

Title: WSAG17: Lo'i Kalo as Retention Basins: A New Approach to Designing Constructed Wetlands in Hawai'i

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Grant Request: \$ 68,006

Matching Funds: \$ 68,006

Total Budget: \$ 136,012

Project Period: September 1, 2017 to August 31, 2018

A. Executive Summary

Wetlands are buffers to filter land-based source pollutants, slowing down surface water flow and increasing freshwater recharge. The lowlands of Hawai'i were once historically managed to divert water to irrigate wetland taro (*kalo*, *Colocasia esculenta*) and create small freshwater fishponds, which provided food security and created habitat for endemic Hawaiian wetland birds and fish. The extensive scale of *kalo* production also encouraged large-scale percolation and seepage of irrigation water back to the groundwater system, which often reemerged as *punawai*, or freshwater springs, downstream. The reduction of surface water also assisted in reducing sediment export to coastal waters by reducing transport capacity. Today, however, most lowlands have been converted to other forms of agriculture or urban development.

The Nature Conservancy of Hawai'i is submitting this proposal to the Department of Land and Natural Resources Commission on Water Resource Management (DLNR-CWRM) to restore and manage 19 acres of estuarine and wetland habitat in He'eia, with a focus on freshwater recharge and reuse. In partnership with local non-profit Kāko'o 'Oiwī, we will use invasive species removal, replanting of native vegetation, and a system of lo'i *kalo* to act as retention basins and improve water recharge.

Lo'i *kalo* (taro fields) have long been known to reduce the impacts of flood, retain water and sediments, and take up nutrients, similar to rice paddy agricultural systems. However, there have been few efforts to quantify percolation and seepage rates into the groundwater that would help to examine that effects of lo'i on the overall water budget. We will test the hypothesis that lo'i increase groundwater recharge by estimating discharge above and below the wetland in areas that are currently planted in taro and in areas that remain covered in California grass (*Urochloa mutica*), guinea grass, ho'io and Job's tears. We will also use the Storm Water Management Model (SWMM) to estimate how scaling up lo'i in parallel and series would affect overall retention in the event of a large storm event.

The goal of this project is to **design and maintain a constructed wetlands system in He'eia, provide new data to quantify groundwater recharge in lo'i kalo, and estimate the impact of continued restoration the He'eia wetlands.** This project is part of a large-scale, multi-partner effort in the He'eia watershed and Kāne'ohe Bay to restore 250 acres of wetland, 1.5 miles of stream, 150 acres of coral reefs, and the 88-acre He'eia Fishpond. This larger effort has been supported by DLNR for years, especially by the DAR Aquatic Invasive Species team through the Super Sucker algae removal project.

B. Scope of Work: Narrative

1. Background / Justification of Need

Anticipated impacts of climate change threaten to reduce Hawai'i's water and food security through drought and flooding, increased coral bleaching and higher ocean temperatures, and greater severity and occurrence of severe weather events. The intensity and frequency of El Niño events are predicted to increase, meaning that freshwater storm pulses and flooding in coastal areas are likely to become more common. Recently, Tropical Storm Darby produced 250-mm of rainfall in a 24-hour period, causing flooding and sewer system overflows, which are also stressors to the coral reef ecosystem (Rodgers et al, 2015). Stream baseflow has also declined over recent decades, meaning that there is less consistent freshwater available to estuarine and wetland environments (Oki, 2004; Ostrader et al, 2008).

By increasing groundwater recharge through seepage and percolation losses, lo'i kalo reduce available surface water and reduce the transport capacity of the water, thereby limiting the amount of sediment that ends up downstream and on the reef. By allowing water to infiltrate to the groundwater, the water is not entirely lost to the system – it still emerges as submarine groundwater discharge at the coast. Groundwater is also filtered to some degree by the soil media through which it travels, and nutrients are taken up by the root system of the taro plants and transformed by the bacteria in the aerobic and anaerobic sediment layers (Deenik et al, 2013).

Lo'i kalo (taro fields) also serve to modulate flood pulses, through their construction as a series of compartments separated by earthen berms and roads slow flooding and increase residence times. Monitoring of water level and turbidity in the He'eia wetlands during Tropical Storm Darby in July 2016, showed that water was not stopped entirely by the presence of lo'i kalo, but are likely slowed down. A significant percentage of the total sediment budget is released during storms, and deposition of sediment in lo'i kalo and the irrigation canals has been documented (LISA project, 1992). During Darby, the inlet water to the taro fields reached up to 1250 FTUs during the storm. Recent research by TNC scientists found that during baseline conditions, the taro fields did not retain sediment, but were able to retain up to 52% of sediment during two-year storm events.

By holding water for between approximately 15 to 40 hours, lo'i kalo also provide sediment and nutrient retention ecosystem services. Retention basins are a way to hold water for a period of time that allows for percolation into the groundwater, also known as the hydraulic residence time (HRT). The residence time is affected by water depth, plot geometry (for instance square versus rectangular) and size and the discharge volume.

In lo'i kalo, like in rice paddies, percolation rates are dependent on a number of factors related to the water depth and the bulk density of the soil. Larger water depths create larger head pressure to

increase the rate of percolation as well as seepage through kuāunas. In addition, the amount of time the water is retained in the paddy is important for infiltration, the health of the taro plant, and the potential for sediment and nutrient retention. Infiltration or percolation rates for kalo are poorly constrained, but have been measured to be very small in rice paddies (between 10^{-2} and 10^{-5} cm/s) (Higashino et al, 2014). Researchers have found that deep percolation to the subsoil in rice and kalo paddy systems is likely to be small (~1-10 mm/d) because of the fine clay and silt soils typical of taro growing areas (Penn, 1992), but also because of the hardpan layer created during the preparation of the soil for planting and flooding. Regardless, capturing water in the tilled soil layer and maintaining long HRT will diffuse the impact of storm events and provide more time for biological uptake of nutrients.

