Appendix D

Assessment of Marine and Pond Environments in the Vicinity of the Kaloko Makai Project
Marine Research Consultants
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AN ASSESSMENT OF MARINE AND POND ENVIRONMENTS IN THE VICINITY OF THE KALOKO MAKAI PROJECT NORTH KONA, HAWAII

Prepared for

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1.0 PURPOSE

Planning is underway to prepare an Environmental Impact Statement (EIS) for 1,139-acres of land known as the Kaloko Makai Project site. The parcel of land is located mauka of the Queen Kaahumanu Highway, is on both sides of Hinalani Drive, and extends to a mauka boundary at an elevation of approximately 760 feet (Figure 1). The project is to be developed in three phases and would consist of a mixture of residential, commercial, industrial and public uses, including a 150-acre dry land forest. None of the proposed land uses includes any alteration of the coastal areas or nearshore waters.

A somewhat unique characteristic of the project is the location relative to the Kaloko-Honokohau National Historical Park (hereafter referred to as KAHO) which lies directly to the west and downslope of the project site on the makai side of Queen Kaahumanu Highway. The National Parks and Recreation Act of 1978 provided for the establishment of the Kaloko-Honokohau National Historical Park to preserve the integrity of the many archaeological features and fishponds found in the area. Kaloko Pond and Aimakapa Pond are large brackish bodies of water separated from the ocean by a basaltic rock wall at Kaloko, and a sand beach berm at Aimakapa. The rock wall at Kaloko Pond has recently been reconstructed, and the new wall incorporates channels which afford a direct connection between the pond and ocean.

Water in the ponds is brackish, consisting of a mixture of low salinity groundwater, and seawater. As a result, water chemistry in the ponds can potentially be influenced by changes in groundwater composition and runoff of surface water. Leaching of materials such as fertilizer nutrients, pest control agents or other materials originating from anthropogenic activities to groundwater could potentially alter pond water chemistry. In addition, as pond water exchanges with ocean water in the nearshore area, there is also potential for alteration of marine water chemistry owing to changes in groundwater composition. Such alterations in water chemistry can, in turn, provide the potential to affect the structure of marine biotic communities in the nearshore area.

In the interest of addressing these concerns and assuring maintenance of environmental quality, it has been deemed appropriate to conduct an assessment of the pond and marine environments that are downslope from the proposed Kaloko Makai project site. The rationale of this assessment is to determine the contribution of groundwater to the pond and marine environments, and the effects of such input on marine community structure and function at the present time before the commencement of any new construction activities. Of particular interest is assessing the nutrient dynamics and associated metabolic activity of the Aimakapa Pond. As this pond is essentially sealed from direct contact with the ocean, the metabolic function of the pond is directly linked to groundwater flux and composition. As a result, Aimakapa Pond is the area with the most potential for changes associated with alteration of groundwater from activities upslope of KAHO.

An important component of the present assessment is the capability to evaluate the effects to water chemistry in Aimakapa and Kaloko Ponds over time. Marine Research Consultants has had the opportunity to conduct investigations of these systems in 2000 and 2007 for other upland development projects using virtually identical methodologies as employed in the 2012 investigations. The opportunity to establish a time-course data series provides a basis to determine how water chemistry has changed over the last eleven years as a result of existing land development makai of the National Park. Combining this information with estimates of changes in groundwater flow rates and chemical composition that will enter the ponds that are predicted to result from the proposed project, it will be possible to evaluate the potential future effects to the composition of the marine and pond environments. Predicted changes in groundwater flow rates and groundwater chemistry have been supplied by Tom Nance Water Resource Engineering (TNWRE) in a report under separate cover entitled "An Assessment of the Potential Impact of the Proposed Kaloko Makai Project on Water Resources" dated December 2012. Results of the combined evaluation will indicate if, and to what degree, there is the potential for negative effects to the aquatic environments from the proposed project.

2.0. METHODS

2.1. WATER CHEMISTRY

2.11. Sampling Sites

The Kaloko-Honokohau National Historical Park is located seaward of the existing Kaloko-Honokohau Industrial development on the mauka side of Queen Kaahumanu Highway, as well as the planned increment of the Kaloko Makai project (Figure 1). Over half of this 1,160-acre National Park is comprised of ocean waters. Contained within its boundaries are also two large fishponds (Kaloko and Aimakapa), tidal areas and wetlands (Figures 2 and 3).

Water samples were collected twice in 2012 (February and November) using a small inflatable boat (February) and kayak (November) paddled along transects that bisected each fishpond in an inshore-offshore direction. Ten sampling stations were established approximately equidistantly along each transect extending from the most landward shoreline of the ponds to the seaward shorelines. For the February event, sampling was continued into the ocean from the shoreline for a distance deemed to reach open coastal ocean (Figures 2 and 3). No ocean sampling was conducted in November 2012. Sampling of the ponds and ocean during previous surveys in 2000 and 2007 were conducted in an identical manner. In addition, in February 2012 samples were collected from three anchialine pools within the Park, designated as numbers 96, 119 and 123.

2.12. Sampling Protocol

All field work was conducted on February 24, 2012 and November 19, 2012. Environmental conditions consisted of light westerly winds and flat seas during both sampling events. Surface water samples were collected by carefully sampling the upper 20 cm of the water column in areas that were not subjected to resuspended sediment plumes. During the February sampling, bottom water was collected using a Niskin-type oceanographic sampling bottle that was lowered to the desired sampling depth with spring-loaded end-caps cocked in an open position allowing free exchange of water through the bottle. At the desired sampling depth, a weighted messenger is released which trips the end-caps closed isolating a 1.8 liter sample of water. During the November sampling, bottom samples were collected by lowering a bottle

attached to a wooden pole to the desired sampling depth and removing the lid with an attached line. Sampling of undisturbed bottom waters presented a challenge in the ponds owing to the shallow water column, extremely turbid conditions and soft, flocculent sediment bottom that was easily resuspended with the slightest water motion. In addition, the bottom topography was extremely variable with numerous deep holes and shallow platforms. Owing to the shallow depth of much of the pond (less than one meter), the highly irregular surface, the extremely flocculent bottom sediments, and the lack of visibility of the bottom from above the water, remote sampling may have resulted in some unavoidable contamination of samples from resuspended material.

Samples were collected in pre-rinsed 1-liter polyethylene bottles. Subsamples for nutrient analyses were immediately filtered into in 125-milliliter (ml) acid-washed, triple rinsed, polyethylene bottles and stored on ice until delivery on the same day as collection to the analytical laboratory in Honolulu. Water for other analyses was subsampled from 1-liter polyethylene bottles and kept chilled until analysis.

2.13. Monitoring Constituents

Water quality parameters evaluated included the 10 specific criteria designated for open coastal waters in Chapter 11-54, Section 06 (Open Coastal waters) of the Water Quality Standards, Department of Health, State of Hawaii. These criteria include: total nitrogen (TN) which is defined as inorganic nitrogen plus organic nitrogen, nitrate + nitrite nitrogen (NO_3^- + NO_2^-, hereafter referred to as NO_3^-), ammonium (NH_4^+), total phosphorus (TP) which is defined as inorganic phosphorus plus organic phosphorus, chlorophyll a (Chl a), turbidity, dissolved oxygen, pH and salinity. In addition, orthophosphate phosphorus (PO_4^{-3}) and silica (Si) were reported because these constituents are sensitive indicators of biological activity and the degree of groundwater mixing, respectively. Vertical profiles of temperature, salinity and dissolved oxygen were acquired at each station using an RBR Model 650 CTD calibrated to factory specifications.

2.14. Analytical Methodology

Analyses for NH_4^+, PO_4^{3-}, and NO_3^- + NO_2^- (hereafter termed NO_3^-) were performed using a Technicon autoanalyzer according to standard methods for seawater analysis (Strickland and Parsons 1968, Grasshoff 1983). TN and TP were analyzed in a similar fashion following persulfate oxidative digestion. For unfiltered samples, total organic nitrogen (TON) and total organic phosphorus (TOP) were calculated as the difference between total nitrogen (TN) and inorganic nitrogen (NO_3^- + NH_4^+), and total phosphorus (TP) and inorganic phosphorus (PO_4^{3-}), respectively. For the filtered samples, dissolved organic nitrogen (DON) and dissolved organic phosphorus (DOP) were calculated in the same manner as the difference between TN and dissolved inorganic nitrogen (DIN), and TP and dissolved inorganic phosphorus (DIP), respectively. The level of detection for the dissolved nutrients is 0.2 µM for TN and Si, 0.02 µM for TP, NO_3^- and NH_4^+, and 0.01 µM for PO_4^{3-}.

Turbidity was measured on a Monitek Model 21 90-degree nephelometer, and reported in nephelometric turbidity units (ntu, level of detection 0.01 ntu). Chl a was measured by filtering

300 ml of water through glass fiber filters; pigments on filters were extracted in 90% acetone in the dark at -5° C for 12-24 hours, and the fluorescence before and after acidification of the extract was measured with a Turner Designs fluorometer (level of detection 0.01 µg/L). Salinity was determined using an AGE Model 2100 laboratory salinometer with a precision of 0.0003‰. pH was determined using a lab meter with combination electrode and a precision of 0.01 pH units. All lab analyses were conducted by Marine Analytical Specialists (Laboratory Certification NO. HI-0009).

2.2. SEDIMENT CHEMISTRY

Surface sediments from a water depth of approximately 10 cm near the shorelines of Aimakapa, Kaloko and anchialine pool 96 were collected in 1-liter glass jars. Jars were sealed, placed on ice and shipped to Calsciences Environmental Laboratories in Garden Grove California for analyses of a organochlorines, organophosphates, chlorinated herbicides, semi-volatile organics and metals.

2.3 BIOTIC COMMUNITY STRUCTURE

The nearshore marine biotic communities off the Kaloko Makai site consist of a well-developed and relatively undisturbed Hawaiian coral reef habitat. The intent of the present study was to describe the overall physical and biotic setting, and to create a benthic habitat map that characterizes this area of the marine environment, particularly with respect to coral cover. The resulting characterization is intended to provide an overview of the habitat characteristics of the region in order to provide information that might be of value relating to the potential effects from upland development. The purpose of the study was not to generate an exhaustive species list of all biota occupying the area.

Evaluation of the marine biological community was conducted by qualitative reconnaissance surveys along the length of the area comprising the marine portion of the Kaloko-Honokohau National Historical Park from the shoreline out to the 10 meters (30 feet) depth contour. Information gathered during the surveys included abundance estimates of the dominant flora and fauna, as well as observations on the factors that affect these biotic assemblages.

An additional component of the biotic evaluation of the area was the production of benthic habitat maps of the area. In brief, this method involved obtaining commercially available remote sensing satellite imagery of the area of interest. Extensive ground-truth data were collected throughout the marine environment fronting the Kaloko Makai property. The ground-truth data were then used to develop a classification system that calibrated the spectral information contained in the remote sensing images. The resulting classification scheme was translated on a pixel-by-pixel basis into area coverage of categories of living benthos (e.g., coral, algae), as well as non-living bottom (e.g., sand, rock). Bathymetry was also added to the maps using available LiDAR (Light Detection and Ranging) data.

The survey area encompassed approximately 1.9 miles [3 km] of linear coastline and extended from the shoreline to a water depth of approximately 33 feet (10 m). While it is acknowledged

that there are deeper reef areas, these reefs are not likely to be affected by activities on land and, hence, were not part of the present survey. The resulting map product provides a unique tool for quantification of components of the entire marine setting that is a valuable asset for understanding the effects of human inputs and subsequent impacts. It is important to note that the purpose of the study was not to generate an exhaustive species list of all biota occupying the area.

All methods utilized in this study to generate nearshore marine habitat maps followed standard procedures for processing coral reef remote sensing imagery (e.g., Andréfouët et al. 2003, Green et al. 2000, Mumby et al. 1998). The benthic habitat map was created based on a fully georeferenced, cloud-free WorldView-2 multispectral satellite image of the Kaloko-Honokohau area that was purchased from the Image Library at DigitalGlobe.com. The image had 2.0 m (6.6 ft) ground sample distance. The WorldView-2 image was processed to highlight submerged features, which revealed areas of different bottom composition.

Fieldwork was carried out on March 19-20, 2012 by divers working from either a 21-ft. boat or from the shoreline. Field operations consisted of assessing 20 "calibration-validation" (cal/val) sites placed strategically throughout the survey areas. Locations of cal/val sites were selected in the field based on investigator knowledge and visual interpretation of existing satellite "true-color" imagery, with the intent of maximizing coverage of all reef areas within the region of interest. Exact locations of cal/val sites were recorded during the course of field work using a waterproofed GPS with a presumed accuracy of <1 m.

At each geo-located site, cal/val data were obtained by digitally recording the composition of the benthic surface using an underwater camera fitted with a 14 mm-wide angle lens. To ensure uniformity of the area of data collection, the camera was mounted on a platform centered over a PVC quadrat frame by four legs, similar to a tripod. The base of the frame forms a quadrat with dimensions of 1 m x 0.66 m, which is the same proportion as a photographic frame. Each cal/val site consists of five photo-quadrats arranged in a "cross" pattern ~5 m in diagonal, resulting in total reef surface area of 3.33 m^2, which encompasses an area of approximately four pixels of remote sensing imagery. For the present project, a substantial portion of the inner reef flat had water depths shallower than the height of the camera platform. In these areas oblique photographs of the bottom were taken and bottom cover data were extracted from these photographs.

Following fieldwork, the digital images were analyzed by projecting a grid dividing the frame into 100 equal-sized segments. Coral cover by species, as well as bottom cover of benthic algae, motile macro-benthos and non-living categories including sand, mud, bare limestone and rubble, were estimated by tabulating cover types within the segments. Zoom features of computer software and the high resolution of the digital photographs (~10 megapixels) generally allowed delineation of corals to the species level. Total cover of all five photographic frames constituted the cover estimates for each cal/val site. An advantage of using such a photo-quadrat method is that it allows for the collection of far more data per unit time than traditional *in-situ* transect techniques, with little or no loss of data quality or interpretation. Thus, the photo-quadrat technique provides far more extensive coverage of the subject area without any significant loss of information. In addition, the photographic survey method provides a permanent data record that can be utilized for future time-course surveys that are of value in determining changes to reef structure. All photo-quadrats evaluated by point counts are contained in Appendix B.

In the lab, map generation was accomplished by locating cal/val points on the geo-referenced satellite multispectral image that served as the basis for statistical image classification. "Training classes" (defined as the combination of geo-morphological zone and bottom cover) were created by assigning a class label to a survey point using the ground truth data for context. To spectrally define a "region of interest" for a training class, 20-30 adjoining pixels were isolated and included in the class. All training classes with the same spectral label were used to create a map showing the distribution of that particular bottom cover over the reef. The resultant analysis produced maps showing discrete classifications of coral, algal and mud/sediment cover. In addition to benthic habitat classifications, maps incorporate depth contours based on available LiDAR data (Figure 22). The data used to create the maps are compatible with ArcGIS.

Abundance of reef fish was estimated at selected cal/val sites using 10-minute stationary point counts. At these locations, an observer remained at the location of the boat anchor and recorded all fish visible within a 360° viewplane.

3.0 RESULTS

3.1 WATER CHEMISTRY

3.1.1 Physical Characteristics of Aimakapa and Kaloko Ponds.

Tables 1-5 and 1A-5A show results of marine and pond water chemical analyses for samples collected in Aimakapa and Kaloko Ponds and the adjacent ocean during four survey increments from 2000 to 2012.Tables 1-5 show nutrient concentrations in micromolar units (μM), while tables 1A-5A show nutrient concentrations in unit of micrograms per liter (μg/L). Tables 1-1A and 2-2A shows results of sampling in Aimakapa Pond and Kaloko Pond and adjacent ocean in February 2012, respectively, while Table 3-3A shows results of pond sampling conducted in November 2012. Tables 4-4A and 5-5A show results from samples collected during surveys in 2007 and 2000, respectively. Concentrations of twelve chemical constituents in surface and bottom water samples from Kaloko and Aimakapa Ponds and the offshore ocean from the four survey years are plotted as functions of distance from the shorelines in Figures 4-17.

Examination of Tables 1-5 and Figures 4-17 show several major patterns of horizontal stratification of water chemistry constituents in the ponds and ocean. The most obvious characteristic of the data set is the major differences between patterns of water quality constituents in Aimakapa/Kaloko Ponds and the ocean. The second most apparent difference in water chemistry is the variation in the patterns of distribution of water chemistry constituents between Aimakapa Pond and Kaloko Pond. These variations between the two large fishponds are primarily the result of differences in physical structure of the barriers between the ponds

and the ocean. Aimakapa pond is separated from the ocean by a fairly wide (~20 m) continuous sand berm which is not very permeable to exchange between the pond and the ocean. Such impermeability is apparent in the sharp, nearly vertical gradients at the shoreline of many of the water chemistry constituents (e.g., Salinity, Si, TN, TP, TON, TOP) in Aimakapa Pond (Figures 4, 5, 11, 12, 13, 14).

Compared to the sand berm bounding Aimakapa Pond, the rock wall that separates Kaloko Pond from the ocean is highly permeable, and exchange of water between the ocean and pond is enhanced by channels ("makahas") constructed into the wall. Hence, the gradation in the water chemistry constituents between pond and ocean are less distinct in Kaloko compared to Aimakapa Pond, and the gradients within Kaloko Pond are more continuous between pond and ocean compared to Aimakapa. It should be noted that these direct connections between the pond and ocean eliminate Kaloko Pond from the designation of "anchialine" which requires that no such connections exist.

While both ponds contain thick sediment bottoms, there is a substantial difference in the quality of the sediment. Bottom composition of Aimakapa Pond consists of soft flocculent silty mud that is easily penetrable for at least one meter. Bottom composition of Kaloko Pond is a hard sand/mud mixture that is largely covered with marine algae, primarily the introduced species *Acanthophora specifera*. Sand/mud bottoms in both ponds were distinctly anaerobic beneath the surface layer as evidenced by the strong odor of H_2S when the bottom was even slightly disturbed.

3.1.2 Horizontal and Vertical Stratification of the Water Column

3.1.2.1 Salinity

During all sampling events, salinity within ponds showed very different horizontal gradations from the ocean to the shoreward sides of the ponds. In Aimakapa Pond, average salinity during the four surveys ranged from 12.45‰ in November 2012, 12.44‰ in February 2012, 12.67‰ in 2007 and 3.17‰ in 2000. The overall salinity in Aimakapa averaged over all four surveys was 12.64‰, with a standard deviation of 0.43‰. These data indicate that the salinity in Aimakapa is remarkable constant over the entire area of the entire pond, as well as over the 12-year interval of sampling. There is however, a slight trend of freshening over time, with the 2012 samples exhibiting the lowest salinities. The constancy of salinity through both time and space in Aimakapa Pond is clearly evident in Figure 4.

The overall pattern of salinity in Kaloko Pond was substantially different than in Aimakapa. Average salinity in the fishpond during the four increments of sampling was 22.93‰ in Nov. 2012, 24.52‰ in Feb. 2012, 19.59‰ in 2007 and 33.02‰ in 2000. The overall average salinity in Kaloko Pond for all surveys was 24.8‰ with a standard deviation of 6.1‰. As Kaloko Pond is "connected" to the ocean, the variability in salinity is a result of sampling at various stages of tide, and is also likely a response to the various stages of construction of the rock wall separating the pond from the ocean. As can be seen in Figure 4, all of the samplings of Kaloko Pond exhibited a pattern of increasing salinity with decreasing distance from the shoreline, indicating gradient of mixing between seawater and groundwater. The overall patterns of salinity, with the lowest values in 2007 and the highest in 2000 do not suggest any consistent pattern with respect to time as a function of groundwater input into the pond.

Inspection of Tables 1-5 reveal slight vertical gradients in salinity in all sample sets with a surface layer of fresher water overlying a water column of saltier water. In Aimakapa Pond, salinity of surface samples was generally about 0.1-0.2‰ lower than bottom samples. In Kaloko Pond, the differences between surface and bottom samples was up to 2-4‰. The difference in vertical stratification between the ponds reflects the different levels of input and mixing between ocean water and groundwater, which are both lower in Aimakapa relative to Kaloko.

Comparing values of salinity within Aimakapa Pond to salinities of anchialine pools located in KAHO indicate that salinity in the fishpond is within the range of salinity as water in three representative pools water (8-14‰), while the salinity in Kaloko Pond is substantially higher than anchialine pools (Table 1). These comparisons again point to the open circulation between Kaloko Pond and the ocean.

Nearshore ocean waters in West Hawaii are typified by a pattern of decreasing salinity with distance from shore. This gradient is indicative of low salinity groundwater entering the ocean near the shoreline and mixing with high salinity ocean water. While this was the general pattern observed on the KAHO transect sites in 2007 and 2012, a somewhat unusual result in the 2000 data is that the lowest salinities in the ocean samples were not found nearest to the shoreline off of either fishpond. Rather, the lowest salinities were measured in surface ocean samples approximately 25-50 m offshore. Such a result suggests that the majority of groundwater flow to the ocean may be around the pond boundaries, rather than through the shoreline barriers that separate the ponds from the ocean.

Horizontal and vertical stratification of salinity in the ocean samples was evident at all stations during all surveys. Beyond 25-50 m from shore, with increasing distance from shore, salinity increased at all stations in both surface and bottom water, while at all sampling stations, surface salinity was lower than the corresponding bottom sample. These gradients indicate that mixing of groundwater entering the ocean does not completely homogenize the water column, with a surface layer of lower salinity water overlying a water column of ocean water.

3.1.2.2 Nutrients

As a result of the differences in permeability between the two ponds in terms of both input of groundwater and mixing with the ocean, the patterns of dissolved nutrients vary considerably between ponds. The patterns prescribed by the concentrations of dissolved Silica (Si) on transects are essentially a mirror image of salinity during all surveys (Figures 4 and 5). These mirror image patterns reflects the two orders of magnitude difference in concentrations of Si between groundwater and ocean water. In addition, the mirror image of Si and salinity indicates that Si is a "conservative" tracer, in that it is not utilized to any measurable extent by biotic or chemical reactions within the ponds and ocean. As a result, there is the same large variation in patterns of concentration of Si between the ponds, and same degree of stratification of Si as was evident in salinity.

In addition to Si, the other nutrient found in high concentrations in groundwater relative to ocean water is nitrate nitrogen (NO_3^-). However, while the distribution patterns of Si in Aimakapa Pond revealed consistent and similar magnitudes of Si concentrations across Aimakapa Pond (Figure 5), the situation for NO_3^- is substantially different. While the concentrations of NO_3^- in the 2000 and 2007 surveys were consistently low (below 0.5 μM) across the entire sampling transect, substantially different patterns occurred in both 2012 surveys. During these two surveys, concentrations of NO_3^- at the inshore end of the pond exhibited peak values with rapidly decreasing concentrations to the center region of the pond (Figures 6 and 7). The magnitude of the gradients was different between the February and November 2012 surveys, with peak values of about 13 μM in February and 50 μM in November. However, the location in the pond where the concentrations dropped to previously measured levels of NO_3^- of less than 1 μM occurred at nearly the same place during both surveys (~150 m from the shoreline) (Figure 6 and 7). The pattern of the other major inorganic nutrient, phosphate phosphorus (PO_4^{3-}) exhibits a similar pattern, with highest values at the shoreward edge of Aimakapa Pond wand sharply decreasing values up to the center of the pond (Figure 9).
These steep horizontal gradients of NO_3^- and PO_4^{3-}, as well as depressed salinity, suggest the possibility of a qualitatively different level of groundwater input at the mauka shoreline of Aimakapa Pond in 2012 relative to past surveys. While it is unlikely that the magnitude of groundwater flux has increased, it is possible that influx varies as a result of water level in the ponds. It has been shown that Aimakapa Pond responds to tidal fluctuations (damped relative to the ocean cycle in both magnitude and time) which push pond water inland during flood tides and draw groundwater into the ponds during ebbing tidal cycles (Tom Nance, personal communication). As pond salinity was higher in 2000 and 2007 relative to 2012 (Figure 7), the distinct differences in nutrient gradients between these years may be a reflection of when samples were collected relative to tidal state. Sample collection in 2012 may have taken place during a stage of ebbing tide resulting in higher groundwater efflux into the pond at the inland shoreline, while sampling in 2000 and 2007 may have occurred during a flooding tide which swamped out the groundwater flow into the pond, or produced a flow from the pond inland.

However, while there is a distinctly higher input flux of NO_3^- and PO_4^{3-} along the mauka shoreline of Aimakapa during 2012, the incoming inorganic plant nutrients are almost completely taken up within the shoreward half of the pond (Figures 6 and 7).

Kaloko Pond also shows distinct gradients of NO_3^- and PO_4^{3-}, with an overall similar pattern to Aimakapa Pond. While the peak values of NO_3^- occurred in 2012 in Aimakapa, the peaks in Kaloko occurred in 2007 corresponding to minimum values of salinity (Figures 6 and 8). In contrast to the steeply declining concentrations of NO_3^- down to very low values before the center of Aimakapa Pond, gradients were less steep and extended further toward the ocean end of Kaloko Pond (Figures 6 and 9).

Gradients of other forms of nitrogen and phosphorus show distinctly different patterns of distributions than NO_3^- and PO_4^{3-}, particularly in Aimakapa Pond. During all four of the sampling events, total nitrogen (TN) is relatively constant across the entirety of Aimakapa Pond, showing little of the steep gradients evident for NO_3^- (Figure 10). While the lowest concentration of NO_3^- occurred in Aimakapa in 2000, the highest levels of TN were present in pond water during that year (Figure 10). Of the peak values of TN in 2000, virtually all of it exists as total organic nitrogen (TON) (Figure 11), rather than either NO_3^- or ammonium (NH_4^+) (Figure 12). In the 2012 surveys, concentrations of TON mirror NO_3^- with lowest values at the inshore end of the pond, and elevated values in the seaward portion of the pond. In particular in the November 2012 survey, the sharp elevation in concentrations of TON occur at the sampling station approximately 150 m from the shoreline, which is the same location that concentrations of NO_3^- dropped to low values. The same patterns are evident for total phosphorus (TP) and total organic phosphorus (TOP) (Figures 13 and 14).

Total organic nitrogen and phosphorus are the end products of decomposition of organic material, while the inorganic nutrients NO_3^- and PO_4^{3-}, as well as NH_4^+ are the nutrients taken up by plants during photosynthetic activity. The considerably different patterns of distributions of these nutrient components in Aimakapa Pond over the last 12 years suggest a shift in metabolic function over time. During the earliest survey in 2000, virtually all of the nitrogen and phosphorus in Aimakapa Pond was in the form an organic form (TON, TOP), with essentially no NO_3^- and PO_4^{3-} present. Such a distribution indicates that the pond was in a decaying state, proceeding toward anoxic conditions. The patterns of pH also confirm such metabolic function with highest values increasing across the pond in 2000 (Figure 15). The increasing metabolic breakdown of organic material and production of carbon dioxide, increases values of pH.

During both 2012 surveys, the metabolic functioning of Aimakapa appears to have shifted toward a more "open" system. High input of low salinity water containing high concentrations of inorganic nutrients found in groundwater are evident along the inland shoreline of the pond. These concentrations decrease with distance seaward until the approximate center of the pond, where concentrations approach the levels found in 2000. TON and pH mirror the pattern of nutrients indicating gradients of progressive uptake and metabolic processes from the mauka edge toward the center of the pond. Hence, the recent data indicates steep gradients within Aimakapa Pond indicate that the entire system does not remain a completely heterotrophic system removing nutrients from the water column, while adding back end products of metabolic decomposition. Rather, the apparent increase in groundwater now results in indications that at least part of the pond is a more open system with respect to metabolic cycling reversing somewhat the progression toward an anoxic system. It may be however, that the differences between nutrient gradients in different sampling years is a response to sampling during different phases of the tidal cycle, with nutrient fluxes into the pond more pronounced during ebbing tides.

Plots of Chlorophyll a (Figure 16) and turbidity (Figure 17) are similar, indicating that most of the turbidity of pond water is a result of phytoplankton. The highest Chlorophyll a levels were evident in bottom waters of Aimakapa pond during the 2000 survey. The close tracking of Chl a and turbidity in this survey indicates that the high values are not the result of resuspension of bottom sediment. Chlorophyll a (Figure 16) and turbidity (Figure 17) are also elevated in surface and bottom waters of Kaloko Pond relative to ocean water, but without the anomalous values in bottom water during 2000.

3.1.3 Conservative Mixing Analysis

A useful treatment of water chemistry data for interpreting the extent of material input from land is application of a hydrographic mixing model. In the simplest form, such a model consists of plotting the concentration of a dissolved chemical species as a function of salinity. Comparison of the curves produced by such plots with conservative mixing lines provides an indication of the origin and fate of the material in question (Officer 1979, Dollar and Atkinson 1992, Smith and Atkinson 1993). This method of data interpretation has recently been adopted by the State of Hawaii Department of Health as a new protocol for evaluating compliance with water quality standards in West Hawaii.

Figures 18-20 show plots of concentrations of four nutrient constituents as functions of salinity for Aimakapa and Kaloko ponds, anchialine pools and ocean water samples collected in the KAHO during the four sampling surveys in 2000, 2007 and 2012. In addition, nutrient concentrations and salinity from data collected in three monitoring wells within the KAHO boundaries are also shown. Each plot in Figures 18-20 also show two conservative mixing lines that was constructed by connecting the end member concentrations of open ocean water and averaged high-level groundwater concentrations from the DWS Honokohau Well (4158-03), and averaged basal groundwater Kaloko Irrigation Well (4160-02) (Well data provided by TNWRE 2012).

If the parameter in question displays purely conservative behavior (no input or removal from any process other than physical mixing), data points should fall on, or very near, the conservative mixing line. If, however, external material is added to the system through processes such as leaching of fertilizer nutrients to groundwater, data points will fall above the mixing line. If material is being removed from the system by processes such as uptake by biotic metabolic processes, data points will fall below the mixing line. It is also important to note that since nutrient concentrations are scaled to salinity, the effects of tidal state are not a factor in interpreting data on source or sinks.

Dissolved Si represents a check on the model as this material is present in high concentration in groundwater, but is not a major component of fertilizer. In addition, Si is not utilized rapidly within the nearshore environment by biological processes. It can be seen in Figure 18 that all of the data points from both Aimakapa and Kaloko Ponds, the three anchialine pools, and the ocean fall very close to the conservative mixing line for Si. Such agreement indicates that the end members used to construct the lines are representative of the system. The only data set that deviates from the linear pattern falling near the conservative mixing lines is for Monitoring Well 1, with anomalously low values in samples collected in 2000 and 2001 (TNWRE 2012). The lack of curvature in the linear arrays of data points also indicate that there is no detectable uptake of Si within the pond and marine system, and no other sources of Si other than groundwater.

The plot of NO_3^- versus salinity reveals distinctly different results than plot of Si (Figure 18). Plots of concentrations of NO_3^- versus salinity in Aimakapa Pond show a distinct nearly vertical line extending from the point of intersection with the mixing line (data from November 2012) to the X-axis with a NO_3^- concentration of essentially zero. This linear array illustrates the process described in the section above where groundwater containing high levels of NO_3^- relative to seawater enters Aimakapa Pond at the mauka shoreline. With mixing of the groundwater into the pond, NO_3^- is rapidly stripped by biotic uptake. The orientation of data points from both of the surveys in 2012 along the same linear array suggests the same degree of removal of nutrients relative to salinity is occurring within the pond.

The arrays of NO_3^- data points for Kaloko Pond are substantially different than for Aimakapa (Figure 16). At the low salinity end of the plots, at salinities less than 15‰, all data points fall on the conservative mixing lines, indicating that concentrations in the pond at these sampling points consists exclusively of mixing of groundwater and ocean water. At salinities higher than 15‰, data points all lie beneath the mixing lines, with concentrations of NO_3^- decreasing steadily to very low values to a salinity of approximately 30‰. These patterns delineate uptake of NO_3^- by biotic processes within the main body of Kaloko Pond. As with the smooth linear array of data points of decreasing value with increasing salinity in Aimakapa, the relatively smooth curve prescribed by the data points in Kaloko indicate that there are no other sources or sinks of NO_3^- within the pond. Salinities above about 30‰ represent samples from the nearshore ocean, which show a slight increase in concentration relative to pond waters. Such an increase suggests that groundwater may be entering the ocean from other entry points than through the ponds.

Concentrations of NO_3^- in the anchialine pools scaled to salinity lie on, or slightly above the conservative mixing lines. The position of these points indicates that the same processes of NO_3^- uptake occurring in the two large fishponds is not occurring in the anchialine pools. Rather, groundwater nutrients remain in essentially the same concentration while in the anchialine pool as in the submarine aquifer. Such a difference in nutrient cycling in the smaller anchialine pools relative to the fishponds is a result of far more rapid flushing and turnover rate of water in the pools. Concentrations of NO_3^- in monitoring wells are generally above the conservative mixing lines, suggesting an external source of NO_3^- other than naturally occurring groundwater.

Phosphate phosphorus (PO_4^{3-}) is also a major component of fertilizer and sewage effluent, but is usually not found to leach to groundwater to the extent of NO_3^-, owing to a high absorptive affinity of phosphorus in soils. The curves defined by the plotted data of PO_4^{3-} as a function of salinity are similar to NO_3^-, although the concentrations differ by an order of magnitude (Figure 19). In addition, data points from the shoreward end of Aimakapa Pond occur above the mixing lines, indicating a source of PO_4^{3-} that is not completely naturally occurring groundwater. However, the near-vertical linear array of data points indicates rapid uptake of PO_4^{3-} beyond the shoreward edge of the pond. The distribution of data points in Kaloko Pond also reflects mixing of groundwater and ocean water along with uptake by biotic activity within the pond, although the magnitude of uptake is less than in Aimakapa Pond (Figure 19). Concentrations of PO_4^{3-} scaled to salinity in the anchialine pools all fall near the conservative mixing lines indicating that there are no external sources of PO_4^{3-} to the anchialine pools from sources other than naturally occurring groundwater. Similar to anchialine pools, the scaled concentrations of PO_4^{3-} for monitoring wells 2 and 3 fall on the conservative mixing lines, while most data points for well 1 lies below the mixing lines.

The other form of dissolved inorganic nitrogen, NH_4^+, shows a reversed pattern of distribution relative to conservative mixing lines when concentrations are plotted as functions of salinity. It can be seen in Figure 19 that the conservative mixing lines are nearly flat with nearly similar concentrations in groundwater and ocean water. The occurrence of nearly all of the data points from all water sources lying above the mixing lines indicates that the observed concentrations of NH_4^+ are not a result of mixing of groundwater and ocean water. Rather, these concentrations are the result of either input from another source, or as is more likely the case, from *in-situ* metabolic processes within the ponds.

Because total organic nitrogen and phosphorus (TON and TOP) occur in very low concentrations in both open ocean water and high level groundwater, the mixing lines for these constituents are essentially flat (Figure 20). The occurrence of data points of TOP and TON far above the mixing lines likely reflects the metabolic cycling conversion of inorganic nutrients to organic nutrients by plant metabolism and decomposition in Aimakapa Pond. Owing to low circulation and flushing of the majority of Aimakapa, and no uptake by biotic function, these organic nutrients remain in the water column. Contrary to Aimakapa Pond, the data points of TOP and TON versus salinity fall near the mixing lines, indicating that the level of organic decomposition and/or flushing of the pond is not occurring at the same level in Kaloko Pond. Within the anchialine pools and monitoring wells, TON and TOP occur at very low levels, supporting the observation that rapid water exchange through the pools and wells prevents accumulation of the products of organic metabolism.

Two major points can be made to summarize the results of the mixing analyses. First, and most importantly, there are no indications of significant input to any of the ponds of inorganic nutrients from sources other than naturally occurring groundwater. None of the data points scaling inorganic nutrients to salinity within the ponds or nearshore ocean indicate substantial nutrient subsidies to groundwater that could be a result of human activities in upland areas. The constituents that show substantial elevations in the ponds (NH_4^+, TON and TOP) are not the direct result of nutrient loading, but rather byproducts of metabolic cycling coupled with long residence time (slow water exchange) within the ponds.

The second major point that is illustrated by the nutrient data and mixing plots is that during the recent samplings in 2012 Aimakapa Pond exhibited a far more detectable pattern of active groundwater flux than in previous surveys. At the inland shoreline of the pond, input of low salinity, high nutrient groundwater was clearly evident during both of the 2012 surveys. Such input was not present in earlier surveys utilizing identical sampling methods. While the nutrient inputs were rapidly taken up within the shoreward half of the pond, the input of groundwater suggests a more active circulation than in the past. While the process responsible for these differences in input over a decadal period are not readily decipherable, it is clear that there is no indication of increased senescence of Aimakapa Pond. Rather, the measured increase in circulation indicates that the pond may be stabilizing the trend of tending toward a system completely dominated by decomposition and infilling of sediment.

While not included in the present data presentation, past investigations of the KAHO area have included comparisons of the nutrient dynamics occurring in the fishponds to the effects of discharges of water from the Natural Energy Laboratory of Hawaii at Keahole Point. These comparisons indicate that subsidies to groundwater of NO_3^- and PO_4^{-3} are far greater at

NELHA than in the Kaloko-Honokohau area as a result of high concentrations in deep seawater that is discharged into disposal trenches along the shoreline.

3.1.3 Pond Metabolism

The major concern regarding impacts to the pond resources at the KAHO from development of the Kaloko-Honokohau Business Park is the effect that increased nutrient loading will have on pond metabolic function. The perception is that increases in nutrient concentrations to groundwater flowing mauka from the development site to the National Park will alter the ponds in an undesirable manner. While the data discussed above indicates that at the present time there is no increases in nutrient loading in the ponds, it is of value to present the results of experiments conducted in Aimakapa Pond during a one-week period in December 2001-January 2002 when pond metabolism was estimated using measured changes in dissolved oxygen.

Figure 21 shows the resulting plots of dissolved oxygen and temperature over the 7-day deployment. Oxygen concentrations and temperature track exceptionally well. The highest daylight temperatures corresponding to the peak oxygen concentrations in mid-afternoon. The temperature and oxygen lows occur just prior to dawn. Peak oxygen concentrations of 11 mg/L at 27.5° correspond to saturation of about 140% while lows of oxygen concentration of 2.5 mg/L at 23° correspond to a saturation of about 33%. Of interest is that the daily amplitude of the peaks and lows for each day is similar with the exception of December 30, 2001, when peak temperature and oxygen were lower than the remainder of the data set. Weather conditions on this day consisted of heavy rainfall, with little direct sun. All other days were sunny.

