15,000 for research and rehabilitation and $15,000 up to a maximum of $30,000 to implement management strategies
Hawaiian hoary bat	Same as Baseline	Up to a maximum of $150,000 for management of bat habitat	Low-wind speed curtailment and additional funding of $15,000 up to a maximum of $75,000 for management

7.2 General Measures

7.2.1 Wildlife Education and Observation Program (WEOP)

A wildlife education and observation program will be conducted for all regular on-site staff. The program will be long-term, on-going, and updated as necessary. Staff will be trained to identify listed and non-listed native species of birds that may be found on-site, to record observations of species protected by the ESA and/or MBTA, and to take appropriate steps when and if downed wildlife is found. A draft plan for the WEOP is attached in Appendix 6.

As part of their safety training, temporary employees, contractors, and any others that may drive project roads will be educated as to project road speed limits, the possibility of downed wildlife being present on roads, and the possibility of Hawaiian short-eared owls flying across roads. These types of personnel will be instructed to contact the Site Environmental Compliance Officer immediately if they detect any downed wildlife on-site.

7.2.2 Downed Wildlife Protocol

The protocol for the recovery, handling, and reporting of downed wildlife will follow that developed for Kaheawa Pastures Wind Energy Generation Facility (Kaheawa Wind Power LLC, 2006) or other protocols approved by USFWS and DLNR. This protocol was developed in cooperation with DLNR and USFWS. All regular on-site staff will be trained in the protocol which will include documenting all observed mortality or injury to wildlife (including MBTA-protected birds not otherwise covered by this HCP). USFWS and DLNR will be notified within three days upon discovery of any injured or dead state or federally protected species (including ESA and MBTA). A Hawaiian duck/Hawaiian duck hybrid identification key will be used in the identification of downed ducks when it becomes available. If morphological features are inconclusive and there is reasonable uncertainty regarding the status of the duck incidentally taken, USFWS and DLNR may request the applicant conduct the appropriate genetic analysis.

Any state or federally listed species found dead or injured in the project area will be handled in accordance with the approved protocol. Injured state or federally-listed species will be photographed from a discrete distance and monitored. The Oahu Wildlife Program manager at DLNR will be notified with three days upon discovery of any injured or dead Hawaiian short-eared owls. As with federally listed species, any owls found dead or injured in the project area will be photo-documented and guarded against scavenging until collection by DLNR personnel. All (covered and non-covered) species will be documented in accordance with approved protocols; collections will be made only by staff personnel permitted by USFWS and DLNR to handle and salvage wildlife. Injured individuals or carcasses will be handled according to guidelines in Appendix 13 of the HCP.

7.3 Shearwater and Petrel

Radar studies documented passage of very few targets resembling Newell's shearwaters and no definitive Hawaiian petrels over the project area and because of this, the level of take of Newell's shearwater and Hawaiian petrel on-site is anticipated to be very low. As Newell's shearwaters are suspected to breed on O‘ahu only in small numbers, and nesting pairs are likely to be widely scattered (IUCN Red List 2009, Spencer pers. comm.), finding a seabird colony on O‘ahu where implementing mitigation measures is practicable and cost effective is not expected. Therefore, with the concurrence of ESRC, USFWS and DLNR, mitigation for the possible take of seabirds for the Kahuku Wind Power project will be implemented at known Hawaiian petrel and Newell's shearwater breeding colonies on Maui, Kauai or elsewhere to provide a net benefit and maximize contributions to the recovery goals of the two species.

Mitigation for seabirds takes into account the expected annual rate of direct and indirect take. Replacement for take of adults or juveniles will include replacement by either increased adult survival or increased fledging success. If increases in adult survival rates at the nesting sites can be demonstrated, then it may be possible to replace a taken adult directly with another adult. However, when replacement is provided by fledglings, the rate of survival to adulthood will be taken into account to ensure that a sufficient number of fledglings reach adulthood to replace those adults incidentally taken.

In addition, because Hawaiian petrels and Newell's shearwaters mature at age 5 and 6 years, respectively, mitigation also takes into account the loss of offspring that may have been produced by taken adults during the time that it takes for replacement fledglings to reach sexual maturity. Juvenile survival rates to adulthood are assumed to be 30% for the Hawaiian petrel (Simons and Hodges 1998) and 24% for Newell's shearwater (Ainley et al. 2001). The loss of productivity is calculated based on the percentage of the adult population breeding per year, yearly adult survivorship, and the reproductive success of a pair or individual (see Appendix 5 for life history details). At the suggestion of USFWS, it is assumed that it could require up to two years for a bird that has lost its mate to a collision event to find a new mate and begin reproducing again. Therefore, in calculating lost productivity, for each of the first two years following an incidental take, lost reproductive success is assumed to be the average annual productivity of a pair. In subsequent years, lost productivity is assumed to be half that rate (i.e. the lost production attributable to the taken individual as its former mate by then will be assumed to again be breeding with a new mate). Table 7-2 below lists the yearly number of fledglings required to be produced to offset the Baseline level of take anticipated at Kahuku Wind Power assuming same-year replacements for the direct take of adults and indirect take of fledglings. If an increase in adult survival is demonstrated, then a one-for-one replacement for adults is also possible.

Table 7-2. Baseline Mitigation Required for Hawaiian Petrel and Newell's Shearwater.

Species	**Baseline take level**			**Average annual fledgling production requirement**
Hawaiian petrel	20-year take limit	Adults	4	
		Fledglings	4	
	Annual average	Adults	0.2	0.67 (=0.2 / 0.30[a])
		Fledglings	0.2	0.2
	Total fledglings			**0.87**
	Total loss of productivity (years 1 and 2)			0.23 (=0.2 x 0.89[b] x 0.93[c] x 0.7[d] x 2)
	Total loss of productivity (years 3 and 4)			0.12 (=0.2 x 0.89[b] x 0.93[c] x (0.7[d]/2) x 2)
	Total fledglings required per year			**1.22**
Newell's shearwater	20-year take limit	Adults	8	
		Fledglings	4	
	Annual average	Adults	0.4	1.67 (=0.4 / 0.24[a])
		Fledglings	0.2	0.20
	Total fledglings			**1.87**
	Total loss of productivity (years 1 and 2)			0.23 (=0.40 x 0.46[b] x 0.90[c] x 0.7[d] x 2)
	Total loss of productivity (years 3 - 5)			0.17 (=0.40 x 0.46[b] x 0.90[c] x (0.7[d]/2) x 3)
	Total fledglings required per year			**2.27**

[a] fledgling survival to adulthood
[b] percentage of the adult population breeding per year
[c] yearly adult survivorship
[d] reproductive success of a pair

The major threats identified for Hawaiian petrels and Newell's shearwaters are: introduced predators, which can prey on adults, eggs and fledglings; feral ungulates, which degrade habitat and may trample burrows; and artificial lighting, which may disorient fledglings and increase their risk of collision with artificial structures (Mitchell et al. 2005). Predation has been shown to have significant negative effects on fledging success for the Hawaiian petrel (Hodges 1994, Hu et al. 2001, Hodges and Nagata 2001, Telfer 1986) and predation on adults has also been documented (Simons 1983). In Haleakalā National Park, Hodges and Nagata (2001) identified predation as accounting for 41% of total terrestrial mortality (adults, fledglings, and eggs) in cases in which a cause of death could be determined. Predation mortality was attributed to cats and mongooses (38%), rats (41%), dogs (14%) and owls (6%) (Hodges and Nagata 2001). Human-related causes (road-kills, collapsed burrows, collision with structures) accounted for 49% of all mortalities, with natural causes accounting for the remaining 10%. It is expected that the causes of Newell's shearwater mortality are generally similar to those of the Hawaiian petrel due to their similar reproductive strategies and the pervasiveness of these threats.

Nesting success rates can vary greatly from year to year and are probably dependent upon many environmental factors. Data from Hodges (1994), Hu et al. (2001), and Hodges and Nagata (2001) show that predator control (trapping and fencing) generally results in a significant increase in Hawaiian petrel nesting success as shown in Table 7-3.

In addition to the identified threats, a major factor limiting the ability to manage Hawaiian petrel and Newell shearwater colonies is their remoteness, which makes ungulate and predator management difficult (Mitchell et al. 2005). Nesting areas that are more accessible may also be difficult to protect if the nesting is highly dispersed (Podolsky and Kress 1992). One method for increasing protection is by attracting first-time breeders to new colonies in accessible areas or increasing seabird densities at existing colonies that are well situated for management. Seabird attraction to specific areas can be achieved by broadcasting audio play-backs of vocalizations of conspecifics. This technique has been shown to work on a wide range of species of seabirds (Gummer 2003), including the Galapagos petrel (*Pterodroma phaeopygia*, Podolsky and Kress 1992), which is closely related to the Hawaiian petrel, the Laysan albatross (*Phoebastria immutabilis,* Podolsky 1990), which also breeds in Hawaii, and the Bermuda petrel (*Pterodroma cahow*, Dobson and Madeiros 2009). Ground-nesting seabird species can be encouraged to nest at a prospective site by the placement of artificial burrows accompanied by vocalization play-backs. This then increases the density of nesting pairs in the area which in turn allows for more effective management (Podolsky and Kress 1992). Artificial burrows may also be positioned in a manner that facilitates monitoring. So far, the use of artificial burrows has been attempted with some success for Newell's shearwaters at Kilauea Point National Wildlife Refuge on Kaua'i (Joyce et al. 2008, U.S. Fish and Wildlife unpubl. data). These techniques have shown considerable success for an increasing number of ground-nesting seabird species at several locations in the Pacific and Atlantic Oceans. The Action Plan for Seabird Conservation in New Zealand states that colony establishment and enhancement is expected to contribute long-term conservation benefit to threatened seabird taxa (Taylor 2000a, b). According to Hawaii's Comprehensive Wildlife Conservation Strategy, while protecting seabird populations and their breeding colonies remains an important management priority, re-establishing former (or even remnant) breeding colonies is also important to reduce the risk of eventual extinction (Mitchell et al. 2005).

A Hawaiian petrel colony was found in West Maui near lower Kahakuloa Valley (called the Makamaka'ole colony) during the implementation of the Kaheawa Wind Power HCP. The presence of Hawaiian petrels was corroborated by DLNR wildlife biologists from Maui and seabird researchers from the USGS and H.T. Harvey and Associates in early July 2007 (Kaheawa Wind Power LLC, 2008). Newell's shearwaters have also been heard calling overhead (Spencer pers. comm.) at this site. This seabird colony is close to existing development (which increases the likelihood of cats and human disturbance), is accessible, and therefore highly likely to benefit from management. This seabird colony, located on State Forest Reserve land, is currently managed by Kaheawa Wind Power which initiated a predator trapping program in 2009 to reduce cat and mongoose populations in the vicinity (Spencer pers. comm.).

Table 7-3. Comparison of Hawaiian Petrel Nesting Success With and Without Predator Control.

Location	Year(s)	Nesting success (%)		Reference
		W/o predator control	W/ predator control	
Haleakala, Maui		42.0	57.0	Hodges 1994
Mauna Loa, Hawaii	1995-96	41.7	61.5	Hu et al. 2001
Haleakala, Maui	1982	0.0	32.7	Hodges and Nagata 2001
Haleakala, Maui	1990	10.0	49.2	Hodges and Nagata 2001
Haleakala, Maui	1991	25.6	48.6	Hodges and Nagata 2001
Haleakala, Maui	1992	15.2	17.0	Hodges and Nagata 2001
Haleakala, Maui	1993	32.8	38.2	Hodges and Nagata 2001
Haleakala, Maui	1994	44.0	23.0	Hodges and Nagata 2001
Haleakala, Maui	1995	31.8	50.0	Hodges and Nagata 2001
Haleakala, Maui	1996	28.1	46.7	Hodges and Nagata 2001
Unweighted Average		**27.1**	**42.4**	

7.3.1 Baseline Mitigation

It is proposed that Baseline mitigation for both seabird species will consist of fencing, predator trapping or habitat and colony enhancement at a seabird colony on Maui, Kaua'i or elsewhere. Currently, the preferred mitigation site is situated on West Maui at Makamaka'ole. Mitigation efforts at this seabird colony are already on-going and currently consist of trapping of cats and mongoose by Kaheawa Wind Power (Kaheawa Wind Power LLC, 2009). As described below, several alternatives have been developed for Kahuku Wind Power to complement the management activities occurring at this seabird colony.

7.3.1.1 Alternative 1 for Baseline Mitigation

Discussions with ESRC, USFWS and DOFAW have led to a recommendation that Kahuku Wind Power, Kaheawa Wind Power, and Kaheawa Wind Power II[1] pool resources and implement a comprehensive plan for seabird colony management at Makamaka'ole. Collectively, Kaheawa Wind Power, Kaheawa Wind Power II, and Kahuku Wind Power would pool funding to implement a fencing and predator trapping (and if needed a social attraction) project (Appendix 14). The area to be fenced shall have the potential to encompass the target number of burrows to meet the Baseline mitigation requirements for all three projects. The number of burrows needed will be determined in concurrence with USFWS and DLNR and will depend on the number needed to offsent the requested Baseline take within a pre-determined number of years within the 20-year duration of the project. The shorter the time period, the greater the number of burrows required. The actual number of burrows required will be determined using a reproductive output and survival model currently being developed for the Hawaiian petrel (Fretz pers. comm.).

The cat-proof fence will be approximately 1.6 – 2 miles (2.6 – 3.2 km) long, the actual length and location of the fence and the size of the enclosed area will be determined in concurrence with USFWS and DLNR. Ideally the identified area will have enough naturally occurring burrows to meet the Baseline mitigation requirements. The Applicant will coordinate closely with USFWS and DLNR to conduct site feasibility assessment within the first year of permit issuance. Kaheawa Wind Power will also revise the existing Makamaka'ole Mitigation Plan and submit the plan as part of the feasibility analysis. The fencing and subsequent predator control will only be implemented if the results of the feasibility assessment are indicative of a high probability of being able to meet the net conservation

[1] Kaheawa Wind Power II, a Maui wind power generation project, is seeking a section 10(a)(1)(B) permit from the USFWS to authorize the incidental take of Hawaiian petrel and Newell's shearwater, among other species.

benefit requirement for all three projects via the specified measures. A decision will be made by September 1, 2010 on whether to fence the specified area.

If a decision is made to construct the fence, all applicable permits will be obtained and the fence will be constructed within the first year of project operation as practicable. Fencing will only be conducted during the non-breeding season of the two Covered seabird species. Following the erection of the fence, cats and mongoose will be eradicated within the area, and rat populations will be controlled. Cat, rat and mongoose activity will be monitored within the fenced area using track pads and other suitable methods. Monitoring will also be conducted to document the effects of reduced predation on seabird survival and productivity within the enclosure.

If insufficient naturally occurring burrows are found within the fenced area, the Applicant will consult with USFWS and DLNR to determine the next most appropriate action. One alternative is to implement social attraction techniques for both Covered seabird species within the fenced area to increase the number of active burrows. Social attraction will consist of broadcasting vocalizations of nesting Hawaiian petrels and/or Newell's shearwaters (whichever is needed) during the prospecting and breeding season to encourage nesting within the area. Artificial burrows would be installed to increase available nesting habitat. Natural and artificial burrows would be monitored to document the success of the social attraction study.

If the fencing and social attraction study is deemed successful by USFWS and DLNR, the fence will be maintained throughout the life of the three projects and monitoring in the enclosure for cats and mongoose will continue and these species will be re-eradicated if they are found to have breached the fence.

If the social attraction and fencing study is deemed to be unsuccessful, mitigation efforts up to that point will be sufficient to meet the Baseline requested take of all three projects (see section 7.3.4).

The actual measures implemented at Makamaka'ole will be determined in concurrence with DLNR, USFWS, Kahuku Wind Power, Kaheawa Wind Power, and Kaheawa Wind Power II. Input will be sought from the Seabird Recovery Group for the State of Hawai'i. However, if mitigation efforts at another seabird colony are identified as a greater need or having a greater potential benefit, priority will be given to other colonies on East Maui, West Maui or Kaua'i or in other areas as determined by DLNR and USFWS.