2. Goals and Objectives

In partnership between The Nature Conservancy and Kāko'o 'Ōiwi, and with support from the University of Hawai'i at Mānoa (UH) and US Geological Survey (USGS), we are proposing to **design and maintain a constructed wetlands system in He'eia, provide new data to quantify groundwater recharge in lo'i kalo, and estimate the impact of continued restoration on the wetlands and coastal area.**

Project objectives are as follows:

Objective A. Restoration

A1: Manage and maintain constructed wetlands system in He'eia through invasive species removal and traditional agricultural practices

A2: Design and oversee the development of additional retention basins in an 11-acre area

A3: Restore stream to channelize fresh water flow into the lo'i kalo / retention basins

Objective B. Monitoring (Quantifying Water Recharge)

B1: Conduct data monitoring and analysis to quantify water budget, hydraulic retention time and infiltration rates

B2: Use the EPA's Storm Water Management Model to scale up continued restoration of the lo'i system

Objective C. Outreach and Community Engagement

C1. Engage community members in traditional and modern restoration practices

C2. Share information through professional working groups including a research hui and local engineers/wetlands practitioners

3. Project Site Description

The ahupua'a of He'eia is a 3,641-acre watershed situated within the moku of Ko'olaupoko, on the island of O'ahu. The watershed is characterized by heavy precipitation and steep, mountainous upland terrain, with median annual rainfall of approximately 60 inches (DLNR, 1986). The principal stream in the watershed is He'eia Stream, which originates as Ha'ikū Stream near the ridge of the Ko'olau Mountains, converges with Ioleka'a Stream approximately 800 feet mauka of Kahekili Highway, then flows through the He'eia wetland and discharges into central Kāne'ohe Bay. (See *Attachment D: Site Map.*)

The project will take place within a 405-acre parcel owned by the State of Hawai'i Community Development Authority (HCDA) and leased by non-profit organization Kāko'o 'Ōiwi under

Ground Lease No. 09-24 dated January 1, 2010, bearing Tax Map Key No(s): (1) 4-6-16:001 and (1) 4-6-16:002, the geographic coordinates of which are 21° 25' 51" North, 157° 48' 38" West.

Mangrove Site (6 acres) Through a grant from NOAA, The Nature Conservancy and Kāko'o 'Ōiwi are restoring a 6-acre portion of the wetlands on the northern portion of the project site, approximately one-half mile inland of the He'eia Stream mouth. The area is dominated by a dense American mangrove forest (*Rhizophora mangle*) that extends across Kamehameha Highway to the mauka kuapā (inland wall) of He'eia Fishpond. Restoration plans for 2017 include the removal of non-native vegetation and installation of native plants in this area, with future plans to remove sediment and establish retention basins.

Lo'i Kalo (2 acres) and New Kalo Corridor (11 acres) Concurrently, Kāko'o 'Ōiwi is also maintaining a 2-acre area of lo'i kalo, and planning to establish additional retention basins and lo'i kalo in an 11-acre corridor, both on the southwestern portion of the project site. This area connects directly to the mangrove removal area. In this project, we will help Kāko'o 'Ōiwi to design this 11-acre parcel to maximize retention time while also maintaining taro yield for commercial production. Located along the CWRM-registered Wing Wo Tai stream diversion to the He'eia Stream, this area is overgrown with non-native California grass, umbrella sedge (*Cyperus involucratus*), and Job's tears (*Coix lacryma-jobi*).

4. Methodology

a. Restoration

The restoration of historic lo'i kalo as retention basins in this constructed wetlands system is intended to (a) retain and recharge freshwater, (b) slow and diffuse storm pulses, (c) increase hydraulic residence time, enabling suspended solids to settle; (d) reduce soil erosion while facilitating microbial denitrification and the sequestration (uptake) of nitrogen by plants, and (e) re-establish a primary food source for Windward O'ahu by restoring area for kalo production. Together, these actions support the larger goals of the community through reviving cultural practices and food production, while also improving water quality and the health of the He'eia Stream, fishpond, coastal and reef areas in Kāne'ohe Bay. Details on the restoration objective are as follows:

Task A1: Manage and maintain lo'i kalo / retention basin system

Kāko'o 'Ōiwi has already removed invasive vegetation from two acres of wetlands, and is re-establishing historic lo'i banks and walls (*kuaūna*) using a backhoe or excavator of appropriate size and capacity. Excavation activities remove no more than six to 12 inches of topsoil. Re-deposition of excavated soils occur within isolated lo'i. Mechanical excavation activities are conducted pursuant to Kuāuna and Agricultural Road Restoration Best Management Practices. The U.S. Army Corps of Engineers (USACOE) has determined that the clearing and excavation activities "will not result in the discharge of more than incidental fallback" and will "neither degrade nor have the effect of degrading the He'eia Stream, its tributaries and/or associated wetlands." Native vegetation cover is installed on walls of all newly restored *kuaūna* and 'auwai (irrigation channel).

Task A2: Design and construct a system of additional retention basins

The next site ready for restoration on the property is an 11-acre area overgrown with invasive species including California grass (*Urochloa mutica*), guinea grass, ho'io and Job's tears. The partners on this proposal, TNC, DLNR and Kāko'o 'Ōiwi, with consultation with community leaders and hydrologists at the USGS and UH, will design this system of lo'i kalo to serve as retention basins as well as food production systems. The New Kalo Corridor site will include, as appropriate, roads, berms and drainages.

Our goal is design this new site to maximize retention time while also maintaining the taro yield. Some initial calculations reveal that with an inflow of one mgd and a water depth of 1.5 ft, hydraulic residence time (HRT), would be about 15 hours. Using the historical USGS gage data from He'eia Stream, we can estimate that peak flow has been about seven times more than baseflow – which would still leave an HRT of between two to four hours for water to be retained during storm events.

Task A3: Restore stream to channelize fresh water flow into the retention basins

The requested funding from DLNR-CWRM will also support the second year of a three-year project (with matching funds provided by NOAA grant) to conduct targeted removal of invasive vegetation from 0.5 miles of stream corridor above the New Kalo Corridor site. Kāko'o 'Ōiwi will use a combination of manual and mechanical removal methods consistent with land clearing BMPs set forth in the site's approved conservation plan. Manual methods will include hand removal and removal by use of hand tools such as shovels, *ō'ō* (digging stick/spade), trowels and sickles. Mechanical methods will include removal by weedwackers and other equipment. Vegetation removed from the wetland will be incorporated either as green waste into mulch piles or as material incorporated into *kuaūna* (taro pond walls/banks). The stream vegetation removal will occur along relatively short reaches, followed by replanting of native species. If necessary, geotextiles will be used until the replanted vegetation has developed a mature root capacity. A restored stream will channelize water flow into the system of retention basins/lo'i kalo.

b. Monitoring (Quantifying Retention and Infiltration)

Building on the work of project partners and research institutions that have and are working in the He'eia watershed, we will monitor water level and discharge at the inlet and outlet of the new retention basin system, and the wetland as a whole to estimate water retention and to begin to build a water budget for the wetland system. With guidance from partners (including USGS, UH SOEST with the Alegado, McManus and Glazer labs and UH Water Resource Research Center), we will monitor discharge and turbidity to assess the effectiveness of the restoration in reducing sediment load and improving flow for a healthier, more resilient habitat. We will also take monthly water quality samples (inorganic nutrients, suspended sediment filtered to 0.2um and analyzed at S-LABS) at identified stations in the wetland, fishpond, and stream (see *Attachment D: Site Map*). This will allow us to monitor changes in the system due to restoration efforts including mangrove removal, construction of lo'i systems, and stream restoration. The monitoring will also fill gaps that are missing for anticipated modeling efforts through data collected at a weather station.

