MĀNĀ PLAIN WETLAND RESTORATION

Phase II: Soil Sampling for the Hydrological Assessment

Mana Wetland Restoration Design





Prepared by:

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On Behalf of:

State of Hawaii Division of Forestry and Wildlife,
PAHIO Development, Inc.,
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Report Prepared for:

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INTRODUCTION

Wetland restoration of the island of Kaua'i is a high priority for the recovery of endangered waterbirds due to its abundant supply of water, lack of introduced mongoose that prey on endemic waterbirds, and the presence of genetically pure Hawaiian ducks (*Anas wyvilliana*) on the island. This project will restore and enhance a total of 141 acres; of which approximately 116 acres are palustrine emergent wetlands and 25 acres are coastal strand and sand dune habitats. This represents a 45% percent increase in the area of existing wetland and aquatic habitats available to native wildlife. The quality of restored managed wetlands will also be higher than existing aquatic habitats.

Prior planning for the Mānā Plain Wetland Restoration project identified the need to collect additional information on site-specific soil characteristics and site-specific hydrologic characteristics. With the assistance of Leigh Fredrickson, I organized a multi-agency, inter-disciplinary team of biologists, wetland ecologists, and soil scientists to assist with the wetland design by evaluating abiotic conditions at the Mānā Plain Wetland Restoration site during the week of June 8, 2009.

The purpose of the multi-disciplinary site-visit during June 2009 was to collect information on soil strata and texture within the restoration area to evaluate how water will move through the system. This sampling, combined with other known biotic and abiotic factors (e.g., groundwater levels, water chemistry, etc), at the site will enable the restoration group to identify an effective design for the restored wetlands. Sharing this information with DOFAW, USFWS, and other interested organizations within Hawai'i will build capacity and advance wetland restoration in the Hawaiian Islands.

Objectives

The objectives of this project are to:

1. Sample soil profile characteristics throughout the proposed restoration area to qualitatively assess how the soils in project area will affect hydrology and restored wetlands.
2. Develop a draft restoration design based on soil data collected integrated with existing information.
3. Complete a wetland delineation of the proposed restoration area.
4. Provide updated soil information for NRCS soil survey.
5. Share methods and results with interested individuals during a ½ day workshop at the Mānā Plain Wetland Restoration site.

TEAM MEMBERS

The team brought together specialists with expertise in wetland restoration and ecology, soils, and wetland construction throughout Hawaii and the continental United States. Team members included:

- Thomas Kaiakapu, Kauai District Manager, DOFAW, Lihue, HI (island of Kauaʻi)
- Jason Vercelli, Biologist, DOFAW, Lihue, HI (island of Kauaʻi)
- Greg Koob, Biologist/Botanist, NRCS, Honolulu, HI (island of Oʻahu)
- Tony Rolfes, Soil Scientist, NRCS, Honolulu, HI (island of Oʻahu)
- Patrick Neimeyer, Soil Scientist, NRCS, Waimea, HI (Big Island)
- Leigh Fredrickson, Senior Wetland Ecologist, WETMES, Inc., Puxico, MO (Dr. Fredrickson is also an Emeritus Professor at the University of Missouri and Adjunct Professor at South Dakota State University)
- John Vradenburg, Land Management Research and Demonstration (LMRD) Program Biologist, Bosque del Apache NWR, USFWS Refuges Region 2
- Dennis Vicente, Heavy Equipment Operator, Bosque del Apache NWR, USFWS Refuges Region 2
- Chadd Smith, Equipment Operator, Kauai NWR Complex, USFWS Refuges, Region 1
- Adonia Henry, Biologist/Wetland Ecologist, USFWS PIFWO Conservation Partnerships Program, USFWS Region 1
- J. Rubey, Coordinator, Hawaii Wetland Joint Venture (a branch of the Pacific Coast Joint Venture)
- Ray Finocchiaro, Wetland Ecologist and Soil Scientist, USGS Northern Prairie Wildlife Research Center, North Dakota (unable to attend site visit, provided technical assistance by phone).

ACCOMPLISHMENTS BY OBJECTIVE

Objective 1: Sample soil profile characteristics throughout the proposed restoration area to qualitatively assess how the soils in project area will affect hydrology and restored wetlands.