7.3.1.2 Alternative 2 for Baseline Mitigation

One possible mitigation alternative that has emerged for Hawaiian petrels through discussion with the National Park Service at Haleakala National Park is the opportunity to participate in the management of the Hawaiian petrel colony breeding in the crater of Haleakala. This alternative also has the potential to be a combined effort of Kahuku Wind Power with KWP I and KWP II, however it is presented here as an alternative for Kahuku Wind Power. This site has the largest known breeding colony of Hawaiian petrels (USFWS 2005, Hodges and Nagata 2001) with over 1,000 known nests in and around Haleakala Crater. The National Park Service has indicated that an approximately 220 ac. (89 ha) area with approximately 100 burrows are protected from habitat damage by feral goats and pigs, but are not protected from predators. The National Park Service does not have funds to conduct the needed predator control in this area and does not anticipate receiving funds in the near future (Bailey pers. comm.). If Kahuku Wind Power participates in the management effort, Kahuku Wind Power will contract the labor and purchase equipment (e.g., traps and bait) required to conduct predator trapping in this area (or a section thereof, depending on mitigation requirement), and to conduct monitoring to document success. Trapping and monitoring protocols used will closely follow the protocols that have already been established by the National Park Service for managing the rest of the colony (Hodges and Nagata 2001). This effort would run for an initial period of five years. If after the initial five years of predator trapping, mitigation is still not at least one fledgling above Baseline requested take, mitigation will continue until that is achieved (see section 7.3.4 below). The limits of the area to be treated, need for additional years of treatment and other details of the mitigation efforts will be decided with concurrence of the National Park Service, DLNR and USFWS. If this alternative were to become a combined effort of all three wind projects then the size of the area and number of years of effort would be determined in concurrence with DLNR and USFWS.

For Newell's shearwater, Kahuku Wind Power proposes to provide support for colony-based protection and productivity enhancement on Kaua'i. This may involve supplementing an island-wide HCP developed for the island of Kauai in proportion to the authorized take and any loss of productivity that may occur in the interim. If the island-wide HCP does not come into fruition within 3 years, then colony-based mitigation will be implemented, either by Kahuku Wind Power alone or as part of a cooperative effort with another entity. Several known colonies on Kaua'i presently receive little or no management attention, and it is considered highly probable that other colonies remain to be discovered. The site chosen by Kahuku Wind Power for colony-based mitigation would be selected with the concurrence of the DLNR and USFWS. Kahuku Wind Power would either support an existing conservation need at a known colony or direct mitigation at a newly discovered colony where no management presently exists. The success of the mitigation efforts of Kahuku Wind Power will be measured using the method that is currently implemented at that site at the time. If the chosen mitigation site was previously unmanaged, the same measures of success used to estimate success at managed sites will be applied as appropriate. Funding has been provided in the budget to allow for the maximum cost scenario, i.e., providing mitigation for petrels at Haleakala National Park, and colony protection and management for Newell's shearwaters on Kauai.

7.3.1.3 Choosing mitigation measures

The most suitable mitigation effort to be conducted by Kahuku Wind Power will be chosen in consultation with DLNR, USFWS and seabird experts. The estimated cost for each measure is presented in Appendix 8. Consultation is necessary to ensure that the proposed management actions for seabirds satisfy the mitigation criteria required of Kahuku Wind Power by both DLNR and USFWS and that they will be complementary to any other management activities that may be taking place for the benefit of these species.

On-site monitoring during operation of the project will be used to determine if take is occurring at Lower, Baseline or Higher levels. Initial mitigation is intended to compensate for take at or below Baseline level as described in Section 7.3.1. If post-construction monitoring shows that take is actually occurring below or in excess of Baseline level, adjustment to mitigation efforts would be made as described in Sections 7.3.2 and 7.3.3.

<u>7.3.2 Mitigation for Higher Rates of Take</u>

Results of post-construction monitoring will be evaluated to determine whether rates of seabird take are exceeding Baseline levels (see Appendix 7 and section 8.2 for a detailed explanation).

If take levels are found to be occurring at Higher rates, Kahuku Wind Power will increase the amount of funding provided for fencing and predator control efforts or other mitigation measures. Additional funding could be used to increase mitigation efforts at the chosen site or implement mitigation measures at additional sites on Maui, Kaua'i or elsewhere. Selection of additional sites, identification of the appropriate mitigation initiatives, and level of effort will be determined in consultation with DLNR and USFWS.

<u>7.3.3 Mitigation for Lower Rates of Take</u>

If rates of take have not already been identified as occurring at Higher rates, a determination will be made whether take of seabirds is occurring below Baseline levels. A Lower rate of take will be determined for Kahuku Wind Power if no downed Hawaiian petrels or Newell's shearwaters are found attributable to the project after five consecutive years of project operation. If mitigation occurs at Makamaka'ole (see Alternative 1 in Section 7.3.1.1), and fencing and trapping is proceeding as planned, no change in mitigation will be implemented even if take occurs at a Lower level.

If Alternative 2 (see section 7.3.1.2) is chosen and no take is found after 5 consecutive years of project operation and mitigation efforts at that point in time have met the Baseline requested take, mitigation obligations will have been met and may cease with the concurrence of DLNR and USFWS. If take returns to Baseline or Higher levels, mitigation may resume if required by DLNR and USFWS.

7.3.4 Measures of Success

Mitigation efforts provided by Kahuku Wind Power will contribute to habitat and colony enhancement, and the control of predator populations and thus will provide a net benefit to, and aid in the recovery of, the two seabird species.

In general, mitigation will be deemed to be successful if the mitigation efforts result in one more fledgling or adult than that required to compensate for the requested take of the required tier. For Alternative 1, these mitigation requirements may be met if sufficient burrows are fenced and enough fledglings and adults are accrued to exceed the requested take level requirements. Fledglings accrued will be the net increase in pair productivity of each seabird species over that of baseline productivity estimates for each seabird species under unmanaged conditions using best available information. Likewise, the adults accrued will be the difference in adult survival rates at the managed site over that under unmanaged conditions. Unmanaged conditions will be represented using the best available information from published studies of the same or similar species with the concurrence of DLNR and USFWS.

However, as decided with prior concurrence with DLNR and USFWS, even if the conservation at Makamakaʽole does not replace more Newell's shearwaters or Hawaiian petrels than authorized, the value of completing a social attraction study will still be considered a net benefit to the covered seabird species due to the inherent value of the knowledge gained for seabird conservation actions. This is so because while social attraction methods appear to hold great promise, they have not been proven in Hawaiʽi, and the results from these mitigation efforts will assist the agencies in determining the next steps to take to promote the recovery of the Hawaiian petrel and Newell's shearwater.

If Alternative 2 is chosen, mitigation will be deemed to be successful if the mitigation efforts result in one more fledgling or adult than that required to compensate for the requested take of the required tier. If the mitigation is conducted within a shorter time frame than the project lifetime, models will be used to demonstrate that the mitigation provided will result in a net benefit for the species at the appropriate tier for the entire permit term. The model with be chosen with the concurrence of Kahuku Wind Power, USFWS and DLNR.

To ensure the success of the mitigation effort, Kahuku Wind Power will establish a $150,000 Seabird Contingency Fund. The fund will be compounded at 2.5% annually over the entire 20-year term of the HCP resulting in a total possible maximum of $245,792 (if left unused at year 20). If the fund is drawn upon at any time, the interest will continue to accrue for the remaining balance. This fund will be available to implement adaptive measures to ensure that mitigation is commensurate with the requested take of the required tier. If at the end of the 20-year period the mitigation is still not commensurate with the requested take of the required tier, any remaining contingency funds will be used for further mitigation efforts and to ensure a net benefit.

In addition, past, current or future funds allocated to other Covered Species may be expended where necessary to provide for the cost of implementing HCP mitigation measures for a particular species as long as the overall expenditure for mitigation at the Baseline tier (excluding contingency funds) does not exceed a total of $2.74M. While Kahuku Wind Power will not be required to expend more than $2.74M (excluding contingency funds) to fulfill its mitigation obligations at the Baseline tier for the Covered Species, funding for any individual Covered Species is not limited to those amounts estimated in Appendix 8.

7.3.5 Mitigation Credit

For Kahuku Wind Power, it is possible that variation in the rates of take between the two seabird species could result in the combined mitigation being performed at a level of effort greater than that which would be required for the species being taken at the lesser rate. It is also possible that variations in the rate of take could cause a short-term rate of take of one or both species to exceed the compensation capability of the mitigation efforts.

Annual reports will provide an accounting of the yearly total direct take of each seabird species, the number of fledglings needed to offset that take, and the number of fledglings actually produced that can be credited to the mitigation efforts. The difference in number of fledglings required for take compensation and number of fledglings produced in response to the mitigation will be recorded for each species as a running sum through the life of the project. For any species that are being taken at rates lower than expected, the prescribed mitigation would result in creation of more fledglings than are needed to compensate for take; i.e., a mitigation credit. Mitigation credit may available to Kahuku Wind Power to offset later same-species take at the Kahuku Wind Power site.

It is possible that mortality rates of some species could be so low that mitigation credit could be accrued for those species that never is needed as take compensation by Kahuku Wind Power. If take at Kahuku Wind Power is adequately documented to be occurring at Baseline or Lower levels for at least five years, and if mitigation credit has accrued in excess of the 20-year Baseline level of requested take, Kahuku Wind Power may use the portion of credit above Baseline to mitigate for the authorized take of these same species at any other wind power projects that it might construct on O'ahu, Maui, or elsewhere in Hawai'i as approved by USFWS and DLNR. Kahuku Wind Power would also be able to sell this credit to any other entity in need of mitigation for the same seabird species for any other type of project occurring on Maui or elsewhere in Hawai'i that receives take authorization from the USFWS and DLNR, including Kaheawa Wind Power and Kaheawa Wind Power II. For projects performed by entities other than Kahuku Wind Power, Kaheawa Wind Power, and Kaheawa Wind Power II, the transfer of credit will be conducted with concurrence of USFWS and DLNR that seabird fledglings produced at Makamaka'ole on Maui would be acceptable as compensation for the authorized take. Credit would be quantified in terms of number of fledglings produced. Commercial value of the credit would be determined through negotiation between Kahuku Wind Power and the receiving entity. If take at the Kahuku project subsequently exceeded the Baseline level, Kahuku Wind Power would be solely responsible for providing the additional mitigation needed to remain commensurate with the requested take, plus a net conservation benefit.

7.4 Waterbirds (Hawaiian Duck, Hawaiian Stilt, Hawaiian Coot, and Hawaiian Moorhen)

Mitigation for potential impacts to the four endangered waterbird species is proposed to be conducted concurrently at one wetland site because of their similar habitat requirements, and because they face similar threats to their habitat and reproductive success. The estimated cost for each proposed measure is presented in Appendix 8.

Measures intended to increase waterbird population sizes have been generally aimed at reducing or eliminating predation through exclusion (i.e. fencing) and eradication of predators from an enclosed breeding area. Garrettson and Rohwer (2001) found that lethal predator control using professional trappers was an effective way to increase waterfowl production; average nest success was nearly twice as high at trapped sites than at untrapped sites. Nest success of several dabbling ducks was also determined to be higher under predator management (by trapping, shooting, or lethal baiting) than at sites without predator management, although this relationship varied with climatic conditions (Drever et al. 2004). Long-term removal of feral mink (*Mustela vison*) via trained animals also resulted in an increase in the breeding densities of four waterfowl species compared to densities in control areas (Nordström et al. 2002).

Proposed mitigation for the take of waterbirds by operation of the Kahuku Wind Power project will focus on predator control and vegetation maintenance at wetland sites on O'ahu that have regular waterbird nesting activity as identified by DLNR and USFWS. Potential wetland sites identified during discussions with DLNR and USFWS included Hamakua Marsh State Wildlife Sanctuary, James Campbell Wildlife Refuge, Kawai Nui Marsh, Ukoa Pond and Pouhala Marsh. James Campbell Wildlife Refuge is a federally-owned wetland site, and therefore a lower priority as a mitigation site (see section 7.1 criteria 8). It was decided that since Kawai Nui Marsh and Ukoa Pond were unmanaged sites with few waterbirds, it would be difficult to implement successful mitigation measures at these locations. Pouhala Marsh, while managed, already had future funding designated to the area. Therefore, Hamakua Marsh, a 23-acre wetland located on east O'ahu, was identified as the mitigation site of first choice for Kahuku Wind Power by USFWS and DLNR. Hamakua Marsh is a state-managed wetland with documented nesting of all four waterbirds in the area. Mitigation by Kahuku Wind Power at this site would also aid in the recovery of the listed waterbird species. Under the Hamakua Marsh Ecosystem Restoration and Community Development Project, management activities conducted at Hamakua Marsh included the removal of red mangrove (*Rhizophora mangle*) from the banks, outplanting of native species, and providing adequate nesting habitat for the waterbird species. Waterbird nesting activity and habitat utilization were measured at Hamakua Marsh in 2003 and 2004, to document their response of these management activities (Smith and Polhemus 2003, Polhemus and Smith 2005). Since 2005, DLNR has conducted the predator trapping, vegetation maintenance and monitoring of waterbid productivity at the marsh.

Mitigation efforts will be directed at increasing productivity and mitigation success will be measured in terms of increased fledgling production over baseline productivity (productivity rates measured before predator control) at the end of the reproductive season for each year. The take of adults or subadults at Kahuku Wind Power will be compensated for by increasing the number of fledglings produced while taking into account fledgling survival to adulthood. For example, if 50% of all Hawaiian stilt fledglings survive to adulthood, the required compensation for the direct take of one adult Hawaiian stilt would be the production of two fledglings so that one can be expected to replace the taken bird. If increased adult survival can be demonstrated, then adults may also be directly replaced by another adult.

In addition to mitigating for the effects of direct and indirect take, mitigation also needs to account for any loss of productivity that could have occurred between the time the direct take occurs and the time that mitigation is provided. Factors that need to be taken into consideration when accounting for loss of productivity include demographic factors such as the age and sex of the individuals taken, the time of year the take occurs, the type of mitigation provided, and the time that elapsed between commencement of mitigation efforts and the direct take.

Given that Hawaiian duck, Hawaiian coot and Hawaiian moorhen have extended breeding periods in Hawaii, it is anticipated that mitigation efforts for direct and indirect take of Hawaiian duck, Hawaiian coot, and Hawaiian moorhen at Kahuku Wind Power will mostly result in same breeding year replacement by fledglings. These three species all reach maturity at year 1 and since same-year replacement is anticipated, no productivity would be lost by take of these species (fledglings will have matured by the next breeding season). However, Hawaiian stilts mature at year 2. Therefore, for this species, one year of productivity is added into the mitigation requirements to account for one year of lag in replacing adults with fledglings. However, should the replacement of adults of any of the covered waterbird species occur only in the subsequent breeding season, one year of loss of productivity will be added to the mitigation requirement. The number of fledglings required to be produced to compensate for Baseline rates of take of the four waterbird species is listed in Table 7-4 and is based on same-year replacement of take by fledglings.

Mitigation measures as described below would be conducted in collaboration with DLNR staff. Monitoring of waterbird health, reproductive success, and population size will also be funded to quantify the success of the mitigation measures. Monitoring would also be essential to identify any emerging threats or to determine the relative significance of existing threats if conditions change over time. This can contribute vital information to adaptive management as needed. The design and scope of each year’s effort would be determined with DLNR in consultation with biologists at USFWS and Kahuku Wind Power. Consultation is necessary to ensure that the proposed management actions for waterbirds on O‘ahu satisfy the mitigation criteria required of Kahuku Wind Power by both DLNR and USFWS and will be complementary to any other management activities that may be taking place for the benefit of these species.

Mitigation targets have been identified based on the “Baseline” and “Higher” take levels. On-site post-construction monitoring will be used to determine whether waterbird take is occurring at Baseline, Higher or Lower levels. Initial mitigation is intended to compensate for take occurring at Baseline level as described in Section 7.4.1. If post-construction monitoring shows that take is actually occurring below or in excess of Baseline level, adjustment to mitigation efforts would be made as described below (sections 7.4.2 and 7.4.3).

Table 7-4. Annual fledgling production requirements for Baseline take of listed waterbird species based on same-year replacement of take by fledglings.

Species	Baseline take level			Average annual fledgling production requirement
Hawaiian duck	20-year take limit	adults	8	
		fledglings	8	
	annual average	adults	0.4	0.62[1]
		fledglings	0.4	0.40
	Total fledglings required			**1.02**
Hawaiian stilt	20-year take limit	adults	8	
		fledglings	4	
	annual average	adults	0.4	0.80[2]
		fledglings	0.2	0.20
	loss of productivity**			0.19[3]
	Total fledglings required			**1.19**
Hawaiian coot	20-year take limit	adults	8	
		fledglings	4	
	annual average	adults	0.4	0.8[2]
		fledglings	0.2	0.20
	Total fledglings required			**1.00**
Hawaiian moorhen	20-year take limit	adults	8	
		fledglings	6	
	annual average	adults	0.4	0.80[2]
		fledglings	0.3	0.30
	Total fledglings required			**1.10**

[1] Annual survival of Hawaiian duck fledgling to adulthood = 0.65
[2] Annual survival of Hawaiian stilt, Hawaiian coot and Hawaiian moorhen fledgling to adulthood = 0.50
[3] Annual productivity for Hawaiian stilt is 0.47 fledglings per adult

As rates of take likely will vary between waterbird species, the level of mitigation effort at the chosen wetland will be determined by the highest rate of take. For example, if three species are found to be taken at the Lower rate but one is taken at a Higher rate, Baseline mitigation would be adjusted to compensate for the Higher rate of take. This would be expected to result in the production of fledglings for other waterbird species in excess of that which would otherwise be required. The Applicant would be able to receive credit for such "extra" fledglings that could then be used to compensate for take incurred in later years. This concept is discussed in Section 7.4.5.