Task B1: Conduct data monitoring and analysis to quantify water budget, hydraulic retention time and infiltration rates

The overall monitoring strategy will involve 1) monitoring of the new 11-acre corridor for discharge at the inlet and outlet, and water level within individual retention basins, to estimate groundwater recharge, 2) estimating the amount of water and sediment coming into and leaving the wetland to establish a larger water and sediment budget. In order to calculate recharge rates, we plan on using a simple bookkeeping method which measures infiltration as percolation into the subsoil. The method calculates the difference between inflow and outflow from the proposed retention basin area (similar to Bourman, 1994).

$$\text{Percolation} = Q_{in} + R - Q_{out} - ET - \Delta d$$

where R is rainfall, Q is discharge, ET is evapotranspiration of the taro and Δd is the change in water depth. Evaporation will be directly measured and supplemented using nearby weather data, and ET will be derived using the Penman equation. Q will be monitored at the inlet and outlet of the corridor using water level sensors that measure height in 4-ft diameter through-pipes. For the outlet of the loi, the plan is to install four-foot diameter culverts. Using a known hydraulic roughness for concrete, combined with ratings curves for different water depth heights, we will be able to calculate discharge. Rainfall will be obtained through installation of a rain gauge on site to monitor precipitation sub-hourly. A nearby weather station (Glazer lab, He'eia fishpond wall) will provide solar radiation for evapotranspiration calculations.

Additionally, grain size, bulk density and percent organic matter will be obtained by taking sediment and deep soil sediment cores for analysis. Because the water table is so shallow at the new retention basin proposed site, saturated hydraulic conductivity (k_{sat}) will be measured at different points using an auger-hole method (Amoozegar and Warrick, 1986). The method consists of pumping the water out of an auger-hole extending below the water table and then measuring the rate of the rise of the water in the hole.

TNC's scientists will estimate hydraulic retention time in each of the retention basins, as estimated by flow into each field and water depth. Estimates of infiltration will then be made by estimating the hydraulic conductivity of the tilled soil and subsoil. For the larger scale retention system, discharge in and out of the retention area will be measured, and a simple water budget will be made to estimate total losses over the area. Flow rates during storm events will also be measured, and be used to calibrate a model of the retention basin, so that the effects of larger storm events can be considered.

Task B2: Use EPA's Stormwater Management Model to scale up continued restoration of the lo'i

Because the one-year length of the project does not necessarily offer a significant amount of time to estimate how lo'i will perform as retention basins under all conditions, we propose to use the Storm Water Management Model (SWMM), developed by the U.S. Environmental Protection Agency as a dynamic rainfall-runoff-subsurface runoff simulation model (Huber and Dickson, 1988). The model was recently employed to estimate sediment retention in Honokowai #8 reservoir on Maui (Babcock et al, 2015). To consider how water and sediment would move during different sized events, the model will consider synthetic rain events and hydrographs as inputs. For this project, we will investigate three types of scenarios – 1) varying water depth between 0.5 and two feet, 2) considering different sizes of synthetic storm events including two-year, 10-year and 100-year storms, and 3) comparing different geometries of lo'i kalo.

c. Outreach and Community Engagement

Task 3A: Community engagement in traditional and modern restoration practices

This project will benefit the surrounding community through engagement in traditional practices based on the Hawaiian value of *mālama āina* (caring for lands and waters). School groups, residents and visitors will have the opportunity to participate in monthly community workdays which are estimated to engage 600 volunteers per month. The Nature Conservancy's strategic communications team will support partners in identifying opportunities for targeted outreach to build awareness and engagement in the He'eia restoration effort.

Task 3B: Information sharing through professional working groups

We will continue to participate in the NOAA-led research group for He'eia, organized by the Hawaiian Islands Sentinel Site Cooperative, which has held annual symposiums for the past two years. We will also convene a yearly meeting with other practitioners who are working on nature-based infrastructure projects in Hawai'i.

5. Budget

The proposal budget is included as *Attachment E*, with a description of the line items as follows:

Personnel – TNC staff salaries, to include Marine Science Advisor, Kaneohe Bay Marine Coordinator, and additional support staff. Fringe benefits are calculated at the approved TNC rate of 41.5%.

Travel – TNC mileage for local transportation and for one interisland trip for Marine Science Advisor to attend working group meetings.

Supplies – Restoration supplies, including tents, sickles, safety equipment, weedwhackers, etc. Monitoring supplies, including hydrologic weather station(s), water quality sensors, etc.

Contractual – Contract to restore stream by removing invasive vegetation and replanting native plants. Contracts to USGS and UH for assistance with research monitoring and equipment.

Other – Community workday costs, trainings and meetings for staff and partners. Publishing fees for outreach and scientific materials.

Specific costs can be provided upon request. Additional information is provided below in *Section D.3. Pricing*.

6. Expected Results and Innovation

This project seeks to integrate green infrastructure design with native Hawaiian agricultural practices to increase food security, reduce sediment and nutrient export into Kane'ohe Bay, provide habitat for native birds, fish and invertebrates and provide a space for Hawaiian community practitioners to practice culture and offer educational opportunities to the next generation.

By using both monitoring and modeling methods to estimate groundwater recharge parameters, this project acts as a large-scale pilot for the incorporation of lo'i kalo in stormwater reduction projects. We expect to generate guidelines for how much groundwater recharge and sediment retention can be achieved by windward, lowland plots. Specifically, we will constrain estimates of hydraulic conductivity and hydraulic retention times for different sizes and shapes of lo'i kalo under different storm conditions. There have not been similar studies conducted in Hawai'i in the recent decade.

(See also the above *Section B.2. Goals and Objectives* and *Section B.4 Methodology* for a full description of expected results and innovative methods proposed.)

7. Possible Shortfalls

Previous attempts to directly measure percolation and seepage in lo'i have been met with the challenges of working in a muddy environment without a clear soil-water interface (Penn, personal communication). By using a simple bookkeeping method for estimate recharge, we anticipated error in calculating evapotranspiration and estimating hydraulic conductivities. We acknowledge this is a lumped approach. However, using hydraulic residence time, combined with a water budget approach, as a guide to groundwater recharge and sediment retention estimates is an approach that we think will be a step in the right direction towards understanding the capacity of lo'i for providing hydrological ecosystem services.

B. Experience and Capabilities

The Nature Conservancy Hawai'i Program (TNC) is a U.S. based international non-profit organization whose mission is to protect the lands and water upon which all life depends. Since its formal establishment in 1980, the Hawai'i program has used its science-based approach to identify the native ecosystems and species in greatest need of protection, and partnered with government and community organizations to protect, restore and implement policies on behalf of those priority sites. TNC started its marine program in 2001 and we now work across five islands to help communities study and adaptively manage marine resources. The Hawai'i Marine Program currently manages 13 federal and state grants totaling \$2.8 million in public funding, including a three-year collaborative agreement with NOAA in the He'eia watershed.