This pattern indicates that pond metabolism is dominated by daylight photosynthesis and dark respiration. Comparing groundwater nutrient loading to the pond with gross production/respiration within the pond indicates that only approximately 4% of the pond metabolism can be supported by "new" nutrients delivered to the pond by groundwater flux. The remaining 96% of nutrient uptake must therefore be supported by recycling of nutrients within the pond. It is likely that the actual percentage of nutrient recycling is even higher (~99%) than the estimate as it is clear from all available data that groundwater flow into the pond is substantially restricted.

3.2. POND SEDIMENT ASSESSMENT

In order to evaluate the presence of toxic compounds and elements in sediments of the KAHO ponds, samples were collected at the seaward ends of Aimakapa Pond (KAHO-1), Kaloko Pond (KAHO-2) and in anchialine pool 96 (KAHO-3). Complete results of analyses are shown in Appendix A. In summary, none of the 28 organochlorides (EPA Method 8081A), 20 organophosphates (EPA Method 8141B), or 10 chlorinated herbicides (EPA Method 8151A) were detected in any pond sediment.

Of the 40 semivolatile organics (EPA Method 8270C), the only compound above the level of detection was phenol, which was present in the sample from Kaloko Pond at a concentration of 0.14 mg/kg. In previous surveys, phenol was also the only compound detected. Phenols are ubiquitous in the environment as they are a naturally occurring component of all foods, particularly plants, and are considered an antioxidant. They are also used in cosmetics, mouthwashes, disinfectants and in the synthesis of manufactured surfaces. The EPA has determined that exposure to phenol in drinking water at a concentration of 6 mg/L for up to 10 days is not expected to cause any adverse effects in children, and that a lifetime exposure to 2 mg/L in drinking water is not expected to cause any adverse effects. The single detection of phenol at a concentration of 0.14 mg/kg in sediments that will never be injested is an order of magnitude lower that the EPA limits.

Results of metal analysis in sediments conducted by Inductively Coupled Plasma Mass Spectrometry (ICPMS) revealed numerous detections in sediments from all three sampling stations (Appendix A). Aluminum, Arsenic, Barium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Molybdenum, Nickel, Selenium, Vanadium and Zinc occurred in all samples, while Cadmium was present in the sample from Aimakapa Pond (KAHO-1). Mercury was not detected in any of the samples. While metals were present in all of the samples, they are naturally present in volcanic soils. Further comparison of the concentrations found in the KAHO samples to reference levels in soils and water will be necessary to determine if the levels present represent significant input from other than natural sources.

3.3. BIOLOGICAL COMMUNITY ASSESSMENT

Marine community structure as represented in this report can be defined as the abundance, diversity, and distribution of a benthos (bottom dwelling organisms), including stony and soft corals, marine plants (algae), a motile benthos such as echinoderms, pelagic species such as reef fish, and federally protected species. When considering environmental changes caused by changes in land use or changes in non-point input of water of altered composition, benthic communities are probably the most useful biological assemblages for direct evaluation of environmental impacts to the offshore marine environment. Because benthos are generally long-lived, immobile, and can be significantly affected by exogenous input of sediments and other potential pollutants, these organisms must either tolerate the surrounding conditions within the limits of adaptability or die.

3.3.1 Zonation of the Marine Habitat

As described above, Kaloko Pond is separated from the ocean by a rampart of basaltic boulders, while Aimakapa Pond is separated from the ocean by a solid berm of beach sand. The main structural feature of the offshore area seaward of both ponds is a shallow basaltic ledge of pahoehoe lava. The ledge is particularly wide fronting Aimakapa Pond. Adjacent to the Kaloko Pond frontage the shoreline is composed of a rocky shoreline composed primarily of outcrops of lava that extend seaward.

Because of the structure of the boulder rampart and beach berm that separate the ponds from the ocean, there is virtually no intertidal area. Beyond the boulder shoreline, the structure of the offshore environment off of Kaloko generally conforms to the pattern that has been documented as characterizing much of the west coast of the Island of Hawaii (Dollar 1975, 1982, Dollar and Tribble 1993).

The zonation scheme consists of three predominant regions. Beginning at the shoreline and moving seaward, the shallowest zone beyond the shoreline is comprised of a seaward extension of the basaltic shoreline bench, consisting largely of essentially bare basalt surfaces. Owing to the shallow depth and exposure to waves, the bench area is characterized by high turbidity and scour from resuspended sand. The most abundant coral occupying the nearshore bench is *Pocillopora meandrina*, a sturdy hemispherical coral is the dominant colonizer of the nearshore area. This species is able to flourish in areas that are physically too harsh for most other species, particularly due to wave stress. The shallow flat pavement area directly in front of the Kaloko Pond seawall appears to be an ideal habitat for *Pocillopora meandrina*. Other corals in the area consist of hemispherical heads of *Porites lobata*, and flat encrustations of *Montipora* spp.

Moving seaward, the flat nearshore bench area terminates in a ledge that has a roughly vertical face that extends to a depth of approximately 25 feet. Beyond the ledge, bottom topography consists of a reef platform that is typical of West Hawaii. The transition area between the shallow flat pavement zone and the reef platform zone is characterized by high relief in the form of undercut ledges and basaltic boulder pinnacles. As wave stress in this region is less than in the shallower areas, and suitable hard substrata abound, the area provides an ideal locale for colonization by attached benthos, particularly reef corals, and generally the widest assortment of species and growth forms are encountered in this region. The predominant coral in the area in *Porites lobata*, which occurs in a variety of growth forms.

The seaward edge of the reef platform (at a depth of about 50 feet) is marked by an increase in slope to an angle of approximately 20-30 degrees. In the deep slope zone, substratum changes from the solid continuation of the island mass to an aggregate of generally unconsolidated sand and rubble. The predominant coral cover in the slope zone is typically interconnected mats of "finger coral" (*Porites compressa*), which grow laterally over unconsolidated substrata.

The physical structure of the offshore region at Aimakapa is somewhat different than off Kaloko. The nearshore area consists of an extended flat basalt shelf that extends approximately 100 m from shore. Figure 22 is an aerial photograph of the Kaloko-Honokohau area that clearly shows the extent of the basaltic shelf that extends off of Aimakapa Pond (as denoted by green, rather than blue water). The surface of the platform contains holes and fissures, and small sand-filled channels, but relatively low cover of living corals. At the seaward termination of the shelf, a reef crest consisting of a shallower ridge of limestone separates the inner bench from the outer reef, which is similar to that described above off of Kaloko Pond.

3.3.2 Coral Communities

The predominant taxon of macrobenthos (bottom-dwellers) throughout the reef zones off of Kaloko Pond are Scleractinian (reef- building) corals. In total, eight species of "stony" corals,

and two "soft corals" were observed throughout the region of study. Table 6 shows summary data of coral coverage at all calibration-validation sites, while Figure 23 shoes the map of coral abundance. Overall coral cover consisted of 40% of bottom cover, with bare basalt rock comprising 33% of bottom cover. The dominant species in all of the zones off Kaloko-Aimakapa was *Porites lobata* which comprised 66% of coral cover. The next most abundant species were *Porites lutea (11%), Porites compressa* (10%), and *Pocillopora meandrina (9%).* These four species comprised 96% of all coral cover. Other species that occurred across the reef were *Montipora capitata, M. patula* and *Pavona varians.*

The mid-depth reef platform zone had the highest number of coral species at both survey sites. In the mid-depth zone, dominant species were *Porites lobata* and *Porites compressa*. *Porites lobata* occurs in various growth forms including flat encrustations and large dome-shaped colonies, which are responsible for much of the true "reef" accumulation in the mid-depth zones. The abundance of suitable solid surfaces for coral settlement and growth, as well as the reduced wave stress compared to the shallower boulder zones provides a suitable setting for a variety of smaller encrusting coral species. Coral cover on the outer reef platform comprised approximately 40-60% of bottom cover (Figure 23).

3.3.3 Other Benthic Macroinvertebrates

The other dominant group of macroinvertebrates are the sea urchins (Class Echinoidea). The most common urchin was *Echinometra matheai*, which occurred in all reef zones. *E. matheai* are small urchins that are generally found within interstitial spaces bored into basaltic and limestone substrata. *Tripneustes gratilla*, and *Heterocentrotus mammillatus* were other species of urchins that occurred commonly throughout the reef. Both of these urchins occur as larger individuals (compared with *E. matheai*) that are generally found on the reef surface, rather than within interstitial spaces.

Sea cucumbers (Holothurians) observed during the survey consisted of three species, *Holothuria atra*, *H. nobilis*, and *Actinopyga obesa*. Individuals of these species were distributed sporadically across the mid-reef and deep reef zones. Numerous sponges were also observed on the reef surface, often under ledges and in interstitial spaces.

Frondose benthic algal occurrence was extremely limited throughout the study area off of Kaloko. However, encrusting red calcareous algae (*Porolithon spp.*, *Peysonellia rubra*, *Hydrolithon spp.*) were common on the boulders and exposed rocks throughout the study area. These algae were also abundant on bared limestone surfaces, and on the nonliving parts of coral colonies.

The design of the reef survey was such that no cryptic organisms or species living within interstitial spaces of the reef surface were enumerated. Since this is the habitat of the majority of mollusks and crustacea, detailed species counts were not included in the assessment. No dominant communities of these classes of biota were observed during the reef surveys at any of the study stations.

3.3.4 Reef Fish Community Structure

Reef fish community structure was largely determined by the topography and composition of the benthos. The reef fish community off Kaloko-Aimakapa is typical of that found along most of the Kona Coast, as described by Hobson (1974), and Walsh (1984). Fish community structure can be divided into six general categories: juveniles, planktivorous damselfishes, herbivores, rubble-dwelling fish, swarming tetrodonts, and surge-zone fish. Table 7 shows results of fish surveys on the Kaloko-Honokohau reefs.

Pomocentridae (Damselfish) were the most abundant family of fish. Planktivorous damselfish, principally of the genera *Chromis* and *Abudefduf* were abundant in all areas surveyed. The next most abundant family was the Acanthuridae (surgeonfish), with the most common species including the yellow tang (*Zebrasoma flavescens*), the goldring surgeonfish (*Ctenochaetus strigosus*), and the brown surgeonfish (*Acanthurus nigrofuscus*). On the shallower reef terrace, adult whitebar surgeonfish (*Acanthurus leucopareius*), orangeband surgeonfish (*A. olivaceus*), and parrotfish (*Chlorurus sp.*) were also common in areas where coral rubble was abundant.

Surge zone fish consisted principally of herbivores such as rudderfish (*Kyphosus bigibbus*), surgeonfish (*Acanthurus spp.*), and unicornfish (mostly *Naso lituratus*). Saddle wrasse (*Thallassoma duperry*) and surge wrasse (*T. purpureum*) were also abundant in the surge zone. Trigger fish (Family Balistidae) including the black durgeon (*Melanichthys niger*) and pinktail durgeon (*M. vidula*) and the boomerang trigger (*Sufflamen bursa*) were also observed congregating in the water column over the reef platform. A variety of butterfly fish (Family Chaetodontidae) were also observed throughout the survey region.

Overall, fish community structure at Kaloko appeared fairly typical of the assemblages found in West Hawaii reef environments.

3.3.5 Endangered and Protected Species

Several species of marine animals that occur in Hawaiian waters have been declared threatened or endangered by Federal jurisdiction. The threatened green sea turtle (*Chelonia mydas*) occurs commonly along the Kona Coast, and is known to feed on selected species of macroalgae. The endangered hawksbill turtle (*Eretmochelys imbricata*) is known infrequently from waters off the Kona Coast. The area off of Aimakapa Pond is clearly a preferred habitat for green turtles, as at least eight individuals were observed in the nearshore zone during the survey. In addition, at least ten turtles were observed hauled out on the basalt shelf to the south of the pond during a low tidal stand when much of the basaltic bench in this area was exposed.

Populations of the endangered humpback whale (*Megaptera novaeangliae*) are known to winter in the Hawaiian Islands from December to April. The present survey was conducted in March, when whales were present in Hawaiian waters. No whales were observed during the course of the survey. Similarly, no Hawaiian monk seals (*Monachus schlauslandi*) were observed in the area.

4.0 DISCUSSION and CONCLUSIONS

4.1 General Considerations of Effects to Pond Chemistry from Existing Development

The purpose of this baseline survey is to provide the information to make valid estimates of the potential for impact to the marine and pond environments at Kaloko Honokohau National Historical Park, and possibly NELHA, from development of the Kaloko-Honokohau Business Park. The information collected for this study provides the basis to understand the processes that are operating in the pond-ocean system, and to specifically address the concerns raised in the planning process.

To summarize, it is generally accepted that the two large fishponds within the Kaloko-Honokohau National Historical Park function in a similar manner to smaller anchialine ponds that occur on the west coast of Hawaii. By definition anchialine ponds are surface exposures of the water table with no direct connection to the ocean that contain brackish water which is a mixture of seaward flowing groundwater and landward flowing seawater. Anchialine ponds in early successional stages usually have sediment-free bottoms which allow for relatively rapid exchange of water. It is important to note that healthy anchialine ponds are NOT nutrient limited systems, and contain high concentrations of plant nutrients. The excess nutrients do not lead to algal dominated water columns (at least until late stages of pond senescence), however, as a result of a balance between short residence time of water within the ponds, and production and consumption by pond biota. Rapid flux of water through the ponds, and grazing by resident populations prevent plankton buildup within the water column.

In the later stages of the anchialine pond cycle, infilling by sediment reduces the rate of water exchange and the balance between production and consumption is lost. Ultimately, in the last stages of pond senescence infilling is complete and ponds transitions to wetlands.

The results of this survey, as well as others (Brock and Kam 1997), indicate that Kaloko Pond is not technically an anchialine pond because it contains direct connections to the ocean. Water in the pond is near oceanic in salinity, indicating that groundwater comprises a very small component of the pond makeup. Groundwater flux into the pond is mixed with ocean water that is driven by wave action carrying water landward through the rock wall.

Aimakapa Pond, on the other hand, can be considered an anchialine pond because it is sealed from direct exchange with the ocean by a sand berm of low permeability. The nearly vertical gradients in salinity between the pond and nearshore ocean provide evidence that the sand berm is essentially impermeable to water exchange (a good analogy is the use of sand bags for flood control levees).

During surveys of Aimakapa Pond conducted in 2000 and 2007 restricted groundwater flow into Aimakapa Pond was borne out by the near complete lack of both vertical and horizontal gradients within the ponds. Such lack of detectable inputs suggested that the pond is essentially a closed system which is accumulating sediment and metabolic decay products which cannot be naturally flushed from the enclosed pond basin. Continued metabolic activity will produce increasing sediment deposition which will elevate rates of nutrient release from sediment decomposition, which will in turn allow for increased phytoplankton growth. Eventually organic sediment deposition will completely dominate the pond to the point where the water column disappears, and the area transitions to a marsh or wetland. Such a progression has been described as the natural "life history" of anchialine ponds.

During a survey in early 2012 conducted for the present report, evidence of groundwater input at stations within the inshore half of Aimakapa Pond was detected as steep horizontal gradients of salinity and inorganic nutrients found in groundwater. To determine whether this situation was an anomaly, another sampling was conducted in November 2012. Results of this sampling indicated an even stronger flux of groundwater into Aimakapa Pond than was previously measured. These results suggest that Aimakapa Pond may be experiencing either increased groundwater input, or at least not a decrease in groundwater input relative to a decade earlier. As the existing development in the Kaloko Industrial area upslope of the KAHO ponds has been in place for the last decade, water quality in the ponds changes can be assumed to be influenced by the present level of development upslope from the KAHO ponds.

Hence, while all data indicate that while the enclosed basin of Aimakapa is characterized by long water residence time, resulting in continued deposition of organic sediment, the recent detection of increased groundwater flux suggests that the pond is still functioning in part as an anchialine system, and has no yet reached a final stage of senescence.

4.2 Sedimentation and Runoff

A potential mechanism for negative impact to nearshore marine and pond systems is increased sedimentation from wind and surface runoff as a consequence of grading and changes in land use. There appears to be little potential for alteration to the pond and marine communities offshore of Kaloko Makai from increased sedimentation associated with the project for several reasons. The climate of the Kaloko area is one of the driest in the Hawaiian Islands. On an annual basis rainfall is likely to be far exceeded by evaporation at the proposed project site. Surface water runoff from storm events is infrequent. The basaltic composition of the land surface is highly porous and is capable of absorbing rainfall with little or no surface runoff. Even in the event of heavy rainfall, the porous nature of the soil ground cover is such that sheet flow carrying suspended sediment toward the ocean would be expected to be relatively small. Rather, most rainwater that would enter the ocean as runoff would do so following percolation through the surface rock layers to the water table, followed by groundwater extrusion at the shoreline.

The project site is presently comprised of extensive areas of exposed soil and rock, with relatively little vegetative groundcover. During the construction phases, it is likely that permit regulations will limit the area of excavation at any particular time, and require dust control measures. In addition, the predominant direction of wind (land breezes) generated by thermal convection from solar heating of the land mass is inland, resulting in transport of dust inland, and not toward the ocean. As a result, it appears that there is little potential for significant input of sediment to the marine and pond environment resulting from the proposed project.

The entire floor of Aimakapa Ponds is covered with a thick layer of fine-grained flocculent sediment. As described above, the sediment layer plays an important role in the metabolic

functioning of the ponds. Pond biota are adapted to this high sediment composition. Should a small amount of sediment reach the pond as a result of construction activity, it is not likely that there will be any qualitative change to sediment composition.

Within the marine environment, the nearshore area contains locally high regions of cover of calcareous sands of marine origin. Corals and other reef organisms are capable of removing sediment suspended by natural phenomena, up to threshold levels of deposition where cleaning mechanisms are overwhelmed and organisms become buried. Because of the existence of natural sands, and the normally turbulent conditions which continually resuspend natural sediment, biotic community structure is presently adapted to extremes in sediment stress from natural conditions. Organisms that do occur in the region are therefore capable of withstanding the stress associated with large natural sediment loads. In comparison to the frequent natural sediment resuspension within the study area, any additional input from land resulting from construction activity would probably not have the potential to accumulate to the point where organisms could be buried.

4.3 Alteration of Groundwater Flow and Composition

TNWRE (2012) provides a detailed description of the hydrology of the Kaloko area and the potential for changes that may occur to groundwater discharge to the ponds and ocean as a result of the Kaloko Makai project. Five aspects of the project development have the potential to change the groundwater flowrate and/or chemistry:

1) consumptive use of potable quality groundwater.
2) disposal of excess R-1 treated effluent in onsite injection wells.
3) potential disposal of RO (reverse osmosis).
4) percolation of excess landscape irrigation.
5) change in local rainfall-recharge.

Detailed consideration of these five factors is discussed in TNWRE (2012). Post-development total changes to basal groundwater flowing beneath the Kaloko Makai Project site are summarized as follows:

Change in groundwater flowrate = 2.125 mgd = + 6.2% change over present
Change in salinity = 1.661‰ = -5.1%
Change in nitrogen = 19.652 lbs per day = +5.2 ‰
Change in phosphorus = 2.889 lbs per day = +2.1 ‰

Based on the results of the water chemistry analyses discussed above, these changes in groundwater parameters can be considered in terms of impacts to the ponds at KAHO. In terms of groundwater flow, it is estimated that the project will result in increased groundwater flux through the aquifer, as well as a decrease in salinity of basal groundwater, primarily as a result of increases in irrigation rates. As the linkage between the physical and metabolic dynamics of the ponds depends on flux of fresh groundwater, the potential increase in flow rate and decrease in salinity cannot be viewed as a negative impact to the ponds. Rather, increased groundwater flux can be viewed as a positive effect as it will enhance water exchange and decrease residence time within the ponds. Potential lowering of salinity of water entering the ponds will not result in effects to pond biota in terms of exceeding an upper salinity tolerance. As noted above, recent surveys indicate an apparent progressive increase in groundwater flux in Aimakapa Pond which is reflected in nutrient concentrations, and a net reduction in metabolic decay products. With projected increased flux from the proposed development, conditions in the ponds could potentially improve further in a direction away from sediment deposition and senescence.

Wastewater generated at the project site and treated in an on-site treatment plant would be reused for irrigation, with the excess disposed of in injection wells if other uses are not found. Using typical nutrient concentrations in wastewater, fertilizers and basal groundwater, as well as changes in local rainfall and recharge and removal rates associated with lateral travel with groundwater to the shoreline, TNWRE (2012) estimated that total nitrogen and total phosphorus will increase by 5.2% and 2.1%, respectively over existing conditions.

Such increases in nutrient loading of about 5% for N and 2% for P will not result in changes to the ponds or nearshore ocean. As described above, healthy anchialine ponds are not nutrient limited, and already contain an excess of nutrients that are not utilized within the biogeochemical cycles within the ponds. So the small projected increases would be inconsequential to anchialine pools.

If all of the metabolically relevant nitrogen and phosphorus in groundwater is considered as NO_3^- and PO_4^{3-}, then the projected increases would result in basal groundwater concentrations would be 75 μM for NO_3^-, and 5.0 μM for PO_4^{3-}. Such changes are well within the natural variability of the system, and essentially represent no change to present conditions. As an example, the average concentration of NO_3^- in high groundwater at present (80 μM) exceeds the projected increase value for NO_3^- in basal groundwater that would reach the shoreline (75 μM) Other areas of West Hawaii also have been shown to have concentrations of NO_3^- in basal groundwater that exceed 75 μM (Dollar and Atkinson 1992). Thus, the projected increase cannot be considered of a magnitude to present any king of potentially problematic situation. As long as there are no changes to the physical structure of healthy anchialine ponds (e.g., infilling) or changes to the balance of native biotic assemblages (e.g., introduction of alien species) the small increase in nutrient concentrations in groundwater entering the ponds would have no effect.

4.4 Effects to the Nearshore Marine Environment

It is also unlikely that there would be any effects to the nearshore marine environment as a result of increases in nutrient concentrations in groundwater. Dollar and Atkinson (1992) modeled the input of nutrients to the ocean downslope from two golf courses in West Hawaii over a four-year period. Results of the studies showed that at a location where fertilizer nutrients entered an embayment (Keauhou Bay) with restricted circulation relative to open coastal shorelines, nitrates increased by about 100% and phosphate increased by about 20% over natural input. However, because the nutrients were retained within a surface layer, there was no exposure to the benthos. Circulation within the embayment was also rapid enough to prevent phytoplankton blooms. These results indicated that even with long-term input of

extremely high nutrient subsidies, there are situations where there are no negative effects to the receiving environment. Similar lack of impact would be expected at the Kaloko-Honokohau region where nutrient subsidies would be far less than have occurred at Keauhou.

Several other important points are also worth mentioning with respect to impacts to coral reef ecosystems. Seasonal long-period swells result in turbulence at the shoreline off the entirety of Kaloko-Honokohau Park, including the nearshore areas off of Aimakapa and Kaloko Ponds. Such wave turbulence is the reason coral communities are poorly developed in the nearshore area. Hence, owing to the high and consistent rates of mixing, as well as minimal input of materials from land to the ocean, it is not likely that nutrient concentrations in the waters downslope from the project site will have any effect on marine communities.

In addition, some clarification on the actual extent of potential damage to coral reefs from nutrients is also important to note. While the perception is that elevated nutrient concentrations are universally detrimental to corals and other reef organisms, the scientific literature does not bear this out as fact. Atkinson et al. (1995) showed that 57 species of corals have grown at in seawater with consistent nutrient concentrations about 10-fold higher than is normally found on Hawaiian reefs. Growth rates of these corals were near the upper rates reported from the field, demonstrating that corals can and do flourish in relatively high nutrient water. Atkinson et al. (1995) conclude that "Statements implying that corals can only grow in low nutrient oligotrophic waters are oversimplifications of the processes that govern growth of these organisms."

Another clear example of the lack of impact to corals from nutrients associated with sewage effluent is illustrated in Figure 24. In the photographs in this figure, corals can be seen covering sewage diffuser that are actively discharging primary treated effluent within Hilo Bay. Similar situations have been noted in Hawaii, where the elevated nutrient concentrations in waters adjacent to ocean sewage outfalls has not impacted corals or coral communities (Dollar 1999, Grigg 1994).

4.5 Potential effects to Endangered and Protected Marine Species

As mentioned above there are several protected marine species that may inhabit the offshore environment. Because there is no plan for any work in the nearshore region, there is no potential for blasting or excavation that might affect behavior of whales, monk seals and other marine mammals. Similarly, as described above, there is little potential for changes in water quality resulting from construction. The Kaloko Makai project will not alter access to the shoreline. Thus, there is little potential for any negative factors associated with the project that may affect turtles or marine mammals

5.0 SUMMARY

A major concern in the planning process for the Kaloko Makai is addressing the potential for impacts to pond and marine environments within the Kaloko-Honokohau National Historical

Park, which lies directly downgradient from the project site. As there will be no alterations of any of the pond or marine habitats by the project, potential impacts could only result from alteration of groundwater that flows under the project site to the ocean. The potential for impact to marine and pond communities as a result of development of the Kaloko Makai project appears to be minimal or non-existent. Kaloko Pond is separated from the ocean by a man-made rock wall that contains openings to promote exchange of pond water and ocean water. Aimakapa Pond is sealed from the ocean by an unbroken sand berm. The distinct discontinuities between concentrations of water chemistry constituents between the seaward end of Aimakapa Pond and the nearshore ocean indicate that the sand berm is an effective barrier preventing free exchange between the pond and ocean.

While Aimakapa previously exhibited little vertical and horizontal stratification, recent studies reveal input of groundwater along the landward shoreline of the pond, resulting in steep gradients of salinity and inorganic nutrients found in groundwater. Tidal oscillations in the ponds result in landward flow of water out of the ponds during periods when pond levels are higher than groundwater in surrounding lava formations, and flow into the pond when pond levels are lower than in surrounding rock. Hence, the differences in groundwater dynamics within the ponds over the 12-year interval of studies may reflect the relationship between sampling and tidal state. In any event, the sequential results indicate that at a minimum the fishponds are not in a more senescent state at present than in previous years. Hence, based on these data, it can be concluded that there does not appear to be any increasing negative effects from the existing development upslope from the Kaloko-Honokohau National Historical Park.

Concentrations of inorganic nutrients, particularly NO_3^- and PO_4^{3-}, which are high in basal groundwater are substantially lower in most of the pond waters. Measurements of metabolism within Aimakapa Pond indicates high rates of both gross production and respiration. Even with no consideration of the limited input of groundwater to the ponds, the maximum amount of metabolism that can be attributed to groundwater nutrients is about 5%. Therefore, a minimum of 95% of pond metabolism is driven by nutrients recycled within the pond. Such a scenario is consistent with the apparent rapid uptake of groundwater nutrients within the pond, lack of stratification throughout the entire width of the ponds, high phytoplankton biomass, and thick flocculent organic sediment that lines the floor of the pond.

In addition, it has been repeatedly documented that healthy anchialine ponds are not nutrient limited, so increases in nutrient concentrations will no effect as long as the physical and biological components of the ponds are kept intact. Estimates of changes in groundwater flow volume that would occur from the Kaloko Makai project are within the range of natural variability. Increases in nutrient concentrations to groundwater from irrigation and other land use factors result in an increase in groundwater flow and nutrient loading to groundwater, along with a reduction in salinity. Such changes are within the natural variability of groundwater composition. In addition, because Aimakapa Pond potentially utilizes groundwater nutrients for only a small percentage of metabolic requirements, the small changes to groundwater composition will not result in detectable differences in pond function.

Scaling nutrients concentrations to salinity indicate that there are no nutrient subsidies to the ponds from sources other than naturally occurring groundwater. These results indicate that under the present scenario, the existing development upslope of KAHO is not causing detectable input of nutrient subsidies, or reduction in groundwater flux to the ponds. Rather, conditions in the ponds appear at present to represent more open systems with respect to hydraulic and nutrient fluxes. Estimates of changes of hydrologic factors resulting from the project indicate increased hydraulic flow, decreased salinity, and minor increases in nutrient concentrations. Hence, both the analyses of shoreline ponds at KAHO that are influenced by the existing level of upslope development, as well as the projections of changes to groundwater dynamics from the Kaloko Makai Project indicate that there is little or no potential for the project to produce negative impacts to the pond or marine environments.

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FIGURE 1. Aerial photograph of section of North Kona, Island of Hawaii showing approximate boundaries of Kaloko Makai Project site (yellow line). The legislated boundary of Kaloko-Honokohau National Historical Park is shown in blue. Also shown are locations of Aimakapa and Kaloko Fishponds, the existing Koloko Industrial Park, and Honokohau Small Boat Harbor.

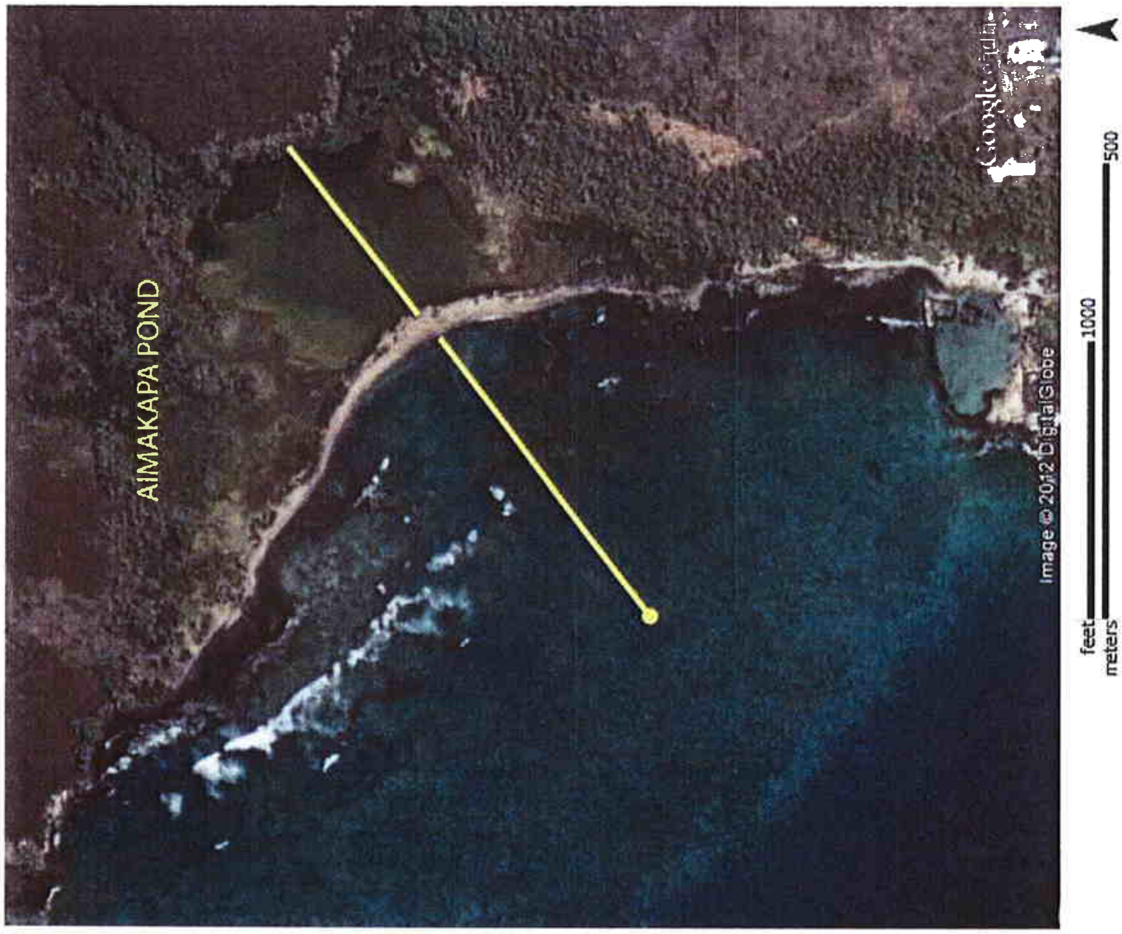

FIGURE 2. Aerial photograph of Aimakapa Pond in Kaloko-Honokohau National Historical Park showing location of transects (yellow lines) on which water samples were collected through the pond and extending into the ocean. While exact locations of sample collection differed between sampling years, the location of the sampling transects were consistent.

TABLE 1. Results of water chemistry measurements in Aimakapa Pond and the coastal ocean directly off of the ponds collected in February 23, 2012. "S" indicates surface sample; "B" indicates bottom sample. "DFS" indicates "distance from shore";negative values indicate distance inland from the beach berm; positive values indicate distance seaward from the beach berm. Nutrient concentrations are shown in micromolar units."Bdl" stands for "below detection limit."For station sampling locations, see

	SAMPLING STATION	DFS (m)	PO_4^{3-} (µM)	NO_3^- (µM)	NH_4^+ (µM)	Si (µM)	TOP (µM)	TON (µM)	TP (µM)	TN (µM)	Turb (ntu)	Salt (o/oo)	pH (rel)	Chl-a (µg/l)	TEMP (deg C)	O2 (%sat)
AIMAKAPA POND	1-S	-230-S	1.30	13.24	3.62	495.68	1.24	34.60	2.54	51.46	1.67	12.097	7.91	0.76	24.3	100.9
	1-B	-230-B	1.52	10.30	2.50	495.84	1.24	34.20	2.76	47.00	1.90	12.152	8.01	1.08	24.4	91.0
	2-S	-205-S	1.52	11.08	2.30	479.02	1.10	28.26	2.62	41.64	1.52	12.074	8.02	0.80	24.5	102.0
	2-B	-205-B	1.44	9.20	2.56	481.30	1.38	35.92	2.82	47.68	1.77	12.115	8.07	1.68	24.4	107.8
	3-S	-190-S	1.42	9.12	3.74	488.06	1.26	32.92	2.68	45.78	2.08	12.155	8.18	1.21	24.3	99.9
	3-B	-190-B	1.16	0.60	3.52	473.82	1.42	36.92	2.58	41.04	2.21	12.422	8.22	2.14	24.3	98.3
	4-S	-170-S	1.02	0.46	4.52	475.46	1.40	37.04	2.42	42.02	2.11	12.322	8.20	1.28	24.2	99.9
	4-B	-170-B	1.16	0.80	3.80	481.10	1.48	39.42	2.64	44.02	1.86	12.343	8.12	1.76	24.3	104.7
	5-S	-150-S	1.34	3.32	3.62	485.78	1.26	34.56	2.60	41.50	2.48	12.345	8.10	1.26	23.9	99.6
	5-B	-150-B	1.46	4.82	3.56	479.40	1.32	34.00	2.78	42.38	2.11	12.712	8.07	1.65	24.0	101.5
	6-S	-130-S	1.08	0.08	1.32	479.06	1.36	39.92	2.44	41.32	2.67	12.507	8.23	1.67	23.8	100.1
	6-B	-130-B	0.80	0.06	1.18	470.98	1.26	36.42	2.06	37.66	2.73	12.512	8.21	3.93	24.2	86.9
	7-S	-110-S	1.02	0.14	1.44	475.56	1.36	39.90	2.38	41.48	2.61	12.535	8.25	1.31	24.0	99.9
	7-B	-110-B	0.88	0.06	1.42	478.84	1.30	38.32	2.18	39.80	2.51	12.525	8.19	1.10	24.0	101.0
	8-S	-80-S	1.02	0.08	1.22	472.68	1.28	38.44	2.30	39.74	2.70	12.605	8.26	1.37	24.0	99.7
	8-B	-80-B	0.96	0.08	1.38	475.16	1.22	37.10	2.18	38.56	2.93	12.574	8.26	2.26	24.3	99.5
	9-S	-40-S	0.98	0.08	1.60	472.86	1.24	37.80	2.22	39.48	2.68	12.686	8.27	1.59	24.2	100.0
	9-B	-40-B	0.88	0.06	1.12	467.24	1.28	38.00	2.16	39.18	2.77	12.672	8.26	2.20	24.3	101.7
	10-S	-1-S	0.94	0.08	1.64	470.12	1.18	38.72	2.12	40.44	2.53	12.717	8.26	1.75	24.6	100.0
	10-B	-1-B	0.96	0.06	1.68	475.50	1.26	39.22	2.22	40.96	2.62	12.720	8.26	1.65	24.8	104.7
OCEAN	11-S	0	0.38	3.52	0.28	75.66	0.24	8.62	0.62	12.42	0.46	31.754	8.03	0.36	25.4	102.2
	12-S	1	0.30	3.54	0.30	77.30	0.20	8.08	0.50	11.92	0.34	31.585	8.04	0.59	25.0	101.9
	13-S	3	0.36	3.16	0.16	72.42	0.18	8.26	0.54	11.58	0.32	31.733	8.05	0.25	24.9	100.4
	14-S	5	0.32	3.16	0.28	69.50	0.24	7.66	0.56	11.10	0.37	31.838	8.05	0.58	24.9	99.2
	15-S	10-S	0.08	1.67	0.01	39.74	0.41	7.49	0.49	9.17	0.19	33.191	8.20	0.12	24.6	100.6
	15-B	10-B	0.19	0.51	0.06	20.15	0.39	6.78	0.58	7.35	0.27	34.013	8.23	0.18	24.4	99.3
	16-S	25-S	0.24	4.73	0.01	60.04	0.43	6.50	0.67	11.24	0.30	32.297	8.25	0.08	24.3	101.2
	16-B	25-B	0.17	0.48	0.03	6.29	0.40	5.01	0.57	5.52	0.18	34.655	8.17	0.10	24.2	100.2
	17-S	50-S	0.25	2.80	0.03	41.13	0.40	5.83	0.65	8.66	0.26	33.131	8.20	0.08	24.3	102.6
	17-B	50-B	0.12	0.18	0.02	5.38	0.44	5.04	0.56	5.24	0.18	34.663	8.15	0.14	24.1	100.4
	18-S	75-S	0.18	1.91	0.01	29.46	0.40	4.65	0.58	6.57	0.27	33.672	8.17	0.07	24.1	99.2
	18-B	75-B	0.15	0.15	0.02	4.35	0.39	4.62	0.54	4.79	0.12	34.759	8.16	0.10	24.1	101.0
	19-S	100-S	0.26	1.71	0.03	10.07	0.36	4.08	0.62	5.82	0.08	34.491	8.13	0.07	23.8	100.3
	19-B	100-B	0.18	0.59	0.03	5.86	0.33	6.66	0.51	7.28	0.11	34.644	8.16	0.07	24.0	100.5
	20-S	200-S	0.19	1.22	0.04	6.81	0.33	5.98	0.52	7.24	0.06	34.554	8.12	0.04	23.9	101.2
	20-B	200-B	0.17	0.10	0.07	3.37	0.32	5.51	0.49	5.68	0.06	34.613	8.12	0.05	23.7	98.2
	21-S	300-S	0.15	0.09	0.04	1.67	0.36	5.68	0.51	5.81	0.04	34.738	8.12	0.04	23.6	99.2
	21-B	300-B	0.15	0.03	0.04	1.63	0.31	5.63	0.46	5.70	0.04	34.869	8.13	0.03	23.4	98.3
ANCHIALINE POOLS	119		2.36	61.02	0.60	457.68	0.03	2.94	2.39	64.56	0.10	14.568	7.56	0.35		
	123		2.98	55.28	4.66	447.48	0.22	24.04	3.20	83.98	0.80	8.360	7.66	1.73		
	96		2.60	52.76	0.68	430.02	0.02	6.58	2.62	60.02	0.26	14.861	7.58	0.40		

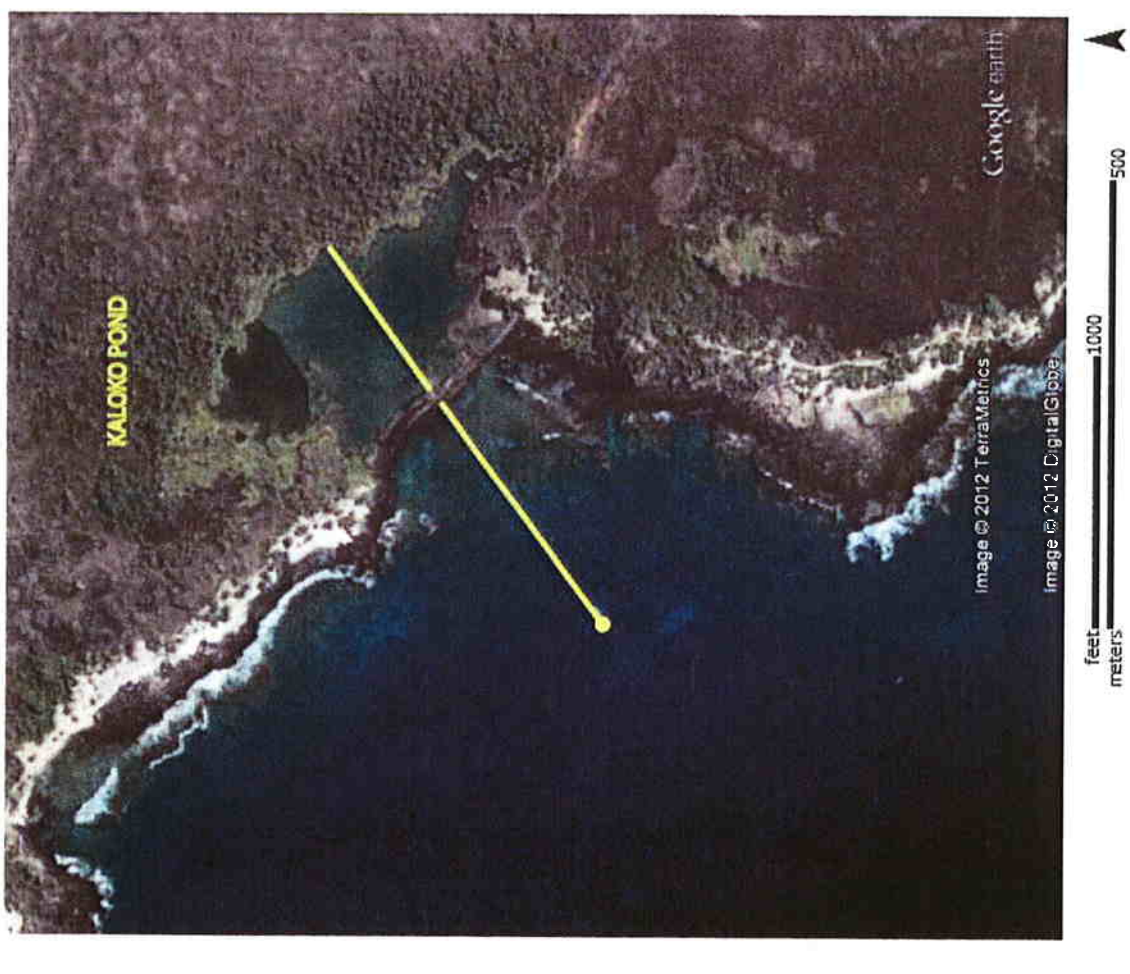

FIGURE 3. Aerial photograph of Kaloko Fish Pond in Kaloko-Honokohau National Historical Park showing location of transects (yellow lines) on which water samples were collected through the pond and extending into the ocean. While exact locations of sample collection differed between sampling years, the location of the sampling transects were consistent.