7.4.1 Baseline Mitigation

Mitigation for the Baseline level of take of the four waterbirds will consist of:

Funding of $291,500 will be provided for three years of management at Hamakua Marsh to a qualified contractor or personnel approved by USFWS and DLNR. Funding will also be provided toward the purchase of a truck (up to a maximum of $12,000) and the initial purchase of monitoring equipment (up to a maximum of $2,000) if necessary. Funding may be re-allocated to extend up to five years as long as the total available funding of $291,500 is not exceeded. Additional contingency funds are provided in the event a third party contractor is required and will only be used for this purpose. Following permit issuance for predator control, vegetation maintenance, and monitoring of waterbird populations and reproductive activity, the following will be conducted:

a. Predator trapping and baiting will begin during the first breeding season after permit issuance to remove predators (e.g., cats, rats, mongoose). Predator trapping will be conducted year round using traps, leg holds, and/or snares. Traps would be placed along the perimeter of the fences 160 to 200 ft (50 - 60 m) apart. Leg holds and snares would be placed deeper within the fenced area, depending on visual observations of predators. Traps will be checked every 48 hrs and snares and leg holds every 24 hrs in accordance with USFWS guidelines. Bait stations will be deployed year-round following protocols set forth by the Department of Agriculture.

b. Vegetation maintenance will be conducted to remove and prevent invasive species from encroaching on waterbird nesting habitat and to enhance available nesting habitat where possible

c. Monitoring of reproductive activity and waterbird populations will quantify the effectiveness of the predator control methods. Monitoring of reproductive activity will be conducted weekly from December through September.

The predator control, vegetation maintenance and monitoring will be performed by a qualified contractor or personnel approved by DLNR and USFWS. After the first three to five years of predator trapping, the number of fledglings or adults accrued for the Covered waterbird species will be examined, and if they are at least one more than required to compensate for the Baseline requested take, the required mitigation is considered fulfilled. This standard applies to the Hawaiian coot, Hawaiian stilt and Hawaiian moorhen. Currently, as no pure Hawaiian ducks exist on Oahu due to hybridization (see section 3.8.4.3), mitigation for Hawaiian ducks will consist of removal of feral ducks, mallards and Hawaiian duck hybrids at Hamakua marsh. A total of 68 and 19 ducks were removed from the marsh in 2008 and 2009 respectively. Ducks are caught in traps or actively hunted during the non-breeding season for stilt. Feral ducks, mallards and Hawaiian duck hybrids still occur at Hamakua marsh (SWCA, pers. obs.) and will need to be removed.

If the number of fledglings or adults accrued are less than required, additional funding (up to a maximum of $291,500 for three years) will be provided by the Applicant for additional mitigation measures until the Baseline requested take for the Hawaiian coot, Hawaiian stilt and Hawaiian moorhen are met (see Appendix 8 Funding Matrix). As the fledglings accrued for each species may be uneven due to differences in pair abundance or reproductive success, more effort may be concentrated on enhancing the productivity of a specific Covered waterbird species in order to achieve the required number of fledglings to meet the Baseline requested level of take, provided the measures do not negatively affect the productivity of other Covered species at the mitigation site. The design and scope of each year's effort will be determined by DLNR in coordination with biologists at USFWS and Kahuku Wind Power. Coordination is necessary to ensure that the proposed management actions funded by Kahuku Wind Power and performed by DLNR for Hamakua Marsh satisfy the mitigation criteria required of Kahuku Wind Power by both DLNR and USFWS. A draft management plan for Hamakua Marsh outlining management measures that will be conducted under this HCP is included in Appendix 11.

If monitoring indicates that factors other than predator control are important or pressing in aiding the recovery of the endangered waterbird species covered in the HCP, Kahuku Wind Power in concurrence with USFWS and DLNR will direct the specified funds toward whatever management action is deemed most appropriate at the time. Should another waterbird nesting site be identified as a more suitable location for mitigation measures, management actions may be conducted in an alternate site as appropriate. Other important management techniques for wetland habitat improvement in Hawaii could include water level control, disease prevention and monitoring of environmental contaminants (USFWS 2005a).

7.4.2 Mitigation for Higher Rates of Take

If a Higher rate of take occurs for any of the waterbird species, the number of fledglings or adults accrued for that Covered species will be examined to determine if the fledglings or adults accrued are enough to cover the number required to be commensurate with the requested take at the Higher tier and achieve a net conservation benefit for the species. If this is determined to be so, then no additional mitigation will be provided. If it is determined that this is not the case, mitigation efforts will first be increased at the Hamakua Marsh site. Increased efforts could include intensifying the trapping effort or implementing additional vegetation management. If increased efforts at Hamakua Marsh are not sufficient to increase adult survival or produce enough fledglings required to be commensurate with the requested take at the Higher tier, and achieve a net conservation benefit for the species at the measured take levels, Kahuku Wind Power will provide funding for a similar set of waterbird management measures at one or more additional sites. Selection of additional sites, and identification of appropriate levels of effort will be determined in consultation with DLNR and USFWS.

7.4.3 Mitigation for Lower Rates of Take

Lower rates of take can only be determined after 5 years of post-construction monitoring. As identified in Section 6.3.2, Lower rates of take for waterbirds will only be identified if no take has been documented over the past 5 years. It is anticipated that by the time Lower rates of take are determined, mitigation at the Baseline level would already have been achieved and no changes to mitigation measures are anticipated.

7.4.4 Mitigation Measures for Waterbirds as a Covered Activity

Concern was expressed by USFWS about the possible take of waterbirds as a consequence of predator trapping at the marsh. Moorhen are attracted to traps (DesRochers et al. 2006) and moorhen on Oahu have been documented entering live traps (DesRochers et al. 2006, Nadig pers. comm.). Thus predator trapping poses some risk of harassment due to capture, and may result in injury or mortality to the Covered waterbird species. However, at Hamakua Marsh, traps are not placed within moorhen habitat (Misaki pers. comm.) and in the five years of predator trapping, no injuries or fatalities due to the by-catch of moorhen or any of the other Covered waterbird species have been reported. Due to the minimal risk of injury or mortality expected at Hamakua Marsh, no additional take is requested for any of the Covered waterbird species.

However, in the unlikely event a waterbird mortality or injury is caused by the mitigation measures, Kahuku Wind Power LLC will mitigate for that loss at a level commensurate with any take that occurs and measures will be emplaced to prevent a repeat of the same occurrence as far a practicable.

7.4.5 Measures of Success

It is anticipated that mitigation for the Covered Waterbird species will be funded by the Applicant and conducted by a qualified contractor or personnel approved by USFWS and DLNR (Section 7.4.1 and Appendix 11). Funding will be provided by the Applicant within 6-months of issuance of the ITL and Baseline mitigation will commence within the first year of the project start date unless circumstances beyond the control of Kahuku Wind Power prevent it from happening. At which point, the Applicant, DLNR and USFWS will discuss and concur on an appropriate start date and modify mitigation efforts if necessary to enable mitigation efforts to commence as soon as possible. If after 3 years, mitigation has still yet to commence, the same equivalent amount of funding will be used to conduct alternate mitigation measures at the same site or at an alternate site. The alternate mitigation measures will be decided in concurrence with DLNR and USFWS. Upon entering a Higher Take level, additional funding will be made available within 6-months of the determination to implement the required mitigation to be commensurate with the requested take at the Higher tier and achieve a net conservation benefit for the species.

If monitoring after two years of predator control indicate that mitigation efforts are not above the baseline productivity (i.e. productivity in the absence of management), as part of adaptive management, mitigation efforts may increase, or other measures may be implemented instead. The baseline productivity will also be examined to determine if it is biologically reasonable and adjusted if necessary (see Appendix 11 for details on the development of baseline productivity). Other measures may also be implemented should monitoring identify more pertinent threats that need to be addressed, or other management activities to be more effective in increasing survival and productivity. Mitigation may also be implemented at other waterbird sites should that be agreed upon as the action most likely to benefit the Covered Species. All actions implemented will be determined in consultation with DLNR and USFWS. After the initial 3 -5 year mitigation period, the mitigation will be deemed successful if the number of fledglings and adults accrued exceed the requested take for Hawaiian coot, Hawaiian stilt and Hawaiian moorhen and result in a net benefit for the three Covered species over the entire permit term. For the Hawaiian duck, mitigation will be deemed successful if the culling of feral ducks, mallards and Hawaiian duck hybrids is carried out as far as practicable and that these ducks do not occur in such numbers on site as to negatively impact the other Covered Species in terms of space or resource use. Net benefit will also be considered to have been achieved as these mitigation efforts will have contributed to a reduction in introduced predator populations, which is considered a form of habitat improvement, and will have contributed to the recovery of the species.

If mitigation efforts still fall short of more than one fledgling required to meet the Baseline requested take, mitigation efforts will be re-evaluated and modified by further consultation with DLNR and USFWS. Mitigation will be extended beyond the 3 -5 year period to ensure that the Baseline requested take for Hawaiian coot, Hawaiian stilt and Hawaiian moorhen are met and result in a net benefit for the three Covered species over the entire permit term. As the increase in adult survival or production of fledglings accrued for each species may be uneven due to differences in pair abundance or reproductive success, more effort may be concentrated on enhancing the productivity of a specific Covered waterbird species in order to achieve the required number of fledglings to meet the Baseline requested level of take, provided the measures do not negatively affect the productivity of other Covered species at the mitigation site.

To ensure the success of the mitigation effort, Kahuku Wind Power will establish a $150,000 Waterbird Contingency Fund. The fund will be compounded at 2.5% annually over the 20-year term of the HCP resulting in a total possible maximum of $245,792 (if left unused at year 20). If the fund is drawn upon at any time, the interest will continue to accrue for the remaining balance. This fund will be available to implement adaptive measures to ensure that mitigation is commensurate with the requested take of the required tier. If at the end of the 20-year period the mitigation is still not commensurate with the requested take of the required tier, any remaining contingency funds will be used for further mitigation efforts and to ensure a net benefit.

In addition, past, current or future funds allocated to other Covered Species may be expended where necessary to provide for the cost of implementing HCP mitigation measures for a particular species as long as the overall expenditure for mitigation at the Baseline tier (excluding contingency funds) does not exceed a total of $2.74M. While Kahuku Wind Power will not be required to expend more than $2.74M (excluding contingency funds) to fulfill its mitigation obligations at the Baseline tier for the Covered Species, funding for any individual Covered Species is not limited to those amounts estimated in Appendix 8.

7.4.6 Mitigation Credit

As mentioned in Section 7.4, it is possible that the rates of increased adult survival or fledgling production accrual for the different species will vary, due to differences in pair abundance or reproductive success. As mitigation is required to continue until the Baseline requested take for the Hawaiian stilt, Hawaiian coot and Hawaiian moorhen is met, credit for some species will accrue in excess of the Baseline requested take.Therefore, if take at Kahuku Wind Power is occurring at Baseline or Lower levels, and if mitigation credit has accrued in excess of the Baseline level of requested take, Kahuku Wind Power may use this credit to mitigate for the authorized take of these same species at any other wind power projects that it might construct on Oʻahu. Kahuku Wind Power would also be able to sell this credit to any other entity in need of mitigation for the same waterbird species for any other type of project occurring on Oʻahu that receives take authorization from the USFWS and DLNR. This mitigation credit could not be applied to projects occurring on islands other than Oʻahu regardless of the species involved. Credit would be quantified in terms of number of fledglings produced. Commercial value of the credit would be determined through negotiation between Kahuku Wind Power and the receiving entity.

7.5 Hawaiian Short-eared Owl

Monitoring of population trends and documentation of habitat occupancy were identified as key monitoring and conservation priorities for the Hawaiian short-eared owl by the Hawaii Comprehensive Wildlife Conservation Strategy (Mitchell et al. 2005). This was because of a lack of basic life history information on the Hawaiian short-eared owl, making management techniques to enhance Hawaiian short-eared owl populations on Oʻahu hard to identify and their effectiveness difficult to quantify because of an absence of adequate baseline studies.

Mitigation targets have been identified based on the levels of take identified as “Baseline” or “Higher.” On-site post-construction monitoring will be used to determine actual rates of Hawaiian short-eared owl take. Initial mitigation is intended to compensate for take at Baseline level as described in Section 7.5.1. If post-construction monitoring shows that take is actually occurring below or in excess of Baseline level, adjustment to mitigation efforts would be made as described below (Sections 7.5.2 and 7.5.3). The estimated cost for each proposed measure is presented in Appendix 8.

7.5.1 Baseline Mitigation

Mitigation for possible take of the Hawaiian short-eared owl by Kahuku Wind Power will consist of three parts: funding research; rehabilitation of injured owls; and subsequently implementing management actions on O‘ahu as they are identified and as needed to bring mitigation ahead of take (i.e., provide a net benefit). Therefore, upon issuance of the incidental take permit, Kahuku Wind Power will contribute $25,000 to appropriate programs to support owl research and rehabilitation.

As little is known about the life history of the Hawaiian short-eared owl, research could be designed to develop protocols to monitor Hawaiian short-eared owl populations, determine habitat use and preferences and evaluate the effectiveness of habitat management techniques. Concurrently, funding will also be used to develop a rehabilitation program for Hawaiian short-eared owls that are found injured (such due to vehicular collisions) and brought in by the public or agencies.

The allocation of funds to research and rehabilitation will be determined by DLNR and USFWS. The research funding may be used for (but not limited to) the purchase of radio transmitters, receivers, or provide support for personnel to conduct research such as a population census. However, these funds will be used for whatever management or research activity is deemed most appropriate at the time, with the concurrence of USFWS and DLNR.

The rehabilitation program could consist of training selected veterinarians in the assessment and appropriate care of injured Hawaiian short-eared owls. This would in turn enable the veterinarians to obtain the necessary permits required to handle the state-endangered birds. Other possible funding applications could be a public outreach program where the public would be informed of the appropriate steps to take upon encountering an injured Hawaiian short-eared owl. The allocation of funds for owl rehabilitation will be determined by DLNR and USFWS and will be used for whatever rehabilitation activity is deemed most appropriate at the time. Hawaiian short-eared owls rehabilitated under the funding of Kahuku Wind Power will be credited as compensation for take that is incurred at the Kahuku Wind Power facility.

It is anticipated that the research conducted will result in the identification of practicable management actions that will aid in the recovery of Hawaiian short-eared owl populations on O‘ahu. At this point, Kahuku Wind Power will provide additional funding of $25,000 up to a maximum of $50,000 to implement a chosen management measure as agreed upon by USFWS and DLNR. The level of funding provided for management will be decided with the concurrence of DLNR and USFWS and will be deemed appropriate to compensate for the Baseline requested take (adjusted for take already mitigated for in the rehabilitation program) and also provide a net benefit to the species.

7.5.2 Mitigation for Higher Rates of Take

If monitoring indicates a Higher level of take, Kahuku Wind Power will provide additional funding of $15,000 for increased owl research and rehabilitation. Examples of possible research include studies of where Hawaiian short-eared owls are likely to breed, quantification of productivity, or developing and testing the effectiveness of management techniques. However, should research indicate that other areas of study are more important or pressing in aiding the recovery of the species, in concurrence with USFWS and DLNR, these funds will be used for whatever management or research activity is deemed most appropriate at the time.

This funding will be followed by an additional $15,000 up to a maximum of $30,000 for implementing chosen management actions as they become available, with the concurrence of USFWS and DLNR. The level of funding provided for management will be decided upon with concurrence of DLNR and USFWS and will be deemed appropriate to compensate for the requested take at a Higher tier and also provide a net benefit to the species.

7.5.3 Mitigation for Lower Rates of Take

Because it is proposed to provide $25,000 up-front for owl research under the Baseline scenario, the Baseline rate of mitigation will have been committed prior to identification of any Lower rate of take. Consequently, no adjustment to the Baseline mitigation effort would be made if monitoring surveys indicate a rate of take below the Baseline level.