TNC Hawai'i has successfully managed multiple large-scale, federally funded restoration grants, including a (1) \$1.4 million three-year collaborative agreement with NOAA in the West Hawai'i Island Habitat Focus Area, (2) \$3.4 million American Recovery and Reinvestment Act grant through the NOAA Restoration Center which cleared more than 27 acres and removed nearly 3,000,000 pounds of invasive alien algae from Maunalua Bay; and (3) the Kāne'ohe Bay Reef Restoration Project which helped remove more than 320,000 pounds of invasive algae from 36 acres of coral reefs, and (4) a multi-year grant to support fishpond restoration in West Hawai'i, the only Pacific-region project funded for this FY17 grant by the NOAA Community-based Restoration Program.

TNC Hawai'i has 70 staff across five islands including 22 marine program staff, a grants specialist who administers federal grants, and a finance director who oversees the Hawai'i program budget. Through its Hawai'i Marine Program, TNC has been working in He'eia and Kāne'ohe Bay for nearly a decade to advance conservation and management of natural resources within the region. Leveraging its internal expertise in ecosystem management, TNC will provide expertise in bio-engineering, water quality monitoring, strategic communications and project management. The Co-Principal Investigators for the proposed project:

Kim Falinski, PhD, Marine Science Advisor, will serve as principal investigator and lead scientist, responsible for ensuring that deliverables are met within the proposed timeline and budget. A water resource engineer and soil scientist specializing in sediment and nutrient transport to the coastal zone, Dr. Falinski's work focuses on best management practices to improve water quality and coastal resilience. As part of a SeaGrant project, she conducted

research in He'eia fishpond on the effects of mangrove removal on sediment and nutrient retention. Her recent work focused on understanding patterns in coastal water quality, including her doctoral work building spatially-explicit decision support tools to compare land use and climate scenarios and effects on coral reefs. Dr. Falinski is the Hawai'i point of contact for the sediment and nutrient ecosystem service models produced by the Natural Capital project (InVEST). In addition to her PhD, she is a certified Engineer-in-Training and has a Master's degree in Biological and Environmental Engineering.

J. Kanekoa (Koa) Kukea-Shultz, Kāne'ōhe Bay Marine Program Coordinator, will oversee site operations at the He'eia wetlands and serve as primary contact with the landowner and community partners. A graduate of Kamehameha Schools, Mr. Kukea Shultz holds a Bachelor's of Science in Marine Science from Occidental College, and Masters of Science in Botany from the University of Hawai'i at Mānoa with an emphasis on Phycology (algae, limu research). Through an agreement with its Board of Directors, Mr. Kukea Shultz is seconded to community organization Kāko'o 'Ōiwi to serve as its executive director, a role that is defined and distinct from his position at TNC. Prior to working at The Nature Conservancy, Mr. Kukea Shultz served as Ocean Resources Specialist for the State of Hawai'i Kaho'olawe Island Resource Commission (KIRC) where he managed marine-related projects. He is a founding member of Paepae O He'eia since 2000, where he worked to mobilize efforts to restore He'eia Fishpond.

Additional members of the TNC staff team will provide support with scientific monitoring, grants and contract management, strategic communications, fiscal tracking and reporting.

C. Partnerships and Sustainability

The project is directly supported by Kāko'o 'Ōiwi, Ko'olaupoko Hawaiian Civic Club, the State of Hawai'i Division of Aquatic Resources, the University of Hawaii, Ka'ala Farms, NOAA and the U.S. Geological Survey. (*Letters of Support can be provided upon request.*)

There is a significant, decades-long investment in the He'eia watershed and Kāne'ōhe Bay and the larger restoration effort is broadly supported by local residents, non-profit organizations, research groups, and local, state and federal agencies. Partners include the State of Hawai'i Division of Aquatic Resources, Hawai'i Community Development Association (landowner), Kāko'o 'Ōiwi (site manager), Ko'olaupoko Hawaiian Civic Club, U.S. Geological Survey (USGS), University of Hawai'i, NOAA, and the Hawaiian Islands Sentinel Site Cooperative, which has mobilized a working group since May 2015 to align and build on the existing watershed restoration efforts in He'eia.

The HCDA lease on the property extends for 38 years, and the project has the full support of the landowner. The presence of the Hawai'i Institute of Marine Biology in Kāne'ōhe Bay ensures that continued academic interest in the area will be ensured for the foreseeable future.

Additionally, He'eia has been designated a National Estuarine Research Reserve, an initiative which is supported by the State of Hawai'i Office of Planning and the Governor's office, and the designation will help to secure long-term educational and research support. Each of the three main non-profit organizations in He'eia (Kāko'o 'Ōiwi, Paepae O He'eia, and Papahana Kuaola) have financial sustainability plans based on the production and sales of native plants, taro, fish and other food products, as well as long-term plans to continue ecological and cultural restoration of the entire watershed.

As set forth in the Ko'olaupoko Watershed Restoration Action Strategy (June 2007), the He'eia Watershed Based Plan (WBP) specifically identified this site as a priority. The WBP identifies the establishment of partnerships with “large landowners identified for preservation and restoration of riparian habitat” along the He'eia Stream and its tributaries as a “high priority.” Further, the proposed activities contribute to the conservation and restoration of wetlands down-gradient at the He'eia Stream mouth (“High Priority”).

DAR's Aquatic Invasive Species Team is a direct partner with TNC on the Kāne'ohe Bay Reef Restoration Project and will advise on the wetlands restoration. The State of Hawai'i Division of Aquatic Resources (DAR) has offered to advise on the related mangrove removal project through Dr. Kimberley Peyton, with technical expertise, training, and methods for biological monitoring. The Division of Forestry and Wildlife has provided consultation and will partner with TNC and the local community on this effort.

We would also like to acknowledge our support of the Ka'ala Farms proposal to DLNR-CWRM, which also aims to measure water recharge in lo'i. The implementation of both projects would provide a comparison of Windward and Leeward lo'i that would benefit the scientific research and present new innovation for understanding infiltration rates for lo'i. Our team would work with the Giambuluca and Deenik labs from the University of Hawai'i at Mānoa to develop monitoring methods, and researchers and farm staff would have the opportunity to bring their students to both sites for cross-lo'i comparisons.