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	SAMPLING STATION	DFS (m)	PO_4^{3-} (μM)	NO_3^- (μM)	NH_4^+ (μM)	Si (μM)	TOP (μM)	TON (μM)	TP (μM)	TN (μM)	Turb (ntu)	Salt (o/oo)	pH (rel)	Chl-a (μg/l)	TEMP (deg. C)	O2 (%sat)
KALOKO POND	1-S	-200-S	1.02	7.08	2.22	319.84	0.72	25.16	1.74	34.46	1.88	20.240	8.12	3.67	24.7	97.9
	2-S	-175-S	0.90	8.00	3.16	317.48	0.70	25.42	1.60	36.58	2.66	20.319	8.10	2.94	24.5	93.5
	2-B	-175-B	1.52	0.20	0.66	168.14	1.08	33.16	2.60	34.02	5.72	27.519	8.22	4.43	25.7	114.7
	3-S	-150-S	1.04	6.30	2.54	306.00	0.84	25.82	1.88	34.66	2.67	21.005	8.12	3.28	24.8	94.6
	3-B	-150-B	0.86	0.14	0.62	163.28	0.98	28.16	1.84	28.92	3.13	27.962	8.15	2.87	25.4	110.0
	4-S	-125-S	1.02	7.04	2.46	310.40	0.68	23.42	1.70	32.92	2.29	20.822	8.12	3.31	24.9	94.3
	4-B	-125-B	0.88	0.28	2.24	163.50	0.56	21.52	1.44	24.04	3.39	28.044	8.12	3.19	24.8	94.3
	5-S	-100-S	0.88	7.12	2.42	305.26	0.66	22.92	1.54	32.46	2.20	21.087	8.12	2.84	25.1	95.7
	5-B	-100-B	0.46	0.14	0.52	167.52	0.74	20.30	1.20	20.96	2.31	27.735	8.16	2.59	24.7	84.1
	6-S	-75-S	0.72	2.98	1.64	266.76	0.66	21.74	1.38	26.36	1.99	22.728	8.18	2.90	25.4	95.4
	6-B	-75-B	0.42	0.10	0.50	153.72	0.74	18.68	1.16	19.28	1.52	27.998	8.16	2.21	24.4	72.7
	7-S	-50-S	0.72	0.64	1.26	264.14	0.74	25.38	1.46	27.28	2.05	23.035	8.20	3.25	25.5	91.6
	7-B	-50-B	0.46	0.08	1.00	176.84	0.88	21.54	1.34	22.62	1.57	27.195	8.19	2.45	24.5	81.5
	8-S	-25-S	0.60	0.14	1.18	229.94	0.68	21.04	1.28	22.36	2.40	24.280	8.26	2.96	25.8	93.0
	8-B	-25-B	0.46	0.06	0.84	156.34	0.82	22.56	1.28	23.46	2.21	28.041	8.22	2.18	24.9	108.9
	9-S	-10-S	0.68	1.78	1.30	247.78	0.70	22.90	1.38	25.98	2.55	23.831	8.24	3.05	26.0	92.9
	9-B	-10-B	0.40	0.26	1.00	218.96	0.78	20.48	1.18	21.74	1.76	25.091	8.29	3.13	26.1	121.5
	10-S	-1	0.50	0.32	1.24	228.10	0.72	22.28	1.22	23.84	1.41	24.565	8.28	3.55	26.1	94.0
OCEAN	11-S	10-S	0.08	1.67	0.01	39.74	0.41	7.49	0.49	9.17	0.19	33.191	8.20	0.12	25.6	101.3
	12-S	10-B	0.19	0.51	0.06	20.15	0.39	6.78	0.58	7.35	0.27	34.013	8.23	0.18	25.3	100.6
	13-S	25-S	0.24	4.73	0.01	60.04	0.43	6.50	0.67	11.24	0.30	32.297	8.25	0.08	25.9	100.4
	14-S	25-B	0.17	0.48	0.03	6.29	0.40	5.01	0.57	5.52	0.18	34.655	8.17	0.10	24.9	99.9
	15-S	75-S	0.20	1.64	0.06	25.36	0.30	4.75	0.50	6.45	0.12	33.999	8.17	0.08	24.8	100.2
	15-B	75-B	0.17	0.25	0.07	4.99	0.32	4.88	0.49	5.20	0.05	34.728	8.11	0.06	24.8	98.4
	16-S	100-S	0.15	1.56	0.09	25.60	0.31	5.14	0.46	6.79	0.14	33.998	8.15	0.10	24.7	99.2
	16-B	100-B	0.16	0.26	0.10	5.30	0.31	5.68	0.47	6.04	0.06	34.707	8.11	0.05	24.8	101.0
	17-S	200-S	0.20	0.49	0.07	9.89	0.29	6.59	0.49	7.15	0.09	34.516	8.11	0.08	24.8	100.3
	17-B	200-B	0.19	0.03	0.10	2.57	0.26	7.06	0.45	7.19	0.06	34.843	8.12	0.05	24.7	99.4
	18-S	300-S	0.19	0.81	0.08	6.92	0.27	12.03	0.46	12.92	0.11	34.590	8.12	0.06	24.9	101.2
	18-B	300-B	0.13	0.02	0.03	2.80	0.29	6.60	0.42	6.65	0.07	34.819	8.12	0.04	24.7	100.5

TABLE 1-A. Results of water chemistry measurements in Aimakapa Pond and the coastal ocean directly off of the ponds collected in February 23, 2012. "S" indicates surface sample; "B" indicates bottom sample. "DFS" indicates "distance from shore";negative values indicate distance inland from the beach berm; positive values indicate distance seaward from the beach berm. Nutrient concentrations are shown in units of micrograms per liter (μg/L). For station sampling locations, see Figure 1.

	SAMPLING STATION	DFS (m)	PO_4^{3-} (μg/L)	NO_3^- (μg/L)	NH_4^+ (μg/L)	Si (μg/L)	TOP (μg/L)	TON (μg/L)	TP (μg/L)	TN (μg/L)	Turb (ntu)	Salt (o/oo)	pH (rel)	Chl-a (μg/l)	TEMP (deg C)	O2 (%sat)
AIMAKAPA POND	1-S	-230-S	40.30	185.36	50.68	13879	38.44	484.40	78.74	720.44	1.67	12.097	7.91	0.76	24.3	100.9
	1-B	-230-B	47.12	144.20	35.00	13884	38.44	478.80	85.56	658.00	1.90	12.152	8.01	1.08	24.4	91.0
	2-S	-205-S	47.12	155.12	32.20	13413	34.10	395.64	81.22	582.96	1.52	12.074	8.02	0.80	24.5	102.0
	2-B	-205-B	44.64	128.80	35.84	13476	42.78	502.88	87.42	667.52	1.77	12.115	8.07	1.68	24.4	107.8
	3-S	-190-S	44.02	127.68	52.36	13666	39.06	460.88	83.08	640.92	2.08	12.155	8.18	1.21	24.3	99.9
	3-B	-190-B	35.96	8.40	49.28	13267	44.02	516.88	79.98	574.56	2.21	12.422	8.22	2.14	24.3	98.3
	4-S	-170-S	31.62	6.44	63.28	13313	43.40	518.56	75.02	588.28	2.11	12.322	8.20	1.28	24.2	99.9
	4-B	-170-B	35.96	11.20	53.20	13471	45.88	551.88	81.84	616.28	1.86	12.343	8.12	1.76	24.3	104.7
	5-S	-150-S	41.54	46.48	50.68	13602	39.06	483.84	80.60	581.00	2.48	12.345	8.10	1.26	23.9	99.6
	5-B	-150-B	45.26	67.48	49.84	13423	40.92	476.00	86.18	593.32	2.11	12.712	8.07	1.65	24.0	101.5
	6-S	-130-S	33.48	1.12	18.48	13414	42.16	558.88	75.64	578.48	2.67	12.507	8.23	1.67	23.8	100.1
	6-B	-130-B	24.80	0.84	16.52	13187	39.06	509.88	63.86	527.24	2.73	12.512	8.21	3.93	24.2	86.9
	7-S	-110-S	31.62	1.96	20.16	13316	42.16	558.60	73.78	580.72	2.61	12.535	8.25	1.31	24.0	99.9
	7-B	-110-B	27.28	0.84	19.88	13408	40.30	536.48	67.58	557.20	2.51	12.525	8.19	1.10	24.0	101.0
	8-S	-80-S	31.62	1.12	17.08	13235	39.68	538.16	71.30	556.36	2.70	12.605	8.26	1.37	24.0	99.7
	8-B	-80-B	29.76	1.12	19.32	13304	37.82	519.40	67.58	539.84	2.93	12.574	8.26	2.26	24.3	99.5
	9-S	-40-S	30.38	1.12	22.40	13240	38.44	529.20	68.82	552.72	2.68	12.686	8.27	1.59	24.2	100.0
	9-B	-40-B	27.28	0.84	15.68	13083	39.68	532.00	66.96	548.52	2.77	12.672	8.26	2.20	24.3	101.7
	10-S	-1-S	29.14	1.12	22.96	13163	36.58	542.08	65.72	566.16	2.53	12.717	8.26	1.75	24.6	100.0
	10-B	-1-B	29.76	0.84	23.52	13314	39.06	549.08	68.82	573.44	2.62	12.720	8.26	1.65	24.8	104.7
OCEAN	11-S	0	11.78	49.28	3.92	2118	7.44	120.68	19.22	173.88	0.46	31.754	8.03	0.36	25.4	102.2
	12-S	1	9.30	49.56	4.20	2164	6.20	113.12	15.50	166.88	0.34	31.585	8.04	0.59	25.0	101.9
	13-S	3	11.16	44.24	2.24	2028	5.58	115.64	16.74	162.12	0.32	31.733	8.05	0.25	24.9	100.4
	14-S	5	9.92	44.24	3.92	1946	7.44	107.24	17.36	155.40	0.37	31.838	8.05	0.58	24.9	99.2
	15-S	10-S	2.48	23.38	0.14	1113	12.71	104.86	15.19	128.38	0.19	33.191	8.20	0.12	24.6	100.6
	15-B	10-B	5.89	7.14	0.84	564	12.09	94.92	17.98	102.90	0.27	34.013	8.23	0.18	24.4	99.3
	16-S	25-S	7.44	66.22	0.14	1681	13.33	91.00	20.77	157.36	0.30	32.297	8.25	0.08	24.3	101.2
	16-B	25-B	5.27	6.72	0.42	176	12.40	70.14	17.67	77.28	0.18	34.655	8.17	0.10	24.2	100.2
	17-S	50-S	7.75	39.20	0.42	1152	12.40	81.62	20.15	121.24	0.26	33.131	8.20	0.08	24.3	102.6
	17-B	50-B	3.72	2.52	0.28	151	13.64	70.56	17.36	73.36	0.18	34.663	8.15	0.14	24.1	100.4
	18-S	75-S	5.58	26.74	0.14	825	12.40	65.10	17.98	91.98	0.27	33.672	8.17	0.07	24.1	99.2
	18-B	75-B	4.65	2.10	0.28	122	12.09	64.68	16.74	67.06	0.12	34.759	8.16	0.10	24.1	101.0
	19-S	100-S	8.06	23.94	0.42	282	11.16	57.12	19.22	81.48	0.08	34.491	8.13	0.07	23.8	100.3
	19-B	100-B	5.58	8.26	0.42	164	10.23	93.24	15.81	101.92	0.11	34.644	8.16	0.07	24.0	100.5
	20-S	200-S	5.89	17.08	0.56	191	10.23	83.72	16.12	101.36	0.06	34.554	8.12	0.04	23.9	101.2
	20-B	200-B	5.27	1.40	0.98	94	9.92	77.14	15.19	79.52	0.06	34.613	8.12	0.05	23.7	98.2
	21-S	300-S	4.65	1.26	0.56	47	11.16	79.52	15.81	81.34	0.04	34.738	8.12	0.04	23.6	99.2
	21-B	300-B	4.65	0.42	0.56	46	9.61	78.82	14.26	79.80	0.04	34.869	8.13	0.03	23.4	98.3
ANCHIALINE POOLS	119		73.16	854.28	8.40	12815	0.93	41.16	74.09	903.84	0.10	14.568	7.56	0.35		
	123		92.38	773.92	65.24	12529	6.82	336.56	99.20	1175.72	0.80	8.360	7.66	1.73		
	96		80.60	738.64	9.52	12041	0.62	92.12	81.22	840.28	0.26	14.861	7.58	0.40		

TABLE 3. Results of water chemistry measurements in Aimakapa and Kaloko Ponds collected in November 19, 2012. "S" indicates surface sample; "B" indicates bottom sample. "DFS" indicates "distance from shore";negative values indicate distance inland from the beach berm; positive values indicate distance seaward from the beach berm. Nutrient concentrations are shown in micromolar units.For station sampling locations, see Figure 1.

	SAMPLING STATION	DFS (m)	PO_4^{3-} (µM)	NO_3^- (µM)	NH_4^+ (µM)	Si (µM)	TOP (µM)	TON (µM)	TP (µM)	TN (µM)	Turb (ntu)	Salt (o/oo)	pH (rel)	Chl-a (µg/l)	TEMP (deg C)	O2 (%sat)
AIMAKAPA POND	1-S	-230-S	3.20	47.34	6.56	530.10	0.50	17.50	3.70	71.40	0.37	11.669	7.60	0.13	25.7	99.3
	1-B	-230-B	3.70	49.16	0.60	529.76	0.22	13.52	3.92	63.28	0.34	11.673	7.60	0.12	25.1	62.4
	2-S	-205-S	3.98	50.48	0.08	544.62	0.18	9.36	4.16	59.92	0.20	11.547	7.54	0.12	24.5	96.7
	2-B	-205-B	3.50	33.28	4.88	541.14	0.68	18.10	4.18	56.26	0.97	12.101	7.76	0.49	24.9	93.1
	3-S	-190-S	4.14	39.88	3.48	537.16	0.22	13.56	4.36	56.92	0.38	11.666	7.52	0.25	24.6	102.7
	3-B	-190-B	3.50	27.12	6.88	546.94	0.90	26.90	4.40	60.90	1.66	12.111	7.86	0.74	25.0	110.0
	4-S	-170-S	3.82	35.42	3.72	540.50	0.26	16.62	4.08	55.76	0.79	11.907	7.63	0.37	24.8	106.3
	4-B	-170-B	2.94	12.72	12.68	550.56	1.10	30.76	4.04	56.16	2.58	12.476	8.02	1.17	24.6	136.7
	5-S	-150-S	2.36	0.90	11.48	554.62	1.92	49.78	4.28	62.16	4.70	12.853	8.27	1.24	24.9	100.4
	5-B	-150-B	2.40	0.44	9.08	556.22	2.08	58.00	4.48	67.52	4.89	12.857	8.29	1.69	24.6	103.1
	6-S	-130-S	2.42	0.24	18.28	557.50	1.70	42.80	4.12	61.32	4.07	12.751	8.28	1.34	24.9	100.0
	6-B	-130-B	2.30	0.20	11.72	553.80	2.10	51.60	4.40	63.52	4.42	12.807	8.30	1.44	24.3	82.7
	7-S	-110-S	2.16	0.34	9.24	550.72	2.40	61.16	4.56	70.74	4.85	12.798	8.38	1.48	25.0	113.9
	7-B	-110-B	2.08	0.16	7.96	551.28	2.04	54.22	4.12	62.34	5.06	12.822	8.38	1.26	24.3	100.6
	8-S	-80-S	2.18	0.78	10.24	558.46	2.10	53.66	4.28	64.68	4.70	12.851	8.32	1.41	24.8	98.9
	8-B	-80-B	2.08	0.46	10.60	553.84	1.84	55.02	3.92	66.08	4.92	12.853	8.33	1.55	24.3	81.9
	9-S	-40-S	2.20	0.32	10.76	546.58	1.98	62.46	4.18	73.54	4.22	12.751	8.36	1.43	25.6	118.0
	9-B	-40-B	2.00	0.50	5.56	555.42	1.86	62.84	3.86	68.90	4.79	12.834	8.40	1.74	24.4	127.5
	10-S	-1-S	2.24	0.62	4.28	545.60	1.74	64.08	3.98	68.98	4.85	12.869	8.40	1.40	25.2	117.5
	10-B	-1-B	2.14	0.24	6.68	547.52	1.90	61.98	4.04	68.90	5.43	12.862	8.43	1.65	25.0	120.2
KALOKO POND	1-S	-200-S	3.28	47.32	1.80	475.04	0.14	10.68	3.42	59.80	0.83	14.848	7.73	1.49	21.7	96.8
	1-B	-200-B	3.06	41.00	3.20	436.28	0.02	10.96	3.08	55.16	1.40	16.233	7.84	2.37	26.0	148.4
	2-S	-175-S	2.54	33.14	4.32	411.88	0.16	11.78	2.70	49.24	1.20	17.601	7.95	2.21	23.7	96.5
	2-B	-175-B	1.96	17.02	7.68	337.20	0.32	15.38	2.28	40.08	2.42	20.915	8.19	2.84	26.5	168.6
	3-S	-150-S	1.74	15.92	6.60	354.50	0.34	18.06	2.08	40.58	1.72	20.160	8.18	2.48	24.7	94.2
	3-B	-150-B	1.30	4.30	7.36	274.40	0.62	23.44	1.92	35.10	1.87	23.650	8.32	3.39	26.2	142.1
	4-S	-125-S	1.42	4.22	10.52	302.82	0.64	19.12	2.06	33.86	1.98	22.339	8.32	3.40	25.3	92.3
	4-B	-125-B	0.94	0.88	6.76	243.98	0.76	18.68	1.70	26.32	2.03	24.795	8.38	3.29	25.9	77.6
	5-S	-100-S	1.04	0.50	9.04	268.58	0.72	21.36	1.76	30.90	1.26	23.615	8.38	3.42	25.5	93.1
	5-B	-100-B	0.74	0.60	6.56	223.40	0.90	20.16	1.64	27.32	2.94	25.631	8.39	3.14	25.9	106.9
	6-S	-75-S	0.94	0.32	9.60	258.60	0.66	17.92	1.60	27.84	4.33	23.916	8.38	3.23	25.6	98.9
	6-B	-75-B	1.06	0.44	11.60	263.18	0.64	16.82	1.70	28.86	2.13	23.950	8.38	3.35	26.1	122.8
	7-S	-50-S	0.84	0.18	8.84	255.80	0.74	17.08	1.58	26.10	2.84	24.158	8.38	3.23	25.7	97.3
	7-B	-50-B	0.76	0.10	7.16	218.64	0.74	17.18	1.50	24.44	2.69	25.910	8.39	2.81	26.0	115.0
	8-S	-25-S	0.96	0.38	8.96	249.68	0.60	17.52	1.56	26.86	2.26	24.447	8.39	3.08	25.7	93.7
	8-B	-25-B	0.64	0.10	7.28	241.78	0.68	18.22	1.32	25.60	2.76	24.942	8.39	3.06	26.0	116.2
	9-S	-10-S	0.90	0.08	7.48	244.00	0.76	20.70	1.66	28.26	2.40	24.741	8.39	3.41	25.7	92.5
	9-B	-10-B	0.78	0.06	7.36	212.16	0.74	21.64	1.52	29.06	2.08	26.160	8.38	2.85	26.2	111.1
	10-S	-1-S	0.90	0.10	7.32	242.40	0.72	20.00	1.62	27.42	2.06	24.662	8.41	3.29	25.8	94.4
	10-B	-1-B	0.62	0.06	5.60	214.94	0.76	17.58	1.38	23.24	2.09	25.989	8.40	2.94	26.0	111.3

TABLE 2-A. Results of water chemistry measurements in Kaloko Pond and the coastal ocean directly off of the ponds collected in February 23, 2012. "S" indicates surface sample; "B" indicates bottom sample. "DFS" indicates "distance from shore";negative values indicate distance inland from the beach berm; positive values indicate distance seaward from the beach berm. Nutrient concentrations are shown in units of micrograms per liter (µg/L). For station sampling locations, see Figure 1.

	SAMPLING STATION	DFS (m)	PO_4^{3-} (µg/L)	NO_3^- (µg/L)	NH_4^+ (µg/L)	Si (µg/L)	TOP (µg/L)	TON (µg/L)	TP (µg/L)	TN (µg/L)	Turb (ntu)	Salt (o/oo)	pH (rel)	Chl-a (µg/l)	TEMP (deg. C)	O2 (%sat)
KALOKO POND	1-S	-200-S	31.62	99.12	31.08	8956	22.32	352.24	53.94	482.44	1.88	20.240	8.12	3.67	24.7	97.9
	2-S	-175-S	27.90	112.00	44.24	8889	21.70	355.88	49.60	512.12	2.66	20.319	8.10	2.94	24.5	93.5
	2-B	-175-B	47.12	2.80	9.24	4708	33.48	464.24	80.60	476.28	5.72	27.519	8.22	4.43	25.7	114.7
	3-S	-150-S	32.24	88.20	35.56	8568	26.04	361.48	58.28	485.24	2.67	21.005	8.12	3.28	24.8	94.6
	3-B	-150-B	26.66	1.96	8.68	4572	30.38	394.24	57.04	404.88	3.13	27.962	8.15	2.87	25.4	110.0
	4-S	-125-S	31.62	98.56	34.44	8691	21.08	327.88	52.70	460.88	2.29	20.822	8.12	3.31	24.9	94.3
	4-B	-125-B	27.28	3.92	31.36	4578	17.36	301.28	44.64	336.56	3.39	28.044	8.12	3.19	24.8	94.3
	5-S	-100-S	27.28	99.68	33.88	8547	20.46	320.88	47.74	454.44	2.20	21.087	8.12	2.84	25.1	95.7
	5-B	-100-B	14.26	1.96	7.28	4691	22.94	284.20	37.20	293.44	2.31	27.735	8.16	2.59	24.7	84.1
	6-S	-75-S	22.32	41.72	22.96	7469	20.46	304.36	42.78	369.04	1.99	22.728	8.18	2.90	25.4	95.4
	6-B	-75-B	13.02	1.40	7.00	4304	22.94	261.52	35.96	269.92	1.52	27.998	8.16	2.21	24.4	72.7
	7-S	-50-S	22.32	8.96	17.64	7396	22.94	355.32	45.26	381.92	2.05	23.035	8.20	3.25	25.5	91.6
	7-B	-50-B	14.26	1.12	14.00	4952	27.28	301.56	41.54	316.68	1.57	27.195	8.19	2.45	24.5	81.5
	8-S	-25-S	18.60	1.96	16.52	6438	21.08	294.56	39.68	313.04	2.40	24.280	8.26	2.96	25.8	93.0
	8-B	-25-B	14.26	0.84	11.76	4378	25.42	315.84	39.68	328.44	2.21	28.041	8.22	2.18	24.9	108.9
	9-S	-10-S	21.08	24.92	18.20	6938	21.70	320.60	42.78	363.72	2.55	23.831	8.24	3.05	26.0	92.9
	9-B	-10-B	12.40	3.64	14.00	6131	24.18	286.72	36.58	304.36	1.76	25.091	8.29	3.13	26.1	121.5
	10-S	-1	15.50	4.48	17.36	6387	22.32	311.92	37.82	333.76	1.41	24.565	8.28	3.55	26.1	94.0
OCEAN	11-S	10-S	2.48	23.38	0.14	1113	12.71	104.86	15.19	128.38	0.19	33.191	8.20	0.12	25.6	101.3
	12-S	10-B	5.89	7.14	0.84	564	12.09	94.92	17.98	102.90	0.27	34.013	8.23	0.18	25.3	100.6
	13-S	25-S	7.44	66.22	0.14	1681	13.33	91.00	20.77	157.36	0.30	32.297	8.25	0.08	25.9	100.4
	14-S	25-B	5.27	6.72	0.42	176	12.40	70.14	17.67	77.28	0.18	34.655	8.17	0.10	24.9	99.9
	15-S	75-S	6.20	22.96	0.84	710	9.30	66.50	15.50	90.30	0.12	33.999	8.17	0.08	24.8	100.2
	15-B	75-B	5.27	3.50	0.98	140	9.92	68.32	15.19	72.80	0.05	34.728	8.11	0.06	24.8	98.4
	16-S	100-S	4.65	21.84	1.26	717	9.61	71.96	14.26	95.06	0.14	33.998	8.15	0.10	24.7	99.2
	16-B	100-B	4.96	3.64	1.40	148	9.61	79.52	14.57	84.56	0.06	34.707	8.11	0.05	24.8	101.0
	17-S	200-S	6.20	6.86	0.98	277	8.99	92.26	15.19	100.10	0.09	34.516	8.11	0.08	24.8	100.3
	17-B	200-B	5.89	0.42	1.40	72	8.06	98.84	13.95	100.66	0.06	34.843	8.12	0.05	24.7	99.4
	18-S	300-S	5.89	11.34	1.12	194	8.37	168.42	14.26	180.88	0.11	34.590	8.12	0.06	24.9	101.2
	18-B	300-B	4.03	0.28	0.42	78	8.99	92.40	13.02	93.10	0.07	34.819	8.12	0.04	24.7	100.5

TABLE 4. Results of water chemistry measurements in Aimakapa Pond (top) and Kaloko Pond (bottom) and the coastal ocean directly off of the ponds collected on November 14, 2007. "S" indicates surface sample; "B" indicates bottom sample. "DFS" indicates "distance from shore";negative values indicate distance inland from the beach berm; positive values indicate distance seaward from the beach berm. Nutrient concentrations are shown in micromolar units. "Bdl" stands for "below detection limit."For station sampling locations, see Figure 1.

	SAMPLING STATION	DFS (m)	PO_4^{3-} (µM)	NO_3^- (µM)	NH_4^+ (µM)	Si (µM)	TOP (µM)	TON (µM)	TP (µM)	TN (µM)	Turb (ntu)	Salt (o/oo)	pH (rel)	Chl-a (µg/l)
AIMAKAPA POND	1-S	-230 s	1.85	2.75	2.35	582.20	1.65	50.75	3.50	55.85	0.92	12.673	8.154	7.280
	2-S	-220 s	1.00	0.05	3.40	595.25	1.85	43.65	2.85	47.10	1.07	12.741	8.302	9.28
	3-S	-190 s	1.60	bdl	3.95	597.95	1.90	51.00	3.50	54.95	1.11	12.740	8.394	6.545
	3-B	-190 b	1.45	bdl	3.10	593.75	1.65	51.45	3.10	54.55	1.08	12.710	8.431	6.241
	4-s	-150 s	1.35	0.05	1.30	594.70	2.00	48.00	3.35	49.35	1.05	12.647	8.417	6.409
	5-S	-140 s	0.50	0.10	5.05	592.40	1.70	48.30	2.20	53.45	1.15	12.626	8.422	5.33
	6-S	-120 s	2.05	0.10	9.45	588.25	1.35	40.20	3.40	49.75	1.04	12.639	8.426	6.61
	7-S	-50 s	1.00	0.15	4.65	584.45	2.00	53.80	3.00	58.60	0.94	12.641	8.426	7.24
	8-S	-20 s	1.45	0.15	4.60	582.60	1.75	44.65	3.20	49.40	0.96	12.632	8.410	5.92
	9-S	-1 s	0.45	0.15	2.75	592.90	1.95	45.80	2.40	48.70	1.03	12.681	8.447	6.26
OCEAN	8-S	0	0.28	1.41	0.23	42.23	0.21	8.61	0.49	10.25	1.01	33.507	8.079	0.241
	9-S	1 s	0.31	1.48	0.33	44.39	0.22	9.26	0.53	11.07	0.93	33.364	8.088	0.199
	10-S	3 s	0.22	1.01	0.22	36.67	0.24	9.40	0.46	10.63	0.87	33.717	8.073	0.157
	11-S	10 s	0.24	1.07	0.21	31.73	0.23	9.12	0.47	10.40	1.85	33.916	8.118	0.210
	12-S	20 s	0.18	0.59	0.15	19.98	0.24	8.31	0.42	9.05	0.71	34.306	8.183	0.126
	13-B	50 s	0.15	0.39	0.18	15.37	0.25	8.69	0.40	9.26	0.47	34.448	8.164	0.126
	14-S	100 s	0.19	0.91	0.24	31.57	0.26	8.88	0.45	10.03	0.67	33.815	8.045	0.136
	14-B	100b	0.17	0.39	0.32	16.60	0.40	10.05	0.57	10.76	1.13	34.417	8.062	0.210
	15-S	250 s	0.10	0.37	0.13	26.11	0.27	9.22	0.37	9.72	0.52	34.025	8.100	0.115
	15-B	250 b	0.14	0.26	0.13	21.58	0.25	8.88	0.39	9.27	0.57	34.181	8.105	0.105
	16-S	500 s	0.13	0.12	0.10	16.90	0.23	7.36	0.36	7.58	0.33	34.374	8.028	0.157
	16-B	500b	0.12	bdl	0.41	6.13	0.26	8.21	0.38	8.62	0.26	34.820	8.066	0.168

	SAMPLING STATION	DFS (m)	PO_4^{3-} (µM)	NO_3^- (µM)	NH_4^+ (µM)	Si (µM)	TOP (µM)	TON (µM)	TP (µM)	TN (µM)	Turb (ntu)	Salt (o/oo)	pH (rel)	Chl-a (µg/l)
KALOKO POND	1-S	-200 s	3.20	56.45	0.95	596.05	0.55	25.75	3.75	83.15	0.11	10.765	7.433	0.766
	2-S	-175 s	2.35	50.80	1.25	560.15	0.50	7.80	2.85	59.85	0.08	13.068	7.457	0.283
	3-S	-160 s	1.40	48.45	1.65	546.25	0.70	14.60	2.10	64.70	0.08	14.296	7.467	0.399
	4-S	-140 s	2.30	31.35	0.30	475.25	0.50	18.05	2.80	49.70	0.20	16.455	7.720	2.171
	5-S	-120 s	2.90	45.35	2.20	549.20	0.35	14.20	3.25	61.75	0.18	13.478	7.337	1.259
	6-S	-100 s	2.10	28.00	1.75	458.40	0.90	21.80	3.00	51.55	0.25	17.516	7.689	1.636
	7-S	-80 s	2.05	31.20	0.90	495.50	0.65	19.65	2.70	51.75	0.19	16.450	7.574	0.892
	7-B	-80 b	0.60	0.45	0.55	181.00	1.30	34.00	1.90	35.00	1.47	28.086	8.041	5.549
	8-S	-60 s	1.75	28.55	0.40	485.20	0.75	16.30	2.50	45.25	0.21	16.876	7.610	1.122
	8-B	-60 b	0.70	0.45	4.35	173.60	0.95	31.85	1.65	36.65	0.66	28.635	7.992	3.881
	9-S	-20 s	2.00	25.55	2.40	465.75	0.50	13.70	2.50	41.65	0.50	17.088	7.809	3.892
	9-B	-20 b	0.30	0.35	6.75	171.30	1.10	29.65	1.40	36.75	0.84	28.645	8.063	5.759
	10-S	-10 s	1.55	20.75	4.70	434.80	0.85	26.80	2.40	52.25	0.58	18.284	7.882	4.804
	10-B	-10 b	0.60	0.40	2.85	185.90	1.00	31.35	1.60	34.60	0.39	27.899	8.133	2.392
	11-S	-5 s	1.45	11.75	4.50	367.40	0.65	24.15	2.10	40.40	0.46	21.022	8.060	2.968
	11-B	-5 b	0.95	0.35	2.95	185.15	0.70	26.75	1.65	30.05	0.87	27.755	8.164	1.909
	12-S	-1 s	2.45	40.85	1.85	472.85	0.25	19.75	2.70	62.45	0.12	16.675	8.147	0.996
OCEAN	13-S	1	1.20	11.85	1.40	258.20	0.70	28.85	1.90	42.10	0.28	25.682	8.108	0.462
	14-S	3	1.00	8.35	1.70	237.45	0.80	23.70	1.80	33.75	0.30	26.135	8.135	0.409
	15-S	10	0.59	5.81	0.43	124.43	0.22	9.00	0.81	15.24	0.31	30.081	8.134	0.524
	16-S	20	0.43	4.39	0.41	92.45	0.22	9.41	0.65	14.21	0.23	31.405	8.147	0.378
	17-S	30	0.40	2.90	0.30	63.38	0.20	9.93	0.60	13.13	0.21	32.599	8.142	0.262
	18-S	50 s	0.05	2.39	bdl	57.54	0.27	9.07	0.32	11.46	0.21	32.820	8.141	0.199
	18-B	50 b	0.05	0.38	bdl	9.91	0.27	8.33	0.32	8.71	0.16	34.710	8.103	0.094
	19-S	100 s	0.20	2.34	0.46	56.69	0.28	10.24	0.48	13.04	0.14	32.861	8.127	0.178
	19-B	100 b	0.06	0.27	0.39	7.98	0.26	9.32	0.32	9.98	0.13	34.773	8.107	0.105
	20-S	500 s	0.06	1.45	0.83	35.23	0.32	7.44	0.38	9.72	0.14	33.802	8.120	0.126
	20-B	500 b	0.04	0.37	0.54	10.64	0.30	9.66	0.34	10.57	0.11	34.662	8.122	0.073

TABLE 4-A. Results of water chemistry measurements in Aimakapa Pond (top) and Kaloko Pond (bottom) and the coastal ocean directly off of the ponds collected on November 14, 2007. "S" indicates surface sample; "B" indicates bottom sample. "DFS" indicates "distance from shore";negative values indicate distance inland from the beach berm; positive values indicate distance seaward from the beach berm. Nutrient concentrations are shown in units of micrograms per liter (µg/L)."Bdl" stands for "below detection limit."For station sampling locations, see Figure 1.