7.5.4 Measures of Success

The success of the mitigation efforts will be determined as follows:

1. Funding for owl research will be considered successful if within 6-months of issuance of the ITL, Kahuku Wind Power contributes $25,000 to an appropriate program to support owl research and rehabilitation. Or if upon entering a Higher Take level, an additional $15,000 is provided for research within 6-months of the determination;
2. Implementation of management measures will be considered successful if Kahuku Wind Power contributes $25,000 to $50,000 (for take at or below Baseline) plus an additional $15,000 to $30,000 (in the event of Higher Take) to fund management that is commensurate with the requested take for the required tier, and the management is carried out and is demonstrated to provide a net benefit to the species. Criteria for the success of the management measures will be determined when the protocols for the chosen management measures are developed.

To ensure the success of the mitigation effort, Kahuku Wind Power will establish a $75,000 Hawaiian Short-eared Owl Contingency Fund. The fund will be compounded at 2.5% annually over the entire 20-year term of the HCP resulting in a total possible maximum of $122,896 (if left unused at year 20). If the fund is drawn upon at any time, the interest will continue to accrue for the remaining balance. This fund will be available to implement adaptive measures to ensure that mitigation is commensurate with the requested take of the required tier. If at the end of the 20-year period the mitigation is still not commensurate with the requested take of the required tier, any remaining contingency funds will be used for further mitigation efforts and to ensure a net benefit.

In addition, past, current or future funds allocated to other Covered Species may be expended where necessary to provide for the cost of implementing HCP mitigation measures for a particular species as long as the overall expenditure for mitigation at the Baseline tier (excluding contingency funds) does not exceed a total of $2.74M. While Kahuku Wind Power will not be required to expend more than $2.74M (excluding contingency funds) to fulfill its mitigation obligations at the Baseline tier for the Covered Species, funding for any individual Covered Species is not limited to those amounts estimated in Appendix 8.

7.6 Hawaiian Hoary Bat

Because of the lack of life history information on the Hawaiian hoary bat, research is identified as one of the key components in the recovery of this subspecies. The Recovery Plan for the Hawaiian Hoary Bat (USFWS 1998) states that "Research is the key to reaching the ultimate goal of delisting the Hawaiian hoary bat because currently available information is so limited that even the most basic management actions cannot be undertaken with the certainty that such actions will benefit the subspecies."

Recent research by Gorresen et al. (2008) on Hawaiian hoary bat detectability and occupancy has identified several key areas of research required to improve life history knowledge. The areas identified are:

- Determining bat occupancy in different habitats
- Determining bat distribution across seasons on a local and regional scale
- Determining seasonal and daily peak bat activity periods
- Monitoring of population trends

Development and implementation of a survey and monitoring program remains a high priority and a key recovery objective for the Hawaiian hoary bat (Gorresen et al 2008, USFWS 1998).

Mitigation targets have been identified based on the levels of take identified as "Baseline" or "Higher." On-site monitoring during operations will be used to determine the tier at which Hawaiian hoary bat take is occurring. Mitigation is intended to compensate for take at Baseline level as described in Section 7.6.1. If monitoring shows that take is actually occurring below or in excess of Baseline level, adjustment to mitigation efforts would be made as described below (Section 7.6.2 and 7.6.3). The estimated cost for each proposed measure is presented in Appendix 8.

7.6.1 Baseline Mitigation

Mitigation for the Hawaiian hoary bat by Kahuku Wind Power was developed through discussions with USFWS, DLNR, and bat experts at USGS, and involved identifying the most immediate needs required for the recovery of the species. Based on the feedback received, the Applicant proposes a combination of,

1. on-site surveys to add to the knowledge base of the species' status on O'ahu;
2. on-site research into bat interactions with the wind facility;
3. implementation of bat habitat improvement measures to benefit bats as determined based on the results of ongoing research, in consultation with DLNR, USFWS and ESRC

7.6.1.1 Bat Habitat Utilization at Kahuku Wind Power and Vicinity

The Applicant will continue to survey for and monitor Hawaiian hoary bats within and in the vicinity of the Kahuku Wind Power site. Surveys will be conducted during years when systematic fatality monitoring is conducted, (i.e., during the first two years and at five year intervals thereafter, or as otherwise determined under the Adaptive Management provisions), to allow observed activity levels to be correlated with any take that is observed. A critical component identified as essential to Hawaiian hoary bat recovery is the need to develop a standardized survey protocol for the Hawaiian hoary bat monitoring program to enable results collected by different parties to be directly comparable. Therefore, the Applicant will expand or modify ongoing efforts to conform to USGS (HBRC) protocols being used in the Hawaiian Islands. The Applicant will also join the Hawai'i Bat Research Cooperative (HBRC) and as a contribution to the on-going research efforts in the state, will conduct its own surveys and monitoring at Kahuku Wind Power and the vicinity. Twelve anabat detectors will be deployed at Kahuku Wind Power and, if suitable sites are identified and landowner permission is granted, in adjacent lands with other habitat types (e.g. gulches or ponds) or in coastal wetland areas.

The goal of this research will be to document bat occurrence, habitat use and habitat preferences on site, as well as identify any seasonal and temporal changes in Hawaiian hoary bat abundance. This research will be an extension of a 5-year survey already underway on the island of Hawai'i and another that will shortly commence on Maui.

7.6.1.2 Research on Bat Interactions with the Wind Facility

In conjunction with the two year study to determine habitat utilization by bats at Kahuku Wind Power and its vicinity, Kahuku Wind Power proposes to conduct additional on-site research that will contribute to identifying areas of potential interactions and vulnerabilities of Hawaiian hoary bats at wind facilities, as follows:

1. Kahuku Wind Power will survey for bat activity near turbine locations for the first two years of operation using acoustic bat detectors. Surveys will also be conducted during years when systematic fatality monitoring is conducted (see Appendix 7 and Section 8.2). USGS (HBRC) monitoring protocols will be used and adjusted if necessary. Thermal imaging or night vision technology will be used to assist acoustic monitoring as trends are detected and would follow similar protocols developed during pre-construction monitoring (see Appendix 4). The use of additional techniques and technologies will also be

considered. These data will be analyzed in an effort to determine seasonal and daily peak bat activity periods on-site, and comparison of data with pre-construction activity levels will help determine if bats are being attracted to the wind facility.

2. Incidental bat observations will be recorded under the WEOP (Section 7.2.1 and Appendix 6).

This in-house research is expected to advance avoidance and minimization strategies that wind facilities in Hawai‘i and elsewhere can employ in the future to reduce bat fatalities.

7.6.1.3 Implementation of Management Measures

The Applicant will contribute an additional negotiated amount of $25,000 up to a maximum of $150,000 to fund an appropriate management program. As recommended by DLNR, USFWS and ESRC, the measures if implemented as stipulated will be sufficient to mitigate for the Baseline requested take and provide a net benefit to the species.

DLNR, USFWS, ESRC and the Applicant will consult to determine the most appropriate measures for implementation. Because the measures have not yet been determined, a budget range for implementing measures has been established based on preserving or enhancing foraging and/or roosting habitat capable of supporting a commensurate number of bats to achieve the mitigation requirement. The Baseline requested take of 12 adult bats and 9 juveniles (see section 6.3.6) equates to a total of 15 adults (with an estimated 30% survival rate of juveniles to adulthood, see Appendix 5 for life history information). The core area for an adult bat is estimated to be 13.3 ac (5.4 ha, see section 3.4.8.4), therefore, a total area of approximately 200 ac (82.5 ha) may be required for 15 adults, assuming no spatial overlap and no empty territories. One preliminary option to improve bat habitat was developed during discussion with DLNR and is listed below.

Native habitat plant restoration at a previously burned forest on Maui was identified as one option for enhancing bat habitat. The Polipoli area of the Kula Forest Reserve in East Maui was burned by a wildfire in 2007. A total of approximately 2,300 acres of forested public lands, including the Polipoli area, within Kula Forest Reserve was burned at this time. This burn unit was dominated by mature closed canopy forest comprised primarily of pines, cypresses, and redwoods. One of the goals in the restoration of this burned unit was to enhance native species habitat and native ecosystem recovery (DLNR 2007b). This unit was known to support a variety of native birds and the Hawaiian hoary bat before the wildfire (Duvall pers. comm.). The initial outplanting has been completed and 50, 30 and 20 percent of the 1,800 acre reforestation areas were planted with native trees (a koa – ohia mixture), redwoods, and grass/shrublands, respectively. DLNR has identified a need for funding for native habitat plant restoration which consists of supplemental planting to replace seedling mortality, implementation of rodent control, weed control and fertilization programs to enhance tree seedling survival and forest establishment. Kahuku Wind Power will support native habitat plant restoration for the entire 1,800 ac reforestation area, estimated to cost $125,000 in 2010 or $100,000 for the year 2011. Alternatively, funding may be used to conduct native habitat plant restoration at the Polipoli area for two years. The funding will be provided to support native plant habitat restoration which will be conducted by a qualified contractor or personnel approved by DLNR or USFWS.

It is anticipated that the measure outlined above or any others that are developed in the future will be conducted in partnership with other conservation groups or entities and that these activities will complement other restoration, reforestation or conservations goals occurring in that area at the time. Other sites may be chosen if they are determined to be more appropriate for the implementation of the mitigation measures. The allocation of the funds for any mitigation measure would be determined by the Applicant in consultation with USFWS and DLNR. Funds will be directed toward whatever management or research activity is deemed most appropriate at the time.

7.6.2 Mitigation for Higher Rates of Take

Should Kahuku Wind Power exceed the Baseline rate of take Kahuku Wind Power will immediately implement low wind-speed curtailment by increasing the cut-in speed of all turbines (or a subset of turbines if so determined by DLNR and USFWS) from their normal operation to 5m/s during periods when bats are active, approximately from dusk till sunrise. Low wind speed curtailment will be implemented unless there is strong evidence that the observed fatalities are a result of some other cause that can be corrected by other means. The final determination of whether to implement low wind speed curtailment will be made by DLNR and USFWS, in consultation with Kahuku Wind Power.

Recent studies on the mainland indicate that most bat fatalities occur at relatively low wind speeds, and consequently the risk of fatalities may be significantly reduced by curtailing operations on nights when winds are light and variable. Research is suggesting this may best be accomplished by increasing the cut-in speed of wind turbines from their normal levels (usually 3.5 or 4 m/s, depending on the model). Research conducted by Arnett et al. (2009) found that bat fatalities could be reduced by 53-87 percent when cut-in speed was increased to 5 m/s. No significant additional improvement over this level was detected when the cut-in speed was increased to 6.5 m/s. Because power increases exponentially with wind speed, at low wind speeds the power loss is generally modest, however, incrementally increasing the cut-in speed above 5 m/s results in an exponential increase in lost power. These findings are encouraging and hold promise for reducing fatalities at projects where bat fatalities have been found to be high.

The times of the year when curtailment is implemented (i.e. year-round or seasonal) at Kahuku Wind Power will be decided based on bat detection data on site, seasonal distributions of observed fatalities on site, and best available science, with concurrence from USFWS and DLNR.

In addition to the immediate implementation of low-wind speed curtailment, Kahuku Wind Power will review the fatality records in an effort to determine whether additional measures can be implemented that will reduce or minimize take. If causes cannot be readily identified Kahuku Wind Power will conduct supplemental investigations that may include but not be limited to:

1. additional analysis of fatality and operational data;
2. deployment of acoustic bat detectors to identify areas of higher bat activity during periods when collisions are believed to be occurring;
3. using thermal imaging or night vision equipment to document bat behavior;
4. determining whether certain turbines are causing most of the fatalities or if fatality rates are related to specific conditions (e.g., wind speed, other weather conditions, season)

Other measures to reduce bat fatalities will be implemented as identified and feasible and may include changes in project operations such as modifying structures and lighting, and implementing measures to repel or divert bats from areas of high risk without causing harm if practicable. These data may also be used to refine low-wind speed curtailment options, such as determining the times of year when curtailment is mandatory, or if curtailment can be confined to a subset of "problem" turbines. These additional measures will be implemented by Kahuku Wind Power with the concurrence of USFWS and DLNR.

An additional negotiated amount of $15,000 up to a maximum of $75,000 will also be provided to implement appropriate Hawaiian hoary bat management measures when identified. This budget range has been determined based on an expenditure of up to 50% above the maximum Baseline budget, which is reasonable considering that provisions are included for low-wind speed curtailment. This funding will be used to conduct mitigation measures that will be deemed appropriate to compensate for the requested take at the Higher tier. The most appropriate mitigation measure to be implemented will be determined in consultation with DLNR and USFWS.

7.6.4 Mitigation for Lower Rates of Take

As the proposed Baseline mitigation will be carried out within the first two years of project operation, no change to mitigation measures will occur should a Lower rate of take be determined.

7.6.5 Measures of Success

The success of the mitigation efforts will be determined as follows:

1. Both components of on-site research into Hawaiian hoary bat habitat utilization and bat interaction with wind facilities will be considered successful if Kahuku Wind Power joins the HBRC and the specified survey and monitoring is carried out, including proper deployment and operation of bat detectors, data reduction and analysis, and reporting of findings to DLNR, USFWS and ESRC;
2. In the event that Kahuku Wind Power exceeds the Baseline rate of take measures to reduce bat fatalities will be considered successful if one or more causes can be identified and corrective measures are implemented that result in an estimated 50 percent or greater reduction in bat fatalities over previous levels when averaged over a five-year period.
3. Implementation of management measures will be considered successful if Kahuku Wind Power contributes $25,000 to $150,000 (for take at or below Baseline) within 6-months of beginning project operations, plus an additional $15,000 to $75,000, for take at a Higher tier within 6-months of the determination, to fund management that is commensurate with the requested take at the required tier, and the management is carried out and is agreed upon by USFWS and DLNR to provide a net benefit to the species.

To ensure the success of the mitigation effort, Kahuku Wind Power will establish a $100,000 Hawaiian Hoary Bat Contingency Fund. The fund will be compounded at 2.5% annually over the entire 20-year term of the HCP resulting in a total possible maximum of $163,861 (if left unused at year 20). If the fund is drawn upon at any time, the interest will continue to accrue for the remaining balance. This fund will be available to implement adaptive measures to ensure that mitigation is commensurate with the requested take of the required tier. This fund will be available to implement adaptive measures to ensure that mitigation is commensurate with the requested take of the required tier. If at the end of the 20-year period the mitigation is still not commensurate with the requested take of the required tier, any remaining contingency funds will be used for further mitigation efforts and to ensure a net benefit.

In addition, past, current or future funds allocated to other Covered Species may be expended where necessary to provide for the cost of implementing HCP mitigation measures for a particular species as long as the overall expenditure for mitigation at the Baseline tier (excluding contingency funds) does not exceed a total of $2.74M. While Kahuku Wind Power will not be required to expend more than $2.74M (excluding contingency funds) to fulfill its mitigation obligations at the Baseline tier for the Covered Species, funding for any individual Covered Species is not limited to those amounts estimated in Appendix 8.

8.0 IMPLEMENTATION

8.1 HCP Administration

This HCP will be administered by Kahuku Wind Power with guidance from the USFWS and DLNR. Other experts may be consulted as needed, including biologists from other agencies (e.g. U.S. Geological Survey), conservation organizations, consultants, and academia. HCP-related issues may also be brought before the ESRC for formal consideration when deemed appropriate by Kahuku Wind Power, USFWS, and DLNR.

The Applicant will meet at least semi-annually with USFWS and DLNR. Additional meetings/conferences may be called by any of the parties at any time to address immediate concerns. The purpose of the regular meetings will be to evaluate the efficacy of monitoring methods, compare the results of monitoring to the estimated take, evaluate the success of mitigation, and develop recommendations for future monitoring and mitigation. Regular meetings will also provide opportunities to consider the need for adaptive management measures. In addition, the Applicant will meet annually with the ESRC to provide updates of monitoring, mitigation, and adaptive management, and to solicit input and recommendations for future efforts. Additional meetings may be requested by the ESRC at any time to address immediate questions or concerns.

8.2 Monitoring and Reporting

Monitoring and reporting by the Applicant will address both compliance and effectiveness of monitoring and mitigation measures. Compliance monitoring will verify the Applicant's implementation of the HCP terms and conditions. Annual reports and other deliverables as described below will be provided to USFWS and DLNR to allow them to independently verify that the Applicant has performed all of the required activities and tasks on schedule. Monitoring will document take relative to authorized levels and the success of the HCP's mitigation program. The monitoring will involve surveys to make sure the authorized level of take is not exceeded, and that minimization and mitigation measures are sufficient and successful.