D. Strategy, Timeline, Plan and Pricing

1. Timeline & Deliverables (September 2017 – August 2018)

#	Deliverable/Task/Activity	Target Date
A1.1	Purchase monitoring and restoration supplies	Oct 2017
B1.1	Execute contracts/subawards with USGS and UH for research support	Oct 2017
B1.2	Work w/ partners at USGS, UH and DAR to finalize monitoring methods	Nov 2017
B1.1	Conduct baseline monitoring to determine initial hydrologic function of lo'i and wetlands	Dec 2017
A2.1	Design system of additional retention basins	Feb 2018
A1.2	Manage and maintain constructed wetlands including lo'i kalo as retention basins	Mar 2018
A3.1	Stream restoration and maintenance	Apr 2018
A2.2	Oversee the development of additional retention basins in new corridor site	June 2018
C2.1	Coordinate and attend meetings with researchers, engineers and/or wetland practitioners	July 2018
B2.1	Conduct 12 months of on-going hydrologic monitoring	Aug 2018
C1.1	Host 12 months of community workdays	Aug 2018
B2.2	Analyze data to quantify the amount of water recharged and hydraulic residence time	Aug 2018

2. Permits and Approvals

All proposed activities are consistent with an approved Soil and Water Conservation District (SWCD) approved Conservation Plan and Jurisdictional Determination and Clean Water Act §404 Exemption Letter issued by the U.S. Army Corps of Engineers.

3. Pricing

The Nature Conservancy is requesting **\$68,006** to accomplish the deliverables described in this proposal. A budget breakdown and compensation schedule are provided as *Attachment E: Proposal Budget Form*. TNC will provide **1:1 match** through a federal grant (see *Attachment H: Confirmation of Matching Funds*) and private donations. In addition to \$68,006 in cash match, TNC will also leverage an additional \$126,776 in funding and in-kind support for the overall wetlands restoration project. Budgeted items are described above in *Section B.5. Budget*. The proposed costs are reasonable and will directly support the Scope of Work described in the RFP.

E. Outreach, Visibility and Demonstration Value

This project benefits from the multiple efforts already underway in He'eia, including stream restoration and native plant nursery in the uplands by Papahana Kuaola and Hui Ku Maoli Ola, wetlands restoration and lo'i kalo in the wetlands by Kāko'o 'Ōiwi, and fishpond restoration by Paepae O He'eia. Specific opportunities to highlight the project include:

Education and community engagement: All of the groups in He'eia offer educational activities and host regular community workdays that encourage positive action and strengthen the connection between people and 'āina. In connection with this project, Kāko'o 'Ōiwi will host monthly workdays to assist with the restoration effort, estimated to engage 600 volunteers per year, for a total of 9,000 hours of in-kind match donated to the larger project effort funded by NOAA. Paepae o He'eia and Papahana Kuaola also host workdays, educational events, service learning projects and ecotour groups, reaching an estimated 14,000 additional residents and visitors each year who will participate in and learn about the ahupua'a restoration effort. The perpetuation of culturally important practices, from gathering of plants for hula and ceremonial use, to the re-integration of agriculture and aquaculture techniques traditionally practiced in Ko'olaupoko, will also help to build long-lasting investment by the local community.

Visibility and outreach: TNC has a team of strategic communications professionals that will be designing signage to mark the project and describe the efforts. The location lends itself to high visibility by both residents and visitors. Once the mangrove is removed in the lower section of the property, the wetlands will be visible from the section of Kamehameha Highway that connects Kāne'ohē with the rest of windward O'ahu and the North Shore. As the restoration continues, the opening of the viewshed from the mountains to Kāne'ohē Bay will generate continued interest in the project. TNC's team will seek to highlight the project in newsletters, website and social media, as well as traditional print media.

Research groups: We will continue to participate in the existing research hui for He'eia, organized by NOAA and the Hawaiian Islands Sentinel Site Cooperative. We will also meet with other practitioners working on design and implementation of nature-based infrastructure projects in Hawai'i. We are seeking to build a new working group that encourages collaboration of non-

profit organizations, farmers, scientists and engineers who are looking to utilize culturally-appropriate methods of stream and wetland restoration and identify and address gaps in policy and management. The group is in its early stages, with participants to-date including representatives from the Coral Reef Alliance, Conservation International, U.S. Fish and Wildlife Service, University of Hawai'i, and local families.

Data sharing: Data collected as part of baseline (pre-) and evaluation (post-) studies will be processed and analyzed, and figures will be made using R and Microsoft Excel. We intend to work closely with NOAA, DLNR and the community groups to identify the data that can be released publicly without jeopardizing the health of the local fisheries and cultural resources. All data so identified and collected under the project will be made available to anyone upon request no later than two years after collection.

References Cited

- Babcock, R., Falinski, K., & Nielson, J. (2015). Sediment retention at Honokōwai structure #8, Wahikuli-Honokōwai priority site, Engineering analysis and development of retrofit designs (pp. 91). Report prepared for Department of Land and Natural Resources, Department of Aquatic Resources, Honolulu, HI.
- Deenik, J., Bruland, G. L., Yamakawa, R., & Cox, L. (2013). Alternative nitrogen fertilizer management strategies to improve fertilizer recovery and water quality in wetland taro (*Colocassia esculenta*) production systems. (pp. 21).
- Higashino, Makoto, & , Heinz G. (2014). Modeling the effect of rainfall intensity on soil-water nutrient exchange in flooded rice paddies and implications for nitrate fertilizer runoff to the Oita River in Japan. *Water Resources Research*, 50(11), 8611-8624.
- Penn, David. (1992). *Modeling water requirements for wetland taro cultivation in Hawai'i*. (PhD), University of Hawai'i at Manoa, Honolulu, HI.
- Oki, Delwyn. (2004). *Trends in streamflow characteristics at long-term gaging stations, Hawai'i*: US Department of the Interior, US Geological Survey.
- Rodgers, Ku'ulei S, Jokiel, Paul L, Brown, Eric K, Hau, Skippy, & Sparks, Russell. (2015). Over a decade of change in spatial and temporal dynamics of Hawaiian coral reef communities 1. *Pacific Science*, 69(1), 1-13.

ATTACHMENTS LIST

- A. Transmittal and Offer Letter
- B. Offer Form OF-1
- C. Offer Form OF-2
- D. Site Map
- E. Proposal Budget Form
- F. 501c3 Tax Exemption Letter
- G. Hawai'i Compliance Express Confirmation
- H. Confirmation of Matching Funds

TRANSMITTAL and OFFER LETTER RFP WSAG17

Name of Organization: The Nature Conservancy of Hawai'iPoint of Contact: FINANCIAL CONTACT: Daniel Delany, Grants SpecialistPhone: (808) 587-6254Email: daniel.delany@tnc.org

Water Security Advisory Group
 Department of Land and Natural Resources, Commission on Water Resource Management
 Punchbowl Street, Room 227
 Honolulu, Hawaii 96813

The undersigned has carefully read and understands the terms and conditions specified in RFP WSAG17, the Special Provisions attached hereto, and hereby submits the following offer to perform the work specified herein, all in accordance with the true intent and meaning thereof. The undersigned further understands and agrees that by submitting this offer, 1) he/she is declaring his/her offer is not in violation of Chapter 84, Hawaii Revised Statutes, concerning prohibited State contracts, and 2) he/she is certifying that the price submitted was independently arrived at without collusion.