We sampled soils at 60 locations throughout the Mānā Plain Wetland Restoration site (see Figure 1). Within the proposed wetland restoration area, soil augers were used to collect soil profiles beginning at the soil surface. Successive soil samples were taken down through the soil until the water table was reached. Soil color and texture were described for each soil sample. The depth below the surface was recorded for each sample, including each change in soil color/texture, capillary fringe, and water table. Soil profiles were also collected along abandoned irrigation ditches to determine if ditches intersected sand or other course texture soil layers.

The surface soils throughout the restoration area were characterized by clay loam; the depth of clay loam averaged 30 inches (76 cm) and ranged 16–58 inches (41–147 cm) below the surface). A layer of sandy clay loam or silty loam was located beneath the clay loam. Further down in the soil profile, most samples contained a layer of sandy loam above a layer of dense fine clay or silty clay loam (Figure 2).

The depth to the water tabled averaged 40 inches (101 cm) below the surface and ranged from 24 to 58 inches (61 to 147 cm). This is similar to data that has been collected during the dry season from 14 ground water wells since 2005. Based on year-long data from ground water wells, the depths to the water table vary seasonally. Most changes occur during the rainy season (November–April) when ground water levels raise in response to increased precipitation inputs.

Figure 1. Soil sampling during June 2009 at the Mānā Plain Wetland Restoration site, island of Kaua‘i.

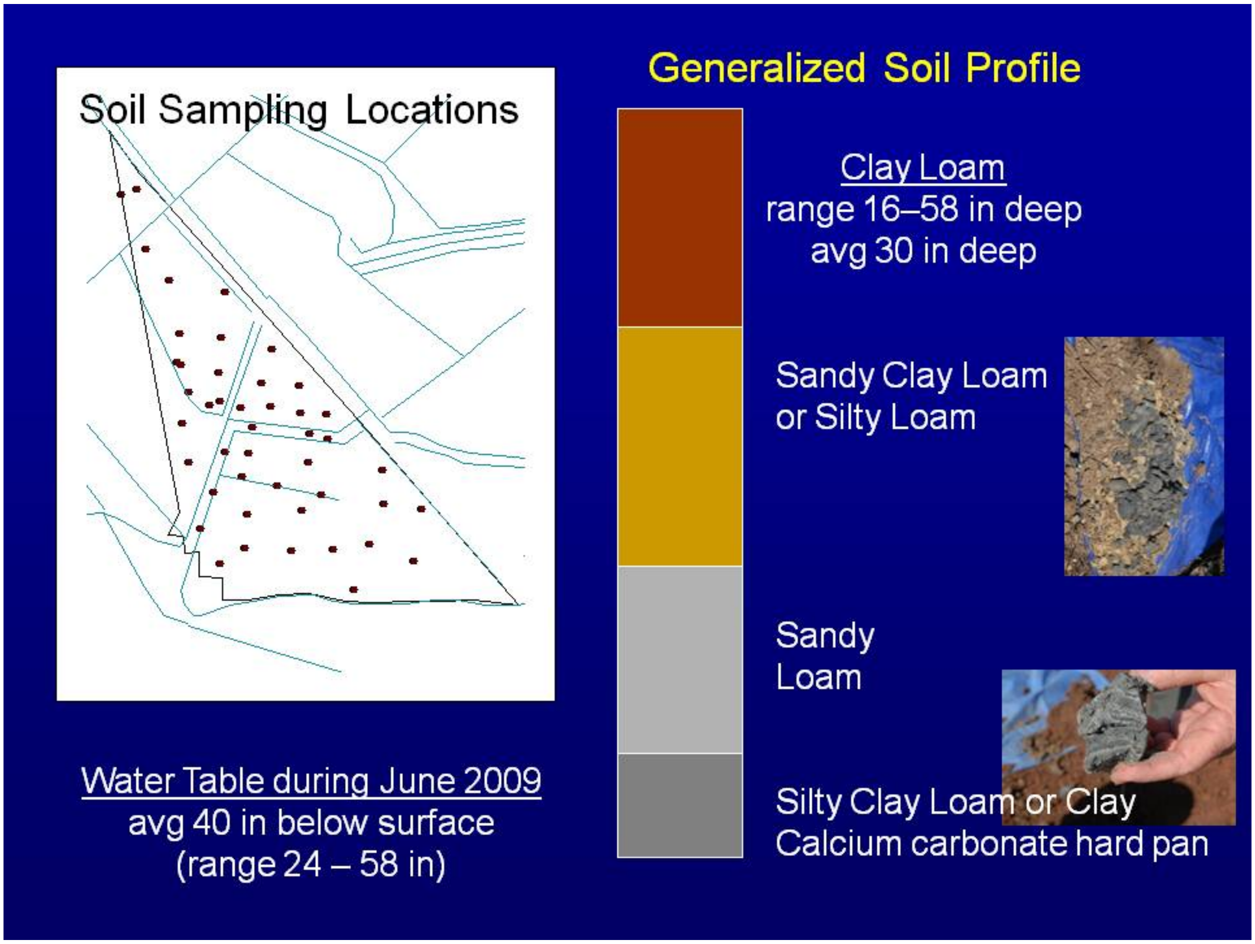

Figure 2. Generalized soil profiles sampled during June 2009 at the Mānā Plain Wetland Restoration Site, island of Kaua‘i.