8.2.1 Monitoring

The Applicant proposes to document bird and bat injuries and fatalities, including covered and non-Covered Species, following methods that have been used effectively at other wind energy generation facilities in Hawai'i and the continental United States. Details of the proposed monitoring protocol are provided in Appendix 7. Key components include:

- Use of Kahuku Wind Power technical staff and/or third-party contractors who have been trained by experienced biologists having specialized expertise in conducting wind turbine/bird interaction studies. Criteria for selecting 3rd party contractors approved by USFWS and DLNR will be developed in consultation with DLNR and USFWS. Additional contingency funds are provided in the event a third party contractor is required for monitoring and will only be used for this purpose.
- Carcass removal (i.e., scavenging) and searcher efficiency (SEEF) trails will be conducted each season using carcasses of different size classes. Two seasons will be addressed: the winter/spring season (December – May) and summer/fall (June – November). Three size classes have been chosen to represent the size classes of the Covered Species - bat sized, medium birds and large birds. Carcass removal and SEEF trials will be conducted with sufficient replication to produce scientifically reliable results. These results will provide a basis for estimating unobserved take (see Appendix 7 on study design and Appendix 8 for take calculation). The Applicant will all cover costs and responsibilities for acquiring carcasses for trials;
- Intensive searches will be conducted for the first two years under the direction of a qualified biologist, after which it is expected that the approach will be reduced to a sampling method based on the results obtained up to that point; Systematic searches of 50% reduced effort

will subsequently be conducted at 5-year intervals and a further reduced but regular sampling method conducted during the interim years;

- The frequency of searches during the intensive search years will ensure that a variety of conditions are included. For example, days after moonless, cloudy, or stormy nights are of particular interest, because the wind turbines would be least visible and the risk of collision would presumably be greater, especially during peak fledging periods;
- Incidental observations by on-site staff of bird use, injury, and mortality will be documented in accordance with the WEOP and Downed Wildlife Protocol described in Section 6.1 and 6.2.

8.2.2 Reporting

If the minimal search interval is exceeded, the Applicant will report the event to USFWS and DLNR within a week. If the minimal search interval is exceeded more than once per season (for reasons other than weather, health or safety), the Applicant, DLNR and USFWS will discuss possible adaptive management measures to address and correct the problem.

Semi-annual meetings with DLNR and USFWS will be held in March and September to provide brief progress reports and summarize the findings of scavenging, SEEF trials and results of mitigation efforts. Electronic copies of HCP related data will also be submitted with the progress reports. If necessary, take limits will be reviewed and changed circumstances or adaptive management measures will be discussed with DLNR and USFWS as needed. In addition, an incident report will be filed within 5 business days of any documented take (i.e., injury or fatality) of Covered Species (Appendix 13).

Annual reports summarizing the results of each of the two years of intensive monitoring will be prepared and submitted to DLNR and USFWS no later than August 1st of each year. These reports will identify: 1) actual frequency of monitoring of search plots 2) directly observed and adjusted levels of take for each species; 3) whether there is a need to modify the mitigation for subsequent years; 4) efficacy of monitoring protocols and whether monitoring protocols need to be revised; 5) results of mitigation efforts conducted as part of the HCP; 6) recommended changes to mitigation efforts if any; 7) all HCP related expenditures for the previous year; and 8) continued evidence of the Applicant's ability to fulfill funding obligations. The annual report will be submitted along with electronic copies of HCP related data. The report may also be presented to ESRC as required.

In subsequent years, monitoring may consist of a reduced level of effort, consisting of smaller search plots at a subset of turbines, with plots being relocated periodically to sample a variety of locations. The ongoing effort will be supplemented by the WEOP Program, as implemented by on-site staff. Depending upon the findings, the location and focus of the ongoing effort can be modified, with the concurrence of the USFWS and DLNR, to target areas or times of particular interest. A table summarizing the results of incidental observations will be submitted to DLNR and USFWS twice each year. In addition, in accordance with the Downed Wildlife Protocol, biologists at DLNR and USFWS will be notified whenever a Covered Species is found dead or injured. The Applicant will confer formally with the USFWS and DLNR following submittal of the annual report to review the results and plan appropriate future mitigation and monitoring measures. Any changes to future mitigation and monitoring would only be made with the concurrence of USFWS and DLNR.

8.3 Adaptive Management Program

According to USFWS policy [*see* 65 Fed. Reg. 35242 (June 1, 2000)], adaptive management is defined as a formal, structured approach to dealing with uncertainty in natural resources management, using the experience of management and the results of research as an on-going feedback loop for continuous improvement. Adaptive approaches to management recognize that the answers to all management questions are not known and that the information necessary to formulate answers is often unavailable. Adaptive management also includes, by definition, a commitment to change management practices when determined appropriate.

In the case of Kahuku Wind Power, some uncertainty exists in the proposed project, from estimated rates of take to the success of the proposed mitigation measures. Fortunately, because of past studies conducted by many researchers on the effectiveness of predator control on improving breeding success of the covered seabirds and waterbirds, the potential for success of the mitigation measures proposed for these species is also considered to carry a very low level of uncertainty.

The proposed tiered approach to mitigation was designed to be adaptive because actual rates of take may not match those projected through modeling. Mitigation efforts will increase if monitoring demonstrates that incidental take is occurring above Baseline levels. Mitigation efforts would also be allowed to decrease if rates of take are found to be occurring below Baseline levels. Any changes in the mitigation effort would be made only with the concurrence of USFWS and DLNR. Regardless of recorded take levels, the avoidance and minimization measures described in Section 5.3 would be employed for the duration of the Kahuku Wind Power project. Tables illustrating mitigation efforts and adaptive management options are included in Section 7.1.

Monitoring of seabird and waterbird mitigation efforts is intended to inform the Applicant, USFWS, and DLNR whether these efforts are adequately compensating for take. If monitoring reveals that a particular mitigation effort is not achieving the necessary level of success, the Applicant will consult with USFWS and DLNR to develop and implement a revised mitigation strategy to meet mitigation requirements. As long as take remains at or below "Higher" levels as identified in Section 6.3, any actions performed in response to this adaptive management process would be performed under the mitigation budget established for the project.

If the take of any of the Covered Species exceeds that Baseline level of take authorized by the ITL but remains within the range identified in Section 6.0 as the "Higher" rate for that species, the Applicant will increase the mitigation effort for that species as prescribed in Section 7.0. The Applicant will also promptly discuss this situation with USFWS and DLNR to review the total take of that species recorded to date at Kahuku Wind Power and the mitigation performed to date on behalf of that species, and to identify whether mitigation performed to date has compensated for the Higher rate of take, or whether changes in mitigation are needed to compensate for the Higher rate of take. The Applicant may also consider whether changes in operational practices are needed to reduce levels of take. Any changes to the mitigation efforts would be made only with the concurrence of the Applicant, USFWS, and DLNR, and within the mitigation budget established for the project.

8.4 Funding

Sufficient funding will be made available to ensure that the proposed measures and actions in the HCP are undertaken in accordance with the schedule. The funding provided allows for the option of State compliance monitoring. An estimate of the costs of funding the proposed mitigation plan is presented in Appendix 8.

Funding for the implementation of the HCP will be provided by Kahuku Wind Power as an annual operating expense paid pari passu with other operating expenditures (operation and maintenance costs, insurance, payroll, lease payments to the State of Hawai‘i, audit costs, and agency fee costs) and most importantly, ahead of both debt service to lenders and dividends to equity investors.

Assurances that adequate funding will be available to support the proposed monitoring and mitigation measures will be provided by Kahuku Wind Power in the form of a bond, letter of credit or similar instrument naming the DLNR as beneficiary. The terms and conditions of such instrument(s) are the subject of ongoing discussions with the agencies and will be included in the final HCP and IA. As currently proposed, Kahuku Wind Power will provide a rolling letter of credit (LC) or bond in the amount of $500,000, which will be available to fund mitigation in the unlikely event of a revenue shortfall or, in the worst case scenario, bankruptcy. The LC will be automatically renewed prior to expiration, unless it is determined to no longer be necessary by the USFWS and DLNR. In the event of a revenue shortfall or bankruptcy the LC could be drawn upon by the USFWS or DLNR to fund any outstanding mitigation obligations of the project.

The Applicant will establish an additional, single bond or letter of credit for the value of the four contingency funds which start at $475,000. The amount of the bond will increase at 2.5% annually over the term of the HCP. If contingency funds are used, the amount of the bond would be reduced accordingly, and the net amount would continue to increase at a 2.5% annual rate.

8.5 Changed Circumstances Provided for in the HCP

Changed circumstances are circumstances that occur during the life of a HCP that can be anticipated and planned for. For Kahuku Wind Power, possible changed circumstances that are anticipated and planned for include: 1) climate change; 2) disease outbreaks in any of the listed species; 3) deleterious change in relative abundance of non-native plant species or ungulates occurring at the mitigation sites for Covered Species; 4); hurricanes or other major storms that may affect the project area and/or mitigation sites 5) changes in the price of raw materials and labor; 6) the de-listing of any species covered in the HCP; and 7) the listing of one or more species that already occur on-site, or fly over the site, not currently covered in the HCP.

The procedures to provide for these scenarios are described below:

1) Global Climate Change Significantly and Negatively Alters Status of the Covered Species

   Global climate change within the life of the project (20 years) has some limited potential to alter the current distribution of vegetation communities utilized by the Covered Species through region-wide changes in weather patterns, sea level, average temperature and levels of precipitation (IPCC 2007). In some instances, climate change may also cause populations of Covered Species to decline. Covered seabird species are likely to be affected through changes in the distribution of their food resources at sea and possible changes in the vegetation at their preferred nesting habitats. Covered waterbird species are most likely to be affected by the loss of wetland habitat due to sea level rise and changes in precipitation. The short-eared owl and Hawaiian hoary bat are not expected to be affected by any changes in climate over the life of the project due to their ability to utilize non-native habitats which are unlikely to decrease in availability during that time frame.

   With climate change, hurricanes or storms may occur with greater intensity (Webster et al. 2005, US Climate Change Science Program 2009), which would increase the risk of damage to established mitigation sites. This is discussed in Scenario 4 below. Sea level is predicted to rise approximately 1 m in Hawai‘i by the end of the 21st Century (Fletcher 2009). Given this, any rise in sea level experienced during the life of the project would likely be less than 1 m. As both seabird and waterbird mitigation sites are at or more than 1 m above sea level, these sites are unlikely to be impacted by sea level rise while the project is operational.

   Precipitation may decline by 5 -10 % in the wet season and increase 5 % in the dry season, due to climate change (Giambelluca et al. 2009). This may result in altered hydrology at the waterbird mitigation site and a possible drying of the wetland basins. Other mitigation sites may also be considered for continued mitigation if the existing site is no longer considered suitable wetland nesting habitat for waterbirds. The alternate mitigation site will be chosen in consultation with USFWS and DLNR.

   Vegetation at the seabird mitigation site may also change with decreased precipitation or increased temperatures, however, changes are expected to be small over the lifetime of the project. Should significant changes in vegetation be deemed to be occurring and demonstrated to affect the productivity of the Covered seabird species, other mitigation sites will be considered for continued mitigation if deemed necessary and will be chosen in consultation with USFWS and DLNR. In all cases, mitigation efforts will remain commensurate with requested take with a net benefit provided to each Covered Species as required by State law.

   Any changes in the mitigation measures implemented for any of the Covered Species due to climate change will be performed under the budget established for mitigation expenses in this HCP which includes funding available for the tier of mitigation required, contingency funds and the Surety Letter or Credit if mitigation actions have not been fully achieved or unmitigated take remains.

2) Disease Outbreaks in Listed Species
The most prevalent disease for the waterbirds covered in this HCP is avian botulism (USFWS 2005a). Avian botulism is caused by a toxin produced in stagnant water by the anaerobic bacteria *Clostridium botulinum* type C_a. If such outbreaks should occur at the chosen waterbird mitigation site(s), Kahuku Wind Power will assist DLNR and USFWS in implementing measures to prevent or reduce the severity of the outbreaks at the mitigation sites as appropriate under the budget established for mitigation expenses which includes funding available for the tier of mitigation required, contingency funds and the Surety Letter or Credit if mitigation actions have not been fully achieved or unmitigated take remains.

Newell's shearwater and Hawaiian petrel have not been documented to have disease outbreaks but Newell's shearwater fledglings have been found with mild symptoms of avian pox (Ainley et al. 1997, Mitchell et al. 2005, Simons and Hodges 1998). Hawaiian short-eared owls may be susceptible to the "sick owl syndrome", the cause of which has yet to be identified (Mitchell et al. 2005). It is currently not known if the Hawaiian hoary bat is susceptible to any diseases. Disease is considered one of the lesser threats to the persistence of the seabirds, owl, and bat covered in the HCP. Should the prevalence of disease increase dramatically and become identified as a major threat to the survival of any of these species by DLNR and USFWS, Kahuku Wind Power will consult with DLNR and USFWS to determine if changes in monitoring, reporting, or mitigation are necessary to provide assistance in documenting or reducing the impact of the disease. Any changes prompted by disease outbreaks in the species covered in the HCP will be performed under the budget established for mitigation expenses which includes funding available for the tier of mitigation required, contingency funds and the Surety Letter or Credit if mitigation actions have not been fully achieved or unmitigated take remains.

3) Deleterious change in relative abundance of non-native plant species or ungulates occurring at the mitigation sites for Covered Species.

Should the proportion or coverage of non-native plant species or ungulates increase at any mitigation site to a point where it is believed that this change is causing significant habitat degradation or loss of habitat for any of the Covered Species, thereby resulting in a measurable decline of the species at the site, the Applicant will consult with DLNR and USFWS to determine if measures to prevent the further spread of non-native plants or incursion of ungulates are available, practical, and necessary. If no such measures are available, mitigation measures for the affected Covered Species may be implemented at another site as determined with DLNR and USFWS. Any such measures and consequent changes in monitoring, reporting or mitigation as deemed appropriate by DLNR and USFWS will be implemented under the budget established for mitigation expenses in the HCP which includes funding available for the tier of mitigation required, contingency funds and the Surety Letter or Credit if mitigation actions have not been fully achieved or unmitigated take remains.

4) Hurricanes and Storms
Of the species covered in the HCP, the waterbirds may be the most vulnerable to the effects and after-effects of hurricanes and storms. Kahuku Wind Power will contribute to measures to rehabilitate waterbird habitat within waterbird mitigation sites that are extensively damaged during any hurricane or major storm as allowed by the mitigation budget established under the HCP. Possible contributions to habitat rehabilitation could include removal of debris, aiding in the recreation of nesting islands, contribution to revegetation efforts or rehabilitation of injured Covered Species as deemed necessary. If the habitat destruction due to the hurricane or storm is so extensive as to render the mitigation site unsalvageable or is altered such that it is no longer utilized by nesting waterbirds, and if the same storm also did not similarly damage wetland habitats more proximate to the project area such that project operations continue to pose a risk of causing take of any of the waterbird species, any remaining mitigation will be carried out at another waterbird nesting site, chosen in consultation with USFWS and DLNR. Any changes in the mitigation measures implemented will be performed

under the budget established for mitigation expenses in this HCP which includes funding available for the tier of mitigation required, contingency funds and the Surety Letter or Credit if mitigation actions have not been fully achieved or unmitigated take remains.

Seabirds such as Newell's shearwater have been shown to vacate nesting areas in response to approaching intense low-pressure areas and thus adults are unlikely to suffer mortality due to hurricane or storm events. If hurricanes were to occur during the chick-rearing period (e.g. Hurricane 'Iniki in 1992), chicks could suffer mortality as a result of destroyed burrows, uprooted trees, and/or mudslides. However, hurricane-related chick mortality has not been documented (Ainley et al. 1997). If necessary, Kahuku Wind Power will contribute to measures to rehabilitate seabird nesting habitat within seabird mitigation sites that are damaged during hurricanes or major storms as allowed by the mitigation budget established under the HCP. Possible contributions could include removing of debris, contribution to revegetation efforts or rehabilitation of injured Covered Species as deemed necessary. If the habitat destruction due to the hurricane or storm is so extensive as to render the mitigation site unsalvageable or is altered such that it is no longer utilized by nesting seabirds, and if the same storm does not eliminate all seabird nesting activity on O'ahu such that project operations continue to pose a risk of causing take, any remaining mitigation will be carried out at another seabird nesting site, chosen in consultation with USFWS and DLNR. Any changes in the mitigation measures implemented will be performed under the budget established for mitigation expenses in the HCP which includes funding available for the tier of mitigation required, contingency funds and the Surety Letter or Credit if mitigation actions have not been fully achieved or unmitigated take remains.