A list of secured and required permits necessary to implement the project are hereto attached.

Proposal Title: WSAG17: Lo'i Kalo as Retention Basins: A New Approach to Designing Constructed Wetlands in Hawai'i
 Total Amount of Proposal: \$ 68,006.00

If awarded, the contract with the State would be made with the following entity (please use the **exact legal name** as registered with the Dept. of Commerce and Consumer Affairs):

THE NATURE CONSERVANCY

Legal name

923 NUUANU AVENUE, HONOLULU, HI 96817

Address (Contract and Billing Address must be the same)

n/a (tax exempt 501(c)3)

State Tax ID No. (GE)

Federal Tax ID No.

[Signature]
 Offeror Signature

Date

4/20/2017

KIM HUM
 Print Name

MARINE PROGRAM DIRECTOR
 Title

OFFER FORM OF-1
2017 IMPLEMENTATION OF WATER SECURITY PROJECTS AND PROGRAMS
 STATE OF HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES
 RFP-WSAG17

Procurement Officer
 Department of Land and Natural Resources
 State of Hawaii
 Honolulu, Hawaii 96813

Dear Procurement Officer:

The undersigned has carefully read and understands the terms and conditions specified in the Specifications and Special Provisions; and hereby submits the following offer to perform the work specified herein, all in accordance with the true intent and meaning thereof. The undersigned further understands and agrees that by submitting this offer, 1) he/she is declaring his/her offer is not in violation of Chapter 84, Hawaii Revised Statutes, concerning prohibited State contracts, and 2) he/she is certifying that the price(s) submitted was (were) independently arrived at without collusion.

Offeror is: Sole Proprietor Partnership *Corporation Joint Venture
 Other _____

*State of incorporation: WASHINGTON, DC

Hawaii General Excise Tax License I.D. No. N/A (tax exempt 501(c)3)

Federal I.D. No. [REDACTED]

Payment address (other than street address below): 923 NU'UANU AVENUE
 City, State, Zip Code: HONOLULU, HI 96817

Business address (street address): SAME
 City, State, Zip Code: _____

Respectfully submitted:

Date: 4/20/2017

(x) 
 Authorized (Original) Signature

Telephone No.: (808) 587-6244

KIM HUM, MARINE PROGRAM DIRECTOR
 Name and Title (Please Type or Print)

Fax No.: _____

E-mail Address: khum@tnc.org

** THE NATURE CONSERVANCY
 Exact Legal Name of Company (Offeror)

**If Offeror is a "dba" or a "division" of a corporation, furnish the exact legal name of the corporation under which the awarded contract will be executed.

OFFER FORM OF-2

Total contract cost for accomplishing the development and delivery of the services.

\$ 68,006.00

Note: Pricing shall include labor, materials, supplies, all applicable taxes, and any other costs incurred to provide the specified services.

I, KIM HUM (Offeror), certify that at time of award the 1:1 matching fund requirement will be met for WSAG17: LŌI KALO (HEEIA) (project). The total amount of matching funds will be \$ 68,006.00

 4/20/2017
Offeror Signature Date

KIM HUM MARINE PROGRAM DIRECTOR
Print Name Title

Legend

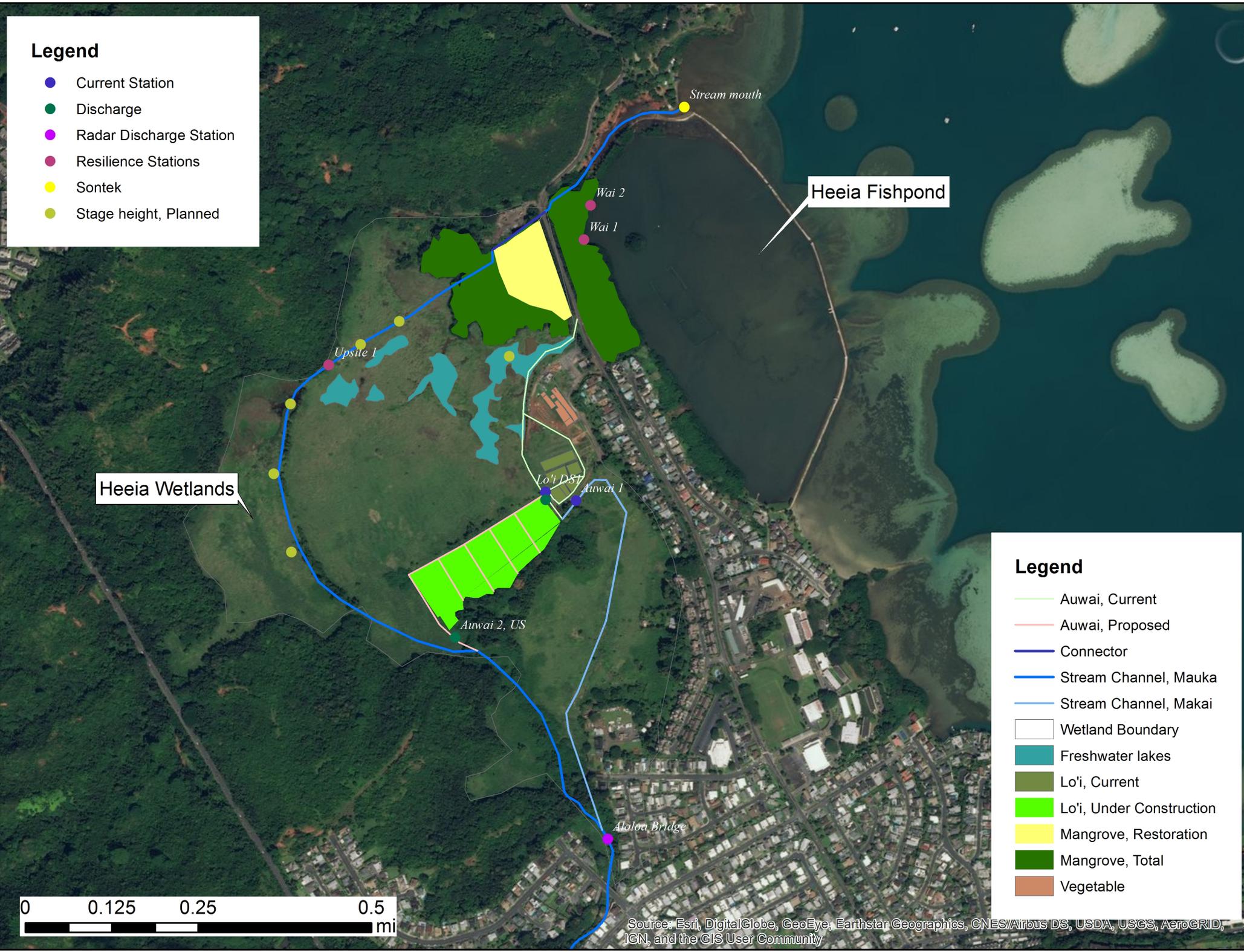
- Current Station
- Discharge
- Radar Discharge Station
- Resilience Stations
- Sontek
- Stage height, Planned

Legend

- Auwai, Current
- Auwai, Proposed
- Connector
- Stream Channel, Mauka
- Stream Channel, Makai
- Wetland Boundary
- Freshwater lakes
- Lo'i, Current
- Lo'i, Under Construction
- Mangrove, Restoration
- Mangrove, Total
- Vegetable



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



WSAG17- Proposal Budget

GRAND TOTAL \$136,012 (including match, but not including additional leveraged funds and in-kind in column E)

Subtotal for labor \$73,098

Subtotal for materials \$5,700

Subtotal for other actions \$31,584

Please round amounts to the nearest dollar.