Objective 2: Develop a draft restoration design based on soil data collected.

Based on the depth and textures of soil layers and other existing information, the location, size, and shape of restored wetland basins (Figure 3) was identified in relation to the distribution and availability of soils capable of holding water (e.g. clay loams). John Vradenburg and Dennis Vicente from Bosque del Apache applied their experience making decisions about levee placement and developing an area to maximize wetland benefits (Figure 4).

Compared to previous draft designs, the number of wetland impoundments was reduced and the size of wetland impoundments was increased due to soil profiles at the site. These changes were made in order to minimize the need for tight-textured soils during construction and reduce the amount of material to be excavated from the site. This design criteria is necessary due to the presence of a course textured sandy layer toward the current water table; excavation of soils will remain within the clay loam surface layer and will not penetrate the course textured soil layers. This will conserve water needed for wetland management by reducing the amount of water that could infiltrate quickly from course textured materials. This will also help to reduce construction costs.

Redesigned levees follow the natural contours to the maximum extent possible in order to take advantage of natural topographic rises within the restoration area. Water inflow and outflow locations (see Figure 3) were identified based on topography and experience with water-level management at Bosque del Apache and Hule‘ia National Wildlife Refuges. Independent water control for each impoundment in the wetland complex (Figure 5) will allow managers to incorporate hydrologic diversity into management prescriptions. This independence will help promote a diversity of vegetation to match the energetic and structural needs of wetland dependent wildlife.

Design also took into consideration access to wetland basins and water control structures for management activities (e.g., control of invasive vegetation). The size of proposed wetland basins ranges from 3 to 16 acres and is within the range of wetlands currently managed for endangered waterbirds endemic to Hawaii. Biological and engineering design criteria (Table 1) were refined based on results of the soil sampling.

Constructed wetlands with replace wetland habitat that has been lost, but due to hydrologic alterations, active water-level management will be used to manage wetlands suitable for foraging and nesting waterbirds. Water depths will be targeted toward preferred foraging depths of endemic and migratory waterbirds to provide resources (e.g., aquatic invertebrates and wetland vegetation) needed to meet energetic requirements for different life history stages. Shallow water (0–18 inches) will be emphasized to complement deeper water (up to 60 inches) at adjacent areas (e.g. Kawaiele Waterbird Sanctuary). Water depths between 0 and 12 inches meet preferred foraging depths for many different species of waterbirds (Table 2). Water control will also be used to facilitate control of invasive species, including species introduced vegetation and fish.

Next Steps

Soil sampling completed as a result of this project also helped to identify sites appropriate for collection of site-specific infiltration data. Single and double ring infiltration tests were subsequently conducted during October 2009 by Jason Vercelli at the Division of Forestry and Wildlife. High variation in infiltration test results among the proposed wetland restoration areas necessitated the need for construction of test ponds (10 x 20 m) that will be used for future hydrologic assessments.

The next step in the planning process is an in-depth hydrologic assessment that will include a conceptual ground-water model, water budget, and water source analysis. The hydrologic assessment will build on existing information and allow us to further refine the draft wetland restoration design. Information from the hydrologic assessment and other planning efforts will be used in the States' Environmental Assessment and will ultimately be used to create construction specifications for bid documents, implementation, and construction management.

Artist rendition of restored wetlands at the Mana Plain Wetland Restoration Project Area. Anonymously donated.