It is not known how Hawaiian short-eared owls or Hawaiian hoary bats respond to storms or hurricanes. However, Kahuku Wind Power will implement changes in monitoring, reporting or mitigation deemed appropriate by DLNR and USFWS if necessary and if such changes can be made within the budget established in the HCP which includes funding available for the tier of mitigation required, contingency funds and the Surety Letter or Credit if mitigation actions have not been fully achieved or unmitigated take remains..

5) Changes in the Price of Raw Materials and Labor
   Annual reviews will be performed to analyze the costs in the previous year's budget for mitigation expenses and cumulative costs. Annual expenses for subsequent years will be adjusted to meet projected costs based on previous years' expenditures, and cumulative spend to date.

6) De-listing of Covered Species
   Should any of the species covered in the HCP be de-listed during the tenure of the permit, it is expected that the mitigation efforts provided by Kahuku Wind Power would have contributed in some part to the de-listing of the species. Therefore mitigation actions for that species will continue to be performed in accordance with the HCP, unless and until USFWS and DLNR agree that such actions may be discontinued.

7) Listing of One or More Species that Already Occur On-site
   In the event that one or more species that occur on-site are listed pursuant to the ESA, Kahuku Wind Power will evaluate the degree to which the species is (or are) at risk of being incidentally taken by project operations. If take of the species appears possible, Kahuku Wind Power will then assess whether the mitigation measures already being implemented provide conservation benefits to the newly listed species and if any additional measures are needed to provide a net conservation benefit to the species. Kahuku Wind Power would then seek coverage for the newly listed species under an amendment to the HCP.

8.6 Changed Circumstances Not Provided for in the HCP

If changed circumstances occur that were not provided for in Section 8.4, and the HCP is otherwise being properly implemented, the USFWS will not require any conservation and mitigation measures in addition to those provided for in the HCP without the consent of Kahuku Wind Power.

8.7 Unforeseen Circumstances and "No Surprises" Policy

Unforeseen circumstances are "changes in circumstance surrounding an HCP that were not or could not be anticipated by HCP participants, DLNR and USFWS, that result in a substantial and adverse change in the status of a covered species" (USFWS and NMFS 1996). Under the "No Surprises" policy, with a properly implemented HCP (Hawaii Revised Statues – Section 195D-23), Kahuku Wind Power will not be required to commit additional land, water, money or financial compensation, or be subject to additional restrictions on land, water or other natural resources to respond to such unforeseen circumstances beyond what has been already agreed upon in the HCP, without the consent of Kahuku Wind Power. For the purposes of this HCP, changes in circumstances not provided for in Section 8.4 that substantially alter the status of the covered species are considered unforeseen circumstances.

The "No Surprises" policy assurances only apply to species "adequately covered" in the HCP. Species considered to be "adequately covered" are those covered by the HCP that satisfy the permit issuance criteria under Hawaii Statutes - Section 195D-21. The species considered adequately covered in this HCP and therefore covered by the No Surprises policy assurances include the Newell's shearwater, Hawaiian petrel, Hawaiian duck, Hawaiian stilt, Hawaiian coot, Hawaiian moorhen, and Hawaiian hoary bat. The No Surprises assurances also apply to the state-endangered Hawaiian short-eared owl as the HCP conditions for the species also satisfy the permit issuance criteria under Hawaii Statutes - Section 195D-21 of the ESA as if the species were listed.

In the event that unforeseen circumstances occur during the term of the Permit and the USFWS and DLNR concludes that any of the Covered Species are being harmed as a result, the agencies may require additional measures of the Permittee where the HCP is being properly implemented only if such measures are limited to modifications of the conservation program for the affected species and maintain the original terms of the HCP to the maximum extent possible. Additional conservation and mitigation measures will not involve the commitment of additional land, water or financial compensation or additional restrictions on the use of land, water, or other natural resources otherwise available for development or use under the original terms of the HCP without the consent of Kahuku Wind Power.

8.8 Notice of Unforeseen Circumstances

The USFWS and DLNR will have the burden of demonstrating that unforeseen circumstances exist, using best available scientific and commercial data. The USFWS and DLNR will notify Kahuku Wind Power in writing should the USFWS or DLNR believe that any unforeseen circumstance has arisen.

8.9 Permit Duration

The HCP for Kahuku Wind Power is written in anticipation of the issuance of an ITL to cover the entire project duration of 20 years.

8.10 Amendment Procedure

Different procedures are present that allow for the amendment to the ITL. However, the cumulative effect of any amendments must not jeopardize any listed species. USFWS and DLNR must be consulted on all proposed amendments and the amendment procedures are listed below.

8.10.1 Minor Amendments

Minor amendments include routine administrative revisions, changes to surveying or monitoring protocols that do not decrease the level of mitigation or increase take. A request for a minor amendment to the HCP may be made with written notice to USFWS and DLNR. A public review process may be required for the minor amendment. The amendment will be implemented upon receiving concurrence from the agencies.

8.10.2 Formal Amendments

Formal amendments are required when the Applicant wishes to significantly modify the project, activity, or conservation program already in place. Formal amendments are also necessary to add species to the HCP that were not originally covered or to implement adjustments required due to unforeseen circumstances. An amendment to the ITL requires written notification to DLNR requesting for an amendment to the HCP addressing the new circumstance(s). Such applications typically require a revised HCP, a complete application form with appropriate fees, a revised implementing agreement and may require environmental review documents in accordance with NEPA. The specific documents required may vary based on the nature of the amendment.

8.11 Renewal and Extension

This HCP proposed by Kahuku Wind Power may be renewed or extended, and amended if necessary, beyond its initial 20-year term with the approval of USFWS and DLNR. A written request will be submitted to both agencies that will certify that the original information provided is still current and conditions unchanged or provide a description of relevant changes to the implementation of the HCP that will take place. The request will also provide species specific information concerning the level of take that has occurred during the HCP's implementation. Such a request shall be made within at least 180 days of the conclusion of the 20-year term, and the HCP shall remain valid and in full force while the renewal or extension is being processed. The permit may not be renewed for levels of take beyond those authorized by the original permit.

8.12 Other Measures

An Implementing Agreement stipulating the HCP's terms and conditions in contractual form will be signed by all parties (Kahuku Wind Power, USFWS, and DLNR) to provide assurances that the HCP will be implemented.

9.0 CONCLUSION

Kahuku Wind Power looks forward to working with the USFWS and DLNR and the ESRC throughout the approval and long-term implementation of the HCP for the Kahuku Wind Power project. While the operation of the Kahuku Wind Power project will aid the State of Hawai'i in meeting its renewable energy mandate, commercial wind energy generation facilities are not without potential for adverse and unavoidable environmental impacts. Kahuku Wind Power is committed to making all reasonable efforts to avoid, minimize, mitigate, and compensate for these impacts as evaluated and determined through the HCP process and its adaptive management strategy to provide a net benefit to the species identified in the HCP, through a transparent and consultative process with all parties concerned.

10.0 LITERATURE CITED

Adams, J. 2008. "Petrels in the Pacific: Tracking the Far-ranging Movements of Endangered 'Ua'u (Hawaiian Petrel)." US Geological Survey, Western Ecological Research Center. Available at: www.microwavetelemetry.com/newsletters/spring_2007Page4.pdf. Accessed February 11, 2008.

Ainley, D.G., L. DeForest, N. Nur, R. Podolsky, G. Spencer and T.C. Telfer. 1995. Status of the threatened Newell's Shearwater on Kaua'i: Will the population soon be endangered?

Ainley, D.G., T.C. Telfer, and M.H. Reynolds. 1997. Townsend's and Newell's Shearwater (*Puffinus auricularis*). In: The Birds of North America, No. 297. (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Ainley, D.G., R. Podolsky, L. DeForest, G. Spencer, and N. Nur. 2001. The status and population trends of the Newell's Shearwater or Kauz'i: insights into modeling. Studies in Avian Biology No. 22: 108-123.

Altamont Pass Avian Monitoring Team. 2008. Altamont Pass Wind Resource Area Bird Fatality Study. July. (ICF J&S 61119.06.) Portland, OR. Prepared for Altamont County Community Development Agency.

Anamizu, Joy. Ecologist, U.S. Army Corps of Engineers, Honolulu District. Personal Communication.

APLIC (Avian Power Line Interaction Committee). 1994. Mitigating bird collisions with power lines: the state of the art in 1994. Edison Electric Institute, Washington, DC. 78 pp.

APLIC (Avian Power Line Interaction Committee). 1996 (reprinted 2000). Suggested practices for raptor protection on powerlines: the state of the art in 1996. Edison Electric Institute/Raptor Research Foundation, Washington, DC. 125 pp.

Arnett, E.B. and M.D. Tuttle. 2004. Cooperative Efforts to Assess the Impacts of Wind Turbines on Bats. Bat Research News 45(4):201-202.

Arnett, E., W. Erickson, J. Kerns, and J. Horn, J. 2005. Relationships Between Bats and Wind Turbines in Pennsylvania and West Virginia: An assessment of fatality search protocols, patterns of fatality, and behavioral interactions with wind turbines. Report prepared for Bats and Wind Energy Cooperative. Available at: http://www.batsandwind.org/pdf/ar2004.pdf.

Arnett, E.B., K. Brown, W.P. Erickson, J. Fielder, T.H. Henry, G.D. Johnson, J. Kerns, R.R. Kolford, T. Nicholson, T. O'Connell, M. Piorkowski, and R. Tankersly. 2008. Patterns of fatality of bats at wind energy facilities in North America. Journal of Wildlife Management 72: 61-78.

Arnett E.B., M. Schirmacher, M.M.P. Huso and J. 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.

Baerwald, E.F., G.H. D'Amours, B.J. Klug, and R.M.R. Barclay. 2008. Barotrauma is a Significant Cause of Bat Fatalities at Wind Turbines. Current Biology 18(16):695-696.

Baker, Patrick J.; Scowcroft, Paul G.; Ewel, John J. 2009. Koa (*Acacia koa*) ecology and silviculture. Gen. Tech. Rep. PSW-GTR-211. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 129 p.

Baldwin, P.H. 1950. Occurrence and Behavior of the Hawaiian Bat. Journal of Mammalogy, 31: 455–456.

Bannor, B.K. and E. Kiviat. 2002. Common Moorhen (*Gallinula chloropus*). In: The Birds of North America, No. 685. (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Belt Collins Hawaii Ltd. 2007. Phase 1 Environmental Site Assessment, TMK (1)5-6—5:Parcels 2,5,6,7,14, and 16. Prepared for UPC Hawaii Wind Partners, LLC.

Bellwood, J.J. and J.H. Fullard. 1984. Echolocation and Foraging Behaviour in the Hawaiian Hoary Bat, *Lasiurus cinereus semotus.* Canadian Journal of Zoology 62:2113-2120.

Berger, A.J. 1972. Hawaiian birdlife. The University Press of Hawaii, Honolulu, HI.

Blackmore, M. and Vitousek, PM. 2000. Cattle grazing, forest loss, and fuel loading in a dry forest ecosystem at Pu'u Wa'aWa'a Ranch, Hawai'i. Biotropica 32(4a): 625-632.

Bradley, J.S., R.D. Wooller, I.J. Skira, and D.L. Serventy. 1989. Age-dependent survival of breeding short-tailed shearwaters *Puffinus tenuirostris*. Journal of Animal Ecology 58:175–188.

Brisbin, Jr., I. Lehr and T.B. Mowbray. 2002. American Coot (*Fulica americana*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology.

Brisbin, Jr., 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.). Philadelphia, PA.

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.

Byrd, G.V. and C.F. Zeillemaker. 1981. Ecology of Nesting Hawaiian Common Gallinules at Hanalei, Hawai'i. Western Birds 12(3):105-116.

Byrd, G.V., J.L. Sincock, T.C. Telfer, D.I. Moriarty, and B.G. Brady. 1984. A Cross-Fostering Experiment with Newell's Race of Manx Shearwater. The Journal of Wildlife Management 48(1):163-168.

Carothers, S.W. 2008. Expert Report: Evaluation of Risks to Avian (birds) and Chiropteran (bats) Resources. Gulf Wind Project, Kenedy County, Texas.

Cooper, B.A. and R.H. Day. 1998. Summer Behavior and Mortality of Dark-rumped Petrels and Newell's Shearwaters at Power Lines on Kaua'i. Colonial Waterbirds 21: 11–19.

Cooper, B.A. and R.H. Day. 2003. Movement of the Hawaiian Petrel to Inland Breeding Sites on Maui Island, Hawai'i. Waterbirds 26(1):67-71.

Cooper, B.A. and R.H. Day. 2004a. Results of Endangered Bird and Bat Surveys at the Proposed Kaheawa Pastures Wind Energy Facility on Maui Island, Hawai'i, Fall 2004. Prepared by ABR, Inc., Forest Grove, OR and Fairbanks, AK for Kaheawa Wind Power, LLC, Makawao, HI and UPC Wind Management, LLC, Newton, MA. 16 pp.

Cooper, B.A. and R.H. Day. 2004b. Modeling Annual Seabird Use and Fatality at the Proposed Kaheawa Pastures Wind Energy Facility, Maui Island, Hawai'i. Prepared by ABR, Inc., Forest Grove, OR and Fairbanks, AK for Kaheawa Wind Power, LLC, Makawao, HI and UPC Wind Management, LLC, Newton, MA. 7 pp.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. (Version 04DEC98).

Courchamp, F., J. Chapuis, and M. Pascal. 2003. Mammal Invaders on Islands: Impact, Control and Control Impact. Biol. Rev. 78:347–383.

Cryan, P.M. 2008. Mating Behavior as a Possible Cause of Bat Fatalities at Wind Turbines. Journal of Wildlife Management 72(3):845-849.

Cryan, P.M. and A.C. Brown. 2007. Migration of Bats Past a Remote Island Offers Clues Toward the Problem of Bat Fatalities at Wind Turbines. Biol. Conserv. 129(1-2):1-11.

Day, R.H. and B.A. Cooper. 1995. Patterns of Movement of Dark-Rumped Petrels and Newell Shearwaters on Kauai. Condor 97(4):1011-1027.

Day, R.H., and B.A. Cooper. 2002. Petrel and shearwater surveys near Kalaupapa, Molokai Island, June 2002. Unpublished report prepared for National Park Service, Hawaii National Park, HI, by ABR, Inc.—Environmental Research & Services, Fairbanks, AK, and Forest Grove, OR. 17 pp.

Day, R.H. and B.A. Cooper. 2008. Results of Endangered Seabird and Hawaiian Hoary Bat Surveys on Northern Oahu Island, Hawaii, October 2007 and July 2008. Prepared by ABR, Inc., Forest Grove, OR and Fairbanks, AK for FirstWind, LLC.

Day, R.H., B.A. Cooper, and T.C. Telfer. 2003a. Decline of Townsend's (Newell's) Shearwaters (*Puffinus auricularis newelli*) on Kauai, Hawaii. Auk 120:669-679.

Day, R.H., B.A. Cooper, Brian A.; Blaha, Richard J. 2003b. Movement Patterns of Hawaiian Petrels and Newell's Shearwaters on the Island of Hawai'i. Pacific Science 57(2):147-159.

Del Hoyo, J., A. Elliott and J. Sargatal. 1992. The Handbook of the Birds of the World, Volume I. Ostrich to Ducks. Lynx Edicions, Barcelona.

Department of Business, Economic Development, and Tourism (DBEDT). 2007. 2006 State of Hawaii Data Book. Available at: http://www.hawaii.gov/dbedt/info/economic/databook/db2006/. Accessed August 21, 2008.

Department of Business, Economic Development, and Tourism (DBEDT). 2008. 2007 State of Hawaii Data Book. Available at: http://hawaii.gov/dbedt/info/economic/databook/db2007/. Accessed November 3, 2008.

Department of Forestry and Wildlife (DLNR) 2007a. Ka'ena Point Ecosystem Restoration Project. Available at: http://www.state.hi.us/dlnr/DLNR/kaena/Kaena_DEA_to_OEQC_Entire.pdf Accessed May 18, 2009

Department of Forestry and Wildlife (DLNR) 2007b. Proposed Hazard Reduction and Reforestation in the Aftermath of the Upper Waiohulu Wildfire. Available at: http://www.state.hi.us/dlnr/dofaw/pubs/KFRproposal-03.27.0761_full.pdf

Department of Planning and Permitting (DPP), City and County of Honolulu. 1999. Ko'olau Loa Sustainable Communities Plan. Honolulu, HI. Available at: http://www.honoluludpp.org/planning/DevSust_Koolauloa.asp. Accessed November 2, 2008.