	SAMPLING STATION	DFS (m)	PO_4^{3-} (µg/L)	NO_3^- (µg/L)	NH_4^+ (µg/L)	Si (µg/L)	TOP (µg/L)	TON (µg/L)	TP (µg/L)	TN (µg/L)	Turb (ntu)	Salt (o/oo)	pH (rel)	Chl-a (µg/l)
AIMAKAPA POND	1-S	-230 s	57.35	38.50	32.90	16302	51.15	710.50	108.50	781.90	0.92	12.673	8.154	7.280
	2-S	-220 s	31.00	0.70	47.60	16667	57.35	611.10	88.35	659.40	1.07	12.741	8.302	9.28
	3-S	-190 s	49.60	bdl	55.30	16743	58.90	714.00	108.50	769.30	1.11	12.740	8.394	6.545
	3-B	-190 b	44.95	bdl	43.40	16625	51.15	720.30	96.10	763.70	1.08	12.710	8.431	6.241
	4-s	-150 s	41.85	0.70	18.20	16652	62.00	672.00	103.85	690.90	1.05	12.647	8.417	6.409
	5-S	-140 s	15.50	1.40	70.70	16587	52.70	676.20	68.20	748.30	1.15	12.626	8.422	5.33
	6-S	-120 s	63.55	1.40	132.30	16471	41.85	562.80	105.40	696.50	1.04	12.639	8.426	6.61
	7-S	-50 s	31.00	2.10	65.10	16365	62.00	753.20	93.00	820.40	0.94	12.641	8.426	7.24
	8-S	-20 s	44.95	2.10	64.40	16313	54.25	625.10	99.20	691.60	0.96	12.632	8.410	5.92
	9-S	-1 s	13.95	2.10	38.50	16601	60.45	641.20	74.40	681.80	1.03	12.681	8.447	6.26
OCEAN	8-S	0	8.68	19.74	3.22	1182	6.51	120.54	15.19	143.50	1.01	33.507	8.079	0.241
	9-S	1 s	9.61	20.72	4.62	1243	6.82	129.64	16.43	154.98	0.93	33.364	8.088	0.199
	10-S	3 s	6.82	14.14	3.08	1027	7.44	131.60	14.26	148.82	0.87	33.717	8.073	0.157
	11-S	10 s	7.44	14.98	2.94	888	7.13	127.68	14.57	145.60	1.85	33.916	8.118	0.210
	12-S	20 s	5.58	8.26	2.10	559	7.44	116.34	13.02	126.70	0.71	34.306	8.183	0.126
	13-B	50 s	4.65	5.46	2.52	430	7.75	121.66	12.40	129.64	0.47	34.448	8.164	0.126
	14-S	100 s	5.89	12.74	3.36	884	8.06	124.32	13.95	140.42	0.67	33.815	8.045	0.136
	14-B	100b	5.27	5.46	4.48	465	12.40	140.70	17.67	150.64	1.13	34.417	8.062	0.210
	15-S	250 s	3.10	5.18	1.82	731	8.37	129.08	11.47	136.08	0.52	34.025	8.100	0.115
	15-B	250 b	4.34	3.64	1.82	604	7.75	124.32	12.09	129.78	0.57	34.181	8.105	0.105
	16-S	500 s	4.03	1.68	1.40	473	7.13	103.04	11.16	106.12	0.33	34.374	8.028	0.157
	16-B	500b	3.72	0.00	5.74	172	8.06	114.94	11.78	120.68	0.26	34.820	8.066	0.168

	SAMPLING STATION	DFS (m)	PO_4^{3-} (µg/L)	NO_3^- (µg/L)	NH_4^+ (µg/L)	Si (µg/L)	TOP (µg/L)	TON (µg/L)	TP (µg/L)	TN (µg/L)	Turb (ntu)	Salt (o/oo)	pH (rel)	Chl-a (µg/l)
KALOKO POND	1-S	-200 s	99.20	790.30	13.30	16689	17.05	360.50	116.25	1164.10	0.11	10.765	7.433	0.766
	2-S	-175 s	72.85	711.20	17.50	15684	15.50	109.20	88.35	837.90	0.08	13.068	7.457	0.283
	3-S	-160 s	43.40	678.30	23.10	15295	21.70	204.40	65.10	905.80	0.08	14.296	7.467	0.399
	4-S	-140 s	71.30	438.90	4.20	13307	15.50	252.70	86.80	695.80	0.20	16.455	7.720	2.171
	5-S	-120 s	89.90	634.90	30.80	15378	10.85	198.80	100.75	864.50	0.18	13.478	7.337	1.259
	6-S	-100 s	65.10	392.00	24.50	12835	27.90	305.20	93.00	721.70	0.25	17.516	7.689	1.636
	7-S	-80 s	63.55	436.80	12.60	13874	20.15	275.10	83.70	724.50	0.19	16.450	7.574	0.892
	7-B	-80 b	18.60	6.30	7.70	5068	40.30	476.00	58.90	490.00	1.47	28.086	8.041	5.549
	8-S	-60 s	54.25	399.70	5.60	13586	23.25	228.20	77.50	633.50	0.21	16.876	7.610	1.122
	8-B	-60 b	21.70	6.30	60.90	4861	29.45	445.90	51.15	513.10	0.66	28.635	7.992	3.881
	9-S	-20 s	62.00	357.70	33.60	13041	15.50	191.80	77.50	583.10	0.50	17.088	7.809	3.892
	9-B	-20 b	9.30	4.90	94.50	4796	34.10	415.10	43.40	514.50	0.84	28.645	8.063	5.759
	10-S	-10 s	48.05	290.50	65.80	12174	26.35	375.20	74.40	731.50	0.58	18.284	7.882	4.804
	10-B	-10 b	18.60	5.60	39.90	5205	31.00	438.90	49.60	484.40	0.39	27.899	8.133	2.392
	11-S	-5 s	44.95	164.50	63.00	10287	20.15	338.10	65.10	565.60	0.46	21.022	8.060	2.968
	11-B	-5 b	29.45	4.90	41.30	5184	21.70	374.50	51.15	420.70	0.87	27.755	8.164	1.909
	12-S	-1 s	75.95	571.90	25.90	13240	7.75	276.50	83.70	874.30	0.12	16.675	8.147	0.996
OCEAN	13-S	1	37.20	165.90	19.60	7230	21.70	403.90	58.90	589.40	0.28	25.682	8.108	0.462
	14-S	3	31.00	116.90	23.80	6649	24.80	331.80	55.80	472.50	0.30	26.135	8.135	0.409
	15-S	10	18.29	81.34	6.02	3484	6.82	126.00	25.11	213.36	0.31	30.081	8.134	0.524
	16-S	20	13.33	61.46	5.74	2589	6.82	131.74	20.15	198.94	0.23	31.405	8.147	0.378
	17-S	30	12.40	40.60	4.20	1775	6.20	139.02	18.60	183.82	0.21	32.599	8.142	0.262
	18-S	50 s	1.55	33.46	bdl	1611	8.37	126.98	9.92	160.44	0.21	32.820	8.141	0.199
	18-B	50 b	1.55	5.32	bdl	277	8.37	116.62	9.92	121.94	0.16	34.710	8.103	0.094
	19-S	100 s	6.20	32.76	6.44	1587	8.68	143.36	14.88	182.56	0.14	32.861	8.127	0.178
	19-B	100 b	1.86	3.78	5.46	223	8.06	130.48	9.92	139.72	0.13	34.773	8.107	0.105
	20-S	500 s	1.86	20.30	11.62	986	9.92	104.16	11.78	136.08	0.14	33.802	8.120	0.126
	20-B	500 b	1.24	5.18	7.56	298	9.30	135.24	10.54	147.98	0.11	34.662	8.122	0.073

TABLE 5. Results of water chemistry measurements in Aimakapa Pond (top) and Kaloko Pond (bottom) and the coastal ocean directly off of the ponds collected in 2000. "S" indicates surface sample; "B" indicates bottom sample. "DFS" indicates "distance from shore";negative values indicate distance inland from the beach berm; positive values indicate distance seaward from the beach berm. Nutrient concentrations are shown in micromolar units. "Bdl" stands for "below detection limit."For station sampling locations, see Figure 1.

	SAMPLING STATION	DFS (m)	PO_4^{3-} (μM)	NO_3^- (μM)	NH_4^+ (μM)	Si (μM)	TOP (μM)	TON (μM)	TP (μM)	TN (μM)	Turb (ntu)	TSS (mg/l)	Salt (o/oo)	pH (rel)	Chl-a (μg/l)	O2 (%sat)
AIMAKAPA POND	1-S	-230-S	0.51	0.16	bdl	439.57	3.28	79.37	3.79	79.53	4.10	6.00	12.855	8.195	2.815	88.1
	1-B	-230-B	0.55	0.19	0.01	439.23	5.71	129.89	6.26	130.09	13.20	85.60	12.864	8.225	15.57	81.9
	2-S	-190-S	0.64	0.25	0.04	403.45	3.58	102.90	4.22	103.19	6.00	13.20	13.158	8.509	5.064	91.3
	2-B	-190-B	0.63	0.29	0.04	403.48	3.61	102.31	4.24	102.64	6.10	22.71	13.164	8.585	9.021	93.0
	3-S	-150-S	0.63	0.28	0.03	402.61	3.57	102.21	4.20	102.52	6.20	16.00	13.169	8.548	5.203	93.7
	3-B	-150-B	0.63	0.28	0.08	382.35	4.19	117.16	4.82	117.52	36.00	290.2	13.184	8.445	59.33	72.7
	4-S	-110-S	0.65	0.30	0.06	397.99	3.72	107.52	4.37	107.88	6.60	19.80	13.248	8.538	16.28	91.3
	4-B	-110-B	0.66	0.28	0.08	393.74	3.83	108.90	4.49	109.26	20.40	203.0	13.253	8.569	49.26	87.5
	5-S	-80-S	0.67	0.32	0.07	397.31	3.77	106.84	4.44	107.23	6.20	9.87	13.175	8.599	23.45	90.6
	5-B	-80-B	0.77	0.32	0.16	405.77	4.86	135.26	5.63	135.74	24.60	283.0	13.179	8.517	51.82	80.7
	6-S	-40-S	0.66	0.31	0.11	395.68	3.83	108.31	4.49	108.73	6.80	15.40	13.223	8.609	16.87	91.7
	6-B	-40-B	0.67	0.32	0.13	395.74	3.83	107.03	4.50	107.48	7.80	180.4	13.239	8.606	26.52	93.8
	7-S	-1-S	0.64	0.28	0.12	397.33	3.58	102.56	4.22	102.96	6.30	8.93	13.253	8.652	4.699	97.7
	7-B	-1-B	0.64	0.35	0.16	394.13	7.31	175.63	7.95	176.14	28.00	278.3	13.369	8.517	106.4	76.9
OCEAN	8-S	1-S	0.26	1.81	0.09	68.18	0.32	9.49	0.58	11.39	0.40	4.40	32.413	8.112	0.751	96.2
	9-S	3-S	0.24	1.81	0.23	68.66	0.30	9.28	0.54	11.32	0.33	3.27	32.287	8.098	0.323	97.6
	10-S	10-S	0.33	2.80	0.08	80.40	0.27	8.98	0.60	11.86	0.21	2.93	31.733	8.152	0.206	102.6
	10-B	10-B	0.30	2.07	0.12	68.01	0.27	8.69	0.57	10.88	0.30	2.29	32.283	8.107	0.260	98.9
	11-S	25-S	0.24	4.09	0.29	138.35	0.31	9.16	0.55	13.54	0.42	9.40	29.343	8.270	0.239	123.6
	11-B	25-B	0.32	2.19	0.36	93.10	0.42	11.68	0.74	14.23	0.35	11.20	31.032	8.226	0.772	117.2
	12-S	50-S	0.28	2.35	0.23	91.72	0.29	9.09	0.57	11.67	0.25	5.20	31.090	8.207	0.696	114.2
	12-B	50-B	0.22	1.35	0.22	61.10	0.32	9.76	0.54	11.33	0.40	2.47	32.305	8.279	0.273	131.3
	13-S	100-S	0.27	0.99	0.13	48.52	0.29	10.48	0.56	11.60	0.19	2.93	32.755	8.229	0.206	112.4
	13-B	100-B	0.14	0.23	0.22	26.78	0.30	9.10	0.44	9.55	0.27	5.67	33.549	8.234	0.210	110.9
	14-S	150-S	0.19	0.70	0.15	11.80	0.24	6.98	0.43	7.83	0.08	2.87	33.956	8.164	0.089	119.7
	14-B	150-B	0.14	0.30	0.03	3.99	0.31	5.99	0.45	6.32	0.11	3.74	34.178	8.163	0.054	99.8

	SAMPLING STATION	DFS (m)	PO_4^{3-} (μM)	NO_3^- (μM)	NH_4^+ (μM)	Si (μM)	TOP (μM)	TON (μM)	TP (μM)	TN (μM)	Turb (ntu)	TSS (mg/l)	Salt (o/oo)	pH (rel)	Chl-a (μg/l)	O2 (%sat)
KALOKO POND	1-S	-200-S	0.35	0.08	0.04	77.57	0.72	23.17	1.07	23.29	0.70	8.87	32.184	8.327	4.800	94.9
	1-B	-200-B	0.30	0.06	0.13	76.27	0.48	18.03	0.78	18.22	0.80	14.80	32.240	8.349	8.979	96.5
	2-S	-170-S	0.23	0.05	0.18	76.71	0.49	17.18	0.72	17.41	0.69	11.20	32.195	8.351	3.633	97.0
	2-B	-170-B	0.39	0.05	0.25	44.03	0.43	16.70	0.82	17.00	0.72	10.80	33.513	8.351	7.951	97.7
	3-S	-140-S	0.24	0.04	0.17	66.69	0.45	17.33	0.69	17.54	0.62	8.20	32.618	8.360	3.143	96.4
	3-B	-140-B	0.35	0.06	0.21	45.37	0.47	16.70	0.82	16.97	0.66	10.80	33.409	8.361	2.903	98.5
	4-S	-110-S	0.24	0.06	0.15	60.35	0.49	17.16	0.73	17.37	0.58	8.93	32.841	8.365	2.941	98.7
	4-B	-110-B	0.31	0.05	0.54	40.77	0.42	15.56	0.73	16.15	0.63	11.86	33.595	8.342	2.530	94.5
	5-S	-80-S	0.21	0.03	0.13	59.51	0.52	17.62	0.73	17.78	0.61	7.60	32.889	8.360	2.618	99.3
	5-B	-80-B	0.36	0.04	0.18	37.85	0.53	18.25	0.89	18.47	0.59	7.27	33.736	8.297	2.736	82.6
	6-S	-50-S	0.28	0.04	0.15	59.68	0.46	17.71	0.74	17.90	0.56	9.40	32.926	8.355	2.564	97.9
	6-B	-50-B	0.26	0.06	0.18	44.48	0.51	16.76	0.77	17.00	0.62	12.40	33.477	8.341	4.116	93.4
	7-S	-20-S	0.24	0.07	0.31	56.38	0.55	17.06	0.79	17.44	0.53	5.80	33.034	8.361	2.316	95.0
	7-B	-20-B	0.30	0.03	0.18	51.81	0.45	15.53	0.75	15.74	0.56	8.93	33.233	8.356	2.622	96.4
	8-S	-1-S	0.23	0.09	0.19	52.00	0.51	18.46	0.74	18.74	0.58	8.40	33.213	8.351	3.415	93.8
	8-B	-1-B	0.23	0.26	0.38	50.39	0.48	16.57	0.71	17.21	0.54	6.47	33.277	8.335	3.176	91.8
OCEAN	9-S	1-S	0.37	3.04	0.40	62.65	0.37	14.27	0.74	17.71	0.31	14.20	32.418	8.408	7.636	94.3
	10-S	3-S	0.33	3.39	0.57	66.43	0.24	9.25	0.57	13.21	0.28	4.80	32.401	8.377	0.885	98.3
	11-S	10-S	0.34	3.67	0.62	66.57	0.25	9.12	0.59	13.41	0.38	2.93	32.418	8.355	0.730	95.9
	12-S	25-S	0.31	5.88	0.25	115.18	0.29	8.66	0.60	14.79	0.19	4.27	30.685	8.333	0.331	115.6
	12-B	25-B	0.73	5.64	0.53	108.98	0.34	19.95	1.07	26.12	0.17	2.80	30.918	8.336	0.470	124.4
	13-S	50-S	0.30	4.13	0.25	83.02	0.29	9.26	0.59	13.64	0.20	3.20	31.791	8.298	0.466	119.1
	13-B	50-B	0.25	3.15	0.20	25.43	0.30	8.15	0.50	11.46	0.14	2.90	32.538	8.289	0.387	117.3
	14-S	100-S	0.17	2.10	0.18	47.33	0.30	7.95	0.47	10.23	0.12	1.80	33.107	8.260	0.277	111.3
	14-B	100-B	0.15	0.48	0.15	12.20	0.30	8.07	0.45	8.70	0.13	1.67	34.298	8.238	0.239	108.8
	15-S	150-S	0.15	0.77	0.13	14.51	0.27	6.36	0.42	7.26	0.13	1.98	33.798	8.180	0.096	112.0
	15-B	150-B	0.11	0.19	0.08	3.87	0.26	6.34	0.37	6.61	0.05	1.78	34.183	8.160	0.075	109.4

TABLE 3-A. Results of water chemistry measurements in Aimakapa and Kaloko Ponds collected in November 19, 2012. "S" indicates surface sample; "B" indicates bottom sample. "DFS" indicates "distance from shore";negative values indicate distance inland from the beach berm; positive values indicate distance seaward from the beach berm. Nutrient concentrations are shown in units of micrograms per liter (μg/L). For station sampling locations, see Figure 1.

	SAMPLING STATION	DFS (m)	PO_4^{3-} (μg/L)	NO_3^- (μg/L)	NH_4^+ (μg/L)	Si (μg/L)	TOP (μg/L)	TON (μg/L)	TP (μg/L)	TN (μg/L)	Turb (ntu)	Salt (o/oo)	pH (rel)	Chl-a (μg/l)	TEMP (deg C)	O2 (%sat)
AIMAKAPA POND	1-S	-230-S	99.20	662.76	91.84	14843	15.50	245.00	114.70	999.60	0.37	11.669	7.60	0.13	25.7	99.3
	1-B	-230-B	114.70	688.24	8.40	14833	6.82	189.28	121.52	885.92	0.34	11.673	7.60	0.12	25.1	62.4
	2-S	-205-S	123.38	706.72	1.12	15249	5.58	131.04	128.96	838.88	0.20	11.547	7.54	0.12	24.5	96.7
	2-B	-205-B	108.50	465.92	68.32	15152	21.08	253.40	129.58	787.64	0.97	12.101	7.76	0.49	24.9	93.1
	3-S	-190-S	128.34	558.32	48.72	15040	6.82	189.84	135.16	796.88	0.38	11.666	7.52	0.25	24.6	102.7
	3-B	-190-B	108.50	379.68	96.32	15314	27.90	376.60	136.40	852.60	1.66	12.111	7.86	0.74	25.0	110.0
	4-S	-170-S	118.42	495.88	52.08	15134	8.06	232.68	126.48	780.64	0.79	11.907	7.63	0.37	24.8	106.3
	4-B	-170-B	91.14	178.08	177.52	15416	34.10	430.64	125.24	786.24	2.58	12.476	8.02	1.17	24.6	136.7
	5-S	-150-S	73.16	12.60	160.72	15529	59.52	696.92	132.68	870.24	4.70	12.853	8.27	1.24	24.9	100.4
	5-B	-150-B	74.40	6.16	127.12	15574	64.48	812.00	138.88	945.28	4.89	12.857	8.29	1.69	24.6	103.1
	6-S	-130-S	75.02	3.36	255.92	15610	52.70	599.20	127.72	858.48	4.07	12.751	8.28	1.34	24.9	100.0
	6-B	-130-B	71.30	2.80	164.08	15506	65.10	722.40	136.40	889.28	4.42	12.807	8.30	1.44	24.3	82.7
	7-S	-110-S	66.96	4.76	129.36	15420	74.40	856.24	141.36	990.36	4.85	12.798	8.38	1.48	25.0	113.9
	7-B	-110-B	64.48	2.24	111.44	15436	63.24	759.08	127.72	872.76	5.06	12.822	8.38	1.26	24.3	100.6
	8-S	-80-S	67.58	10.92	143.36	15637	65.10	751.24	132.68	905.52	4.70	12.851	8.32	1.41	24.8	98.9
	8-B	-80-B	64.48	6.44	148.40	15508	57.04	770.28	121.52	925.12	4.92	12.853	8.33	1.55	24.3	81.9
	9-S	-40-S	68.20	4.48	150.64	15304	61.38	874.44	129.58	1029.56	4.22	12.751	8.36	1.43	25.6	118.0
	9-B	-40-B	62.00	7.00	77.84	15552	57.66	879.76	119.66	964.60	4.79	12.834	8.40	1.74	24.4	127.5
	10-S	-1-S	69.44	8.68	59.92	15277	53.94	897.12	123.38	965.72	4.85	12.869	8.40	1.40	25.2	117.5
	10-B	-1-B	66.34	3.36	93.52	15331	58.90	867.72	125.24	964.60	5.43	12.862	8.43	1.65	25.0	120.2
KALOKO POND	1-S	-200-S	101.68	662.48	25.20	13301	4.34	149.52	106.02	837.20	0.83	14.848	7.73	1.49	21.7	96.8
	1-B	-200-B	94.86	574.00	44.80	12216	0.62	153.44	95.48	772.24	1.40	16.233	7.84	2.37	26.0	148.4
	2-S	-175-S	78.74	463.96	60.48	11533	4.96	164.92	83.70	689.36	1.20	17.601	7.95	2.21	23.7	96.5
	2-B	-175-B	60.76	238.28	107.52	9442	9.92	215.32	70.68	561.12	2.42	20.915	8.19	2.84	26.5	168.6
	3-S	-150-S	53.94	222.88	92.40	9926	10.54	252.84	64.48	568.12	1.72	20.160	8.18	2.48	24.7	94.2
	3-B	-150-B	40.30	60.20	103.04	7683	19.22	328.16	59.52	491.40	1.87	23.650	8.32	3.39	26.2	142.1
	4-S	-125-S	44.02	59.08	147.28	8479	19.84	267.68	63.86	474.04	1.98	22.339	8.32	3.40	25.3	92.3
	4-B	-125-B	29.14	12.32	94.64	6831	23.56	261.52	52.70	368.48	2.03	24.795	8.38	3.29	25.9	77.6
	5-S	-100-S	32.24	7.00	126.56	7520	22.32	299.04	54.56	432.60	1.26	23.615	8.38	3.42	25.5	93.1
	5-B	-100-B	22.94	8.40	91.84	6255	27.90	282.24	50.84	382.48	2.94	25.631	8.39	3.14	25.9	106.9
	6-S	-75-S	29.14	4.48	134.40	7241	20.46	250.88	49.60	389.76	4.33	23.916	8.38	3.23	25.6	98.9
	6-B	-75-B	32.86	6.16	162.40	7369	19.84	235.48	52.70	404.04	2.13	23.950	8.38	3.35	26.1	122.8
	7-S	-50-S	26.04	2.52	123.76	7162	22.94	239.12	48.98	365.40	2.84	24.158	8.38	3.23	25.7	97.3
	7-B	-50-B	23.56	1.40	100.24	6122	22.94	240.52	46.50	342.16	2.69	25.910	8.39	2.81	26.0	115.0
	8-S	-25-S	29.76	5.32	125.44	6991	18.60	245.28	48.36	376.04	2.26	24.447	8.39	3.08	25.7	93.7
	8-B	-25-B	19.84	1.40	101.92	6770	21.08	255.08	40.92	358.40	2.76	24.942	8.39	3.06	26.0	116.2
	9-S	-10-S	27.90	1.12	104.72	6832	23.56	289.80	51.46	395.64	2.40	24.741	8.39	3.41	25.7	92.5
	9-B	-10-B	24.18	0.84	103.04	5940	22.94	302.96	47.12	406.84	2.08	26.160	8.38	2.85	26.2	111.1
	10-S	-1-S	27.90	1.40	102.48	6787	22.32	280.00	50.22	383.88	2.06	24.662	8.41	3.29	25.8	94.4
	10-B	-1-B	19.22	0.84	78.40	6018	23.56	246.12	42.78	325.36	2.09	25.989	8.40	2.94	26.0	111.3

TABLE 5-A. Results of water chemistry measurements in Aimakapa Pond (top) and Kaloko Pond (bottom) and the coastal ocean directly off of the ponds collected in 2000. "S" indicates surface sample; "B" indicates bottom sample. "DFS" indicates "distance from shore";negative values indicate distance inland from the beach berm; positive values indicate distance seaward from the beach berm. Nutrient concentrations are shown in units of micrograms per liter (µg/L). "Bdl" stands for "below detection limit."For station sampling locations, see Figure 1.

	SAMPLING STATION	DFS (m)	PO_4^{3-} (µg/L)	NO_3^- (µg/L)	NH_4^+ (µg/L)	Si (µg/L)	TOP (µg/L)	TON (µg/L)	TP (µg/L)	TN (µg/L)	Turb (ntu)	TSS (mg/l)	Salt (o/oo)	pH (rel)	Chl-a (µg/l)	O2 (%sat)
AIMAKAPA POND	1-S	-230-S	15.81	2.24	bdl	12308	101.68	1111.18	117.49	1113.42	4.10	6.00	12.855	8.195	2.815	88.1
	1-B	-230-B	17.05	2.66	0.14	12298	177.01	1818.46	194.06	1821.26	13.20	85.60	12.864	8.225	15.57	81.9
	2-S	-190-S	19.84	3.50	0.56	11297	110.98	1440.60	130.82	1444.66	6.00	13.20	13.158	8.509	5.064	91.3
	2-B	-190-B	19.53	4.06	0.56	11297	111.91	1432.34	131.44	1436.96	6.10	22.71	13.164	8.585	9.021	93.0
	3-S	-150-S	19.53	3.92	0.42	11273	110.67	1430.94	130.20	1435.28	6.20	16.00	13.169	8.548	5.203	93.7
	3-B	-150-B	19.53	3.92	1.12	10706	129.89	1640.24	149.42	1645.28	36.00	290.2	13.184	8.445	59.33	72.7
	4-S	-110-S	20.15	4.20	0.84	11144	115.32	1505.28	135.47	1510.32	6.60	19.80	13.248	8.538	16.28	91.3
	4-B	-110-B	20.46	3.92	1.12	11025	118.73	1524.60	139.19	1529.64	20.40	203.0	13.253	8.569	49.26	87.5
	5-S	-80-S	20.77	4.48	0.98	11125	116.87	1495.76	137.64	1501.22	6.20	9.87	13.175	8.599	23.45	90.6
	5-B	-80-B	23.87	4.48	2.24	11362	150.66	1893.64	174.53	1900.36	24.60	283.0	13.179	8.517	51.82	80.7
	6-S	-40-S	20.46	4.34	1.54	11079	118.73	1516.34	139.19	1522.22	6.80	15.40	13.223	8.609	16.87	91.7
	6-B	-40-B	20.77	4.48	1.82	11081	118.73	1498.42	139.50	1504.72	7.80	180.4	13.239	8.606	26.52	93.8
	7-S	-1-S	19.84	3.92	1.68	11125	110.98	1435.84	130.82	1441.44	6.30	8.93	13.253	8.652	4.699	97.7
	7-B	-1-B	19.84	4.90	2.24	11036	226.61	2458.82	246.45	2465.96	28.00	278.3	13.369	8.517	106.4	76.9
OCEAN	8-S	1-S	8.06	25.34	1.26	1909	9.92	132.86	17.98	159.46	0.40	4.40	32.413	8.112	0.751	96.2
	9-S	3-S	7.44	25.34	3.22	1922	9.30	129.92	16.74	158.48	0.33	3.27	32.287	8.098	0.323	97.6
	10-S	10-S	10.23	39.20	1.12	2251	8.37	125.72	18.60	166.04	0.21	2.93	31.733	8.152	0.206	102.6
	10-B	10-B	9.30	28.98	1.68	1904	8.37	121.66	17.67	152.32	0.30	2.29	32.283	8.107	0.260	98.9
	11-S	25-S	7.44	57.26	4.06	3874	9.61	128.24	17.05	189.56	0.42	9.40	29.343	8.270	0.239	123.6
	11-B	25-B	9.92	30.66	5.04	2607	13.02	163.52	22.94	199.22	0.35	11.20	31.032	8.226	0.772	117.2
	12-S	50-S	8.68	32.90	3.22	2568	8.99	127.26	17.67	163.38	0.25	5.20	31.090	8.207	0.696	114.2
	12-B	50-B	6.82	18.90	3.08	1711	9.92	136.64	16.74	158.62	0.40	2.47	32.305	8.279	0.273	131.3
	13-S	100-S	8.37	13.86	1.82	1359	8.99	146.72	17.36	162.40	0.19	2.93	32.755	8.229	0.206	112.4
	13-B	100-B	4.34	3.22	3.08	750	9.30	127.40	13.64	133.70	0.27	5.67	33.549	8.234	0.210	110.9
	14-S	150-S	5.89	9.80	2.10	330	7.44	97.72	13.33	109.62	0.08	2.87	33.956	8.164	0.089	119.7
	14-B	150-B	4.34	4.20	0.42	112	9.61	83.86	13.95	88.48	0.11	3.74	34.178	8.163	0.054	99.8

	SAMPLING STATION	DFS (m)	PO_4^{3-} (µg/L)	NO_3^- (µg/L)	NH_4^+ (µg/L)	Si (µg/L)	TOP (µg/L)	TON (µg/L)	TP (µg/L)	TN (µg/L)	Turb (ntu)	TSS (mg/l)	Salt (o/oo)	pH (rel)	Chl-a (µg/l)	O2 (%sat)
KALOKO POND	1-S	-200-S	10.85	1.12	0.56	2172	22.32	324.38	33.17	326.06	0.70	8.87	32.184	8.327	4.800	94.9
	1-B	-200-B	9.30	0.84	1.82	2136	14.88	252.42	24.18	255.08	0.80	14.80	32.240	8.349	8.979	96.5
	2-S	-170-S	7.13	0.70	2.52	2148	15.19	240.52	22.32	243.74	0.69	11.20	32.195	8.351	3.633	97.0
	2-B	-170-B	12.09	0.70	3.50	1233	13.33	233.80	25.42	238.00	0.72	10.80	33.513	8.351	7.951	97.7
	3-S	-140-S	7.44	0.56	2.38	1867	13.95	242.62	21.39	245.56	0.62	8.20	32.618	8.360	3.143	96.4
	3-B	-140-B	10.85	0.84	2.94	1270	14.57	233.80	25.42	237.58	0.66	10.80	33.409	8.361	2.903	98.5
	4-S	-110-S	7.44	0.84	2.10	1690	15.19	240.24	22.63	243.18	0.58	8.93	32.841	8.365	2.941	98.7
	4-B	-110-B	9.61	0.70	7.56	1142	13.02	217.84	22.63	226.10	0.63	11.86	33.595	8.342	2.530	94.5
	5-S	-80-S	6.51	0.42	1.82	1666	16.12	246.68	22.63	248.92	0.61	7.60	32.889	8.360	2.618	99.3
	5-B	-80-B	11.16	0.56	2.52	1060	16.43	255.50	27.59	258.58	0.59	7.27	33.736	8.297	2.736	82.6
	6-S	-50-S	8.68	0.56	2.10	1671	14.26	247.94	22.94	250.60	0.56	9.40	32.926	8.355	2.564	97.9
	6-B	-50-B	8.06	0.84	2.52	1245	15.81	234.64	23.87	238.00	0.62	12.40	33.477	8.341	4.116	93.4
	7-S	-20-S	7.44	0.98	4.34	1579	17.05	238.84	24.49	244.16	0.53	5.80	33.034	8.361	2.316	95.0
	7-B	-20-B	9.30	0.42	2.52	1451	13.95	217.42	23.25	220.36	0.56	8.93	33.233	8.356	2.622	96.4
	8-S	-1-S	7.13	1.26	2.66	1456	15.81	258.44	22.94	262.36	0.58	8.40	33.213	8.351	3.415	93.8
	8-B	-1-B	7.13	3.64	5.32	1411	14.88	231.98	22.01	240.94	0.54	6.47	33.277	8.335	3.176	91.8
OCEAN	9-S	1-S	11.47	42.56	5.60	1754	11.47	199.78	22.94	247.94	0.31	14.20	32.418	8.408	7.636	94.3
	10-S	3-S	10.23	47.46	7.98	1860	7.44	129.50	17.67	184.94	0.28	4.80	32.401	8.377	0.885	98.3
	11-S	10-S	10.54	51.38	8.68	1864	7.75	127.68	18.29	187.74	0.38	2.93	32.418	8.355	0.730	95.9
	12-S	25-S	9.61	82.32	3.50	3225	8.99	121.24	18.60	207.06	0.19	4.27	30.685	8.333	0.331	115.6
	12-B	25-B	22.63	78.96	7.42	3051	10.54	279.30	33.17	365.68	0.17	2.80	30.918	8.336	0.470	124.4
	13-S	50-S	9.30	57.82	3.50	2325	8.99	129.64	18.29	190.96	0.20	3.20	31.791	8.298	0.466	119.1
	13-B	50-B	7.75	44.10	2.80	712	9.30	114.10	15.50	160.44	0.14	2.90	32.538	8.289	0.387	117.3
	14-S	100-S	5.27	29.40	2.52	1325	9.30	111.30	14.57	143.22	0.12	1.80	33.107	8.260	0.277	111.3
	14-B	100-B	4.65	6.72	2.10	342	9.30	112.98	13.95	121.80	0.13	1.67	34.298	8.238	0.239	108.8
	15-S	150-S	4.65	10.78	1.82	406	8.37	89.04	13.02	101.64	0.13	1.98	33.798	8.180	0.096	112.0
	15-B	150-B	3.41	2.66	1.12	108	8.06	88.76	11.47	92.54	0.05	1.78	34.183	8.160	0.075	109.4

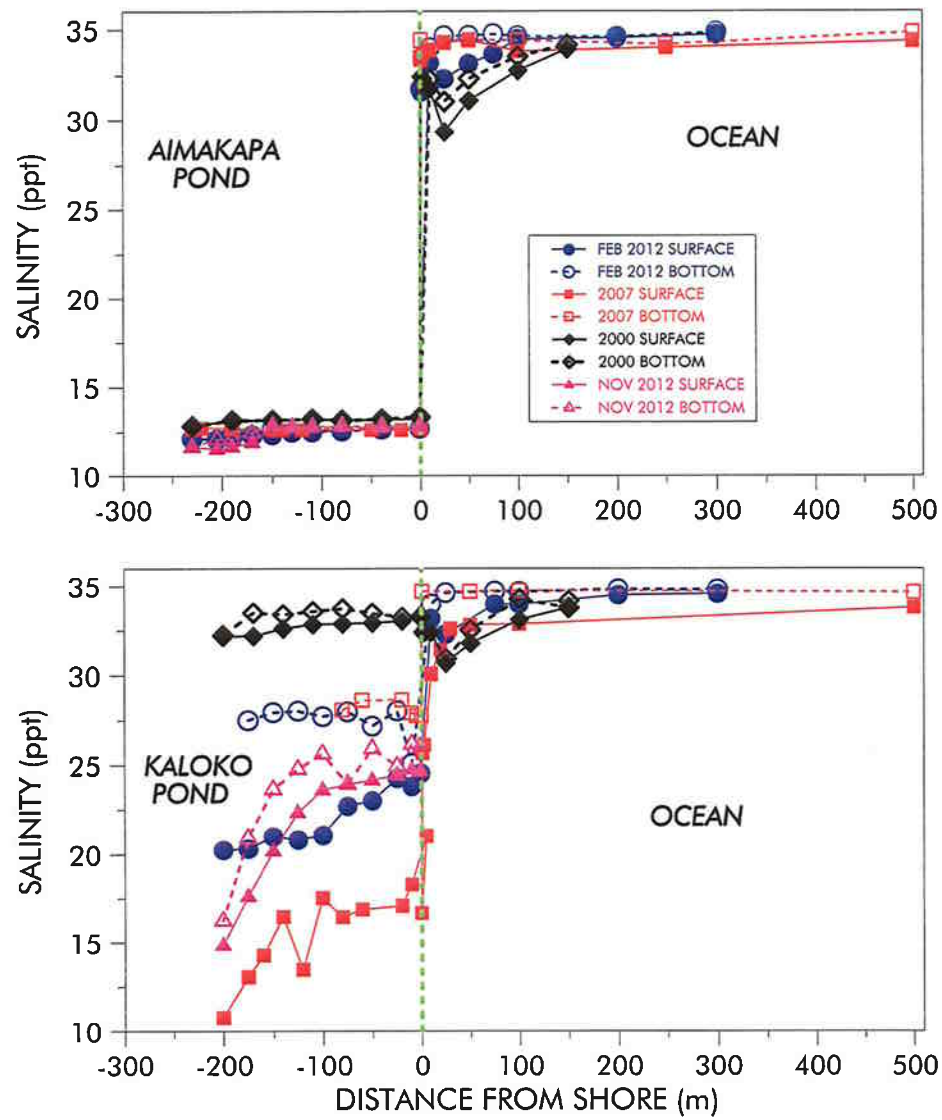

FIGURE 4. Plots of salinity in Aimakapa Pond (top) and Kaloko Pond (bottom) and adjacent offshore ocean as functions of distance from the shoreline measured in 2000, 2007 and 2012 (sampled in February and November). Shoreline is represented by green vertical line; positive values indicate distance seaward from the shoreline in the ocean; negative values indicate distance inland from the shoreline in the ponds. For locations of sampling transects, see Figures 2 and 3.