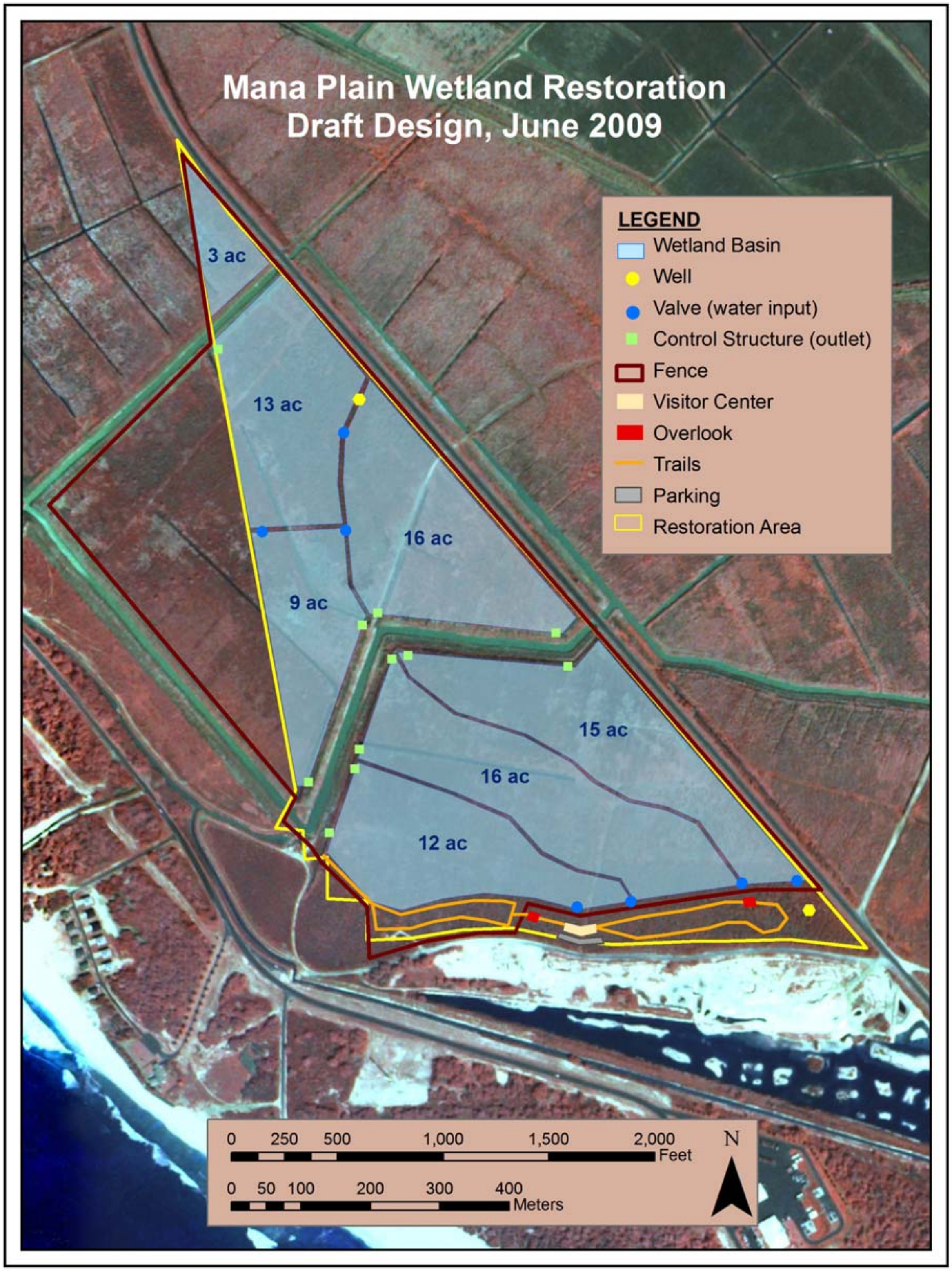

Figure 3. Revised conceptual restoration plan based on soil data collected during June 2009 at the Mānā Plain Wetland Restoration site, island of Kaua'i.

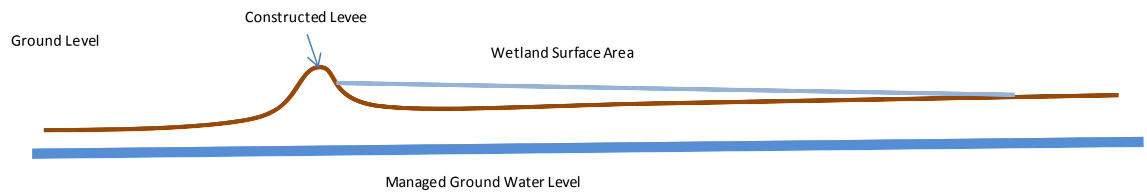

Figure 4. Conceptual cross-section of a constructed wetland impoundment at Mana Plain. Diagram courtesy of John Vradenburg, LMRD biologist Bosque del Apache NWR.