DesRochers, David W., Michael D. Silbernagle, Aaron Nadig, J. Michael Reed. 2006. Improving population estimates of Hawaiian Moorhen *(Gallinula chloropus sandvicensis)* with call response surveys and banding data, unpublished.

Dobson AF. and Madeiros J. 2009. Threats facing bermuda's breeding seabirds: measures to assist future breeding success. Proceedings of the Fourth International Partners in Flight Conference Tundra to Tropics pp 223-226.

Drever, M.C., A. Wins-Purdy, T.D. Nudds, and R.G. Clark. 2004. Decline of Duck Nest Success Revisited: Relationship With Predators and Wetlands in Dynamic Prairie Environments. The Auk 121(2):497-508.

Engilis, Jr., A., K.J. Uyehara, and J.G. Giffin. 2002. Hawaiian Duck (*Anas wyvilliana*). In: The Birds of North America, No. 694. (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Engilis, Jr., A. 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, OR.

Engilis, Jr., A. and T.K. Pratt. 1993. Status and Population Trends of Hawaii's Native Waterbirds, 1977-1987. Wilson Bulletin 105:142-158.

Erickson, W.P. 2003. Updated Information Regarding Bird and Bat Mortality and Risk at New Generation Wind Projects in the West and Midwest. National Wind Coordinating Committee, Wildlife Workgroup Meeting, November 18, 2003. Resolve, Inc., Washington, D.C. Available at: http://www.nationalwind.org/events/wildlife/2003-2/presentations/erickson.pdf.

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 Publication.

Evans, K., D. Woodside and M. Bruegmann. 1994. A Survey of Endangered Waterbirds on Maui and O'ahu and Assessment of Potential Impacts to Waterbirds from the Proposed Hawaii Geothermal Project Transmission Corridor. U.S. Fish and Wildlife Services, Ecological Services. Honolulu, Hi.

FAA (Federal Aviation Administration). 2000. Obstruction marking and lighting. Advisory Circular AC 70/7460-1K, Air Traffic Airspace Management, March 2000. 31 pp.

Federal Register. 2004. Incidental Take Permit and Habitat Conservation Plan for the Kaua'i Island Utility Cooperative, Hawai'i. 69(135): 42447- 42449.

Fiedler, J. K. 2004. Assessment of bat mortality and activity at Buffalo Mountain windfarm, Eastern Tennessee. Thesis, University of Tennessee, Knoxville, USA.

Fiedler, J. K., T. H. Henry, C. P. Nicholson, and R. D. Tankersley. 2007. Results of bat and bird mortality monitoring at the expanded Buffalo Mountain windfarm, 2005. Tennessee Valley Authority, Knoxville, USA. http://www.batcon.org/windliterature

First Wind and Kaheawa Wind Power. 2007a. Kaheawa Pastures Wind Energy Generation Facility Habitat Conservation Plan 2006 Annual Report Part 1. 43pp

First Wind and Kaheawa Wind Power. 2007b. Kaheawa Pastures Wind Energy Generation Facility Habitat Conservation Plan 2006 Annual Report Part 2. 52pp

First Wind and Kaheawa Wind Power. 2008. Kaheawa Pastures Wind Energy Generation Facility Habitat Conservation Plan Year 2 HCP Implementation. 82pp

Fletcher C.H. 2009. Current Understanding of Global Sea-level Rise and Impacts in Hawai'i. Presentation by the Coastal Geology Group, accessible at: http://www.soest.hawaii.edu/coasts/sealevel/FletcherSeaLevel09_web.pps

Foote, D.E., E.L. Hill, S. Nakamura, and F. Stephens. 1972. Soil Survey of the Islands of Kaua'i, O'ahu, Maui, Moloka'i, and Lana'i, State of Hawai'i. U. S. Department of Agriculture, Soil Conservation Service.

Fullard, J.H. 2001. Auditory Sensitivity of Hawaiian Moths (Lepidoptera: Noctuidae) and Selective Predation by the Hawaiian Hoary Bat (Chiroptera: *Lasiurus cinereus semotus*) Proceedings of the Royal Society of London B. 268:1375-1380.

Garrettson, P.R., and F.C. Rohwer. 2001. "Effects of Mammalian Predator Removal on Production of Upland-Nesting Ducks in North Dakota." Journal of Wildlife Management 65(3):398–405.

Giambelluca, T., Diaz H., Timm O. 2009. Climate Variability and Change in Hawai'i. Abstract *In:* Hawai'i Conservation Conference 2009 Hawai'i in a changing climate: ecological, cultural, economic and policy challenges and solutions.

Global Energy Concepts, LLC. 2006. A Catalog of Potential Sites for Renewable Energy in Hawaii. Prepared for the State of Hawaii Department of Land and Natural Resources and the Department of Business, Economic Development, and Tourism.

Gorresen, P.M., A.C. Miles, T.M. Todd, F.J. Bonaccorso and T.J. Weller. 2008. Assessing Bat Detectability with Multiple Automated Echolocation Detectors. Journal of Mammalogy 89(1):11-17.

Gruver, J.C. 2002. Assessment of Bat Community Structure and Roosting Habitat Preferences for the Hoary Bat (Lasiurus cinereus) Near Foote Creek Rim, Wyoming. Thesis, University of Wyoming, Laramie, USA.

Gummer, H. 2003. Chick Translocation as a Method of Establishing New Surface-nesting Seabird Colonies: A Review Wellington (New Zealand) New Zealand Department of Conservation. Science Internal Series 150.

Haines, W.P., Heddle ML., WeltonP., Rubinoff DA. 2009. Recent Outbreak of the Hawaiian Koa Moth, Scotorythra paludicola (Lepidoptera: Geometridae), and a Review of Outbreaks between 1892 and 2003. Pacific Science 63(3): 349-369

Harrison, C. 1990. Seabirds of Hawaii. Natural History and Conservation. Cornell University Press, Ithaca.

Hawaii Audubon Society. 2005. Hawaii's Birds: 6th Edition. Island Heritage: Waipahu: Hawaii.

Hays, W.S.T. and S. Conant. 2007. Biology and Impacts of Pacific Island Invasive Species. 1. A Worldwide Review of Effects of the Small Indian Mongoose, *Herpestes javanicus* (Carnivora : Herpestidae). Pacific Science 61(1):3-16.

Hobdy, R.W. 2007. Biological Resources Survey for the North Shore Wind Power Project, Kahuku, Koolauloa, Hawaii. Prepared for North Shore Wind Power, LLC.

Hobdy, R.W. 2009. Biological Resources Survey for Kahuku Wind Power Project, Kahuku, Oahu, Hawaii. Prepared for First Wind Energy, LLC.

Hodges, C.S. 1994. Effects of Introduced Predators on the Survival and Fledging Success of the Endangered Hawaiian Dark-rumped Petrel (*Pterodroma phaeo-pygia sandwichensis*). M.S. thesis, Univ. of Washington, Seattle.

Hodges, C.S.N. and R.J. Nagata. 2001. Effects of Predator Control on the Survival and Breeding Success of the Endangered Hawaiian Dark-rumped Petrel. Studies in Avian Biology 22: 308-318.

Horn, J.W., E.B. Arnett, and T.H. Kunz. 2008. Behavioral Responses of Bats to Operating Wind Turbines. Journal of Wildlife Management 72(1):123-132.

Hötker, H, K.M. Thomsen, H. Jeromin. 2006. Impacts on biodiversity of exploitation of renewable energy sources: the example of birds and bats. Facts, gaps in knowledge, demands for further research, and onithological guidelines for the development of renewable energy exploitation. Michael-Otto-Institut im NABU, Bergenhusen.

Hu, D., C. Glidden, J.S. Lippert, L. Schnell, J.S. MacIvor, and J. Meisler. 2001. Habitat use and limiting factors in a population of Hawaiian Dark-romped Petrels on Mauna Loa, Hawai'i. Pages 234-242 *in* J. M. Scott, S. Conant, and C. van Riper III, eds. Ecology, conservation, and management of endemic Hawaiian birds: A vanishing avifauna. Stud. Avian BioI. 22.

Hunt, C.D. 1996. Geohydrology of Oahu, Hawaii: U.S. Geological Survey Professional Paper 1412-B. 54 p.

Hunt, C.D and E.H. De Carlo. 2000. Hydrology and Water and Sediment Quality at James Campbell National Wildlife Refuge Near Kahuku, Island of O'ahu, Hawaii. U.S. Geological Survey Water-Resources Investigations Report 99-4171.

Huso, M. 2008. Statistical properties of fatality estimators. Paper presented at NWCC Research Meeting, Milwaukee, Wisconsin. November 2008.

IPCC (Intergovermental Panel on Climate Change). 2007. 2007: Summary for Policymakers. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Jain, A.A. 2005. Bird and Bat Behavior and Mortality at a Northern Iowa Windfarm. Masters Thesis, Iowa State University. 113 pp.

Jain, A., P. Kerlinger, R. Curry, and L. Slobodnik. 2007. Annual report for the Maple Ridge wind power project post-construction bird and bat fatality study–2006. Annual report prepared for PPM Energy and Horizon Energy, Curry and Kerlinger LLC, Cape May Point, New Jersey, USA. ,http://www.batcon.org/windliterature.

Jacobs, D.S. 1994. Distribution and Abundance of the Endangered Hawaiian Hoary Bat, *Lasiurus cinereus semotus*, on the Island of Hawaii. Pacific Science 48(2): 193–200.

Janss, G.F.E. 2000. Avian mortality from power lines: a morphologic approach of a species-specific mortality. Biological Conservation 95:353-359.

Jensen, P. 1989. Archaeological Inventory Survey, Punamano and Malaekahana Golf Courses. Lands of Ulupehupehu, Punaluu, Kahuku, Malaekahana, and Laie Koolauloa District, Island of Oahu. Paul H. Rosendahl, Ph.D., Inc., Report 483-040489. Prepared for Kuilima Resort Company, Honolulu, Hawaii.

Johnson, G. D. 2005. A Review of Bat Mortality at Wind-energy Developments in the United States. Bat Research News 46:45-49.

Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd and D.A. Shepherd. 2000. Final Report, Avian Monitoring Studies at the Buffalo Ridge, Minnesota Wind Resource Area: Results of a 4-year study. Prepared for Northern States Power Company, Minneapolis, by Western Ecosystems Technology, Inc.

Johnson, G.D., W.P. Erickson, M.D Strickland 2003a. Mortality of Bats at a Large-scale Wind Power Development at Buffalo Ridge, Minnesota. American Midland Naturalist 150(2):332-342.

Johnson, G.D., W.P. Erickson, and M.D. Strickland. 2003b. What is Known and Not Known About Bat Collision Mortality at Windplants? In: Carlton, R. L. (ed.), Proc. Workshop on Avian Interactions at Wind Turbines, 16-17 October, 2002, Jackson Hole, WY. Electric Power Research Inst., Palo Alto, CA.

Johnson, G. D., M. K. Perlik, W. P. Erickson, and M. D. Strickland. 2004. Bat activity, composition, and collision mortality at a large wind plant in Minnesota. Wildlife Society Bulletin 32:1278–1288.

Joyce, T., Zaun, B., Kuhn, D. and Holmes, N. 2008. A seabird social attraction project at Kilauea Point National Wildlife Refuge. Abstract from the 16th Hawaii Conservation Conference, 2008. http://hawaii.conference-services.net/resources/337/1232/pdf/HCC16_0225.pdf

Juvik, S.P. and J.O. Juvik. 1998. Atlas of Hawai'i, Third edition. University of Hawai'i Press: Honolulu, HI. 333 pp.

Kaheawa Wind Power, LLC. 2006. Kaheawa Pastures Wind Energy Generation Facility Habitat Conservation Plan. Ukumehame, Maui, Hawai'i.

Kaheawa Wind Power, LLC. 2008a. Kaheawa Pastures Wind Energy Generation Facility Habitat Conservation Plan, Year 2 HCP Implementation (July, 2007 – June, 2008).

Kaheawa Wind Power, LLC. 2008b. KWP I and KWP II Acoustic Monitoring of Bat Activity. Unpublished report.

Kaheawa Wind Power, LLC. 2009. Kaheawa Pastures Wind Energy Generation Facility, Habitat Conservation Plan: Year 3 Annual Report. First Wind Energy, LLC, Environmental Affairs, Boston, MA 02111.

Kennedy, J. 1989. Archaeological Assessment & Reevaluation Report Concerning the Recently Surveyed, Proposed Punamano Golf Course; A Portion of the Country Courses at Kahuku (TMK:1- 5-6-05, -7-01). Archaeological Consultants of Hawaii, Haleiwa, Hawaii. Prepared for Mr. William Wanket, Honolulu, Hawaii.

Kepler, C.B. and J.M. Scott. 1990. Notes on the Distribution and Behavior of the Endangered Hawaiian Hoary Bat (*Lasiurus cinereus semotus*), 1964–1983. Elepaio 50: 59-64.

Kerlinger, P. and J. Guarnaccia. 2005. Avian Risk Assessment for the Kenedy Wind Project, Kenedy County, Texas. Report Prepared for Superior Renewable Energy. Curry & Kerlinger, Cape May Point, New Jersey.

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: Arnett, E.B., editor. 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, Texas, USA. ,http://www.batcon.org/windliterature. Accessed 1 Sep 2007.

Kingsley, A., and B. Whittam. 2007. Wind Turbines and Birds: A Background Review for Environmental Assessment, Draft. Canadian Wildlife Service, Environment Canada, Gatineau, Quebec.

Koford, R., A. Jain, G. Zenner and A. Hancock. 2004. Avian Mortality Associated with the Top of Iowa Wind Farm: Progress Report, Calendar Year 2003. Iowa Cooperative Fish and Wildlife Research Unit, Iowa State University, Ames, Iowa. 9pp.

Kunz, T.H., E.B. Arnett, B.M. Cooper, W.P. Erickson, R.P. Larkin, T. Mabee, M.L. Morrison, M.D. Strickland, and J.M. Szewczak. 2007. Assessing Impacts of Wind-energy Development on Nocturnally Active Birds and Bats: A Guidance Document. Journal of Wildlife Management 71: 2449–2486.

Kusao & Kurahashi, Inc. 2003. Appendix IX: Plan for Handling Downed Wedge-Tailed Shearwaters. Special Management Area Use and Shoreline Setback Variance Permit Application and Final Environmental Assessment for Turtle Bay Resort.

Kushlan, J.A., M.J. Steinkamp, K.C. Parsons, J. Capp, M.A. Cruz, M. Coulter, I. Davidson, L. Dickson, N. Edelson, R. Elliot, R.M. Erwin, S. Hatch, S. Kress, R. Milko, S. Miller, K. Mills, R. Paul, R. Phillips, J. E. Saliva, B. Sydeman, J. Trapp, J. Wheeler, and K. Wohl. 2002. Waterbird Conservation for the Americas: The North American Waterbird Conservation Plan, Version 1. Waterbird Conservation for the Americas, Washington, DC.

Lau, L.S. and J.F. Mink. 2006. Hydrology of the Hawaiian Islands. University of Hawai'i Press, Honolulu.

Macdonald, G.A. and A.T. Abbott. 1970. Volcanoes in the Sea. University of Hawai'i Press, Honolulu. 441 pp.

Martin, E.M. and P.I. Padding. 2002. Preliminary Estimates of Waterfowl Harvest and Hunter Activity in the United States During the 2001 Hunting Season. United States Fish and Wildlife Service Division of Migratory Bird Management, Laurel, Maryland.

Menard, T. 2001. Activity Patters of the Hawaiian Hoary Bat (*Lasiurus cinereus semotus*) in Relation to Reproductive Time Periods. Masters thesis, Univ. of Hawaii, Hawaii.

Miller, J.A., R.L. Whitehead, D.S. Oki, S.B. Gingerich, and P.G. Olcott. 1999. Ground Water Atlas of the United States. Segment 13, Alaska, Hawaii, Puerto Rico, and the U.S. Virgin Islands. U.S. Geological Survey.

Mineau, P. 2005. Direct Losses of Birds to Pesticides–Beginnings of a Quantification. Vol. 2. Pages 1065–1070 in C.J. Ralph and T.D. Rich (eds.). Bird Conservation Implementation and Integration in the Americas: Proceedings of the Third International Partners in Flight Conference, March 20–24, 2002, Asilomar, California. USDA Forest Service General Technical Report PSW-GTR-191.

Mink, J.F. 1982. Koolauloa Water Resources Assessment. Board of Water Supply.

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, HI. Available at: http://www.state.hi.us/dlnr/DLNR/cwcs/index.html. Accessed August 21, 2008.