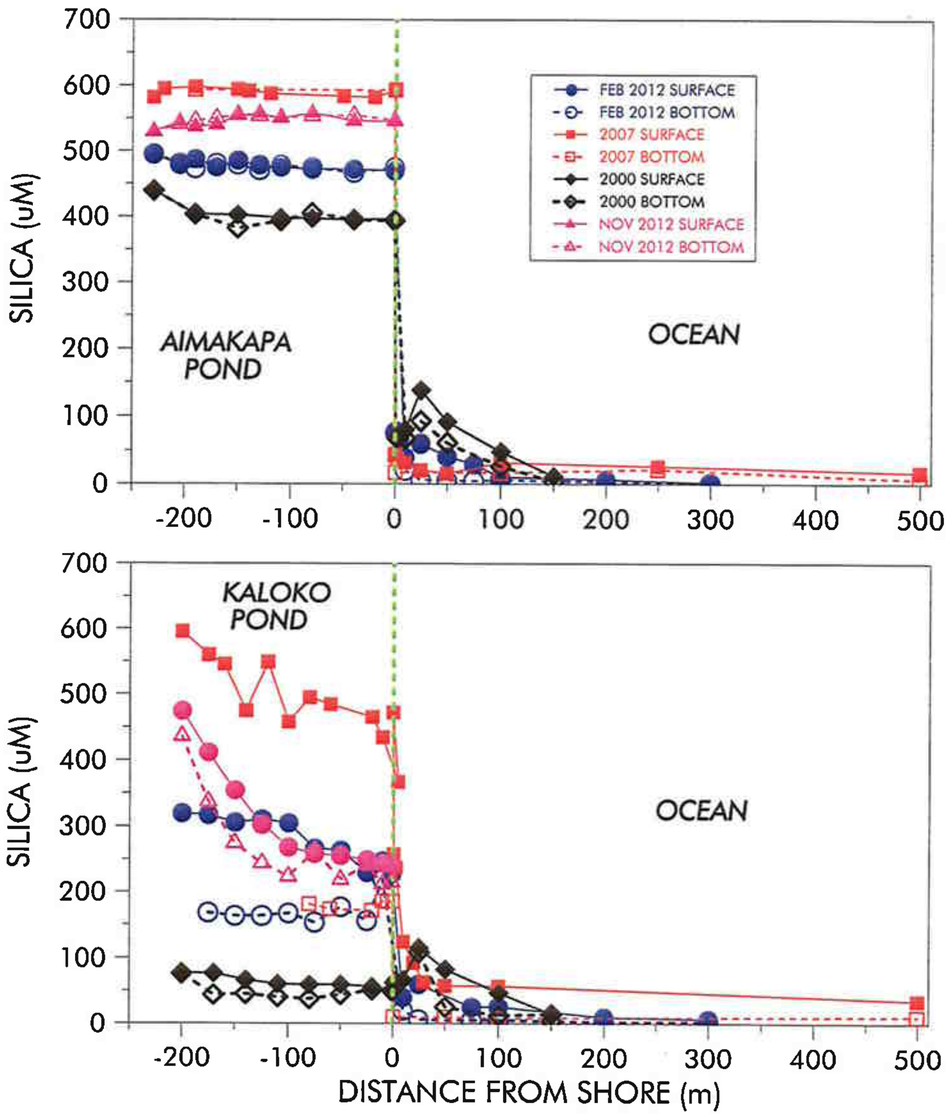

FIGURE 5. Plots of silica in Aimakapa Pond (top) and Kaloko Pond (bottom) and adjacent ocean as functions of distance from the shoreline measured in 2000, 2007 and 2012 (sampled in february and november). The shoreline is represented by the green vertical line; positive values indicate distance seaward from the shoreline in the ocean; negative values indicate distance inland from the shoreline in the ponds. For locations of sampling transects, see Figures 2 and 3.

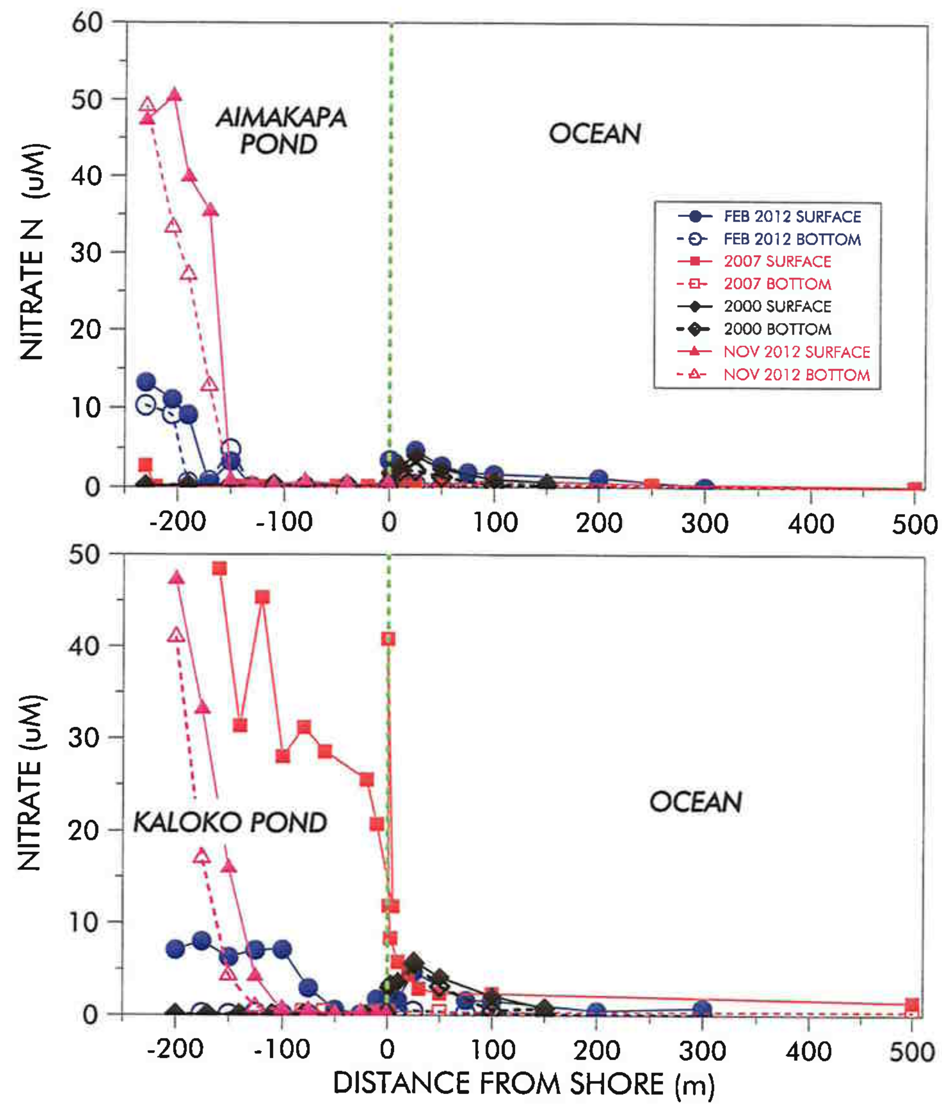

FIGURE 6. Plots of nitrate nitrogen in Aimakapa Pond (top) and Kaloko Pond (bottom) and adjacent ocean as functions of distance from the shoreline measured in 2000, 2007 and 2012 (sampled in February and November. The shoreline is represented by the green vertical line; positive values indicate distance seaward from the shoreline in the ocean; negative values indicate distance inland from the shoreline in the ponds. For locations of sampling transects, see Figures 2 and 3.

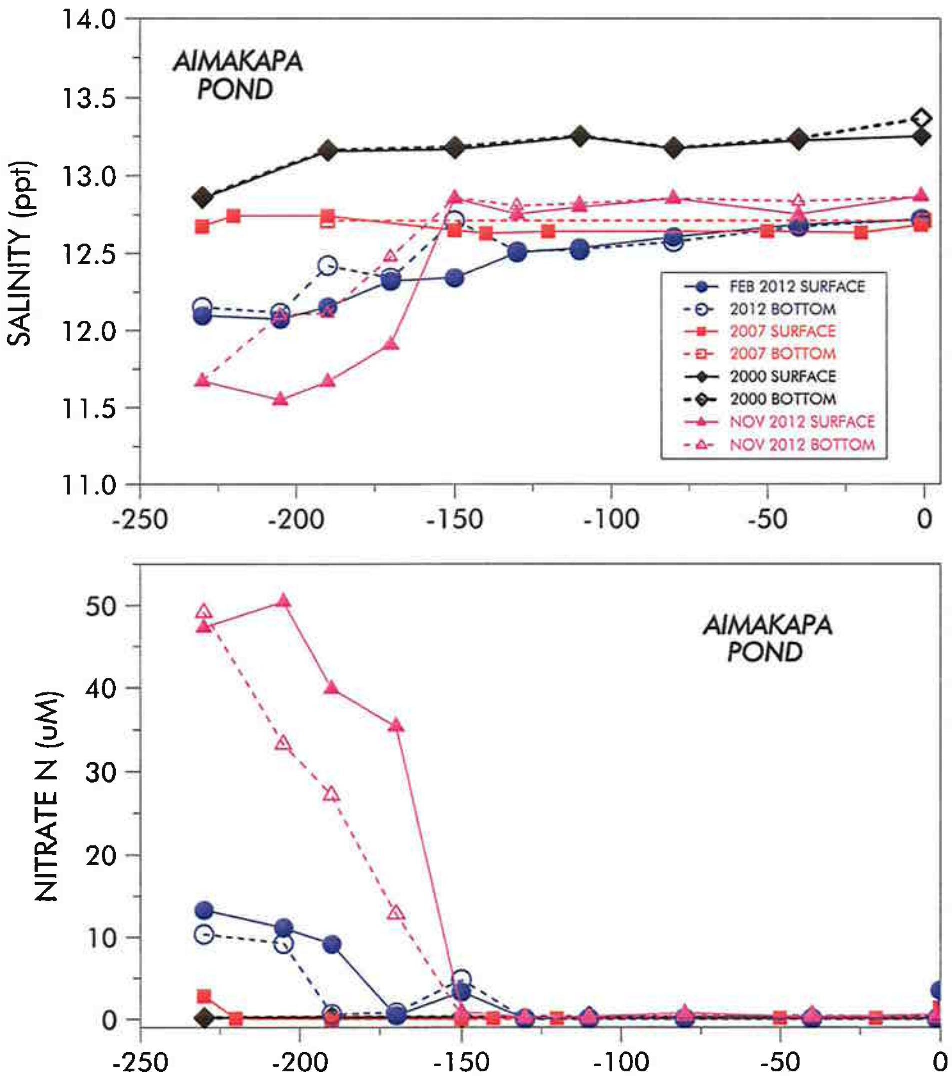

FIGURE 7. Plots of salinity (top) and nitrate nitrogen (bottom) measured in Aimakapa Pond on four occasions (2000, 2007 February 2012 and November 2012). Zero distance indicates the shoreline, or most seaward edge of the Pond, while negative values indicate distance inland from the shoreline. For location of sampling transect in Aimakapa Pond, see Figure 2.

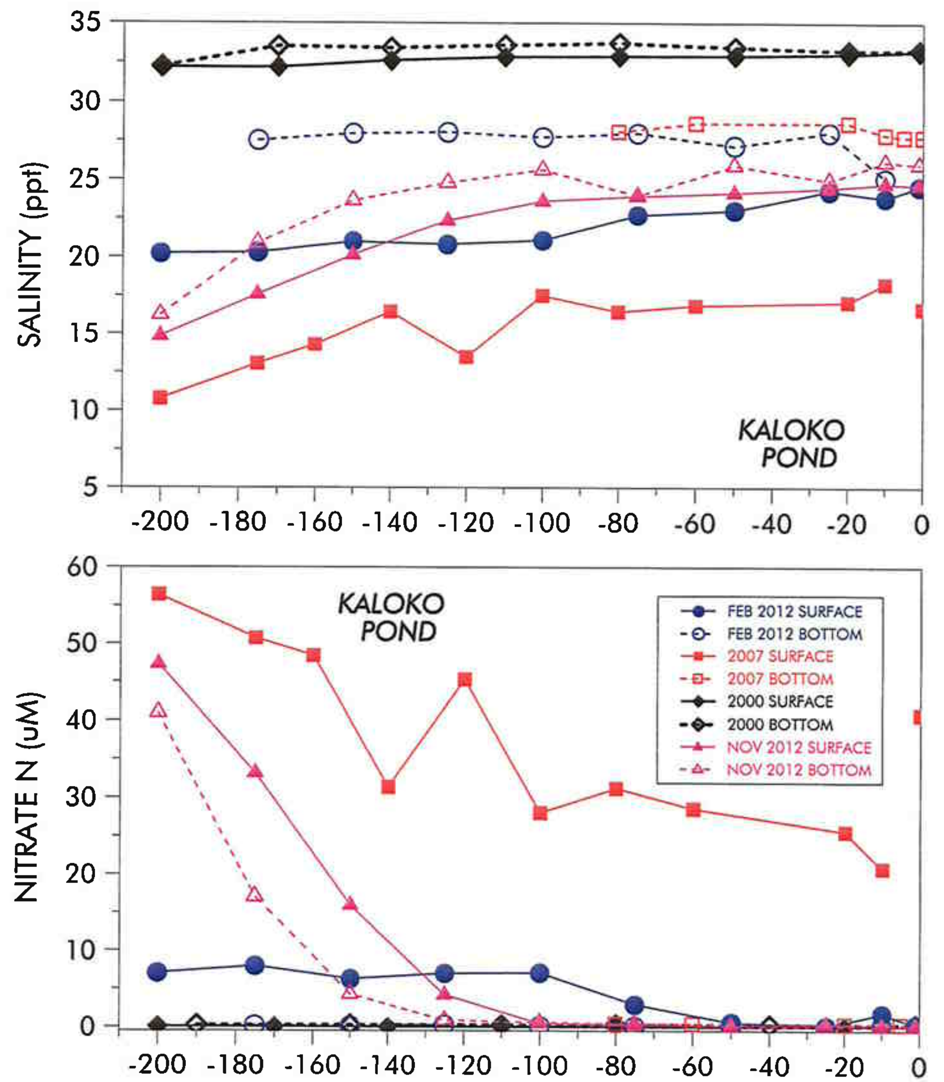

FIGURE 8. Plots of salinity (top) and nitrate nitrogen (bottom) measured in Kaloko Pond on four occasions (2000, 2007, February 2012 and November 2012 Zero distance indicates the shoreline, or most seaward edge of the Pond, while negative values indicate distance inland from the shoreline. For the location of sampling transect in Kaloko Pond, see Figure 3.

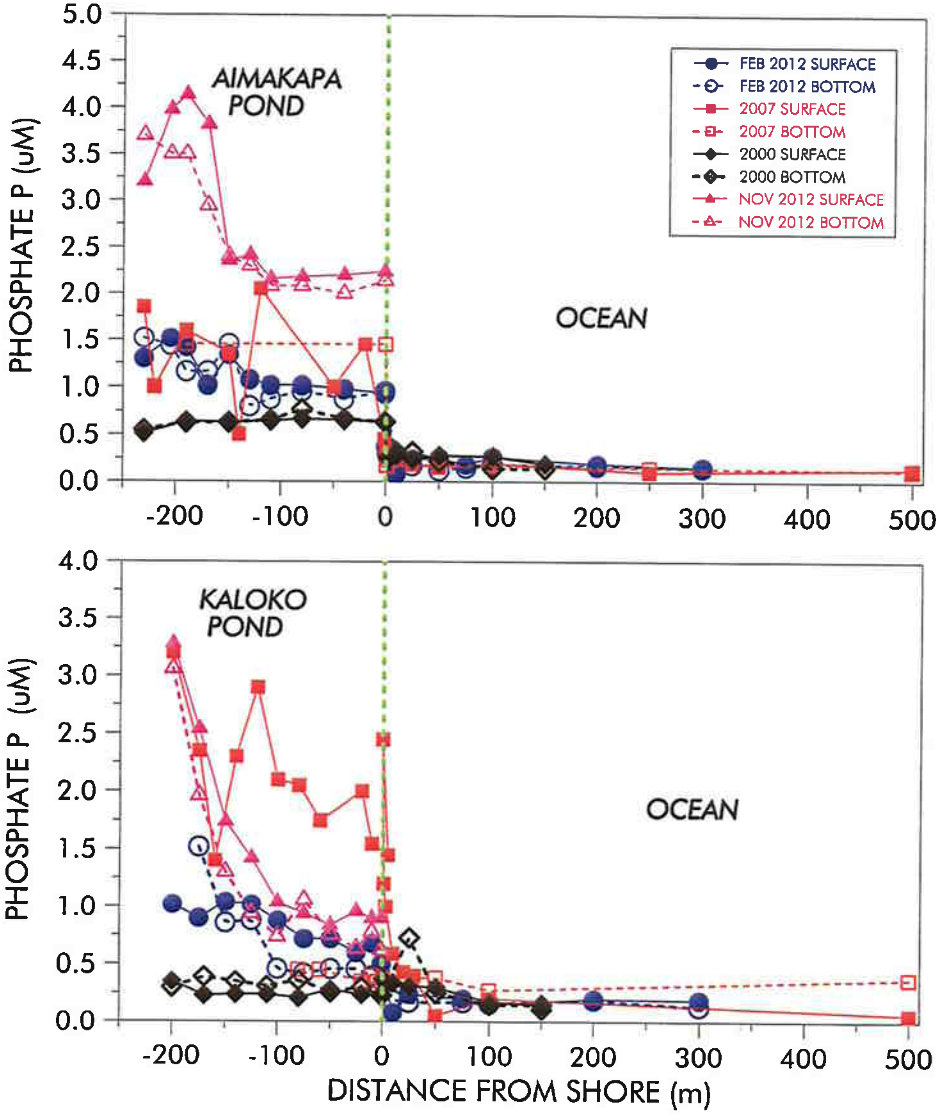

FIGURE 9. Plots of phosphate phosphorus in Aimakapa Pond (top) and Kaloko Pond (bottom) and adjacent ocean as functions of distance from the shoreline measured in 2000, 2007 and 2012 (sampled in February and November). The shoreline is represented by the green vertical line; positive values indicate distance seaward from the shoreline in the ocean; negative values indicate distance inland from the shoreline in the ponds. For locations of sampling transects, see Figures 2 and 3.

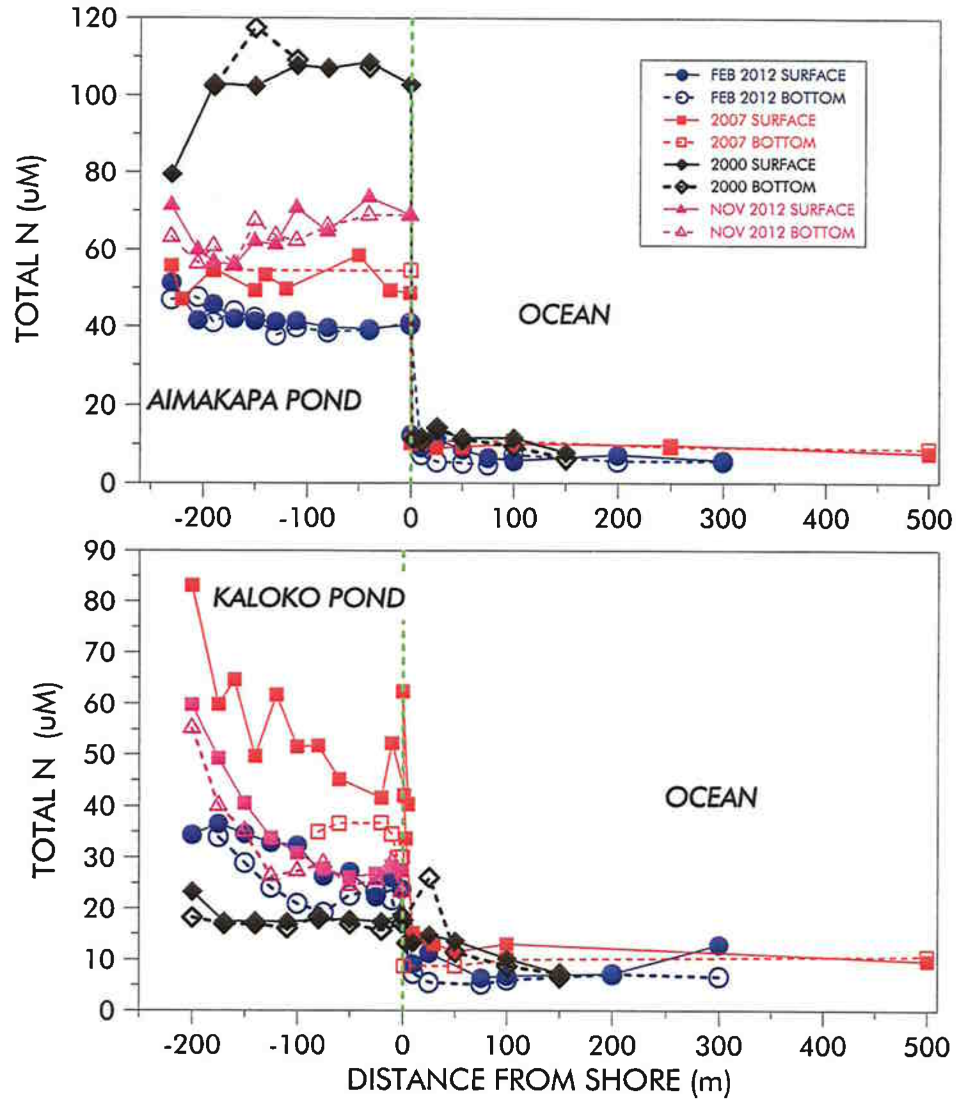

FIGURE 10. Plots of Total Nitrogen in Aimakapa Pond (top) and Kaloko Pond (bottom) and adjacent ocean as functions of distance from the shoreline measured in 2000, 2007 and 2012 (sampled in February and November). The shoreline is represented by the green vertical line; positive values indicate distance seaward from the shoreline in the ocean; negative values indicate distance inland from the shoreline in the ponds. For locations of sampling transects, see Figures 2 and 3

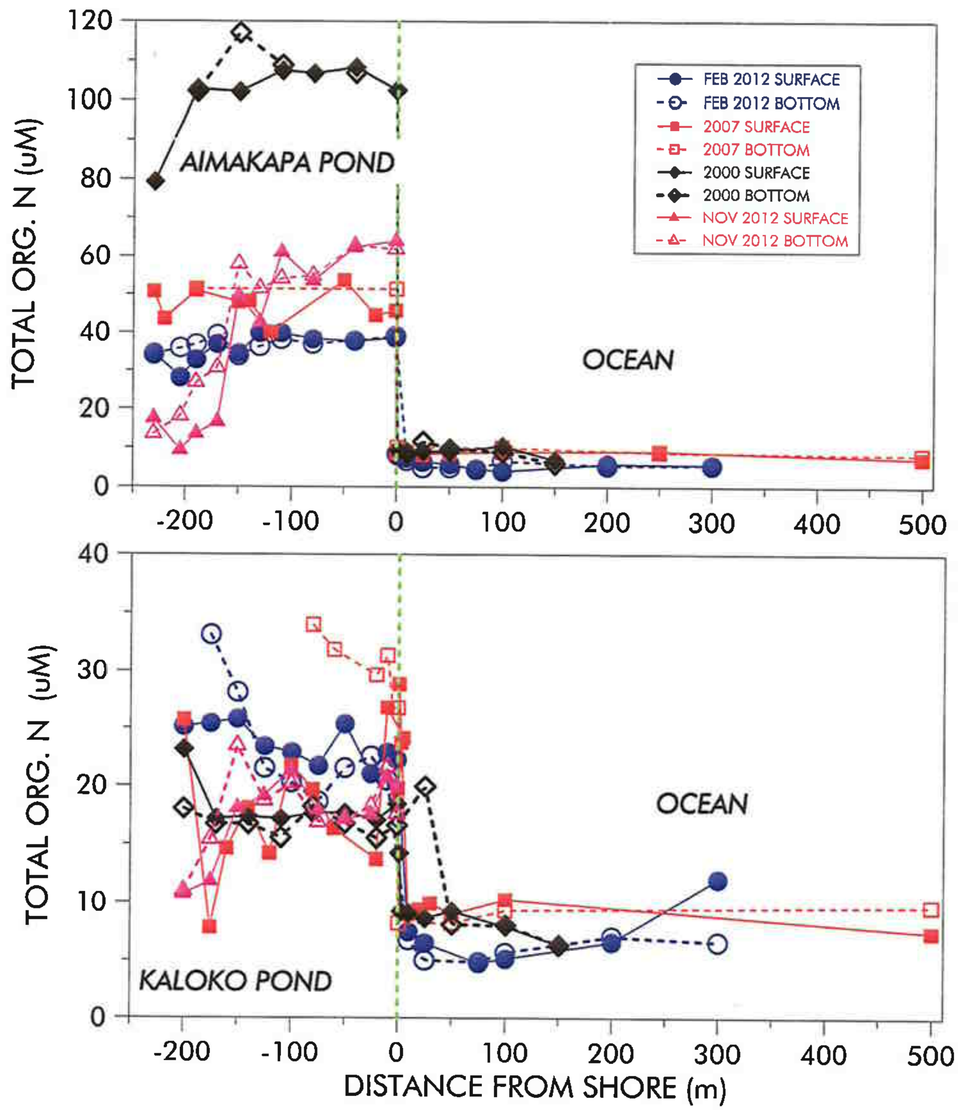

FIGURE 11. Plots of Total Organic Nitrogen in Aimakapa Pond (top) and Kaloko Pond (bottom) and the adjacent ocean as functions of distance from the shoreline measured in 2000, 2007 and 2012 (sampled in February and November). The shoreline is represented by a green vertical line; positive values indicate distance seaward from the shoreline in the ocean; negative values indicate distance inland from the shoreline in the ponds. For locations of sampling transects, see Figures 2 and 3.

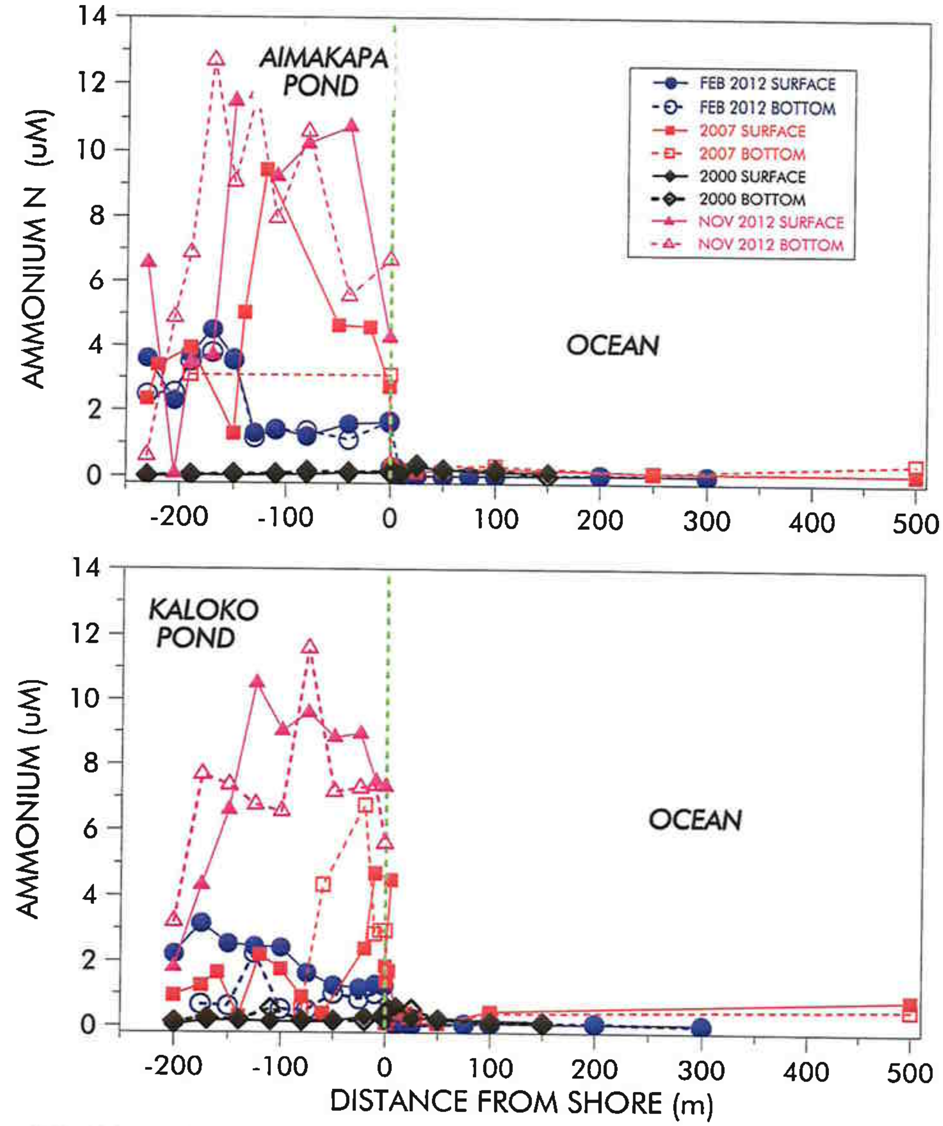

FIGURE 12. Plots of ammonium nitrogen in Aimakapa Pond (top) and Kaloko Pond (bottom) as functions of distance from the shoreline measured in 2000, 2007 and 2012 (sampled in February and November). The shoreline is represented by the green vertical lines; positive values indicate distance seaward from the shoreline in the ocean; negative values indicate distance inland from the shoreline in the ponds. For locations of sampling transects, see Figures 2 and 3.

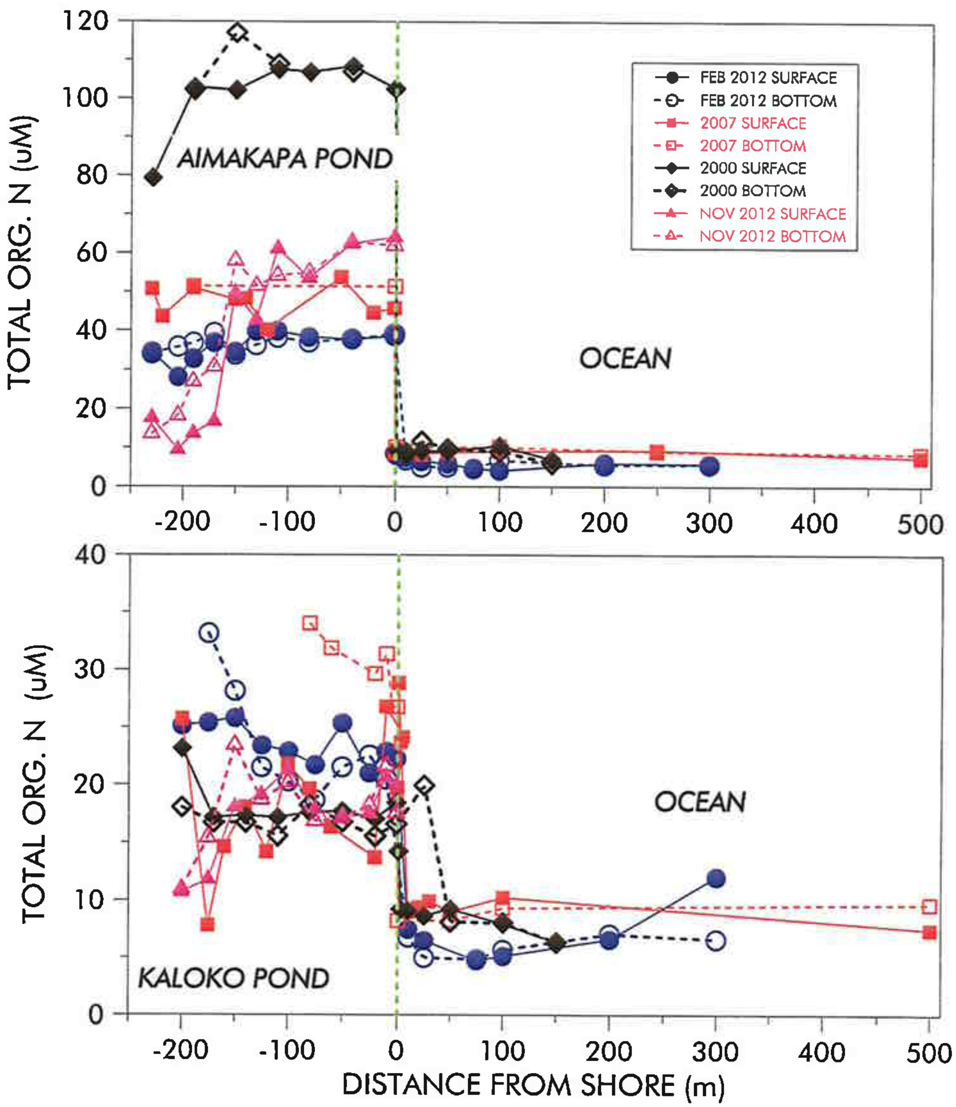

FIGURE 13. Plots of Total Organic Nitrogen in Aimakapa Pond (top) and Kaloko Pond (bottom) and the adjacent ocean as functions of distance from the shoreline measured in 2000, 2007 and 2012 (sampled in February and November). The shoreline is represented by a green vertical line; positive values indicate distance seaward from the shoreline in the ocean; negative values indicate distance inland from the shoreline in the ponds. For locations of sampling transects, see Figures 2 and 3.

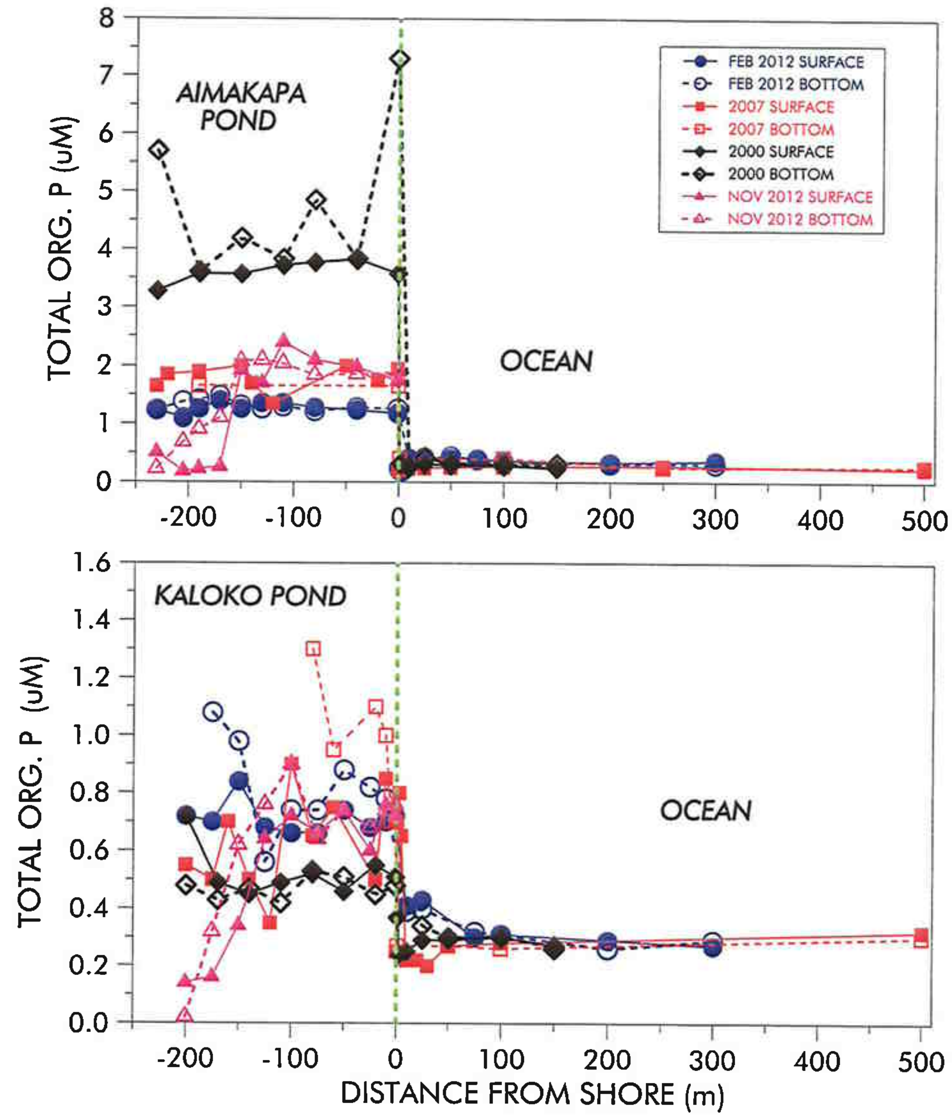

FIGURE 14. Plots of Total Organic Phosphorus in Aimakapa Pond (top) and Kaloko Pond (bottom) and adjacent ocean as functions of distance from the shoreline measured in 2000, 2007 and 2012 (sampled in February and November. Shoreline is represented by green vertical line; positive values indicate distance seaward from the shoreline in the ocean; negative values indicate distance inland from the shoreline in the ponds. For locations of sampling transects, see Figures 2 and 3.

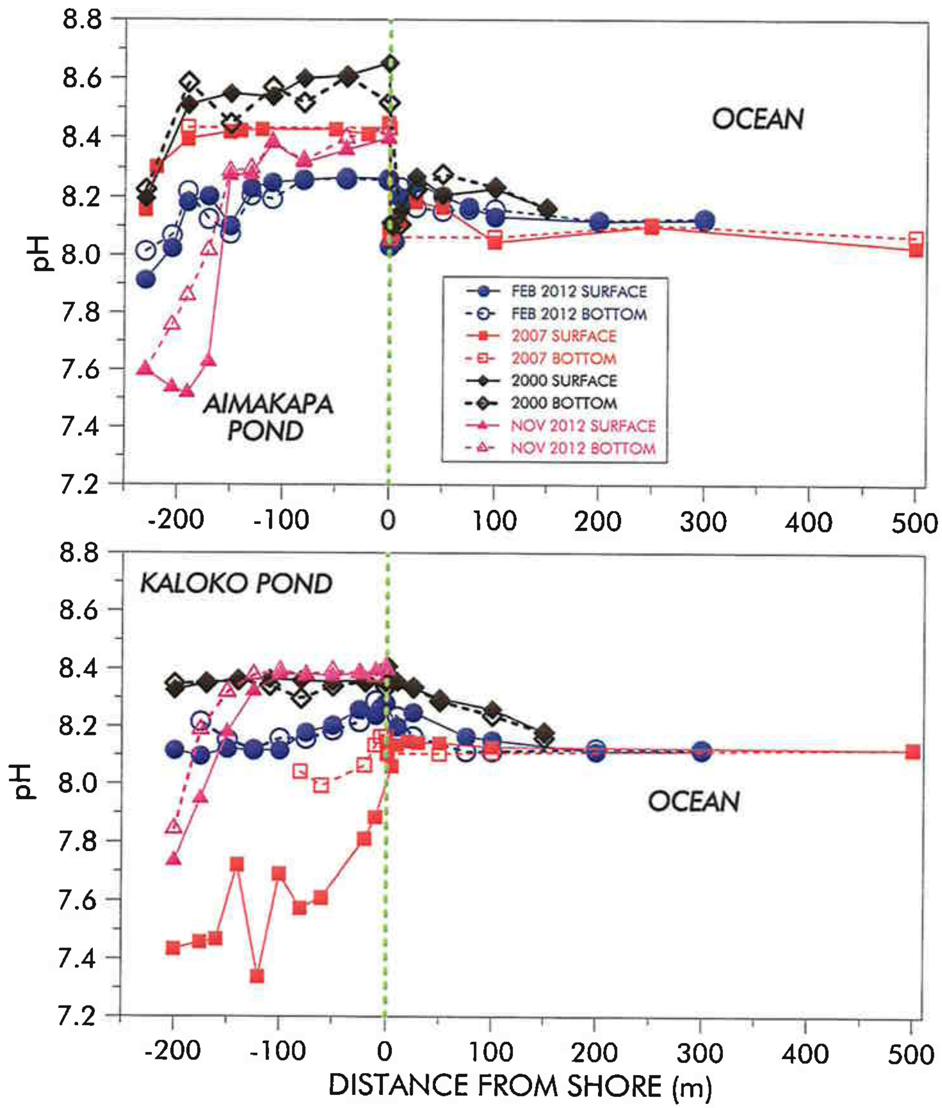

FIGURE 15. Plots of pH in Aimakapa Pond (top) and Kaloko Pond (bottom) and adjacent ocean as functions of distance from the shoreline measured in 2000, 2007 and 2012 (sampled in February and November). Shoreline is represented by green vertical lines; positive values indicate distance seaward from the shoreline in the ocean; negative values indicate distance inland from the shoreline in the ponds. For locations of sampling transects, see Figures 2 and 3.