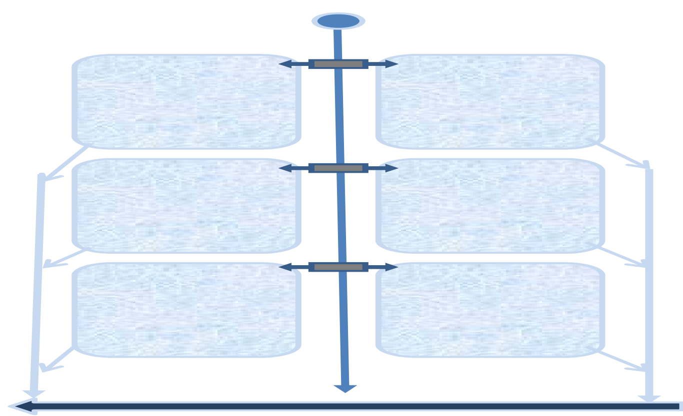

Figure 5. Conceptual inflow and outflow patterns of a constructed wetland complex with independent water control. Inflow and outflow patterns designed for Mana are shown in Figure 5. Diagram courtesy of John Vradenburg, LMRD biologist, Bosque del Apache NWR.

Table 1. Biological and engineering design criteria for the Mānā Plain Wetland Restoration, island of Kauaʻi.

Constructed Wetlands

1. Maximize wetland habitat within the 105 acre restoration area (target 90 acres of wetlands; 15 acres of coastal strand habitat and main drain).
2. Balance cut/fill.
3. Minimize berm height of constructed wetlands.
4. Do not excavate into sand horizon below clay/clay loam/silty clay loam soil on top (top layer is between 16 and 40 inches deep).
5. Do not excavate down to water table so wetlands can be drained as needed for management.
6. Utilize natural elevation patterns to reduce quantity of soil needed for berms.
7. Constructed wetland size between 5 and 20 acres (flexible depending on need to balance cut/fill).
8. More than 5 constructed wetlands to allow to variable management among wetlands.
9. Curved or irregular shaped wetlands preferable to maximize edge habitat.
10. Slope of wetland basins between 1:5 and 1:15 (not hard and fast, can be changed as needed).
11. Use micro-topography within each constructed wetland to increase habitat heterogeneity.
12. Equipment access to wetlands along berms (i.e., 15 ft wide).

Water Source/Delivery

13. Ground water and/or agricultural runoff water (surface water) most viable options at this point; irrigation water used for agriculture not viable because it is off-site.
14. Water delivery will prevent the introduction of invasive fish.
15. Allow for release of invasive fish that get into wetlands (e.g., after flood event, by human dumping, etc).
16. Salinity of source water should be between 0 and 8 ppt (if salinity is higher, need to discuss water-level management options to reduce salt build-up).
17. Independent water control for each wetland.
18. Outlet structures capable of controlling water levels in 1 or 2 inch increments.
19. Inlet and outlet structures accessible from berms or other dry land.
20. Inflows capable of maintaining flow-through system in order to prevent the build-up of salt.
21. Ability to drain a wetland in 2 days if needed to manage botulism outbreak.
22. Ability to gradually drain a wetland (e.g. over 2–4 weeks) for habitat and/or waterbird management.
23. Desired water depths 0–24 inches (0–18 inches is suitable).
24. Maximize areas of 0–12 inches water for Hawaiian stilts and Hawaiian ducks.
25. Do not increase flooding risk to highway or surrounding landowners.
26. Allow water to sheet flow into constructed wetlands during flood events.
27. Do not increase velocity of water in main drains by building high berms; allow water from main drains to flood into constructed wetlands during flood events (e.g., one-way control gates, berm set-backs, other).

Water level management (will be rotated among constructed wetlands as much as possible)

28. Spring drawdown to create mudflats for nesting stilts Mar – July; gradual reflooding to 9 inches maximum after nesting to increase foraging opportunities.
29. Fall drawdown of at least 1 wetland basin with complex vegetation structure to create suitable nesting habitat (e.g., dry) for Hawaiian ducks from Dec – Mar.
30. At least 2 wetland basins will remain flooded (2 ft or less) throughout the winter for nesting coots and moorhen and foraging migratory ducks.