A Budget Category	B	C	D	E	F
	Grant Request	Match	Total Budget	Additional Leverage*	Total Project Cost
	DLNR-CWRM	NOAA	GRANT+MATCH	NOAA/Private/In-Kind	
Salary and wages	\$ 38,468	\$ 34,630	\$ 73,098	\$ 66,735	\$ 139,833
Materials and supplies	\$ 333	\$ 5,367	\$ 5,700	\$ -	\$ 5,700
Travel	\$ 388	\$ 776	\$ 1,164	\$ -	\$ 1,164
Training	\$ -	\$ -	\$ -	\$ -	\$ -
Contracts	\$ 21,350	\$ 6,500	\$ 27,850	\$ -	\$ 27,850
Rentals	\$ -	\$ -	\$ -	\$ -	\$ -
Other (Trainings & Meetings, Participant Travel, etc.)	\$ 1,285	\$ 1,285	\$ 2,570	\$ 1,281	\$ 3,851
Subtotal Direct Costs	\$ 61,824	\$ 48,558	\$ 110,382	\$ 68,016	\$ 178,398
Indirect Costs	\$ 6,182	\$ 11,275	\$ 17,457	\$ 14,510	\$ 40,140
Unrecovered Indirect	\$ -	\$ 8,173	\$ 8,173	\$ -	\$ -
In-Kind Volunteer	\$ -	\$ -	\$ -	\$ 44,250	\$ 44,250
Total Cost	\$ 68,006	\$ 68,006	\$ 136,012	\$ 126,776	\$ 262,788

* "Additional Leverage" column shows the amount of additional investment in this project, but is not match for the DLNR funds

The targeted percentage for indirect costs should not exceed 10% of total costs requested. If there are different indirect costs for different budget categories, please create different spreadsheets for each indirect cost rate.

Compensation and Payment Schedule

#	Deliverable/Task/Activity	Grant Amount (\$)	Matching (\$)	Cash	Total Amount (\$)
A1.1	Purchase initial monitoring and restoration supplies (<i>Materials</i>)	\$ 333	\$ 2,367	\$ 2,700	\$ 2,700
B1.1	Execute contracts/subawards with USGS and UH for research support (<i>Contractual, Labor</i>)	\$ 24,500	\$ 6,500	\$ 31,000	\$ 31,000
B1.1	Work w/ research partners at USGS, UH and DAR to finalize monitoring methods (<i>Labor</i>)	\$ 3,750	\$ 5,750	\$ 9,500	\$ 9,500
B1.2	Conduct baseline monitoring to determine initial hydrologic function of wetlands (<i>Labor, Materials</i>)	\$ 5,000	\$ 7,500	\$ 12,500	\$ 12,500
A2.1	Design system of additional retention basins (<i>Labor, Other</i>)	\$ 2,750	\$ 3,250	\$ 6,000	\$ 6,000
A1.2	Manage and maintain constructed wetlands including lo'i kalo as retention basins (<i>Labor, Materials, Other</i>)	\$ 5,000	\$ 7,500	\$ 12,500	\$ 12,500
A3.1	Stream restoration and maintenance (<i>Labor, Materials, Other</i>)	\$ 2,750	\$ 2,250	\$ 5,000	\$ 5,000
A2.2	Oversee the development of additional retention basins in new corridor site (<i>Labor, Other</i>)	\$ 3,250	\$ 5,000	\$ 8,250	\$ 8,250
C2.1	Coordinate and attend meetings with researchers, engineers and/or wetland practitioners (<i>Labor, Travel, Other</i>)	\$ 1,200	\$ 1,800	\$ 3,000	\$ 3,000
B2.1	Conduct 12 months of on-going hydrologic monitoring (<i>Labor</i>)	\$ 8,500	\$ 12,500	\$ 21,000	\$ 21,000
C1.1	Host 12 months of community workdays (<i>Labor, Other</i>)	\$ 4,723	\$ 5,589	\$ 10,312	\$ 10,312
B2.2	Analyze data to quantify the amount of water recharged and hydraulic residence time (<i>Labor</i>)	\$ 6,250	\$ 8,000	\$ 14,250	\$ 14,250
Totals		\$ 68,006	\$ 68,006	\$ 136,012	\$ 136,012



Internal Revenue Service
Washington, DC 20224

Date: DEC 19 1968 In reply refer to: T:I:I:1:1

▷ The Nature Conservancy
1522 K Street, N. W.
Washington, D. C. 20005

Attention: E. R. Kingman
Vice President

Gentlemen:

This is in reply to your letter dated October 9, 1968, requesting a ruling that you qualify as a "publicly supported" organization under section 170(b)(1)(A)(vi) of the Internal Revenue Code so that contributions to you are subject to the special limitation provisions of section 170(b)(1)(A) of the Code.

Under section 170(b)(1)(A) of the Code an individual is allowed an additional deduction not exceeding 10 percent of his adjusted gross income for contributions made to certain organizations, including an organization described in section 170(b)(1)(A)(vi) of the Code.

Section 170(b)(1)(A)(vi) of the Code describes an organization referred to in section 170(c)(2) which normally receives a substantial part of its support (exclusive of income received in the exercise or performance by such organization of its charitable, educational, or other purpose or function constituting the basis for its exemption under section 501(a)) from a governmental unit referred to in section 170(c)(1) or from direct or indirect contributions from the general public.

The information submitted with your request discloses the following:

You are exempt from Federal income tax as an organization described in section 501(c)(3) of the Code, which is substantially similar to section 170(c)(2), and contributions to you are deductible under section 170 of the Code.

You were incorporated in October 1951 as a nonprofit corporation under the laws of the District of Columbia. Your purposes, as set forth in your Certificate of Incorporation, are (a) to preserve or

aid in the preservation of all types of wild nature, including natural areas, features, objects, flora and fauna, and biotic communities; (b) to establish nature reserves or other protected areas to be used for scientific, educational, and esthetic purposes; (c) to promote the conservation and proper use of natural resources; (d) to engage in or promote the study of plant and animal communities and of other phases of ecology, natural history, and conservation; and (e) to promote education in the fields of nature preservation and conservation.