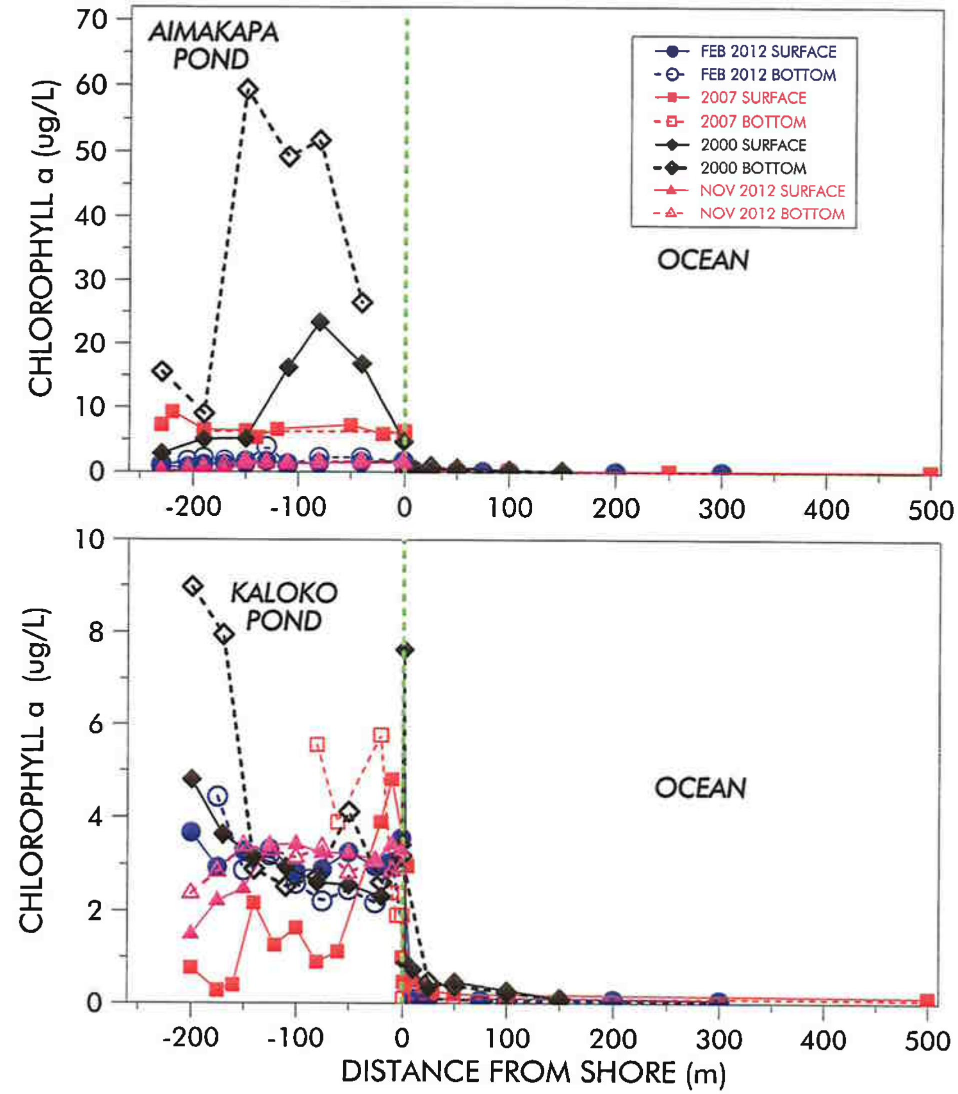

FIGURE 16. Plots of Chlorophyll a in Aimakapa Pond (top) and Kaloko Pond (bottom) as functions of distance from the shoreline measured in 2001, 2007 and 2012 (sampled in February and November). The shoreline is represented by the green vertical lines; positive values indicate distance seaward from the shoreline in the ocean; negative values indicate distance inland from the shoreline in the ponds. For locations of sampling transects, see Figures 2 and 3.

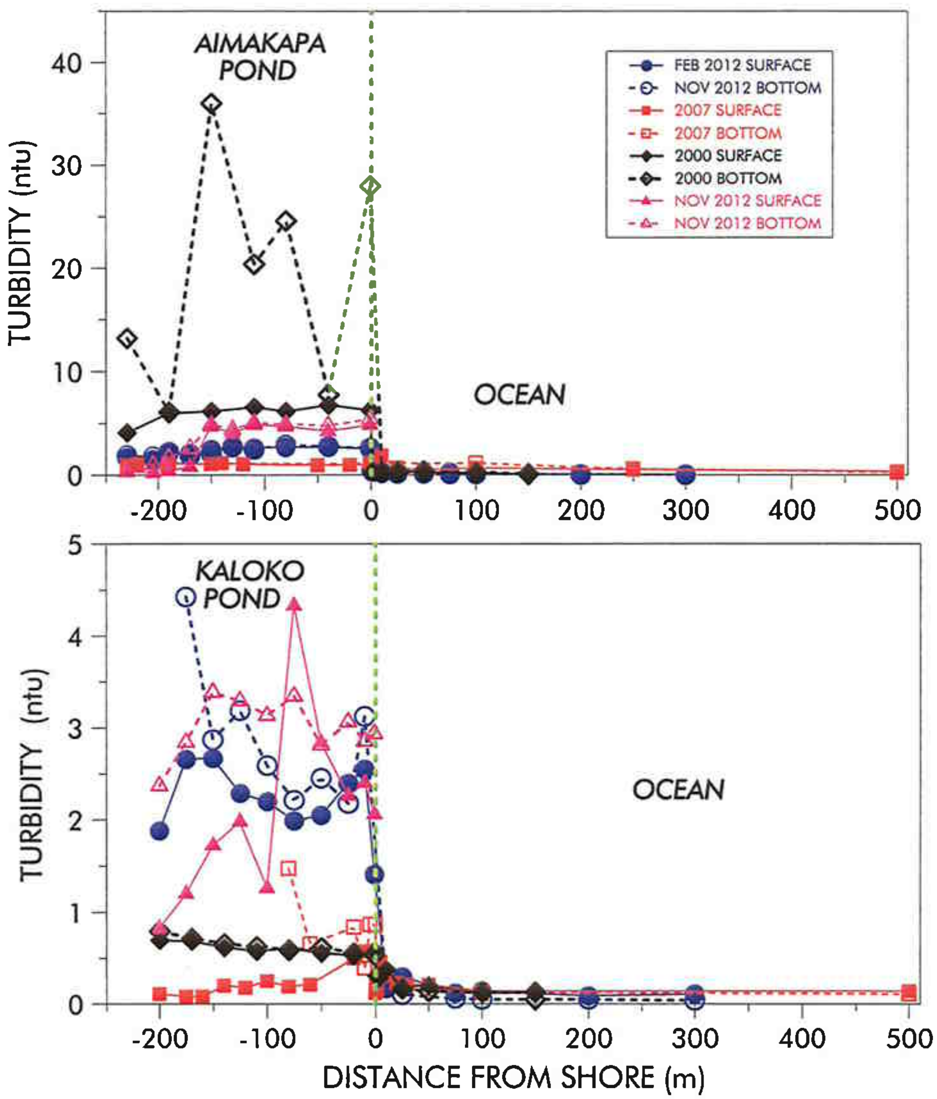

FIGURE 17. Plots of turbidity in Aimakapa Pond (top) and Kaloko Pond (bottom) and adjacent oceanas functions of distance from the shoreline measured in 2000, 2007 and 2012 (sampled in February and November). Shoreline is represented by green vertical line; positive values indicate distance seaward from the shoreline in the ocean; negative values indicate distance inland from the shoreline in the ponds. For locations of sampling transects, see Figures 2 and 3

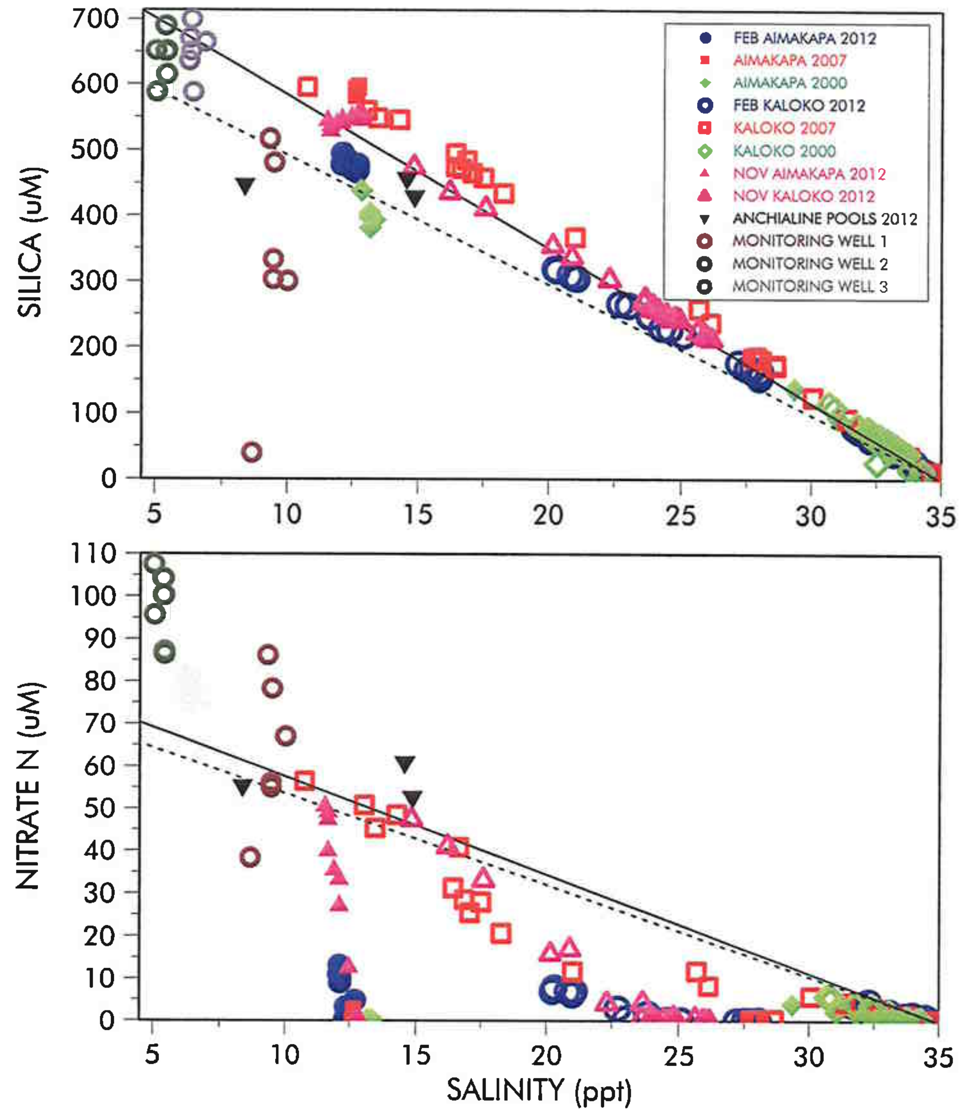

FIGURE 18. Mixing plots showing Silica (top) and nitrate nitrogen as functions of salinity in Aimakapa and Kaloko Fishponds, anchialine pools and the adjacent ocean during four sampling periods (2000, 2007, Feb. 2012 and Nov. 2012). Also shown are data from three KAHO Monitoring wells. Solid line is conservative mixing line connecting endpoint concentrations from the open ocean and high level groundwater from the DWS Honokohau Well (4158-03), while dashed line is conservative mixing line connecting open ocean concentrations to basal groundwater sampled from the Kaloko Irrigation Well (4160-02)

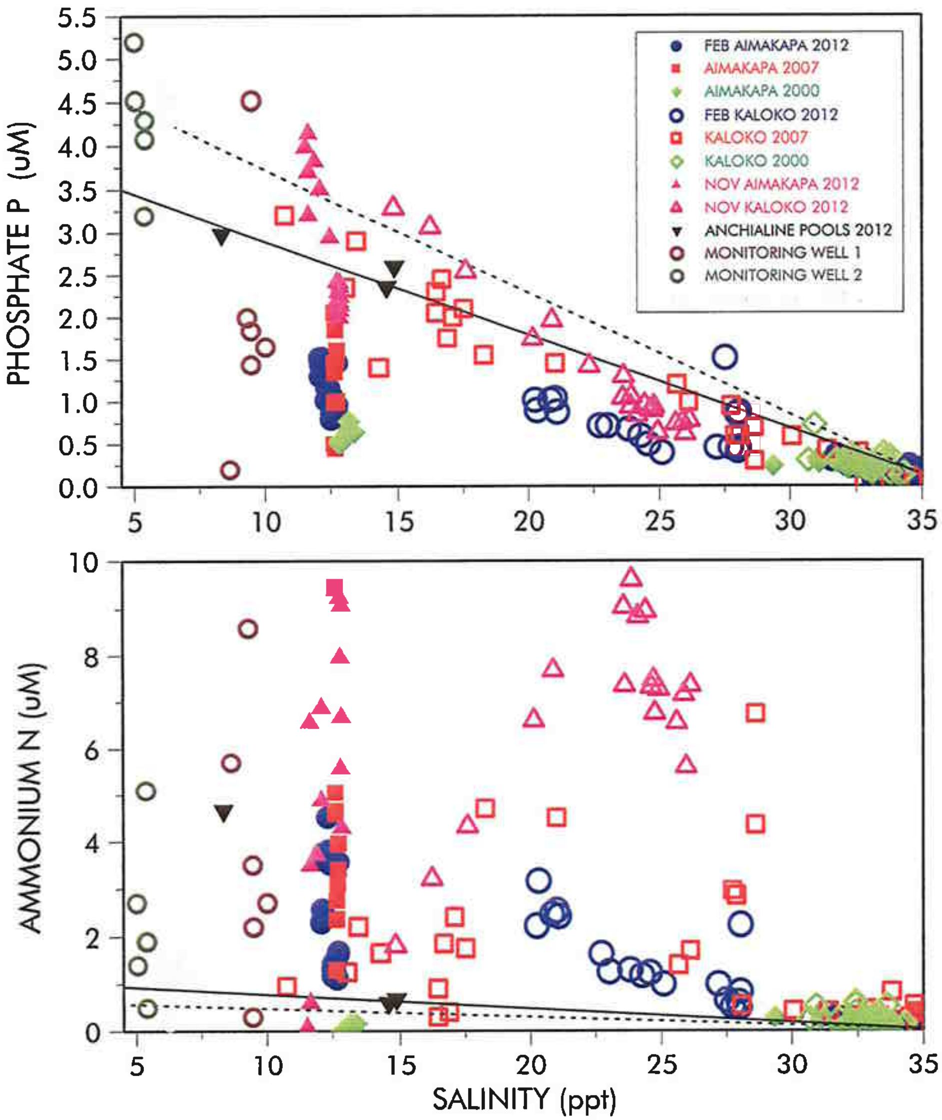

FIGURE 19. Mixing plots showing Phosphate phosphorus (top) and Ammonium nitrogen as functions of salinity in Aimakapa and Kaloko Fishponds, anchialine pools wells and the adjacent ocean during four sampling periods (2000, 2007, Feb. 2012 and Nov. 2012). Also shown are data from KAHO monitoring wells. Solid line is conservative mixing line connecting endpoint concentrations from the open ocean and high level groundwater from the DWS Honokohau Well (4158-03), while dashed line is conservative mixing line connecting open ocean concentrations to basal groundwater sampled from the Kaloko IrrigationWell (4160-02)

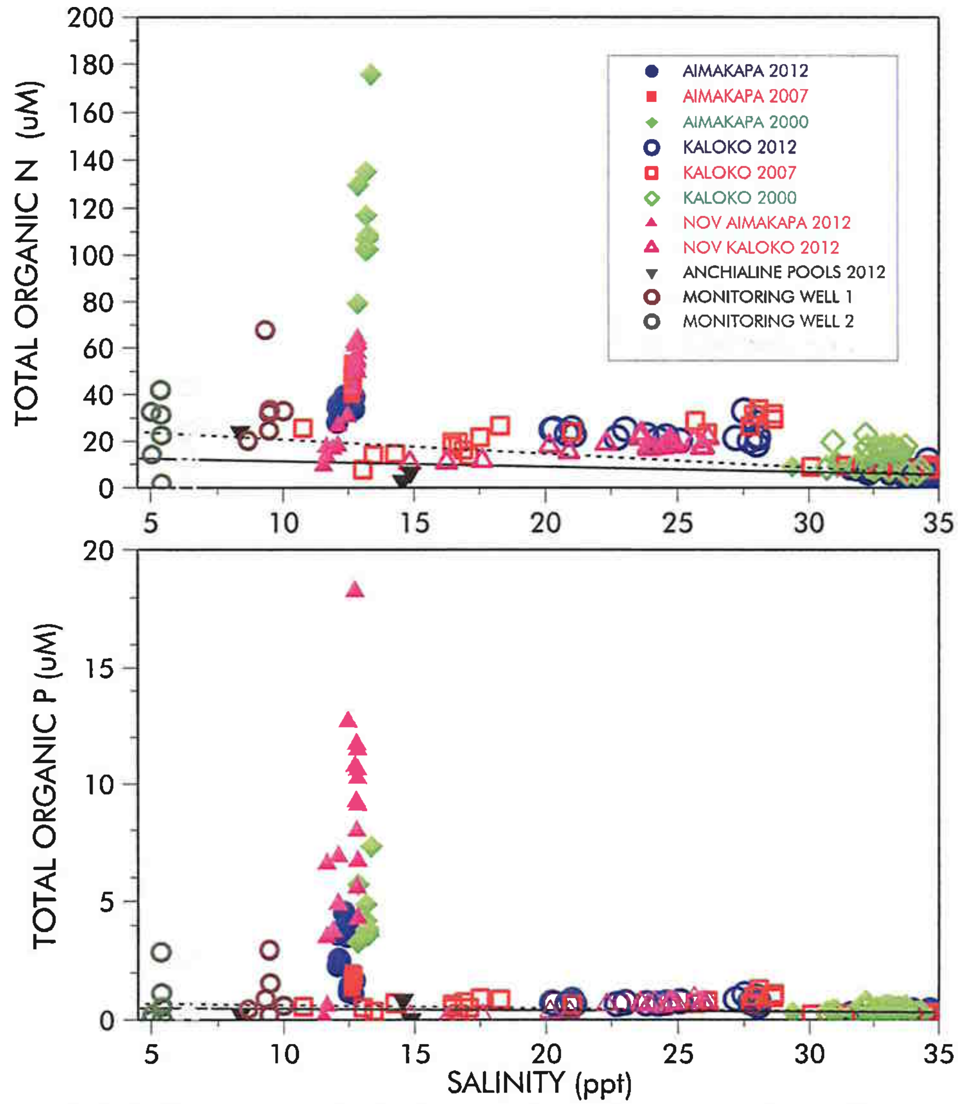

FIGURE 20. Mixing plots showing Total Organic Nitrogen (top) and Total Organic Phosphorus (bottom) functions of salinity in Aimakapa and Kaloko Fishponds, anchialine pools and the adjacent ocean during four sampling periods (2000, 2007, Feb. 2012 and Nov. 2012). Also shown are data from three KAHO monitoring wells. Solid line is conservative mixing line connecting endpoint concentrations from the open ocean and high level groundwater from the DWS Honokohau Well (4158-03), while dashed line is conservative mixing line connecting open ocean concentrations to basal groundwater sampled from the Kaloko Irrigation Well (4160-02)

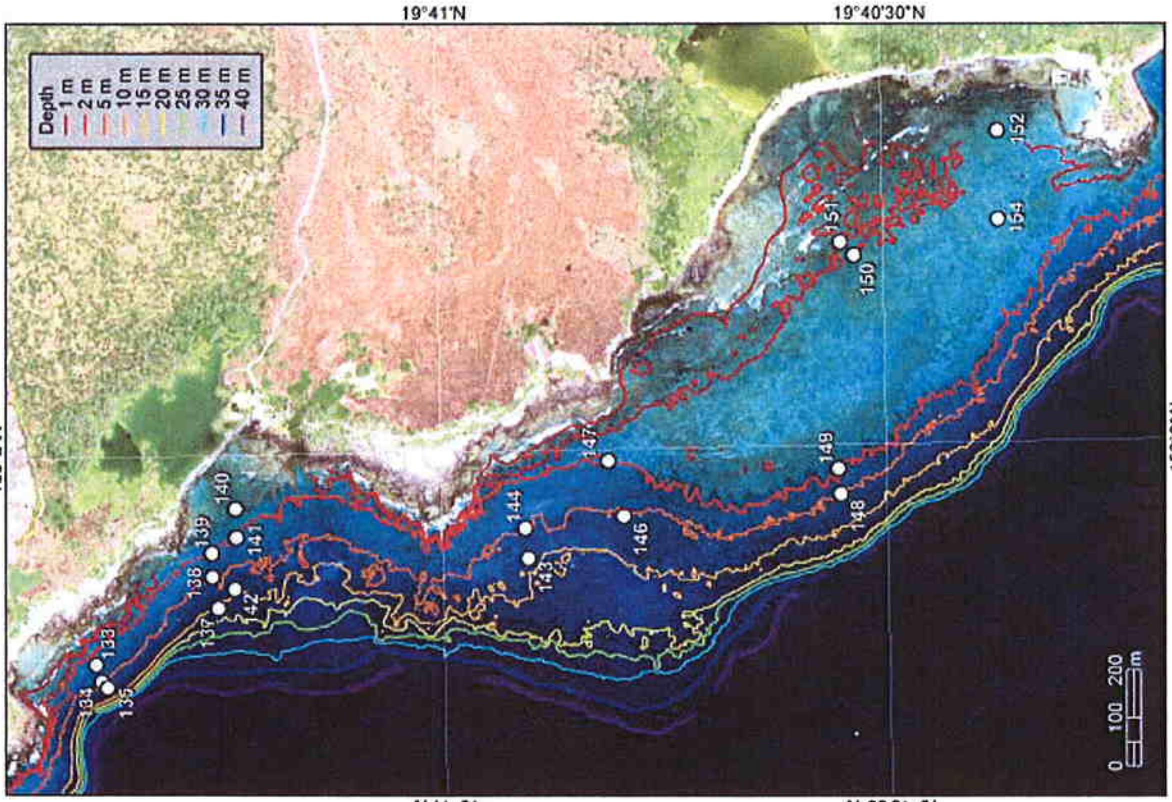

FIGURE 22. Satellite image of Kaloko-Honokohau nearshore marine environment show depth contours. Also shown are locations of calibration/validations points used to gather ground-truth data to construct maps of coral abundance.

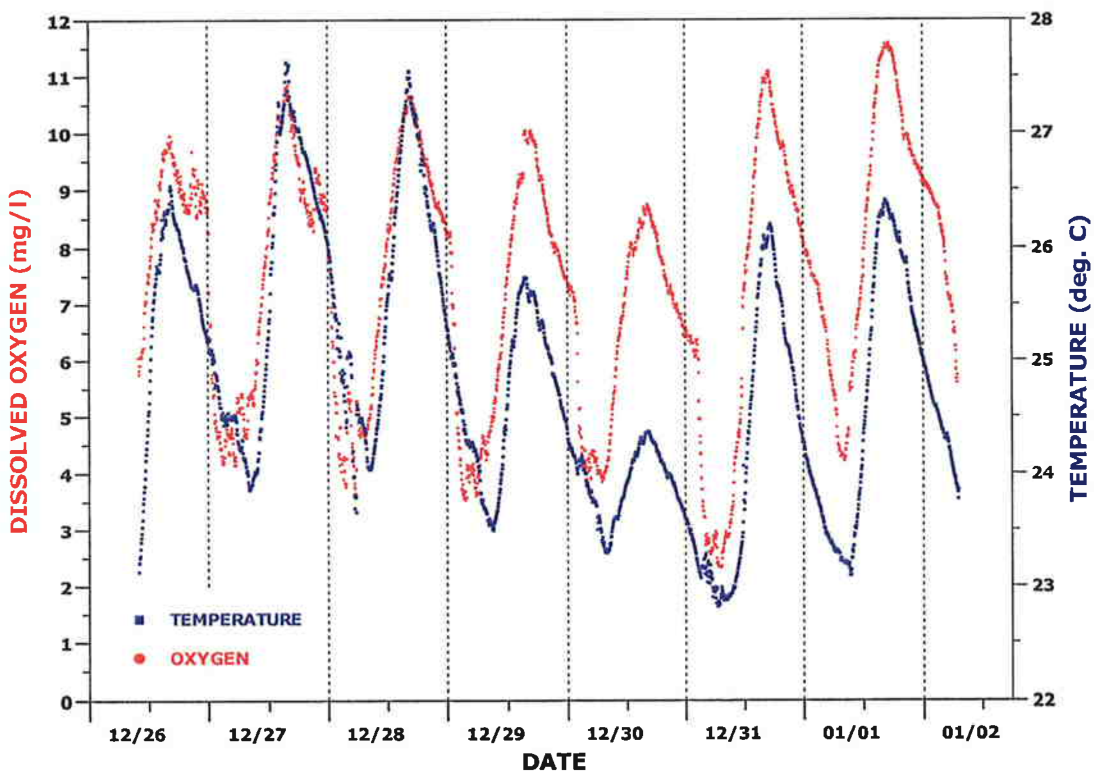

FIGURE 21. Plots of dissolved oxygen and temperature in Aimakapa Pond from Dec. 26, 2001 to January 2, 2002.

TABLE 6. Summar of percent coverage of marine benthic cover of Kaloko Honokohau from in-situ calibration validation photos. See Figure 23 for site locations, and Appendix B for photos.

SITE	Mc	Mp	Pc	Pd	Pe	Pl	Pm	Pv	Zo	TC	A	TUR	SP	SA	R	RU	DC	CCA	TBS	INV
104	0	0	18	0	0	67.8	1.2	0	0	87	1	0	0	0	10.8	0	0	1	0	0.2
105	0	0	37	0	5.4	37.2	0.2	0.2	0	80	1	0	0	0	7	1.6	0	10.4	0	0
106	0.2	0	7.6	0	3.6	39.6	0	0	0	51	10.6	0	0.4	0	29.8	1.2	0	7	0	0
107	0	0	33	0.2	19.2	30.6	0	0	0	83	0	0	0	0	12.6	0	0	4.4	0	0
108	0	0	0	0	14.6	20.6	0.8	0	0	36	2	0	8.2	2	30	0	0.2	20.4	0	1.2
109	0.6	0	0	0	0	20.6	0.4	0	0	21.8	2.6	0	1.6	1.4	66	5.8	0	0.8	0	0
110	0	0	1.2	0	0	44	0.4	0	0	45.6	0	0	0	1.6	38	13.8	0	1	0	0
111	0	0	0.6	0	0	0	0	0	0	0.6	1	0	0	8.8	0	89.6	0	0	0	0
112	6.8	0	0	0	1.8	3.2	10.2	0	0	22	0	0	1.2	3	57.6	0	0	15.6	0	0.6
113	0.4	0	1.4	0	20.2	22	6	0	0	50	0	0	0	0.4	49.2	0	0.4	0	0	0
114	0.4	0	0	0.2	0	4.2	28	0	0	32.8	0	0	0	0	46.6	0	0	20	0	0.6
115	2.8	0	0.8	0	7.6	23	4.2	0	0	38.4	0	41.6	0	9.4	10.6	0	0	0	0	0
117	0.8	0.4	0.6	0	15.6	7.6	9.6	0	0	34.6	0	0	0.4	1.6	53	0	0.4	9.6	0	0.4
118	0.4	0.2	0	0	2.4	3.2	16.4	0	0	22.6	0	0	0	2	73.8	0	0	1.6	0	0
119	0.4	0	2.6	0	28.6	23.8	4	0	0	59.4	2	0	0	1.2	36.4	0	1	0	0	0
120	0	1.4	0	0	1	15.6	14	0	0	32	8	0	0	0	57	0	0	3	0	0
121	1	0	2.6	0	2.8	41.8	1.8	0	0	50	2.2	7	0	8.6	30.6	0	0.8	0.8	0	0
122	3.4	0	0	0.2	3.2	16.6	12.4	0	0	36	0	0	0	0	59.8	0	0	4	0	0.2
123	24	0	0	0	4	31	0	0	0	59	0	0	0	0	12	0	0	29	0	0
126	0	0	0	0	1.4	34	3.6	0	0	39	9	0	0.2	0	37.6	0	0	14	0	0.2
133	0.8	0	0.4	0	9.6	25.6	2.2	0	0	38.6	0	15.8	0	0	29.8	13.4	0	1.4	0	1
134	0.4	0	0	0	0.2	31.6	4.6	0	0	36.8	1	0	0.2	2	53.8	1	1.8	2	0	1.4
135	0	0	0	0	0	0.4	0	0	0	0.4	0	9	1	1	5	82	0	0	0	1.6
137	0	0	31.6	0.2	0	44	0.4	0	0	76.2	0	0	0	0	11.6	0	0	12.2	0	0
138	0	0	8.4	0	6.4	45	1.6	0	0	61.4	1	0	0	0	28.6	0.2	0	1	7.4	0.4
139	0	0	0.8	0	7.4	42.4	0	0.2	0	50.8	0	1	0	0	41.6	0	0	6	0	0.6
140	0	0	0	0	0	0.8	5.8	0	0.4	7	0	0	0	0	71	0	1.6	20.4	0	0
141	0.2	0.6	0	0	7.6	41	1.6	0	0	51	0	0	0	3	29.2	0	0	16.6	0	0.2
142	0	0	14.2	0	0	48.4	3.8	0	0	66.4	0	0	0.2	0	32.4	0	0	1	0	0
143	0	0	0	0	4	16.67	0	0	0	20.667	0	15	0	0	64	0	0	0	0	0.33
144	0.2	0	0	0.2	0	16.2	0	0	0	16.6	0	11.4	0.2	9.6	26.6	9.2	0	12	13.6	0.8
146	0.4	0	0.8	0	2	31.2	0	0	0	34.4	0	30.2	0.2	2.6	22.6	8.4	0	1.2	0	0.4
147	0	0	0	0	0.8	60.2	0	0	0	61	0	14.8	0	0	21	0	0.2	3	0	0
148	0	0	1	0	0.6	16	0	0	0	17.6	2	17	0	0	46	4	0	13	0	0.4
149	0	0	0	0	0	17	3.6	0	0	20.6	0	19.4	1.4	0	42.8	0	0	15.2	0	0.6
150	0	0	0	0	1	55	1.6	0	0	57.6	7.4	29.6	0	0	2.2	0	0	3	0	0.2
151	0	0	0	0	0	4	0	0	0	4	4.4	89.2	0	0	0	0	0	1.6	0	0.8
152	0	0	0	0.4	0	0.8	0	0	0	1.2	0	96.4	0	0	0	0	0	1.2	0	1.2
154	0	0	0	0	0	43	4.2	0	0	47.2	0	9	0.4	0	43.4	0	0	0	0	0
% TC	2.8	0.2	10.5	0.1	11.0	66.2	9.2	0.0	0.0	100.0										
% Bottom	1.1	0.1	4.2	0.0	4.4	26.3	3.7	0.0	0.0	39.8	1.4	10.4	0.4	1.5	33.1	5.9	0.2	6.5	0.5	0.3

Mc = "Montipora capitata"
Mp = "Montipora patula"
Pc = "Porites compressa"
Pd = "Pocillipora damicornis"
Pe = "Porites lutea"
Pl = "Porites lobata"
Pm = "Pocillopora meandrina"
Pv = "Pavona varians"
Zo = "Zooanthid"
TC = "Total Coral Cover"
A = "Algae"
TUR = "Turf"
SP = "Sponge"
SA = "Sand"
R = "Rock"
RU = "Rubble"
DC = "Dead coral"
CCA = "Crustose Coralline Algae"
TBS = "Turf-Bound-Sediment"
INV = "Invertebrate"

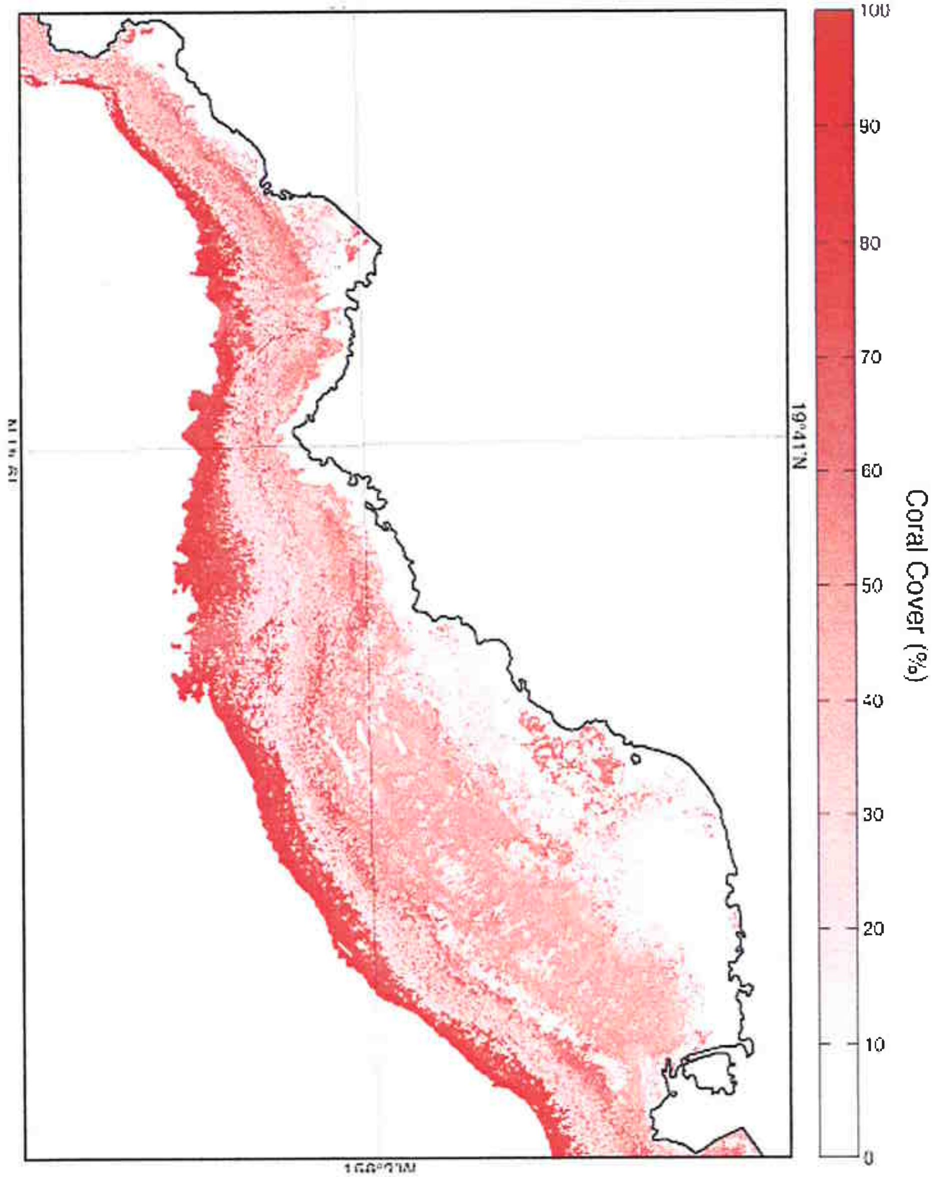

FIGURE 23. Map of coral abundance in Kaloko-Honokohau nearshore marine environment produced using satellite imagery and in-situ groundtruth. Note low levels of coral occurrence in nearshore areas, particularly on the reef flat fronting Aimakapa Pond.

FIGURE 24. Two views of ocean diffuser in Hilo Bay from Hilo Wastewater Treatment Plant. Note abundant coral growth on diffuser pipe and ports that are exposed to effluent plume.

TABLE 7. Fish abundance censused from stationary point counts at calibration-validation stations off Kaloko Makai site. See Figure 22 for locations of sampling stations.

Site ID	104	105	106	107	108	109	110	111	112	113	114	115	117	118	119	120	121	122	125	126
FAMILY *Species*																				
CIRRHITIDAE																				
Paracirrhites arcatus	1		1	1				1			1		1	4		1	2	1	1	
P. forsteri				1														1		
C pinnulatus																	1			
MULLIDAE																				
Parupeneus bifasciatus											1					2				
P. multifasciatus	1							2			1		2						1	
Mulloidichthysflavolineatus																			10	
CHAETODONTIDAE																				
C. ornitissimus	4		1		2								1							1
C. auriga									2		1									
C. multicinctus	2		2		3	2			4		2	2	1				6	4	3	2
C. unimaculatus													2							
C. lunula				1			2		2		2		2		1	1			3	
C. quadrimaculatus	1								2			1		1	1					
Hemitaurichthys polylepis	1																			
Forcipiger longirostris/flavissimus							1		1	3		1			2		2			2
POMACENTRIDAE																				
Chromis vanderbilti		25		20		30	30		30		30	30	20	40		20	10	50		50
C. agilis			3					50		100	1				50		2		200	
C. hanui															1				2	
C. verater								30					4							
Dascyllus albisella																	1		5	
Plectroglyphidodon johnstonianus															1				1	
Stegastes marginatus	4		3			1														
Abudefduf abdominalis		2		10	2				200				200	50						
LABRIDAE																				
Gomphosus varius						2			2		1		2	1				1		1
Thalassoma duperrey		2			7	5	3				2	4		10	1	3	6	3	1	2
Halichoeres ornatissimus		2			2	2							1					1		
Labroides phthirophagus							3									1		1		2
ACANTHURIDAE																				
Acanthurus olivaceus		2	2		2			1			1	1	1	1				1		1
A. triostegus					5								2	5		3		2		
A. nigrofuscus	3	5	5	2	20	15	20		10	20	5	20	2	3	1		2	15	10	10
A. nigroris													1							
A. leucopareius					20	20						30		2						
A. achilles		2				1						1								
Naso lituratus						1			5	1	1	5	3	2	2	1		2	2	1
N. unicornis						2														
N. hexacanthus	1									3						1			3	
Zebrasoma flavescens	7	8	6	8	40	20	30	20	40	10	20	30	20	20		10	10	5	15	40
Z. veliferum							2						2							
Ctenochaetus strigosus	1			1	20		30	2	20	5	10	20	10	10	5		4	5	15	10
BALISTIDAE																				
Sufflamen bursa			1		2	1					1		2	1	2	2	2	5	2	1
Melichthys niger				3									4	20	5				10	
M. vidua				1						1			2	1	1			1	3	
TETRADONTIDAE																				
Arothron hispidus											1									
Canthigaster jactator											1				1					
SCARIDAE																				
S. psittacus		3																		
Chlorurus spilurus	1					5		1	2	20	2	6	4		1		1			
POMACANTHIDAE																				
Centropyge potteri							1													
AULOSTOMIDAE																				
Aulostomus chinensis		1					1													
ZANCLIDAE																				
Zanclus cornutus							2							2		3				
MONACANTHIDAE																				
Pervagor aspricaudus										1					1					
NUMBER SPECIES	12	10	9	10	12	14	12	8	13	10	19	13	23	17	16	12	13	16	18	13
NUMBER INDIVIDUALS	26	52	23	46	125	107	125	106	320	164	83	151	288	169	76	47	46	96	286	123

APPENDIX A.