Revegetation/Habitat

31. Implement best management practices to reduce erosion.
32. Volunteer planting days to establish hardy species quickly.
33. Volunteer weed removal.
34. Water level management to encourage natural germination of suitable species.
35. Water level management to discourage invasive species.
36. Prevention and rapid response for invasive species not currently present (e.g. *Batis*), including cleaning of ALL equipment before entering the area during and after construction.

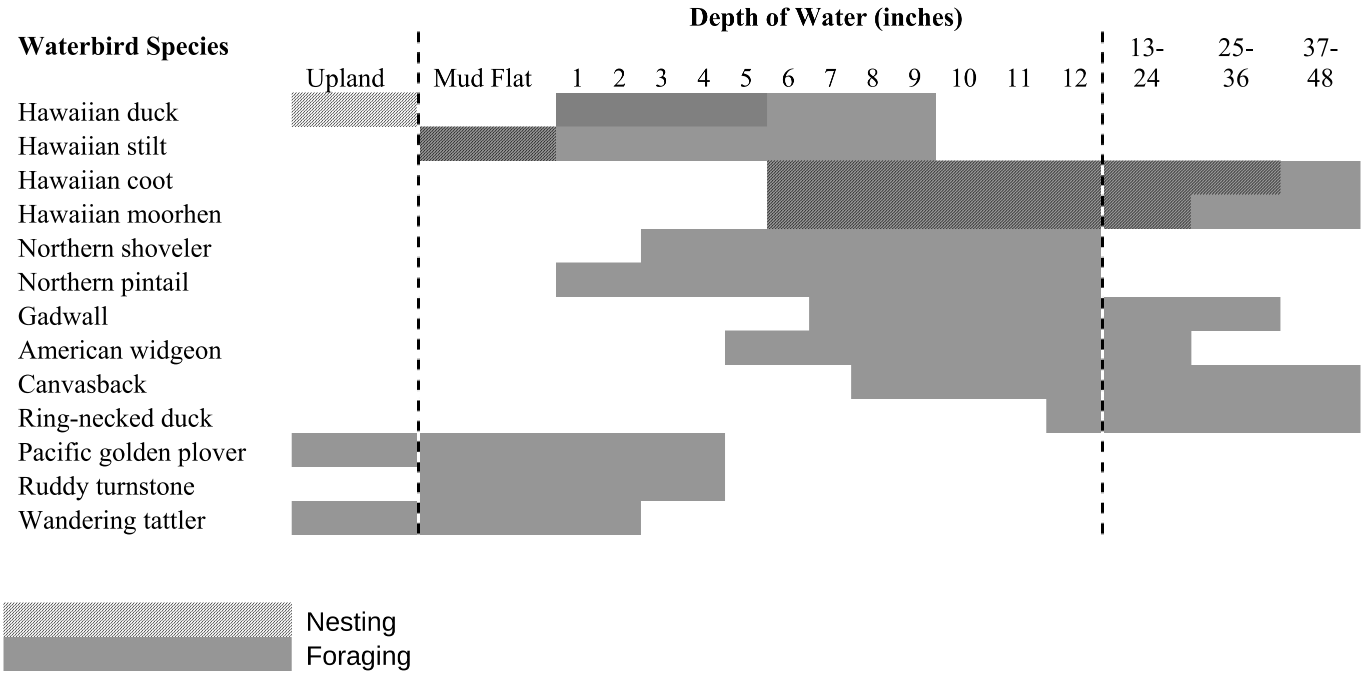

Table 2. Preferred water depths for foraging and nesting waterbirds endemic and migratory to the Hawaiian Islands. Information compiled from multiple published sources.

Hawaiian stilt

Hawaiian duck

Objective 3: Complete a wetland delineation of the proposed restoration area.

The following information is summarized from the wetland delineation report by USDA Natural Resources Conservation Service (NRCS). A copy of the full report is available from the State of Hawaii Division of Forestry and Wildlife or the USDA NRCS.

Wetland identification procedures were completed according to the *U.S. Army Corps of Engineers Wetland Delineation Manual* (Environmental Laboratory 1987) and applied the standards established in the USACE 1987 manual. Field investigations were conducted on June 2009 by staff from USDA, NRCS with assistance from the Hawai‘i Coastal Joint Venture. A routine small-area method was utilized to identify the location of wetland boundaries in areas of the 105-acre site that were not dominated by upland plant species such as koa haole (*Leucaena leucocephala*) or kiawe (*Prosopis pallida*).