Moore, J.G. 1964. Giant Submarine Landsides on the Hawaiian Ridge. United States Geological Survey Professional Paper 501-D:95-98.

Mostello, C.S. 1996. Diets of the Pueo, Barn Owl, the Cat, and the Mongoose in Hawai'i: Evidence for Competition. Masters Thesis, University of Hawaii at Manoa.

Mounce, H.L. 2008. What threat do native avian predators pose to Hawaiian Honeycreepers? Two case of predation by Pueo (*Asio flammeus sandwichensis*). 'Elepaio 68:19-26.

Nagata, S.E. 1983. Status of the Hawaiian Gallinule on Lotus Farms and a Marsh on Oahu, Hawaii. M.Sc. Thesis, Colorado State University, Fort Collins, Colorado.

National Oceanic and Atmospheric Administration (NOAA). 2002. Climatography of the United States No. 81 Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days, 1971 – 2000, 51 Hawaii. National Climatic Data Center Asheville, North Carolina. 21 pp.

National Wind Coordination Collaborative (NWCC). 2004. Wind Turbine Interactions with Birds and Bats: A Summary of Research Results and Remaining Questions. Fact Sheet: Second Edition. 7 pp.

NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: December 24, 2008).

NESH Working Group 2005. DRAFT Newell's Shearwater Five-year Workplan. http://state.hi.us/dlnr/DLNR/fbrp/docs/NESH_5yrPlan_Sept2005.pdf

Nishibayashi, E. 1997. Downed Wildlife Survey at Six Leeward West Maui Wind Monitoring Towers. Unpublished report prepared for Zond Pacific, Inc., Wailuku, HI, by Eric Nishibayashi Biological Consulting, Kahului, HI. 11 pp.

Nordström, M., J. Högmander, J. Munnelin, N. Laanetu, and E. Korpimäki. 2002. Variable responses of waterfowl breeding populations to long-term removal of introduced American mink. Ecography 25: 385-394.

Percival, S.W. 2003. Birds and Wind Farms in Ireland: A Review of Potential Issues and Impact Assessment. 25 pp.

Pitman, R.L. 1986. Atlas of Seabird Distribution and Relative Abundance in the Eastern Tropical Pacific. La Jolla, California: NOAA, NMFS, Southwest Fisheries Center Administrative Report LJ-86-02C

Podolsky, R.H. 1990. Effectiveness of social stimuli in attracting Laysan Albatross to new potential nesting sites. The Auk 107 (1): 119-125.

Podolsky, R. and S.W. Kress. 1992. Attraction of the endangered Dark-rumped Petrel to recorded vocalizations in the Galápagos Islands. The Condor 94: 448-453.

Podolsky, R., D.G. Ainley, G. Spencer, L. DeForest, and N. Nur. 1998. Mortality of Newell's Shearwaters Caused by Collisions with Urban Structures on Kaua'i. Colonial Waterbirds 21: 20–34.

Polhemus, D.A., J. Maciolek and J. Ford. 1992. An ecosystem classification of inland waters for the tropical Pacific Islands. Micronesica 25: 155-173.

Polhemus, D.A. 2007. Biology Recapitulates Geology: the Distribution of Megalagrion Damselflies on the Ko'olau Volcano of O'ahu, Hawai'i. In N.L. Evenhuis & J.M. Fitzsimons (ed.): Bishop Museum Bulletin in Cultural and Environmental Studies 3:233-246.

Polhemus, J.T. and D.G. Smith. 2005. Update on Nesting Activity and Habitat Utilization by Native Waterbirds at the Hamakua Marsh State Wildlife Sanctuary, Kailua, O'ahu. Elepaio 65(3):17-21

Pratt, T. K. 1988. Recent observations, March-May 1988. 'Elepaio 48:65–66.

Pratt, H.D., P.L. Bruner, and D.G. Berrett. 1987. The Birds of Hawaii and the Tropical Pacific. Princeton University Press, Princeton, NJ.

Rauzon, M.J. and D.C. Drigot. 2002. "Red mangrove eradication and pickleweed control in a Hawaiian wetland, waterbird responses, and lessons learned," in Turning the Tide: The Eradication of Invasive Species, edited by C.R. Veitch and M.N. Clout, Occasional Paper of the IUCN Species Survival Commission No. 27, IUCN – The World Conservation Union, Gland, Switzerland.

Rechtman Consulting, LLC. 2008. An Archaeological Inventory Plan for the First Wind Kahuku Project Area (TMK:1-5-6-05:007). Prepared by M.R. Clark and R.B. Rechtman. Prepared for First Wind.

Rechtman, B. 2009. A Comprehensive Archaeological Survey of the First Wind Kahuku Wind Power Project Area in Compliance with Section 106 of the National Historic Preservation Act, Kahuku Ahupua'a, Ko'olauloa District, Island of O'ahu. Prepared by Rechtman Consulting, LLC. Hilo. Hawaii.

Reed, J.M., C.S. Elphick, and L.W. Oring. 1998. Life-history and Viability Analysis of the Endangered Hawaiian Stilt. Biological Conservation 84:35-45.

Reynolds, M.H. and G.L. Richotte. 1997. Evidence of Newell's Shearwater breeding in Puna District, Hawaii. Journal of Field Ornithology 68:26-32.

Reynolds, M.H., B.A. Cooper, and R.H. Day. 1997. Radar study of seabirds and bats on windward Hawaii. Pacific Science 51: 97-106.

Richardson, F. and D.H. Woodside. 1954. Rediscovery of the nesting of the Dark-rumped Petrel in the Hawaiian Islands. Condor 56: 323-327.

Robinson, J.A., J.M. Reed, J.P. Skorupa, and L.W. Oring. 1999. Black-necked Stilt (*Himantopus mexicanus*). In The Birds of North America, No. 449. (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Schwartz, C.W. and E.R. Schwartz. 1949. A Reconnaissance of the Game Birds in Hawaii. Board of Commissioners of Agriculture and Forestry, Division of Fish and Game, Territory of Hawaii, Hilo.

Scowcroft, PG. and Giffin, JG. 1983. Feral herbivores suppress mamane and other browse species on Mauna Kea. Journal of Range Management 36: 638-645

SIMONS, T.R. 1983. Biology and conservation of the endangered Dark-rumped Petrel (*Pterodroma phaeopygia sandwichensis*). CPSU/UW83-2. Seattle: National Park Service, Cooperative Park Studies Unit, University of Washington, Seattle.

Simons, T.R. 1984. A population model of the endangered Hawaiian dark-rumped petrel. J. Wildl. Mgmt. 48(4) 1065-1076.

Simons, T.R. 1985. Biology and behavior of the endangered Hawaiian Dark-rumped Petrel. Condor 87:229-245.

Simons, T. R., and C. N. Hodges. 1998. Dark-rumped Petrel (Pterodroma phaeopygia). In The Birds of North America, No. 345 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Smith D.G., and J.T. Polhemus. 2003. Habitat Use and Nesting Activity by the Hawaiian Stilt (*Himanotopus mexicanus knudseni*) and Hawaiian Moorhen (*Gallinula chloropus sandvicensis*) at the Hamakua Marsh State Wildlife Sanctuary, Kailua, O‘ahu. ‘Elepaio 63(8):59-62.

Smith, D.G., J.T. Polhemus, and E.A. VanderWerf. 2002. Comparison of Managed and Unmanaged Wedge-tailed Shearwater Colonies on Oahu: Effects of Predation. Pacific Science 56: 451-457.

Smith, Young & Assoc. 1990. Appendix A. Engineering Studies – The County Courses at Kahuku, Punamano Site. Final EIS, Volume II, The County Courses at Kahuku (Punamano), Kahuku, O‘ahu. Prepared for the Estate of James Campbell.

Snetsinger, T.J., S.G. Fancy, J.C. Simon, and J.D. Jacobi. 1994. Diets of Owls and Feral Cats in Hawai‘i. ‘Elepaio 54:47-50.

Spear, L.B., D.G. Ainley, N. Nur, S.N.G. Howell, S.N.G. 1995. Population size and factors affecting at-sea distributions of four endangered *procellariids* in the tropical Pacific. Condor 97:613-638.

Stantec Consulting Ltd. 2007. Environmental Review Report for Wolfe Island Wind Project. Kingston, Ontario.

State of Hawaii and U.S. Department of Energy (USDOE). 2008. Memorandum of Understanding Between the State of Hawaii and the U.S. Department of Energy. Available at: http://hawaii.gov/dbedt/info/energy/hcei/hawaii_mou.pdf. Accessed November 3, 2008.
Stearns, H. T. and K. N. Vacsik. 1932. Geology and Ground-water Resources of the Island of O‘ahu, Hawaii. Bulletin No. 7, Hawaii Division of Hydrography, Honolulu 363 pp.

Stone, C.P. 1985. Alien Animals in Hawaii's Native Ecosystems: Toward Controlling the Adverse Effects of Introduced Vertebrates. Pages 251-297 in C.P. Stone and J.M. Scott (eds), Hawaii's Terrestrial Ecosystems: Preservation and Management. University of Hawaii Cooperative Resources Studies Unit, University of Hawaii Press, Honolulu.

Stone, C.P., L.W. Cuddihy, and J.T. Tunison. 1992. Responses of Hawaiian Ecosystems to the Removal of Feral Pigs and Goats. Pages 666-704 In: C.P. Stone, C.W. Smith, and J.T. Tunison (eds.), Alien Plant Invasions in Native Ecosystems of Hawaii: Management and Research. Cooperative National Park Resources Studies Unit, University of Hawaii, Honolulu. 887 pages.

Stride, M., T. Craddock, and H. Hammatt. 2003. Archaeological Inventory Survey of the Proposed 785-Acre Kahuku Agricultural Park (TMK:1-5-6-8:2). Cultural Surveys Hawaii, Inc. Prepared for M and E Pacific, Inc.

SWCA Environmental Consultants (SWCA). 2008. First Wind Kahuku Wind Farm Jurisdictional Wetland Determination Study.

SWCA Environmental Consultants (SWCA) and First Wind. 2008. Kahuku Wind Power Wildlife Monitoring Report and Fatality Estimates for Waterbirds and Bats (October 2007 – October 2008).

Swindle, Keith. Veterinarian, USFWS. Personal communication.

Szewczak, J. M., and E.B. Arnett. 2006. Ultrasound emissions from wind turbines as a potential attractant to bats: a preliminary investigation. An investigative report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, Texas, USA.

Szewczak J.M. and Arnett E. 2009. Ultrasound emissions from wind turbines as a potential attractant to bats: a preliminary investigation.

Taylor, G.A. 2000a. Action plan for seabird conservation in New Zealand. Part A: threatened seabirds. *Threatened Species Occasional Publication 16*. Department of Conservation, Wellington, New Zealand. 234 p.

Taylor, G.A. 2000b. Action plan for seabird conservation in New Zealand. Part B: non-threatened seabirds. *Threatened Species Occasional Publication 17*. Department of Conservation, Wellington, New Zealand. 199 p.

Telfair, R.C., II. 1994. Cattle Egret (*Bulbulcus ibis*). In: The Birds of North America, No. 113. (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Telfer, T.C. 1986. Newell's shearwater nesting colony establishment study on the island of Kauai. Final Report, Statewide Pittman-Robertson Program. Department of Lands and Natural Resources, State of Hawaii, Honolulu, HI.

Telfer, T.C., J.L. Sincock, G.V. Byrd, and J.R. Reed. 1987. Attraction of Hawaiian Seabirds to Lights: Conservation Efforts and Effects of Moon Phase. Wildlife Society Bulletin 15:406–413.

Tetra Tech EC, Inc. 2008. Draft Environmental Assessment For Issuance of an Endangered Species Act Section 10 (a)(1)(B) Permit for the Incidental Take of Listed Species for the Lanai Meteorological Towers Project. Castle & Cooke Resorts, LLC. Prepared for U.S. Fish & Wildlife Service.

Thierry, M.W. and J. Hale. 1996. Causes of Owl Mortality in Hawaii, 1992 to 1994. Journal of Wildlife Diseases 32(2): 266-273.

Tomich, P.Q. 1969. Mammals in Hawaii: A Synopsis and Notational Bibliography. B.P. Bishop Museum, Honolulu, HI. Spec. Pub. 57. 238 pp.

U.S. Climate Change Science Program 2009. Climate and Coasts. Abstract *In:* Hawai'i Conservation Conference 2009 Hawai'i in a changing climate: ecological, cultural, economic and policy challenges and solutions.

U.S. Department of Wind Energy. 2008. 20% Wind Energy by 2030: Increasing Wind Energy's Contribution to U.S. Electricity Supply. Available at http://www.20percentwind.org/Final_DOE_Executive_Summary.pdf. Accessed September 5, 2008.

USFWS. 1983. Hawaiian Dark-Rumped Petrel and Newell's Manx Shearwater Recovery Plan. U.S. Fish and Wildlife Service, Portland, OR. 57 pp.

USFWS. 1998. Recovery Plan for the Hawaiian Hoary Bat *(Lasiurus cinereus semotus*). U.S. Fish and Wildlife Service, Portland, OR.

USFWS. 2000. Notice of Availability of a Final Addendum to the Handbook for Habitat Conservation Planninng and Incidental Take Permitting Process. Federal Register 65(106):35242-35257

USFWS. 2002. O'ahu National Wildlife Refuge Complex. Annual Narrative Report Calendar Year 2002. Honolulu, HI.

USFWS. 2003. Interim Voluntary Guidelines to Avoid and Minimize Wildlife Impacts from Wind Turbines. Available at: http://www.fws.gov/habitatconservation/wind.html. Accessed March 20, 2009.

USFWS. 2005a. Draft Revised Recovery Plan for Hawaiian Waterbirds, Second Draft of Second Revision. U.S. Fish and Wildlife Service, Portland, OR.

USFWS. 2005b. Regional Seabird Conservation Plan, Pacific Region. U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region, Portland, OR.

USFWS. 2007. City and County of Honolulu Conditional Use Permit Application No. 2007/CUP-141 for UPC Wind Farm, Kahuku, Oahu, Hawaii. Letter to City and County of Honolulu, Department of Planning and Permitting.

USFWS. 2008. Draft Environmental Assessment for Fencing of the Kona Forest Unit of the Hakalau Forest National Wildlife Refuge Hawai'i County, Hawai'i. South Kona District Hawai'i County, Hawai'i.

USFWS and National Marine Fisheries Service (NMFS). 1996. Habitat Conservation Planning and Incidental Take Permit Processing Handbook.

Uyehara, K.J., A. Engilis, Jr., and M. Reynolds. 2007. Hawaiian Duck's Future Threatened by Feral Mallards. U.S. Geological Survey Fact Sheet 2007-3047. Available at: http://pubs.usgs.gov/fs/2007/3047/. Accessed June 20, 2008.

Uyehara, K.J., A. Engilis, B.D. Dugger. 2008. Wetland Features That Influence Occupancy by the Endangered Hawaiian Duck. The Wilson Journal of Ornithology 120(2):311–319.

VanderWerf, E.A., K.R. Wood, C. Swenson, M. LeGrande, H. Eijzenga, and R.L. Walker. 2007. Avifauna of Lehua Islet, Hawai'i: Conservation Value and Management Needs. Pacific Science 61:39-52.

Webster, P.J., G.J. Holland, J.A. Curry, and H.R. Chang. 2005. Changes in Tropical Cyclone Number, Duration, and Intensity in a Warming Environment. Science 309(5742):1844-1846.

Whitaker, J.O. and P.Q. Tomich. 1983. Food Habits of the Hoary Bat *Lasiurus cinereus,* from Hawaii. Journal of Mammalogy 64:151-52.

Whitton, G.C. 1997. Wedge-tailed Shearwater (*Puffinus pacificus*). In: The Birds of North America, No. 305. (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

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.eres.library.manoa.hawaii.edu/bna/species/062doi:10.2173/bna.62

Winter, L. 2003. Popoki and Hawai'i's native birds. 'Elepaio 63:43-46.

Woodlot Alternatives, Inc. 2003. An Assessment of Factors Associated with Avian Mortality at Communications Towers – A Review of Existing Scientific Literature and Incidental Observations. Technical comments prepared in response to the August 20, 2003, Notice of Inquiry Issued by the Federal Communications Commission (FCC) WT docket No. 03-187.

Zimmerman. N., Hughes, RF., Cordell, S., Hart, P., Chang, HK., Perez, D., Like, RK. and Ostertag, R. 2008. Patterns of primary succession of native and introduced plants in lowland wet forests in eastern Hawaii. Biotropica 40: 277-284.