It is stated that your primary objective is to acquire and to protect outstanding natural areas. By early 1968, you had been instrumental in having nearly 95,000 acres set aside as sanctuaries and preserves throughout the United States, and you anticipate that you will reach the 100,000 acre mark before the end of the calendar year. You acquire land either by gift or by purchase and a great deal of this procurement is for Federal, state and local governments. Your activities include the chartering of local subordinate chapters to perform local functions in carrying out your purposes.

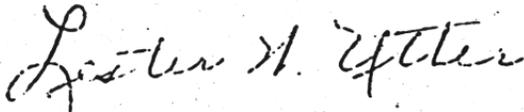
Your by-laws provide for several classes of membership and specify the contribution required for membership in each membership class. Membership in your organization is open to any individual or organization approving of your objectives.

You are governed by a Board of Governors which presently consists of a Chairman of the Board, a Vice Chairman, Secretary, Treasurer and twenty-one members at large. It is stated that the members at large are chosen, insofar as possible, because of their skills, varied interests, and their deep and devoted interest in the conservation of this country's natural resources and an abiding love of the land itself. Additionally, an attempt is made to have the Board represent as many areas of the country as possible.

Your support for the four fiscal years June 30, 1965 through June 30, 1968, was derived substantially from contributions received directly and indirectly from the general public, as well as from membership dues and investment income. An article in the Sunday, November 10, 1968, issue of the Washington Post states that the Ford Foundation is giving you \$6 million to buy 97 tracts of land and hold them for later government use. Your method of making financial reports available to the public has been through your publication, The Nature Conservancy News. In addition to printing a summary in the News, you have always carried a notice stating that the complete financial statement was available upon request to your national headquarters office.

The facts and circumstances presented indicate that you are a publicly supported organization described in section 170(b)(1)(A)(vi) of the Code. Accordingly, the special limitation provided in section 170(b)(1)(A) of the Code is applicable to contributions made to you by individual donors.

Very truly yours,

A handwritten signature in cursive script, appearing to read "Lester H. Ytter".

Chief, Individual Income Tax Branch



**STATE OF HAWAII
STATE PROCUREMENT OFFICE**

CERTIFICATE OF VENDOR COMPLIANCE

This document presents the compliance status of the vendor identified below on the issue date with respect to certificates required from the Hawaii Department of Taxation (DOTAX), the Internal Revenue Service, the Hawaii Department of Labor and Industrial Relations (DLIR), and the Hawaii Department of Commerce and Consumer Affairs

Vendor Name: THE NATURE CONSERVANCY

DBA/Trade Name: THE NATURE CONSERVANCY

Issue Date: 04/19/2017

Status: Compliant

Hawaii Tax#:

New Hawaii Tax#:

FEIN/SSN#: XX-XXX2652

UI#: XXXXXX1123

DCCA FILE#: 2202

Status of Compliance for this Vendor on issue date:

Form	Department(s)	Status
A-6	Hawaii Department of Taxation	Compliant
	Internal Revenue Service	Compliant
COGS	Hawaii Department of Commerce & Consumer Affairs	Exempt
LIR27	Hawaii Department of Labor & Industrial Relations	Compliant

Status Legend:

Status	Description
Exempt	The entity is exempt from this requirement
Compliant	The entity is compliant with this requirement or the entity is in agreement with agency and actively working towards
Pending	The entity is compliant with DLIR requirement
Submitted	The entity has applied for the certificate but it is awaiting approval
Not Compliant	The entity is not in compliance with the requirement and should contact the issuing agency for more information

FINANCIAL ASSISTANCE AWARD

GRANT COOPERATIVE AGREEMENT

FEDERAL AWARD ID NUMBER

NA17NMF4630007

PERIOD OF PERFORMANCE

01/01/2017-12/31/2019

STREET ADDRESS

4245 NORTH FAIRFAX DR STE 100

FEDERAL SHARE OF COST

\$721,095.00

CITY, STATE, ZIP CODE

ARLINGTON VA 22203-1637

RECIPIENT SHARE OF COST

\$361,120.00

AUTHORITY

16 USC 661; 16 USC 1891a

TOTAL ESTIMATED COST

\$1,082,215.00

CFDA NO. AND NAME

11.463 , Habitat Conservation

PROJECT TITLE

Restoration of a Hawaiian wetland and stream in He'eia, O'ahu
to increase ecosystem and community resilience

This Award Document (Form CD-450) signed by the Grants Officer constitutes an obligation of Federal funding. By signing this Form CD-450, the Recipient agrees to comply with the Award provisions checked below and attached. Upon acceptance by the Recipient, the Form CD-450 must be signed by an authorized representative of the Recipient and returned to the Grants Officer. If not signed and returned without modification by the Recipient within 30 days of receipt, the Grants Officer may unilaterally withdraw this Award offer and de-obligate the funds.

DEPARTMENT OF COMMERCE FINANCIAL ASSISTANCE STANDARD TERMS AND CONDITIONS (DECEMBER 2014)

R & D AWARD

FEDERAL-WIDE RESEARCH TERMS AND CONDITIONS, AS ADOPTED BY THE DEPT. OF COMMERCE

BUREAU-SPECIFIC ADMINISTRATIVE STANDARD AWARD CONDITIONS

SPECIAL AWARD CONDITIONS

LINE ITEM BUDGET

2 CFR PART 200, UNIFORM ADMINISTRATIVE REQUIREMENTS, COST PRINCIPLES, AND AUDIT REQUIREMENTS, AS ADOPTED PURSUANT TO 2 CFR § 1327.101

48 CFR PART 31, CONTRACT COST PRINCIPLES AND PROCEDURES

MULTI-YEAR AWARD (PLEASE SEE THE MULTI-YEAR SPECIAL AWARD CONDITION.)

DEPARTMENT OF COMMERCE PRE-AWARD NOTIFICATION REQUIREMENTS FOR GRANTS AND COOPERATIVE AGREEMENTS (REF:79 FR 78390 DECEMBER 30, 2014)

OTHERS(S):

This award is being made under competitive Federal Funding Opportunity Number NOAA-NMFS-HCPO-2016-2004840 posted at Grants.gov on 06/09/2016.

SIGNATURE OF DEPARTMENT OF COMMERCE GRANTS OFFICER

Tarsha Johnson

Grants Officer

DATE

01/06/2017

PRINTED NAME, PRINTED TITLE AND SIGNATURE OF AUTHORIZED RECIPIENT OFFICIAL

DAN DE LANY, GRANTS SPECIALIST *Dan DeLany*

DATE

1/23/17