An assessment of USACE hydric indicators (soils, hydrology, and vegetation) was conducted at representative locations within the project area (Figure 6). Ten sample sites were established in areas that were not dominated by upland plant species unless there were understory vegetation or hydrological indicators that suggested the possibility of a wetland. The indicator status of plants identified at the site referenced the “Wetland Status List for Hawaiian Plants” (Puttock and Imada 2004). Soil pits were dug to a depth of approximately 26 inches to evaluate indicators of wetland soils and hydrology. Parameters evaluated included soil color, texture, saturation, and other indicators of inundation. Soil colors were determined using the *Munsell Soil Color Chart* (Munsell 1998).

No wetlands were delineated within the 105-acre project site. Upland areas on this site are dominated by koa haole (UPL) with either little to no understory or with a slender mimosa (*Desmanthus pernambucanus*, FACU) understory. Other areas within the site included patches of vegetation-free areas, dead woody plants and areas dominated by herbaceous or woody layer that is FAC to FACW with species such as ‘ākulikuli (*Sesuvium portulacastrum*, FAC), Indian fleabane (*Pluchea indica*, FAC), swollen fingergrass (*Chloris barbata*, FAC) or California grass (*Urochloa mutica*, FACW). Hydrologic indicators were most often seen as sediment deposits or drift lines. The source of hydrology appears to be rainfall and associated rise of the water table.

The soils in the project area include Kaloko clay loam (Kf), Kaloko clay (Kfa) and Nohili clay (Nh). In examining the soils on this project site no hydric soil indicators were observed within the required depth from the soil surface in order to be identified as hydric soils. However, many of the soils observed did have redoximorphic features indicating saturation occurring below 12 inches and greater from the soil surface. The soil matrix colors in the upper 12 inches typically were found to be dominated by Munsel Soil Color Chart hues of 10YR3/3 and 10YR4/3 with faint or distinct redox concentrations, 10YR4/4 and 7.5YR4/4 respectively. Having these soil matrix colors with redox concentrations indicates the soils are not saturated long enough in the upper part to develop anaerobic conditions as required by definition to be a hydric soil. In completing all soil sample site observations no hydric soils were found on the project site area.

The Mānā Plain contained vast wetlands prior to being drained for agricultural purposes during the 1920s. There is evidence of occasional flooding (drift lines, water marks, and sediment deposits), but these areas do not meet the hydric soils requirement. The soils in the project area were not identified as hydric soils based on the observed soils matrix colors and lack of the necessary redoximorphic features within the required depths. It appears that drainage of the historical wetlands during the 1920s – 1950s and the subsequent agricultural activities have changed the soil characteristics so that they no longer have identifiable hydric soil features or meet the definition of a hydric soil. The current flooding and inundation that occurs in this area is apparently not often enough and/or for long enough periods of time in order for the soils to form hydric soil features.