Results of Sediment Analyses

Kaloko-Honokohau National Historical Park

Calscience Environmental Laboratories, Inc.
Work Order 12-0201625

Calscience Environmental Laboratories, Inc.

CALSCIENCE

WORK ORDER NUMBER: 12-02-1625

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Analytical Report For

Client: Marine Research Consultants, Inc.
Client Project Name: C KAHO SEDIMENT PESTICIDES
Attention: Steve Dollar
1039 Waakaua Pl.
Honolulu, HI 96822-1173

Approved for release on 03/15/2012 by:
Danielle Gonsman
Project Manager

ResultLink ▸

Email your PM ▸

nelac

Calscience Environmental Laboratories certifies that the test results provided in this report meet all NELAC requirements for parameters for which accreditation is required or available. Any exceptions to NELAC requirements are noted in the case narrative. The original report of subcontracted analyses, if any, is provided herein, and follows the standard Calscience data package. The results in this analytical report are limited to the samples tested and any reproduction thereof must be made in its entirety. Note that the Chain-of-Custody Record and Sample Receipt Form are integral parts of this report.

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NELAP ID: 03220CA | DoD-ELAP ID: L10-41 | CSDLAC ID: 10109 | SCAQMD ID: 93LA0830

Calscience Environmental Laboratories, Inc.

Contents

Client Project Name: C KAHO SEDIMENT PESTICIDES
Work Order Number: 12-02-1625

Calscience Environmental Laboratories, Inc.

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CASE NARRATIVE

Calscience Work Order No.: 12-02-1625
Project ID: C KAHO SEDIMENT PESTICIDES

Provided below is a narrative of our analytical effort, including any unique features or anomalies encountered as part of the analysis of the sediment samples.

Sample Condition on Receipt

Three sediment samples were received for this project on February 28, 2012. The samples were transferred to the laboratory in an ice-chest with wet ice, following strict chain-of-custody (COC) procedures. The temperature of the samples upon receipt at the laboratory was 5.5°C. All samples were given laboratory identification numbers, logged into the Laboratory Information Management System (LIMS) and then stored under refrigeration pending sediment chemistry testing.

Tests Performed

Chlorinated Pesticides by EPA 8081A
Organophosphorus Pesticides by EPA 8141
Chlorinated Herbicides by EPA 8151
SVOCs by EPA 8270 SIM
Trace Metals by EPA 6020
Mercury by EPA 7471A

Data Summary

All samples were homogenized prior to preparation and analysis.

Holding times

All holding times were met with the following exceptions.

The samples were analyzed past the EPA Method recommended 7-day holding time (in solid samples) for Total Solids (for dry wt. determination). However, the samples were stored frozen prior to holding time expiration and Calscience follows standard industry practice and the Puget Sound Protocol, which states the holding times for sediment samples may be extended up to one year if kept frozen after collection. Therefore, the results have not been flagged as exceeding the EPA recommended extractions holding time.

Calibration

Frequency and control criteria for initial and continuing calibration verifications were met.

Reporting Limits

All reporting limits were met.

Blanks

Concentrations of target analytes in the method blank were found to be below reporting limits for all testing.

Laboratory Control Samples

A Laboratory Control Sample (LCS) analysis was performed at the required frequencies, and unless otherwise noted, all parameters were within the established control limits.

Matrix Spikes

Matrix spiking was performed on both project and non-project samples, and all matrix spike parameters were within the established control limits with the following exceptions.

The MS/MSD and PDS/PDSD recoveries for various metals (by EPA 6020) were outside the established control limits due to matrix interference. However, since the associated LCS/LCSD recoveries and RPDs were in control, the data are released with no further action.

The MS/MSD RPDs for 2,4-D and 2,4,5-T were above the established control limits. However, since the associated LCS/LCSD RPDs were in control, the data are released with no further action.

Surrogates

Surrogate recoveries for all applicable tests and samples were within the established control limits.

Acronyms

LCS/LCSD- Laboratory Control Sample/Laboratory Control Sample Duplicate
PDS/PDSD- Post Digestion Spike/Post Digestion Spike Duplicate
MS/MSD- Matrix Spike/Matrix Spike Duplicate
RPD- Relative Percent Difference

Analytical Report

Marine Research Consultants, Inc.	Date Received: 02/28/12
1039 Waakaua Pl.	Work Order No: 12-02-1625
Honolulu, HI 96822-1173	Preparation: N/A
	Method: SM 2540 B

Project: C KAHO SEDIMENT PESTICIDES — Page 1 of 1

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
KAHO 1	12-02-1625-1-A	02/23/12 10:22	Sediment	N/A	03/14/12	03/14/12 18:00	C0314TSB2

Parameter	Result	RL	DF	Qual	Units
Solids, Total	74.8	0.100	1		%

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
KAHO 2	12-02-1625-2-A	02/23/12 12:36	Sediment	N/A	03/14/12	03/14/12 18:00	C0314TSB2

Parameter	Result	RL	DF	Qual	Units
Solids, Total	61.3	0.100	1		%

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
KAHO 3	12-02-1625-3-A	02/23/12 13:42	Sediment	N/A	03/14/12	03/14/12 18:00	C0314TSB2

Parameter	Result	RL	DF	Qual	Units
Solids, Total	8.10	0.100	1		%

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
Method Blank	099-05-019-1,861	N/A	Solid	N/A	03/14/12	03/14/12 18:00	C0314TSB2

Parameter	Result	RL	DF	Qual	Units
Solids, Total	ND	0.100	1		%

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

Calscience Environmental Laboratories, Inc.

Analytical Report

Marine Research Consultants, Inc.		Date Received:	02/28/12
1039 Waakaua Pl.		Work Order No:	12-02-1625
Honolulu, HI 96822-1173		Preparation:	EPA 3545
		Method:	EPA 8081A
		Units:	ug/kg

Project: C KAHO SEDIMENT PESTICIDES

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
KAHO 1	12-02-1625-1-A	02/23/12 10:22	Sediment	GC 51	03/01/12	03/07/12 14:56	120301L05

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Aldrin	ND	1.3	1		Endosulfan I	ND	1.3	1	
Alpha-BHC	ND	1.3	1		Endosulfan II	ND	1.3	1	
Beta-BHC	ND	1.3	1		Endosulfan Sulfate	ND	1.3	1	
Delta-BHC	ND	1.3	1		Endrin	ND	1.3	1	
Gamma-BHC	ND	1.3	1		Endrin Aldehyde	ND	1.3	1	
Chlordane	ND	13	1		Endrin Ketone	ND	1.3	1	
Dieldrin	ND	1.3	1		Heptachlor	ND	1.3	1	
Trans-nonachlor	ND	1.3	1		Heptachlor Epoxide	ND	1.3	1	
2,4'-DDD	ND	1.3	1		Methoxychlor	ND	1.3	1	
2,4'-DDE	ND	1.3	1		Toxaphene	ND	27	1	
2,4'-DDT	ND	1.3	1		Alpha Chlordane	ND	1.3	1	
4,4'-DDD	ND	1.3	1		Oxychlordane	ND	1.3	1	
4,4'-DDE	ND	1.3	1		Gamma Chlordane	ND	1.3	1	
4,4'-DDT	ND	1.3	1		Cis-nonachlor	ND	1.3	1	

Surrogates:	REC (%)	Control Limits	Qual	Surrogates:	REC (%)	Control Limits	Qual
2,4,5,6-Tetrachloro-m-Xylene	94	50-130		Decachlorobiphenyl	91	50-130	

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
KAHO 2	12-02-1625-2-A	02/23/12 12:36	Sediment	GC 51	03/01/12	03/07/12 15:13	120301L05

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Aldrin	ND	1.6	1		Endosulfan I	ND	1.6	1	
Alpha-BHC	ND	1.6	1		Endosulfan II	ND	1.6	1	
Beta-BHC	ND	1.6	1		Endosulfan Sulfate	ND	1.6	1	
Delta-BHC	ND	1.6	1		Endrin	ND	1.6	1	
Gamma-BHC	ND	1.6	1		Endrin Aldehyde	ND	1.6	1	
Chlordane	ND	16	1		Endrin Ketone	ND	1.6	1	
Dieldrin	ND	1.6	1		Heptachlor	ND	1.6	1	
Trans-nonachlor	ND	1.6	1		Heptachlor Epoxide	ND	1.6	1	
2,4'-DDD	ND	1.6	1		Methoxychlor	ND	1.6	1	
2,4'-DDE	ND	1.6	1		Toxaphene	ND	33	1	
2,4'-DDT	ND	1.6	1		Alpha Chlordane	ND	1.6	1	
4,4'-DDD	ND	1.6	1		Gamma Chlordane	ND	1.6	1	
4,4'-DDE	ND	1.6	1		Oxychlordane	ND	1.6	1	
4,4'-DDT	ND	1.6	1		Cis-nonachlor	ND	1.6	1	

Surrogates:	REC (%)	Control Limits	Qual	Surrogates:	REC (%)	Control Limits	Qual
2,4,5,6-Tetrachloro-m-Xylene	79	50-130		Decachlorobiphenyl	87	50-130	

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Analytical Report

Marine Research Consultants, Inc.		Date Received:	02/28/12
1039 Waakaua Pl.		Work Order No:	12-02-1625
Honolulu, HI 96822-1173		Preparation:	EPA 3545
		Method:	EPA 8081A
		Units:	ug/kg

Project: C KAHO SEDIMENT PESTICIDES

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
KAHO 3	12-02-1625-3-A	02/23/12 13:42	Sediment	GC 51	03/01/12	03/07/12 15:42	120301L05

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Aldrin	ND	12	1		Endosulfan I	ND	12	1	
Alpha-BHC	ND	12	1		Endosulfan II	ND	12	1	
Beta-BHC	ND	12	1		Endosulfan Sulfate	ND	12	1	
Delta-BHC	ND	12	1		Endrin	ND	12	1	
Gamma-BHC	ND	12	1		Endrin Aldehyde	ND	12	1	
Chlordane	ND	120	1		Endrin Ketone	ND	12	1	
Dieldrin	ND	12	1		Heptachlor	ND	12	1	
Trans-nonachlor	ND	12	1		Heptachlor Epoxide	ND	12	1	
2,4'-DDD	ND	12	1		Methoxychlor	ND	12	1	
2,4'-DDE	ND	12	1		Toxaphene	ND	250	1	
2,4'-DDT	ND	12	1		Alpha Chlordane	ND	12	1	
4,4'-DDD	ND	12	1		Oxychlordane	ND	12	1	
4,4'-DDE	ND	12	1		Gamma Chlordane	ND	12	1	
4,4'-DDT	ND	12	1		Cis-nonachlor	ND	12	1	

Surrogates:	REC (%)	Control Limits	Qual	Surrogates:	REC (%)	Control Limits	Qual
2,4,5,6-Tetrachloro-m-Xylene	105	50-130		Decachlorobiphenyl	116	50-130	

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
Method Blank	099-12-858-129	N/A	Solid	GC 51	03/01/12	03/06/12 14:09	120301L05

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Aldrin	ND	1.0	1		Endosulfan I	ND	1.0	1	
Alpha-BHC	ND	1.0	1		Endosulfan II	ND	1.0	1	
Beta-BHC	ND	1.0	1		Endosulfan Sulfate	ND	1.0	1	
Delta-BHC	ND	1.0	1		Endrin	ND	1.0	1	
Gamma-BHC	ND	1.0	1		Endrin Aldehyde	ND	1.0	1	
Chlordane	ND	10	1		Endrin Ketone	ND	1.0	1	
Dieldrin	ND	1.0	1		Heptachlor	ND	1.0	1	
Trans-nonachlor	ND	1.0	1		Heptachlor Epoxide	ND	1.0	1	
2,4'-DDD	ND	1.0	1		Methoxychlor	ND	1.0	1	
2,4'-DDE	ND	1.0	1		Toxaphene	ND	20	1	
2,4'-DDT	ND	1.0	1		Alpha Chlordane	ND	1.0	1	
4,4'-DDD	ND	1.0	1		Oxychlordane	ND	1.0	1	
4,4'-DDE	ND	1.0	1		Gamma Chlordane	ND	1.0	1	
4,4'-DDT	ND	1.0	1		Cis-nonachlor	ND	1.0	1	

Surrogates:	REC (%)	Control Limits	Qual	Surrogates:	REC (%)	Control Limits	Qual
2,4,5,6-Tetrachloro-m-Xylene	92	50-130		Decachlorobiphenyl	98	50-130	

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Analytical Report

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Marine Research Consultants, Inc.		Date Received:	02/28/12
1039 Waakaua Pl.		Work Order No:	12-02-1625
Honolulu, HI 96822-1173		Preparation:	EPA 3545
		Method:	EPA 8141B
		Units:	mg/kg

Project: C KAHO SEDIMENT PESTICIDES

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
KAHO 1	**12-02-1625-1-A**	**02/23/12 10:22**	**Sediment**	**GC 35**	**02/29/12**	**03/06/12 20:13**	**120229L12**

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Demeton-o/s	ND	0.67	1		Fenthion	ND	0.67	1	
Azinphos Methyl	ND	0.67	1		Merphos	ND	0.67	1	
Bolstar	ND	0.67	1		Methyl Parathion	ND	0.67	1	
Chlorpyrifos	ND	0.67	1		Mevinphos	ND	0.67	1	
Coumaphos	ND	0.67	1		Naled	ND	5.3	1	
Diazinon	ND	0.67	1		Phorate	ND	0.67	1	
Dichlorvos	ND	0.67	1		Ronnel	ND	0.67	1	
Disulfoton	ND	0.67	1		Strophos	ND	2.7	1	
Ethoprop	ND	0.67	1		Tokuthion	ND	0.67	1	
Fensulfothion	ND	0.67	1		Trichloronate	ND	0.67	1	

Surrogates:	REC (%)	Control Limits	Qual
Tributylphosphate	108	30-130	

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
KAHO 2	**12-02-1625-2-A**	**02/23/12 12:36**	**Sediment**	**GC 35**	**02/29/12**	**03/06/12 20:59**	**120229L12**

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Demeton-o/s	ND	0.82	1		Fenthion	ND	0.82	1	
Azinphos Methyl	ND	0.82	1		Merphos	ND	0.82	1	
Bolstar	ND	0.82	1		Methyl Parathion	ND	0.82	1	
Chlorpyrifos	ND	0.82	1		Mevinphos	ND	0.82	1	
Coumaphos	ND	0.82	1		Naled	ND	6.5	1	
Diazinon	ND	0.82	1		Phorate	ND	0.82	1	
Dichlorvos	ND	0.82	1		Ronnel	ND	0.82	1	
Disulfoton	ND	0.82	1		Strophos	ND	3.3	1	
Ethoprop	ND	0.82	1		Tokuthion	ND	0.82	1	
Fensulfothion	ND	0.82	1		Trichloronate	ND	0.82	1	

Surrogates:	REC (%)	Control Limits	Qual
Tributylphosphate	101	30-130	

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Calscience Environmental Laboratories, Inc.

Analytical Report

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Marine Research Consultants, Inc.		Date Received:	02/28/12
1039 Waakaua Pl.		Work Order No:	12-02-1625
Honolulu, HI 96822-1173		Preparation:	EPA 3545
		Method:	EPA 8141B
		Units:	mg/kg

Project: C KAHO SEDIMENT PESTICIDES

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
KAHO 3	**12-02-1625-3-A**	**02/23/12 13:42**	**Sediment**	**GC 35**	**02/29/12**	**03/06/12 21:45**	**120229L12**

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Demeton-o/s	ND	6.2	1		Fenthion	ND	6.2	1	
Azinphos Methyl	ND	6.2	1		Merphos	ND	6.2	1	
Bolstar	ND	6.2	1		Methyl Parathion	ND	6.2	1	
Chlorpyrifos	ND	6.2	1		Mevinphos	ND	6.2	1	
Coumaphos	ND	6.2	1		Naled	ND	49	1	
Diazinon	ND	6.2	1		Phorate	ND	6.2	1	
Dichlorvos	ND	6.2	1		Ronnel	ND	6.2	1	
Disulfoton	ND	6.2	1		Strophos	ND	25	1	
Ethoprop	ND	6.2	1		Tokuthion	ND	6.2	1	
Fensulfothion	ND	6.2	1		Trichloronate	ND	6.2	1	

Surrogates:	REC (%)	Control Limits	Qual
Tributylphosphate	87	30-130	

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
Method Blank	**099-12-465-110**	**N/A**	**Solid**	**GC 35**	**02/29/12**	**03/02/12 23:23**	**120229L12**

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Demeton-o/s	ND	0.50	1		Fenthion	ND	0.50	1	
Azinphos Methyl	ND	0.50	1		Merphos	ND	0.50	1	
Bolstar	ND	0.50	1		Methyl Parathion	ND	0.50	1	
Chlorpyrifos	ND	0.50	1		Mevinphos	ND	0.50	1	
Coumaphos	ND	0.50	1		Naled	ND	4.0	1	
Diazinon	ND	0.50	1		Phorate	ND	0.50	1	
Dichlorvos	ND	0.50	1		Ronnel	ND	0.50	1	
Disulfoton	ND	0.50	1		Strophos	ND	2.0	1	
Ethoprop	ND	0.50	1		Tokuthion	ND	0.50	1	
Fensulfothion	ND	0.50	1		Trichloronate	ND	0.50	1	

Surrogates:	REC (%)	Control Limits	Qual
Tributylphosphate	62	30-130	

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Calscience Environmental Laboratories, Inc.

Analytical Report

Marine Research Consultants, Inc.		Date Received:	02/28/12
1039 Waakaua Pl.		Work Order No:	12-02-1625
Honolulu, HI 96822-1173		Preparation:	EPA 8151A
		Method:	EPA 8151A
		Units:	mg/kg

Project: C KAHO SEDIMENT PESTICIDES

Page 1 of 2

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
KAHO 1	**12-02-1625-1-A**	**02/23/12 10:22**	**Sediment**	**GC 40**	**03/07/12**	**03/09/12 14:00**	**120307L02**

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Dalapon	ND	0.33	1		2,4-D	ND	0.13	1	
Dicamba	ND	0.013	1		2,4,5-TP (Silvex)	ND	0.013	1	
MCPP	ND	13	1		2,4,5-T	ND	0.013	1	
MCPA	ND	13	1		2,4-DB	ND	0.13	1	
Dichlorprop	ND	0.13	1		Dinoseb	ND	0.067	1	

Surrogates:	REC (%)	Control Limits	Qual
2,4-Dichlorophenylacetic acid	36	30-130	

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
KAHO 2	**12-02-1625-2-A**	**02/23/12 12:36**	**Sediment**	**GC 40**	**03/07/12**	**03/09/12 14:33**	**120307L02**

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Dalapon	ND	0.41	1		2,4-D	ND	0.16	1	
Dicamba	ND	0.016	1		2,4,5-TP (Silvex)	ND	0.016	1	
MCPP	ND	16	1		2,4,5-T	ND	0.016	1	
MCPA	ND	16	1		2,4-DB	ND	0.16	1	
Dichlorprop	ND	0.16	1		Dinoseb	ND	0.082	1	

Surrogates:	REC (%)	Control Limits	Qual
2,4-Dichlorophenylacetic acid	43	30-130	

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
KAHO 3	**12-02-1625-3-A**	**02/23/12 13:42**	**Sediment**	**GC 40**	**03/07/12**	**03/09/12 15:05**	**120307L02**

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Dalapon	ND	3.1	1		2,4-D	ND	1.2	1	
Dicamba	ND	0.12	1		2,4,5-TP (Silvex)	ND	0.12	1	
MCPP	ND	120	1		2,4,5-T	ND	0.12	1	
MCPA	ND	120	1		2,4-DB	ND	1.2	1	
Dichlorprop	ND	1.2	1		Dinoseb	ND	0.62	1	

Surrogates:	REC (%)	Control Limits	Qual
2,4-Dichlorophenylacetic acid	52	30-130	

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

Calscience Environmental Laboratories, Inc.

Analytical Report

Marine Research Consultants, Inc.		Date Received:	02/28/12
1039 Waakaua Pl.		Work Order No:	12-02-1625
Honolulu, HI 96822-1173		Preparation:	EPA 8151A
		Method:	EPA 8151A
		Units:	mg/kg

Project: C KAHO SEDIMENT PESTICIDES

Page 2 of 2

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
Method Blank	**095-01-033-992**	**N/A**	**Solid**	**GC 40**	**03/07/12**	**03/09/12 12:23**	**120307L02**

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Dalapon	ND	0.25	1		2,4-D	ND	0.10	1	
Dicamba	ND	0.010	1		2,4,5-TP (Silvex)	ND	0.010	1	
MCPP	ND	10	1		2,4,5-T	ND	0.010	1	
MCPA	ND	10	1		2,4-DB	ND	0.10	1	
Dichlorprop	ND	0.10	1		Dinoseb	ND	0.050	1	

Surrogates:	REC (%)	Control Limits	Qual
2,4-Dichlorophenylacetic acid	40	30-130	

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

Calscience Environmental Laboratories, Inc.

Analytical Report

Marine Research Consultants, Inc.
1039 Waakaua Pl.
Honolulu, HI 96822-1173

Date Received:	02/28/12
Work Order No:	12-02-1625
Preparation:	EPA 3545
Method:	EPA 8270C SIM
Units:	mg/kg

Project: C KAHO SEDIMENT PESTICIDES

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
KAHO 1	12-02-1625-1-A	02/23/12 10:22	Sediment	GC/MS MM	03/01/12	03/06/12 20:18	120301L08

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
2,6-Dimethylnaphthalene	ND	0.013	1		Benzo (a) Anthracene	ND	0.013	1	
Perylene	ND	0.013	1		Benzo (a) Pyrene	ND	0.013	1	
Biphenyl	ND	0.013	1		Benzo (b) Fluoranthene	ND	0.013	1	
Benzo (e) Pyrene	ND	0.013	1		Benzo (g,h,i) Perylene	ND	0.013	1	
1-Methylnaphthalene	ND	0.013	1		Benzo (k) Fluoranthene	ND	0.013	1	
2,4,5-Trichlorophenol	ND	0.013	1		Chrysene	ND	0.013	1	
2,4,6-Trichlorophenol	ND	0.013	1		Dibenz (a,h) Anthracene	ND	0.013	1	
2,4-Dichlorophenol	ND	0.013	1		Fluoranthene	ND	0.013	1	
2,4-Dimethylphenol	ND	0.013	1		Fluorene	ND	0.013	1	
2,4-Dinitrophenol	ND	0.67	1		Indeno (1,2,3-c,d) Pyrene	ND	0.013	1	
2-Chlorophenol	ND	0.013	1		Naphthalene	ND	0.013	1	
2-Methylnaphthalene	ND	0.013	1		Pentachlorophenol	ND	0.67	1	
2-Methylphenol	ND	0.013	1		Phenanthrene	ND	0.013	1	
2-Nitrophenol	ND	0.013	1		Phenol	ND	0.013	1	
3/4-Methylphenol	ND	0.013	1		Pyrene	ND	0.013	1	
4,6-Dinitro-2-Methylphenol	ND	0.67	1		1,6,7-Trimethylnaphthalene	ND	0.013	1	
4-Chloro-3-Methylphenol	ND	0.013	1		2,3,4,6-Tetrachlorophenol	ND	0.013	1	
4-Nitrophenol	ND	0.67	1		2,6-Dichlorophenol	ND	0.013	1	
Acenaphthene	ND	0.013	1		Benzoic Acid	ND	0.13	1	
Acenaphthylene	ND	0.013	1		1-Methylphenanthrene	ND	0.013	1	
Anthracene	ND	0.013	1		Dibenzothiophene	ND	0.013	1	

Surrogates:	REC (%)	Control Limits	Qual	Surrogates:	REC (%)	Control Limits	Qual
2,4,6-Tribromophenol	56	32-143		2-Fluorobiphenyl	51	14-146	
2-Fluorophenol	54	15-138		Nitrobenzene-d5	42	18-162	
p-Terphenyl-d14	58	34-148		Phenol-d6	51	17-141	

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

Calscience Environmental Laboratories, Inc.

Analytical Report

Marine Research Consultants, Inc.
1039 Waakaua Pl.
Honolulu, HI 96822-1173

Date Received:	02/28/12
Work Order No:	12-02-1625
Preparation:	EPA 3545
Method:	EPA 8270C SIM
Units:	mg/kg

Project: C KAHO SEDIMENT PESTICIDES

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
KAHO 2	12-02-1625-2-A	02/23/12 12:36	Sediment	GC/MS MM	03/01/12	03/06/12 20:44	120301L08

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Benzo (e) Pyrene	ND	0.016	1		Benzo (a) Anthracene	ND	0.016	1	
Perylene	ND	0.016	1		Benzo (a) Pyrene	ND	0.016	1	
Biphenyl	ND	0.016	1		Benzo (b) Fluoranthene	ND	0.016	1	
2,6-Dimethylnaphthalene	ND	0.016	1		Benzo (g,h,i) Perylene	ND	0.016	1	
1-Methylnaphthalene	ND	0.016	1		Benzo (k) Fluoranthene	ND	0.016	1	
2,4,5-Trichlorophenol	ND	0.016	1		Chrysene	ND	0.016	1	
2,4,6-Trichlorophenol	ND	0.016	1		Dibenz (a,h) Anthracene	ND	0.016	1	
2,4-Dichlorophenol	ND	0.016	1		Fluoranthene	ND	0.016	1	
2,4-Dimethylphenol	ND	0.016	1		Fluorene	ND	0.016	1	
2,4-Dinitrophenol	ND	0.82	1		Indeno (1,2,3-c,d) Pyrene	ND	0.016	1	
2-Chlorophenol	ND	0.016	1		Naphthalene	ND	0.016	1	
2-Methylnaphthalene	ND	0.016	1		Pentachlorophenol	ND	0.82	1	
2-Methylphenol	ND	0.016	1		Phenanthrene	ND	0.016	1	
2-Nitrophenol	ND	0.016	1		Phenol	0.14	0.016	1	
3/4-Methylphenol	0.069	0.016	1		Pyrene	ND	0.016	1	
4,6-Dinitro-2-Methylphenol	ND	0.82	1		1,6,7-Trimethylnaphthalene	ND	0.016	1	
4-Chloro-3-Methylphenol	ND	0.016	1		2,3,4,6-Tetrachlorophenol	ND	0.016	1	
4-Nitrophenol	ND	0.82	1		2,6-Dichlorophenol	ND	0.016	1	
Acenaphthene	ND	0.016	1		1-Methylphenanthrene	ND	0.016	1	
Acenaphthylene	ND	0.016	1		Benzoic Acid	ND	0.16	1	
Anthracene	ND	0.016	1		Dibenzothiophene	ND	0.016	1	

Surrogates:	REC (%)	Control Limits	Qual	Surrogates:	REC (%)	Control Limits	Qual
2,4,6-Tribromophenol	52	32-143		2-Fluorobiphenyl	46	14-146	
2-Fluorophenol	53	15-138		Nitrobenzene-d5	40	18-162	
p-Terphenyl-d14	51	34-148		Phenol-d6	50	17-141	

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

Calscience Environmental Laboratories, Inc.

Analytical Report

Marine Research Consultants, Inc.
1039 Waakaua Pl.
Honolulu, HI 96822-1173

Date Received: 02/28/12
Work Order No: 12-02-1625
Preparation: EPA 3545
Method: EPA 8270C SIM
Units: mg/kg

Project: C KAHO SEDIMENT PESTICIDES

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
KAHO 3	12-02-1625-3-A	02/23/12 13:42	Sediment	GC/MS MM	03/01/12	03/08/12 14:41	120301L08

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Benzo (e) Pyrene	ND	0.12	1		Benzo (a) Anthracene	ND	0.12	1	
2,6-Dimethylnaphthalene	0.53	0.12	1		Benzo (a) Pyrene	ND	0.12	1	
Biphenyl	ND	0.12	1		Benzo (b) Fluoranthene	ND	0.12	1	
Perylene	ND	0.12	1		Benzo (g,h,i) Perylene	ND	0.12	1	
1-Methylnaphthalene	ND	0.12	1		Benzo (k) Fluoranthene	ND	0.12	1	
2,4,5-Trichlorophenol	ND	0.12	1		Chrysene	ND	0.12	1	
2,4,6-Trichlorophenol	ND	0.12	1		Dibenz (a,h) Anthracene	ND	0.12	1	
2,4-Dichlorophenol	ND	0.12	1		Fluoranthene	ND	0.12	1	
2,4-Dimethylphenol	ND	0.12	1		Fluorene	ND	0.12	1	
2,4-Dinitrophenol	ND	6.2	1		Indeno (1,2,3-c,d) Pyrene	ND	0.12	1	
2-Chlorophenol	ND	0.12	1		Naphthalene	ND	0.12	1	
2-Methylnaphthalene	ND	0.12	1		Pentachlorophenol	ND	6.2	1	
2-Methylphenol	ND	0.12	1		Phenanthrene	ND	0.12	1	
2-Nitrophenol	ND	0.12	1		Phenol	ND	0.12	1	
3/4-Methylphenol	ND	0.12	1		Pyrene	ND	0.12	1	
4,6-Dinitro-2-Methylphenol	ND	6.2	1		1,6,7-Trimethylnaphthalene	ND	0.12	1	
4-Chloro-3-Methylphenol	ND	0.12	1		2,3,4,6-Tetrachlorophenol	ND	0.12	1	
4-Nitrophenol	ND	6.2	1		2,6-Dichlorophenol	ND	0.12	1	
Acenaphthene	ND	0.12	1		1-Methylphenanthrene	ND	0.12	1	
Acenaphthylene	ND	0.12	1		Benzoic Acid	ND	1.2	1	
Anthracene	ND	0.12	1		Dibenzothiophene	ND	0.12	1	

Surrogates:	REC (%)	Control Limits	Qual	Surrogates:	REC (%)	Control Limits	Qual
2,4,6-Tribromophenol	62	32-143		2-Fluorobiphenyl	54	14-146	
2-Fluorophenol	54	15-138		Nitrobenzene-d5	52	18-162	
p-Terphenyl-d14	58	34-148		Phenol-d6	58	17-141	

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Analytical Report

Marine Research Consultants, Inc.
1039 Waakaua Pl.
Honolulu, HI 96822-1173

Date Received: 02/28/12
Work Order No: 12-02-1625
Preparation: EPA 3545
Method: EPA 8270C SIM
Units: mg/kg

Project: C KAHO SEDIMENT PESTICIDES

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
Method Blank	099-12-413-362	N/A	Solid	GC/MS MM	03/01/12	03/06/12 16:26	120301L08

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Benzo (e) Pyrene	ND	0.010	1		Benzo (a) Anthracene	ND	0.010	1	
Perylene	ND	0.010	1		Benzo (a) Pyrene	ND	0.010	1	
Biphenyl	ND	0.010	1		Benzo (b) Fluoranthene	ND	0.010	1	
2,6-Dimethylnaphthalene	ND	0.010	1		Benzo (g,h,i) Perylene	ND	0.010	1	
1-Methylnaphthalene	ND	0.010	1		Benzo (k) Fluoranthene	ND	0.010	1	
2,4,5-Trichlorophenol	ND	0.010	1		Chrysene	ND	0.010	1	
2,4,6-Trichlorophenol	ND	0.010	1		Dibenz (a,h) Anthracene	ND	0.010	1	
2,4-Dichlorophenol	ND	0.010	1		Fluoranthene	ND	0.010	1	
2,4-Dimethylphenol	ND	0.010	1		Fluorene	ND	0.010	1	
2,4-Dinitrophenol	ND	0.50	1		Indeno (1,2,3-c,d) Pyrene	ND	0.010	1	
2-Chlorophenol	ND	0.010	1		Naphthalene	ND	0.010	1	
2-Methylnaphthalene	ND	0.010	1		Pentachlorophenol	ND	0.50	1	
2-Methylphenol	ND	0.010	1		Phenanthrene	ND	0.010	1	
2-Nitrophenol	ND	0.010	1		Phenol	ND	0.010	1	
3/4-Methylphenol	ND	0.010	1		Pyrene	ND	0.010	1	
4,6-Dinitro-2-Methylphenol	ND	0.50	1		1,6,7-Trimethylnaphthalene	ND	0.010	1	
4-Chloro-3-Methylphenol	ND	0.010	1		2,3,4,6-Tetrachlorophenol	ND	0.010	1	
4-Nitrophenol	ND	0.50	1		2,6-Dichlorophenol	ND	0.010	1	
Acenaphthene	ND	0.010	1		1-Methylphenanthrene	ND	0.010	1	
Acenaphthylene	ND	0.010	1		Benzoic Acid	ND	0.10	1	
Anthracene	ND	0.010	1		Dibenzothiophene	ND	0.010	1	

Surrogates:	REC (%)	Control Limits	Qual	Surrogates:	REC (%)	Control Limits	Qual
2,4,6-Tribromophenol	59	32-143		2-Fluorobiphenyl	58	14-146	
2-Fluorophenol	67	15-138		Nitrobenzene-d5	70	18-162	
p-Terphenyl-d14	55	34-148		Phenol-d6	54	17-141	

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

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Analytical Report

Marine Research Consultants, Inc.
1039 Waakaua Pl.
Honolulu, HI 96822-1173

Date Received:	02/28/12
Work Order No:	12-02-1625
Preparation:	EPA 3050B
Method:	EPA 6020
Units:	mg/kg

Project: C KAHO SEDIMENT PESTICIDES

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
KAHO 1	12-02-1625-1-A	02/23/12 10:22	Sediment	ICP/MS 04	03/02/12	03/05/12 14:37	120302L01E

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Aluminum	9310	6.68	1		Lead	0.963	0.134	1	
Antimony	ND	0.668	1		Manganese	246	0.668	1	
Arsenic	2.06	0.134	1		Molybdenum	0.872	0.267	1	
Barium	25.6	0.134	1		Nickel	57.1	0.134	1	
Beryllium	ND	0.668	1		Selenium	0.483	0.134	1	
Cadmium	0.239	0.134	1		Silver	ND	0.134	1	
Chromium	28.5	0.134	1		Thallium	ND	0.134	1	
Cobalt	12.3	0.134	1		Vanadium	61.9	1.34	1	
Copper	24.3	0.134	1		Zinc	23.0	1.34	1	
Iron	18700	6.68	1						

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
KAHO 2	12-02-1625-2-A	02/23/12 12:36	Sediment	ICP/MS 04	03/02/12	03/05/12 14:33	120302L01E

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Aluminum	2250	8.16	1		Lead	1.72	0.163	1	
Antimony	ND	0.816	1		Manganese	77.8	0.816	1	
Arsenic	1.02	0.163	1		Molybdenum	0.454	0.326	1	
Barium	6.21	0.163	1		Nickel	28.0	0.163	1	
Beryllium	ND	0.816	1		Selenium	0.437	0.163	1	
Cadmium	ND	0.163	1		Silver	ND	0.163	1	
Chromium	14.9	0.163	1		Thallium	ND	0.163	1	
Cobalt	4.86	0.163	1		Vanadium	35.8	1.63	1	
Copper	9.56	0.163	1		Zinc	12.5	1.63	1	
Iron	6640	8.16	1						

Calscience Environmental Laboratories, Inc.

Analytical Report

Marine Research Consultants, Inc.
1039 Waakaua Pl.
Honolulu, HI 96822-1173

Date Received:	02/28/12
Work Order No:	12-02-1625
Preparation:	EPA 3050B
Method:	EPA 6020
Units:	mg/kg

Project: C KAHO SEDIMENT PESTICIDES

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
KAHO 3	12-02-1625-3-A	02/23/12 13:42	Sediment	ICP/MS 04	03/02/12	03/05/12 14:41	120302L01E

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Aluminum	2390	61.7	1		Lead	10.0	1.23	1	
Antimony	ND	6.17	1		Manganese	48.0	6.17	1	
Arsenic	3.43	1.23	1		Molybdenum	33.1	2.47	1	
Barium	4.90	1.23	1		Nickel	20.0	1.23	1	
Beryllium	ND	6.17	1		Selenium	5.80	1.23	1	
Cadmium	ND	1.23	1		Silver	ND	1.23	1	
Chromium	90.5	1.23	1		Thallium	ND	1.23	1	
Cobalt	2.50	1.23	1		Vanadium	1410	12.3	1	
Copper	137	1.23	1		Zinc	143	12.3	1	
Iron	4470	61.7	1						

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
Method Blank	096-10-002-2,193	N/A	Solid	ICP/MS 04	03/02/12	03/06/12 16:40	120302L01E

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Aluminum	ND	5.00	1		Lead	ND	0.100	1	
Antimony	ND	0.500	1		Manganese	ND	0.500	1	
Arsenic	ND	0.100	1		Molybdenum	ND	0.200	1	
Barium	ND	0.100	1		Nickel	ND	0.100	1	
Beryllium	ND	0.500	1		Selenium	ND	0.100	1	
Cadmium	ND	0.100	1		Silver	ND	0.100	1	
Chromium	ND	0.100	1		Thallium	ND	0.100	1	
Cobalt	ND	0.100	1		Vanadium	ND	1.00	1	
Copper	ND	0.100	1		Zinc	ND	1.00	1	
Iron	ND	5.00	1						

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Analytical Report

Marine Research Consultants, Inc.
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Honolulu, HI 96822-1173

Date Received: 02/28/12
Work Order No: 12-02-1625
Preparation: EPA 7471A Total
Method: EPA 7471A

Project: C KAHO SEDIMENT PESTICIDES

Page 1 of 1

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
KAHO 1	12-02-1625-1-A	02/23/12 10:22	Sediment	Mercury	03/07/12	03/07/12 17:55	120307L01E

-Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Units
Mercury	ND	0.0268	1		mg/kg

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
KAHO 2	12-02-1625-2-A	02/23/12 12:36	Sediment	Mercury	03/07/12	03/07/12 17:57	120307L01E

-Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Units
Mercury	ND	0.0327	1		mg/kg

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
KAHO 3	12-02-1625-3-A	02/23/12 13:42	Sediment	Mercury	03/07/12	03/07/12 18:04	120307L01E

-Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Units
Mercury	ND	0.247	1		mg/kg

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
Method Blank	099-12-452-275	N/A	Solid	Mercury	03/07/12	03/07/12 11:02	120307L01E

Parameter	Result	RL	DF	Qual	Units
Mercury	ND	0.0200	1		mg/kg

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

Calscience Environmental Laboratories, Inc.