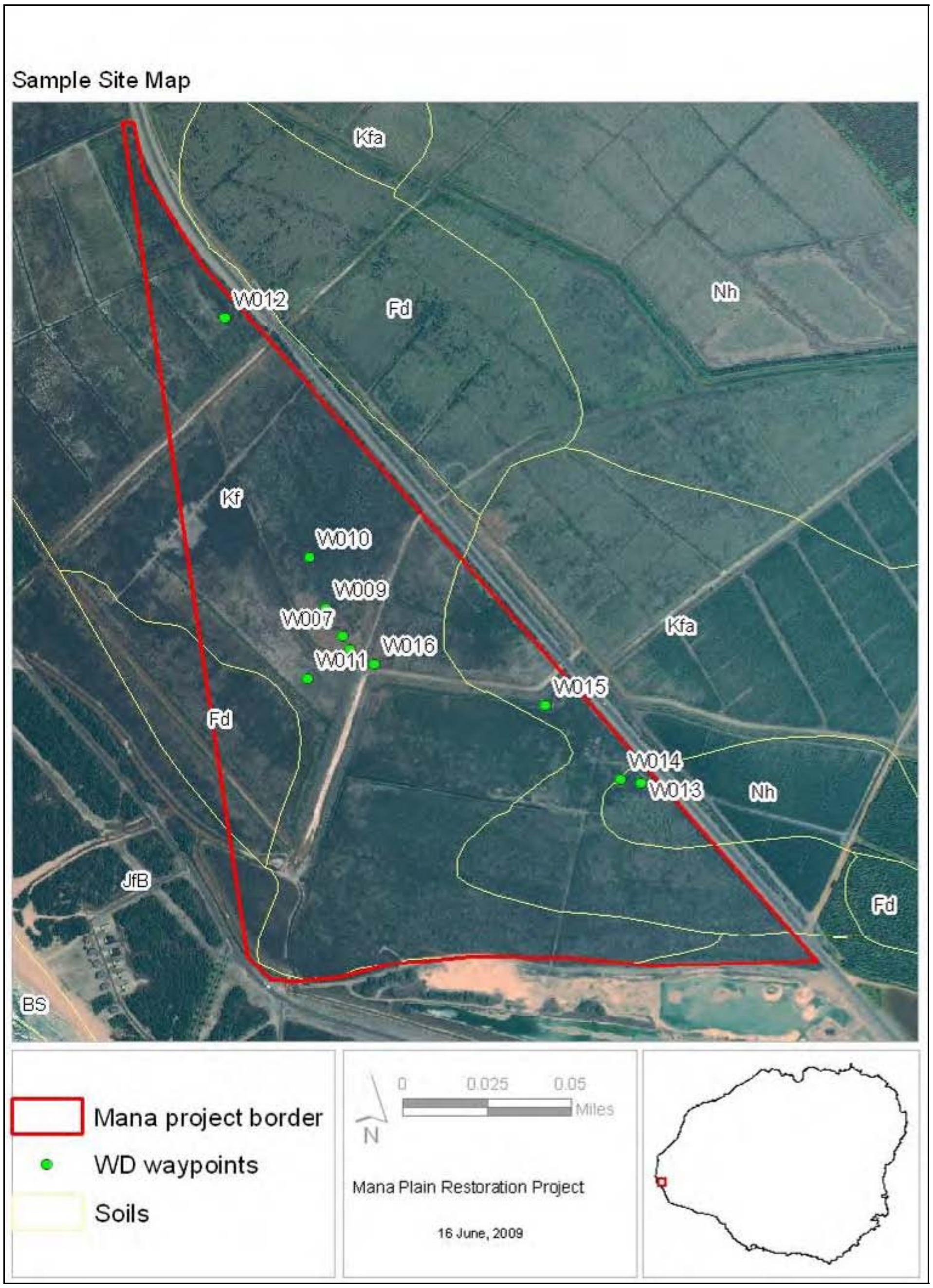

Figure 6. Locations sampled during June 2009 to complete the wetland delineation of the project area for the Mana Plain Wetland Restoration. Map provided by USDA Natural Resources Conservation Service.

Objective 4: Provide updated soil information for NRCS soil survey.

Copies of all field notes and data were provided to NRCS. This information will be used to update the NRCS soil survey descriptions. Additional soil data were also collected at Kawaiele Waterbird Sanctuary (Figure 7) and other areas on the Mānā Plain outside of the project site.

Figure 7. Additional soil samples collected during June 2009 at Kawaiele Waterbird Sanctuary.

Objective 5: Share methods and results with interested individuals during a ½ day workshop at the Mānā Plain Wetland Restoration site.

On Friday June 12, 2009, we hosted a ½ day on-site workshop open to interested individuals. The Hawaii Wetland Joint Venture distributed the announcement through their mailing list. During the workshop, members of the inter-disciplinary team gave a brief tour of the site and explained the planning components we were implementing to develop the wetland restoration design (Figure 8). Adonia Henry provided an overview of the project. Dennis Vicente and Chadd Smith explained how they used the information on soils and topography to generate a revised conceptual design.

Figure 8. On-site workshop following the soil sampling during June 2009 at the Mānā Plain Wetland Restoration site, island of Kaua'i.

A presentation on the Mānā Plain Wetland Restoration project and associated planning efforts was co-presented by Adonia Henry, Dennis Vicente, and Chadd Smith during September 2009 at a wetland workshop (Figure 9). The workshop, *Moist-soil Management for Biologists and Maintenance Staff*, held at Bosque del Apache National Wildlife Refuge was attended by 25 biologists, managers, and equipment operators from FWS Refuges and State-managed Conservation Areas throughout the United States. Jason Vercelli, biologist with the State of Hawaii Division of Forestry and Wildlife on the island of Kaua'i attended the workshop. The Mānā Plain Wetland Restoration project was used as a case example where partners had successfully integrated multiple abiotic and biotic components into the conceptual design of the wetland restoration project.

Figure 9. Title slide of the Mānā Plain Wetland Restoration presentation given during September 2009 at a wetland workshop, *Moist-soil Management for Biologists and Maintenance Staff*, at Bosque del Apache National Wildlife Refuge, Socorro, New Mexico.

References

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