Quality Control - Spike/Spike Duplicate

Marine Research Consultants, Inc.
1039 Waakaua Pl.
Honolulu, HI 96822-1173

Date Received: 02/28/12
Work Order No: 12-02-1625
Preparation: EPA 3050B
Method: EPA 6020

Project C KAHO SEDIMENT PESTICIDES

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	MS/MSD Batch Number
KAHO 2	Sediment	ICP/MS 04	03/02/12	03/05/12	120302S01

Parameter	SPIKE ADDED	MS %REC	MSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Aluminum	25.00	4X	4X	80-120	4X	0-20	Q
Antimony	25.00	66	57	80-120	15	0-20	3
Arsenic	25.00	109	108	80-120	1	0-20	
Barium	25.00	123	113	80-120	7	0-20	3
Beryllium	25.00	111	110	80-120	1	0-20	
Cadmium	25.00	99	96	80-120	2	0-20	
Chromium	25.00	109	119	80-120	6	0-20	
Cobalt	25.00	108	106	80-120	1	0-20	
Copper	25.00	103	107	80-120	3	0-20	
Iron	25.00	4X	4X	80-120	4X	0-20	Q
Lead	25.00	113	112	80-120	0	0-20	
Manganese	25.00	191	176	80-120	4	0-20	3
Molybdenum	25.00	115	113	80-120	2	0-20	
Nickel	25.00	123	128	80-120	3	0-20	3
Selenium	25.00	127	112	80-120	12	0-20	3
Silver	12.50	97	95	80-120	2	0-20	
Thallium	25.00	99	103	80-120	4	0-20	
Vanadium	25.00	124	148	80-120	11	0-20	3
Zinc	25.00	98	94	80-120	3	0-20	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - PDS / PDSD

Marine Research Consultants, Inc.
1039 Waakaua Pl.
Honolulu, HI 96822-1173

Date Received: 02/28/12
Work Order No: 12-02-1625
Preparation: EPA 3050B
Method: EPA 6020

Project: C KAHO SEDIMENT PESTICIDES

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	PDS / PDSD Batch Number
KAHO 2	Sediment	ICP/MS 04	03/02/12	03/05/12	120302S01

Analysis Comment: * - Analyzed 3/6/2012 5:16:07 PM

Parameter	SPIKE ADDED	PDS %REC	PDSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Aluminum	25.00	4X	4X	75-125	4X	0-20	Q
Antimony	25.00	92	94	75-125	2	0-20	
Arsenic	25.00	104	105	75-125	1	0-20	
Barium	25.00	100	103	75-125	3	0-20	
Beryllium	25.00	108	110	75-125	3	0-20	
Cadmium	25.00	92	94	75-125	2	0-20	
Chromium	25.00	98	99	75-125	1	0-20	
Cobalt	25.00	98	98	75-125	1	0-20	
Copper	25.00	95	97	75-125	2	0-20	
Iron	25.00	4X	4X	75-125	4X	0-20	Q
Lead	25.00	103	104	75-125	1	0-20	
Manganese	25.00	103	96	75-125	2	0-20	
Molybdenum	25.00	109	110	75-125	1	0-20	
Nickel	25.00	97	98	75-125	0	0-20	
Selenium	25.00	125	108	75-125	15	0-20	
Silver	12.50	81	81	75-125	0	0-20	
Thallium	25.00	94	95	75-125	2	0-20	
Vanadium	25.00	109	103	75-125	3	0-20	
Zinc	25.00	85	86	75-125	1	0-20	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - Duplicate

Marine Research Consultants, Inc.
1039 Waakaua Pl.
Honolulu, HI 96822-1173

Date Received: 02/28/12
Work Order No: 12-02-1625
Preparation: N/A
Method: SM 2540 B

Project: C KAHO SEDIMENT PESTICIDES

Quality Control Sample ID	Matrix	Instrument	Date Prepared:	Date Analyzed:	Duplicate Batch Number
12-03-0909-1	Sediment	N/A	03/14/12	03/14/12	C0314TSD2

Parameter	Sample Conc	DUP Conc	RPD	RPD CL	Qualifiers
Solids, Total	39.9	40.7	2	0-10	

RPD - Relative Percent Difference , CL - Control Limit

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Calscience Environmental Laboratories, Inc.

Quality Control - Spike/Spike Duplicate

Marine Research Consultants, Inc.
1039 Waakaua Pl.
Honolulu, HI 96822-1173

Date Received: 02/28/12
Work Order No: 12-02-1625
Preparation: EPA 7471A Total
Method: EPA 7471A

Project C KAHO SEDIMENT PESTICIDES

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	MS/MSD Batch Number
12-03-0330-1	Solid	Mercury	03/07/12	03/07/12	120307S01

Parameter	SPIKE ADDED	MS %REC	MSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Mercury	0.8350	105	104	71-137	1	0-14	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - Spike/Spike Duplicate

Marine Research Consultants, Inc.
1039 Waakaua Pl.
Honolulu, HI 96822-1173

Date Received: 02/28/12
Work Order No: 12-02-1625
Preparation: EPA 8151A
Method: EPA 8151A

Project C KAHO SEDIMENT PESTICIDES

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	MS/MSD Batch Number
KAHO 2	Sediment	GC 40	03/07/12	03/09/12	120307S02

Parameter	SPIKE ADDED	MS %REC	MSD %REC	%REC CL	RPD	RPD CL	Qualifiers
2,4-D	0.4000	45	66	30-130	38	0-30	4
2,4,5-T	0.04000	42	65	30-130	42	0-30	4
2,4-DB	0.4000	34	37	30-130	8	0-30	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - Spike/Spike Duplicate

Marine Research Consultants, Inc.
1039 Waakaua Pl.
Honolulu, HI 96822-1173

Date Received: 02/28/12
Work Order No: 12-02-1625
Preparation: EPA 3545
Method: EPA 8081A

Project C KAHO SEDIMENT PESTICIDES

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	MS/MSD Batch Number
12-02-1512-2	Sediment	GC 51	03/01/12	03/06/12	120301S05

Parameter	SPIKE ADDED	MS %REC	MSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Aldrin	5.000	83	73	50-135	12	0-25	
Alpha-BHC	5.000	95	76	50-135	22	0-25	
Beta-BHC	5.000	103	90	50-135	13	0-25	
Delta-BHC	5.000	95	82	50-135	14	0-25	
Gamma-BHC	5.000	89	76	50-135	16	0-25	
Dieldrin	5.000	89	79	50-135	12	0-25	
4,4'-DDD	5.000	107	93	50-135	14	0-25	
4,4'-DDE	5.000	116	103	50-135	12	0-25	
4,4'-DDT	5.000	85	70	50-135	19	0-25	
Endosulfan I	5.000	86	76	50-135	13	0-25	
Endosulfan II	5.000	87	75	50-135	14	0-25	
Endosulfan Sulfate	5.000	89	78	50-135	14	0-25	
Endrin	5.000	102	88	50-135	14	0-25	
Endrin Aldehyde	5.000	70	57	50-135	21	0-25	
Endrin Ketone	5.000	94	76	50-135	20	0-25	
Heptachlor	5.000	82	70	50-135	16	0-25	
Heptachlor Epoxide	5.000	86	74	50-135	14	0-25	
Methoxychlor	5.000	75	62	50-135	19	0-25	
Alpha Chlordane	5.000	96	85	50-135	12	0-25	
Gamma Chlordane	5.000	90	78	50-135	15	0-25	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - Spike/Spike Duplicate

Marine Research Consultants, Inc.
1039 Waakaua Pl.
Honolulu, HI 96822-1173

Date Received: 02/28/12
Work Order No: 12-02-1625
Preparation: EPA 3545
Method: EPA 8141B

Project C KAHO SEDIMENT PESTICIDES

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	MS/MSD Batch Number
12-02-1607-9	Solid	GC 35	02/29/12	03/06/12	120229S12

Parameter	SPIKE ADDED	MS %REC	MSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Azinphos Methyl	4.000	83	80	30-130	4	0-30	
Bolstar	4.000	89	85	30-130	4	0-30	
Chlorpyrifos	4.000	77	75	30-130	3	0-30	
Coumaphos	4.000	88	84	30-130	5	0-30	
Diazinon	4.000	84	79	30-130	6	0-30	
Disulfoton	4.000	86	80	30-130	7	0-30	
Ethoprop	4.000	88	84	30-130	5	0-30	
Fensulfothion	4.000	88	85	30-130	4	0-30	
Fenthion	4.000	82	79	30-130	3	0-30	
Merphos	4.000	85	82	30-130	4	0-30	
Methyl Parathion	4.000	79	76	30-130	3	0-30	
Phorate	4.000	91	85	30-130	6	0-30	
Ronnel	4.000	76	74	30-130	3	0-30	
Stirophos	4.000	72	68	30-130	5	0-30	
Tokuthion	4.000	80	78	30-130	4	0-30	
Trichloronate	4.000	78	76	30-130	3	0-30	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - Spike/Spike Duplicate

Marine Research Consultants, Inc.		Date Received:	02/28/12
1039 Waakaua Pl.		Work Order No:	12-02-1625
Honolulu, HI 96822-1173		Preparation:	EPA 3545
		Method:	EPA 8270C SIM

Project C KAHO SEDIMENT PESTICIDES

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	MS/MSD Batch Number
12-02-1512-2	Sediment	GC/MS MM	03/01/12	03/06/12	120301S08

Parameter	SPIKE ADDED	MS %REC	MSD %REC	%REC CL	RPD	RPD CL	Qualifiers
2,4,6-Trichlorophenol	1.000	65	64	40-160	2	0-20	
2,4-Dichlorophenol	1.000	69	69	40-160	0	0-20	
2-Methylphenol	1.000	57	56	40-160	1	0-20	
2-Nitrophenol	1.000	61	61	40-160	0	0-20	
4-Chloro-3-Methylphenol	1.000	65	66	40-160	2	0-20	
Acenaphthene	1.000	60	58	40-106	3	0-20	
Benzo (a) Pyrene	1.000	61	60	17-163	2	0-20	
Chrysene	1.000	58	57	17-168	3	0-20	
Di-n-Butyl Phthalate	1.000	60	59	40-160	2	0-20	
Dimethyl Phthalate	1.000	60	59	40-160	2	0-20	
Fluoranthene	1.000	62	60	26-137	3	0-20	
Fluorene	1.000	63	62	59-121	2	0-20	
Naphthalene	1.000	59	58	21-133	2	0-20	
Phenanthrene	1.000	61	59	54-120	3	0-20	
Phenol	1.000	55	54	40-160	1	0-20	
Pyrene	1.000	61	60	6-156	2	0-46	

Calscience Environmental Laboratories, Inc.

Quality Control - LCS/LCS Duplicate

Marine Research Consultants, Inc.		Date Received:	N/A
1039 Waakaua Pl.		Work Order No:	12-02-1625
Honolulu, HI 96822-1173		Preparation:	EPA 3050B
		Method:	EPA 6020

Project: C KAHO SEDIMENT PESTICIDES

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	LCS/LCSD Batch Number
096-10-002-2,193	Solid	ICP/MS 04	03/02/12	03/06/12	120302L01E

Parameter	SPIKE ADDED	LCS %REC	LCSD %REC	%REC CL	ME CL	RPD	RPD CL	Qualifiers
Aluminum	25.00	119	107	80-120	73-127	11	0-20	
Antimony	25.00	95	94	80-120	73-127	1	0-20	
Arsenic	25.00	96	94	80-120	73-127	2	0-20	
Barium	25.00	103	102	80-120	73-127	1	0-20	
Beryllium	25.00	101	100	80-120	73-127	1	0-20	
Cadmium	25.00	104	104	80-120	73-127	1	0-20	
Chromium	25.00	99	95	80-120	73-127	5	0-20	
Cobalt	25.00	101	99	80-120	73-127	2	0-20	
Copper	25.00	101	99	80-120	73-127	2	0-20	
Iron	25.00	87	105	80-120	73-127	19	0-20	
Lead	25.00	85	85	80-120	73-127	1	0-20	
Manganese	25.00	98	97	80-120	73-127	1	0-20	
Molybdenum	25.00	95	94	80-120	73-127	1	0-20	
Nickel	25.00	99	98	80-120	73-127	1	0-20	
Selenium	25.00	93	93	80-120	73-127	0	0-20	
Silver	12.50	75	73	80-120	73-127	2	0-20	ME
Thallium	25.00	92	92	80-120	73-127	0	0-20	
Vanadium	25.00	97	96	80-120	73-127	2	0-20	
Zinc	25.00	102	120	80-120	73-127	17	0-20	

Total number of LCS compounds : 19
Total number of ME compounds : 1
Total number of ME compounds allowed : 1
LCS ME CL validation result : Pass

Calscience Environmental Laboratories, Inc.

Quality Control - LCS/LCS Duplicate

Marine Research Consultants, Inc.
1039 Waakaua Pl.
Honolulu, HI 96822-1173

Date Received: N/A
Work Order No: 12-02-1625
Preparation: EPA 7471A Total
Method: EPA 7471A

Project: C KAHO SEDIMENT PESTICIDES

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	LCS/LCSD Batch Number
099-12-452-275	Solid	Mercury	03/07/12	03/07/12	120307L01E

Parameter	SPIKE ADDED	LCS %REC	LCSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Mercury	0.8350	100	100	82-124	0	0-16	

Calscience Environmental Laboratories, Inc.

Quality Control - LCS/LCS Duplicate

Marine Research Consultants, Inc.
1039 Waakaua Pl.
Honolulu, HI 96822-1173

Date Received: N/A
Work Order No: 12-02-1625
Preparation: EPA 8151A
Method: EPA 8151A

Project: C KAHO SEDIMENT PESTICIDES

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	LCS/LCSD Batch Number
095-01-033-992	Solid	GC 40	03/07/12	03/09/12	120307L02

Parameter	SPIKE ADDED	LCS %REC	LCSD %REC	%REC CL	RPD	RPD CL	Qualifiers
2,4-D	0.4000	81	63	30-130	25	0-30	
2,4,5-T	0.04000	81	71	30-130	12	0-30	
2,4-DB	0.4000	37	31	30-130	17	0-30	

Calscience Environmental Laboratories, Inc.

Quality Control - LCS/LCS Duplicate

Marine Research Consultants, Inc.
1039 Waakaua Pl.
Honolulu, HI 96822-1173

Date Received: N/A
Work Order No: 12-02-1625
Preparation: EPA 3545
Method: EPA 8081A

Project: C KAHO SEDIMENT PESTICIDES

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	LCS/LCSD Batch Number
099-12-858-129	Solid	GC 51	03/01/12	03/06/12	120301L05

Parameter	SPIKE ADDED	LCS %REC	LCSD %REC	%REC CL	ME CL	RPD	RPD CL	Qualifiers
Aldrin	5.000	91	89	50-135	36-149	2	0-25	
Alpha-BHC	5.000	93	87	50-135	36-149	7	0-25	
Beta-BHC	5.000	93	94	50-135	36-149	0	0-25	
Delta-BHC	5.000	94	84	50-135	36-149	11	0-25	
Gamma-BHC	5.000	96	90	50-135	36-149	7	0-25	
Dieldrin	5.000	93	91	50-135	36-149	3	0-25	
4,4'-DDD	5.000	95	93	50-135	36-149	2	0-25	
4,4'-DDE	5.000	95	93	50-135	36-149	2	0-25	
4,4'-DDT	5.000	88	83	50-135	36-149	6	0-25	
Endosulfan I	5.000	91	89	50-135	36-149	2	0-25	
Endosulfan II	5.000	90	88	50-135	36-149	2	0-25	
Endosulfan Sulfate	5.000	89	86	50-135	36-149	4	0-25	
Endrin	5.000	96	87	50-135	36-149	10	0-25	
Endrin Aldehyde	5.000	88	88	50-135	36-149	0	0-25	
Endrin Ketone	5.000	94	93	50-135	36-149	1	0-25	
Heptachlor	5.000	93	85	50-135	36-149	9	0-25	
Heptachlor Epoxide	5.000	89	87	50-135	36-149	2	0-25	
Methoxychlor	5.000	87	83	50-135	36-149	5	0-25	
Alpha Chlordane	5.000	92	90	50-135	36-149	3	0-25	
Gamma Chlordane	5.000	93	91	50-135	36-149	3	0-25	

Total number of LCS compounds : 20
Total number of ME compounds : 0
Total number of ME compounds allowed : 1
LCS ME CL validation result : Pass

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - LCS/LCS Duplicate

Marine Research Consultants, Inc.
1039 Waakaua Pl.
Honolulu, HI 96822-1173

Date Received: N/A
Work Order No: 12-02-1625
Preparation: EPA 3545
Method: EPA 8141B

Project: C KAHO SEDIMENT PESTICIDES

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	LCS/LCSD Batch Number
099-12-465-110	Solid	GC 35	02/29/12	03/02/12	120229L12

Parameter	SPIKE ADDED	LCS %REC	LCSD %REC	%REC CL	ME CL	RPD	RPD CL	Qualifiers
Azinphos Methyl	4.000	68	74	30-130	13-147	8	0-30	
Bolstar	4.000	75	78	30-130	13-147	4	0-30	
Chlorpyrifos	4.000	67	69	30-130	13-147	3	0-30	
Coumaphos	4.000	72	77	30-130	13-147	7	0-30	
Diazinon	4.000	71	72	30-130	13-147	2	0-30	
Disulfoton	4.000	72	73	30-130	13-147	1	0-30	
Ethoprop	4.000	75	76	30-130	13-147	2	0-30	
Fensulfothion	4.000	73	77	30-130	13-147	6	0-30	
Fenthion	4.000	70	72	30-130	13-147	3	0-30	
Merphos	4.000	72	75	30-130	13-147	4	0-30	
Methyl Parathion	4.000	68	70	30-130	13-147	3	0-30	
Phorate	4.000	77	79	30-130	13-147	2	0-30	
Ronnel	4.000	66	68	30-130	13-147	3	0-30	
Stirophos	4.000	60	63	30-130	13-147	5	0-30	
Tokuthion	4.000	68	72	30-130	13-147	5	0-30	
Trichloronate	4.000	68	71	30-130	13-147	4	0-30	

Total number of LCS compounds : 16
Total number of ME compounds : 0
Total number of ME compounds allowed : 1
LCS ME CL validation result : Pass

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - LCS/LCS Duplicate

Marine Research Consultants, Inc.		Date Received:	N/A
1039 Waakaua Pl.		Work Order No:	12-02-1625
Honolulu, HI 96822-1173		Preparation:	EPA 3545
		Method:	EPA 8270C SIM

Project: C KAHO SEDIMENT PESTICIDES

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	LCS/LCSD Batch Number
099-12-413-362	**Solid**	**GC/MS MM**	**03/01/12**	**03/06/12**	**120301L08**

Parameter	SPIKE ADDED	LCS %REC	LCSD %REC	%REC CL	ME CL	RPD	RPD CL	Qualifiers
2,4,6-Trichlorophenol	1.000	60	58	40-160	20-180	3	0-20	
2,4-Dichlorophenol	1.000	65	64	40-160	20-180	1	0-20	
2-Methylphenol	1.000	52	53	40-160	20-180	2	0-20	
2-Nitrophenol	1.000	53	51	40-160	20-180	3	0-20	
4-Chloro-3-Methylphenol	1.000	63	62	40-160	20-180	1	0-20	
Acenaphthene	1.000	58	57	48-108	38-118	3	0-11	
Benzo (a) Pyrene	1.000	61	58	17-163	0-187	5	0-20	
Chrysene	1.000	56	54	17-168	0-193	5	0-20	
Di-n-Butyl Phthalate	1.000	63	60	40-160	20-180	4	0-20	
Dimethyl Phthalate	1.000	62	60	40-160	20-180	4	0-20	
Fluoranthene	1.000	61	59	26-137	8-156	4	0-20	
Fluorene	1.000	58	58	59-121	49-131	1	0-20	ME
Naphthalene	1.000	62	61	21-133	2-152	1	0-20	
Phenanthrene	1.000	59	57	54-120	43-131	3	0-20	
Phenol	1.000	53	53	40-160	20-180	1	0-20	
Pyrene	1.000	53	51	28-106	15-119	4	0-16	

Total number of LCS compounds : 16
Total number of ME compounds : 1
Total number of ME compounds allowed : 1
LCS ME CL validation result : Pass

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Glossary of Terms and Qualifiers

Work Order Number: 12-02-1625

Qualifier	Definition
*	See applicable analysis comment.
<	Less than the indicated value.
>	Greater than the indicated value.
1	Surrogate compound recovery was out of control due to a required sample dilution. Therefore, the sample data was reported without further clarification.
2	Surrogate compound recovery was out of control due to matrix interference. The associated method blank surrogate spike compound was in control and, therefore, the sample data was reported without further clarification.
3	Recovery of the Matrix Spike (MS) or Matrix Spike Duplicate (MSD) compound was out of control due to matrix interference. The associated LCS and/or LCSD was in control and, therefore, the sample data was reported without further clarification.
4	The MS/MSD RPD was out of control due to matrix interference. The LCS/LCSD RPD was in control and, therefore, the sample data was reported without further clarification.
5	The PDS/PDSD or PES/PESD associated with this batch of samples was out of control due to a matrix interference effect. The associated batch LCS/LCSD was in control and, hence, the associated sample data was reported without further clarification.
6	Surrogate recovery below the acceptance limit.
7	Surrogate recovery above the acceptance limit.
B	Analyte was present in the associated method blank.
BU	Sample analyzed after holding time expired.
E	Concentration exceeds the calibration range.
ET	Sample was extracted past end of recommended max. holding time.
HD	The chromatographic pattern was inconsistent with the profile of the reference fuel standard.
HDH	The sample chromatographic pattern for TPH matches the chromatographic pattern of the specified standard but heavier hydrocarbons were also present (or detected).
HDL	The sample chromatographic pattern for TPH matches the chromatographic pattern of the specified standard but lighter hydrocarbons were also present (or detected).
J	Analyte was detected at a concentration below the reporting limit and above the laboratory method detection limit. Reported value is estimated.
ME	LCS/LCSD Recovery Percentage is within Marginal Exceedance (ME) Control Limit range.
ND	Parameter not detected at the indicated reporting limit.
Q	Spike recovery and RPD control limits do not apply resulting from the parameter concentration in the sample exceeding the spike concentration by a factor of four or greater.
SG	The sample extract was subjected to Silica Gel treatment prior to analysis.
X	% Recovery and/or RPD out-of-range.
Z	Analyte presence was not confirmed by second column or GC/MS analysis.

Solid - Unless otherwise indicated, solid sample data is reported on a wet weight basis, not corrected for % moisture. All QC results are reported on a wet weight basis.
MPN - Most Probable Number

TR25

FedEx. USA Airbill Express

FedEx Tracking Number 8431 3189 3749

0215

1 From
Date 2/27/12
Sender's Name STEVEN DOLLAR
Phone 808 988-5009
Company STEVEN DOLLAR
Address 1039 WAAKAUA PL
City HONOLULU State HI ZIP 96822-1173

2 Your Internal Billing Reference

3 To
Recipient's Name CALSCIENCES
Phone 714 895-5494
Company ENVIRONMENTAL LABS
Address 7440 LINCOLN WAY
City GARDEN GROVE State CA ZIP 92841-1427

4a Express Package Service: FedEx Priority Overnight [X]
5 Packaging: FedEx Pak
6 Special Handling: No [X]
7 Payment: Sender [X]

8431 3189 3749

447

CHAIN OF CUSTODY

MARINE RESEARCH CONSULTANTS
1039 WAAKAUA PL. HON. HI 96822

SUBMITTED TO:

Calsciences Environmental Labs
7440 Lincoln Way
Garden Grove CA 92841-1427
714 895-5494

12-02-1625

PROJECT: C KAHO SEDIMENT PESTICIDES

	SAMPLE ID	DATE	TIME	SAMPLE TYPE	# OF CONTAINERS	REQUESTED ANALYSES FOR ALL SAMPLES	PRESERVE
1	KAHO 1	2/23/12	10:22	12 OZ GRAB	1	8081, 8141, 8151, 8270 (PAH) METALS	chill
2	KAHO 2	2/13/2012	12:36	"	1		"
3	KAHO 3	2/23/2012	13:42	"	1		"

SAMPLED BY:	RELINQUISHED BY:	RECEIVED BY:
Steven Dollar 2/23/12	Steven Dollar 2/27/12	[signature]
PRINT DATE	PRINT DATE	PRINT DATE
[signature]	[signature] 11:00	3. PATEL 2/28/12
SIGNATURE TIME	SIGNATURE TIME	SIGNATURE TIME 1000

PLEASE RETURN SIGNED CHAIN OF CUSTODY FORM IN ENCLOSED ENVELOPE.
SAMPLE RESULTS DUE BY:

Calscience Environmental Laboratories, Inc.

WORK ORDER #: 12-02-1625

SAMPLE RECEIPT FORM

Cooler 1 of 1

CLIENT: Marine Research

DATE: 02/28/12

TEMPERATURE: Thermometer ID: SC3 (Criteria: 0.0 °C – 6.0 °C, not frozen)

Temperature 5.8 °C - 0.3 °C (CF) = 5.5 °C ☐ Blank ☑ Sample

☐ Sample(s) outside temperature criteria (PM/APM contacted by: ______).

☐ Sample(s) outside temperature criteria but received on ice/chilled on same day of sampling.

☐ **Received at ambient temperature, placed on ice for transport by Courier.**

Ambient Temperature: ☐ Air ☐ Filter Initial: JP

CUSTODY SEALS INTACT:

☐ Cooler ☐ ______ ☐ No (Not Intact) ☑ Not Present ☐ N/A Initial: JP

☐ Sample ☐ ______ ☐ No (Not Intact) ☑ Not Present Initial: NS

SAMPLE CONDITION:	Yes	No	N/A
Chain-Of-Custody (COC) document(s) received with samples	☑	☐	☐
COC document(s) received complete	☑	☐	☐
☐ Collection date/time, matrix, and/or # of containers logged in based on sample labels.			
☐ No analysis requested. ☐ Not relinquished. ☐ No date/time relinquished.			
Sampler's name indicated on COC	☑	☐	☐
Sample container label(s) consistent with COC	☑	☐	☐
Sample container(s) intact and good condition	☑	☐	☐
Proper containers and sufficient volume for analyses requested	☑	☐	☐
Analyses received within holding time	☑	☐	☐
pH / Res. Chlorine / Diss. Sulfide / Diss. Oxygen received within 24 hours	☐	☐	☑
Proper preservation noted on COC or sample container	☐	☐	☑
☐ Unpreserved vials received for Volatiles analysis			
Volatile analysis container(s) free of headspace	☐	☐	☑
Tedlar bag(s) free of condensation	☐	☐	☑

CONTAINER TYPE:

Solid: ☐4ozCGJ ☐8ozCGJ ☐16ozCGJ ☐Sleeve (____) ☐EnCores® ☐TerraCores® ☑500CGJ

Water: ☐VOA ☐VOAh ☐VOAna$_2$ ☐125AGB ☐125AGBh ☐125AGBp ☐1AGB ☐1AGBna$_2$ ☐1AGBs ☐500AGB ☐500AGJ ☐500AGJs ☐250AGB ☐250CGB ☐250CGBs ☐1PB ☐1PBna ☐500PB ☐250PB ☐250PBn ☐125PB ☐125PBznna ☐100PJ ☐100PJna$_2$ ☐______ ☐______ ☐______

Air: ☐Tedlar® ☐Summa® **Other:** ☐______ **Trip Blank Lot#:** ______ **Labeled/Checked by:** NS

Container: C: Clear A: Amber P: Plastic G: Glass J: Jar B: Bottle Z: Ziploc/Resealable Bag E: Envelope **Reviewed by:** JP

Preservative: h: HCL n: HNO_3 na$_2$: $Na_2S_2O_3$ na: NaOH p: H_3PO_4 s: H_2SO_4 u: Ultra-pure znna: $ZnAc_2$+NaOH f: Filtered **Scanned by:** JP

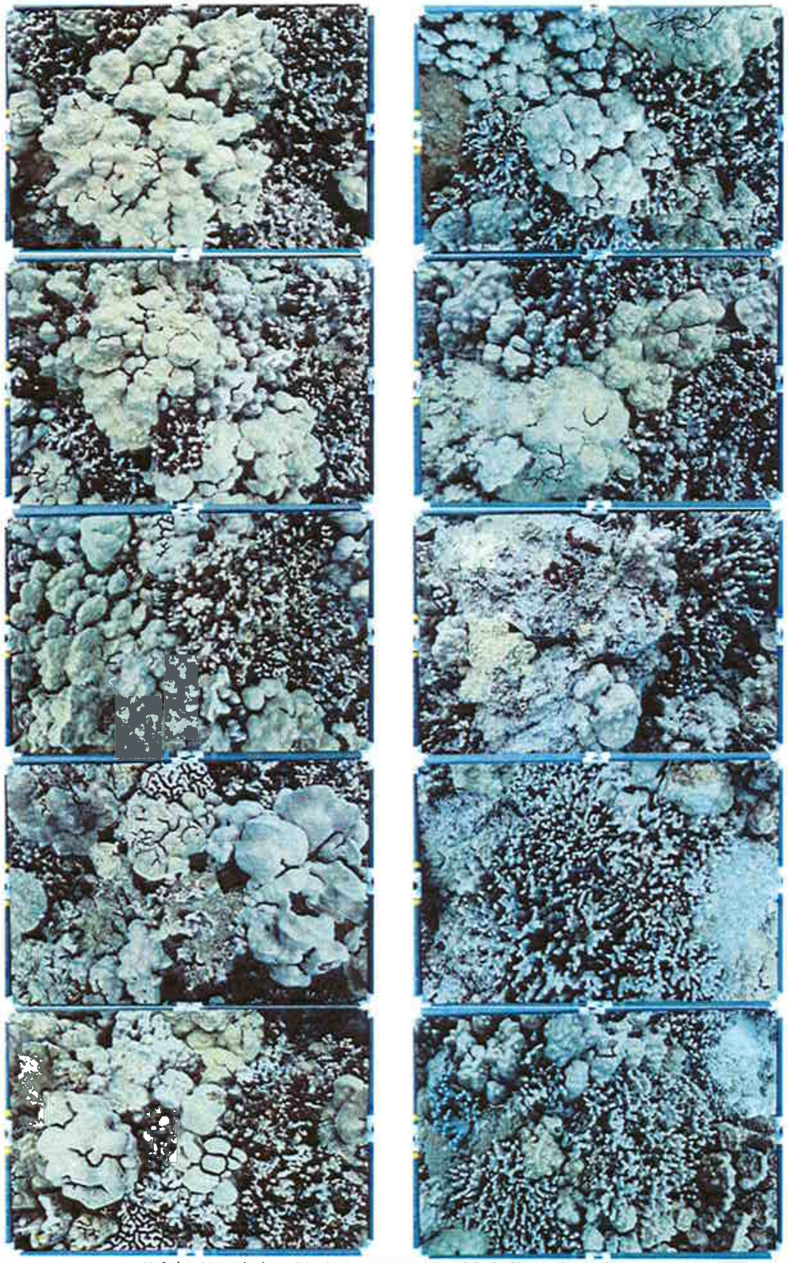
SOP T100_090 (12/06/11)

APPENDIX B.

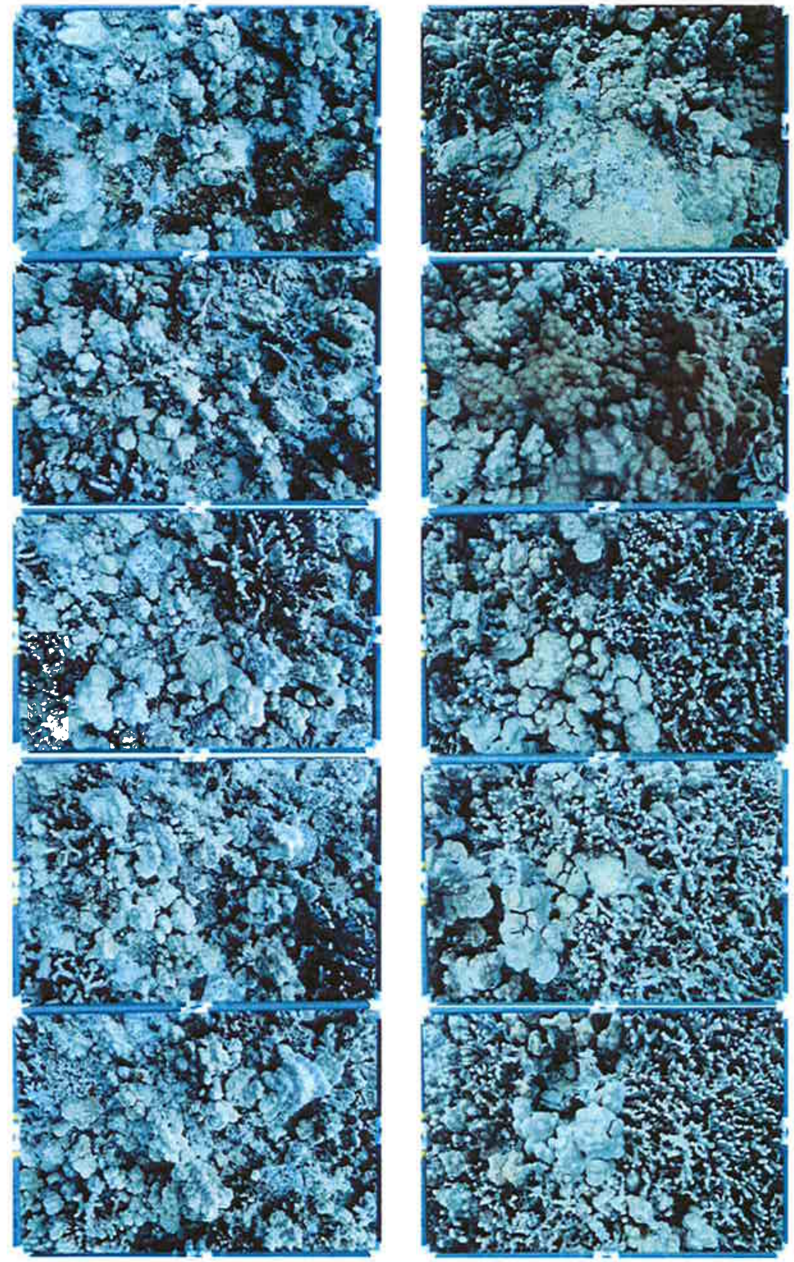
Calibration-Validation Photographs

Kaloko-Honokohau

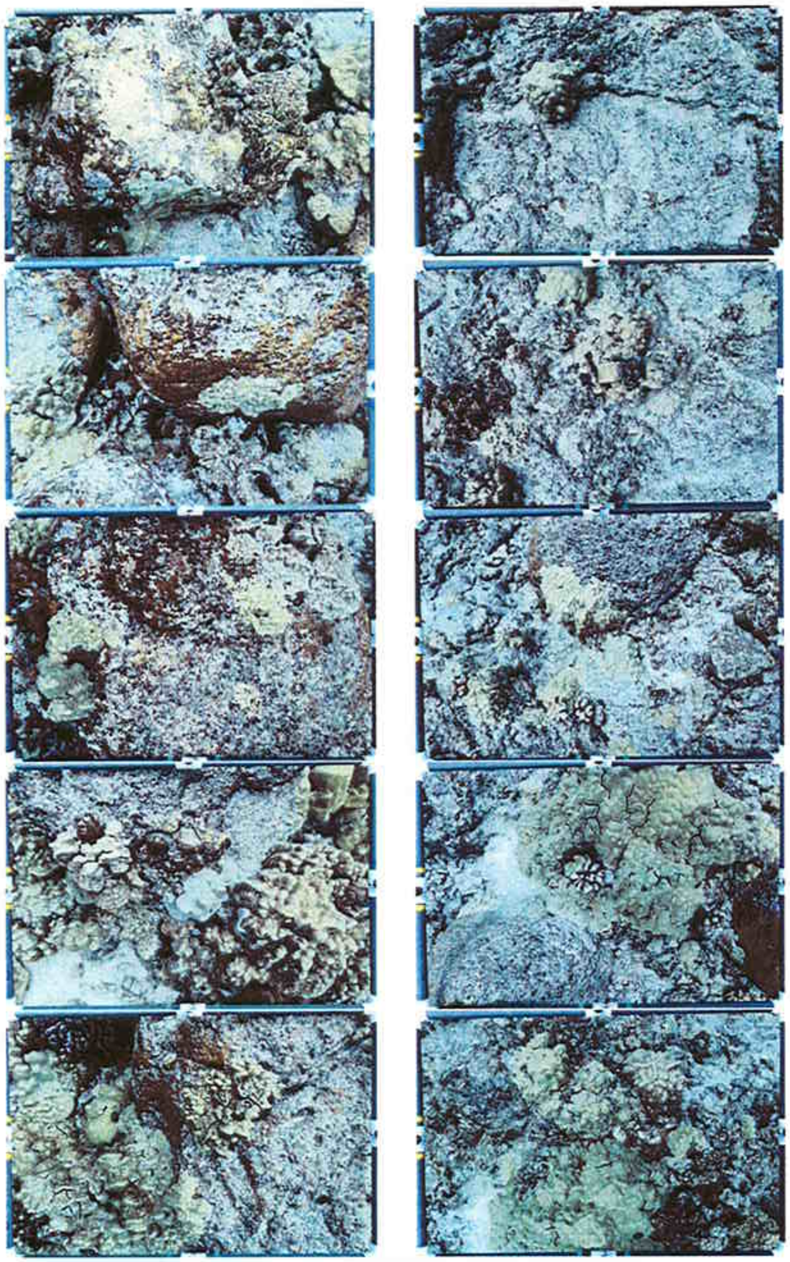
March 2012



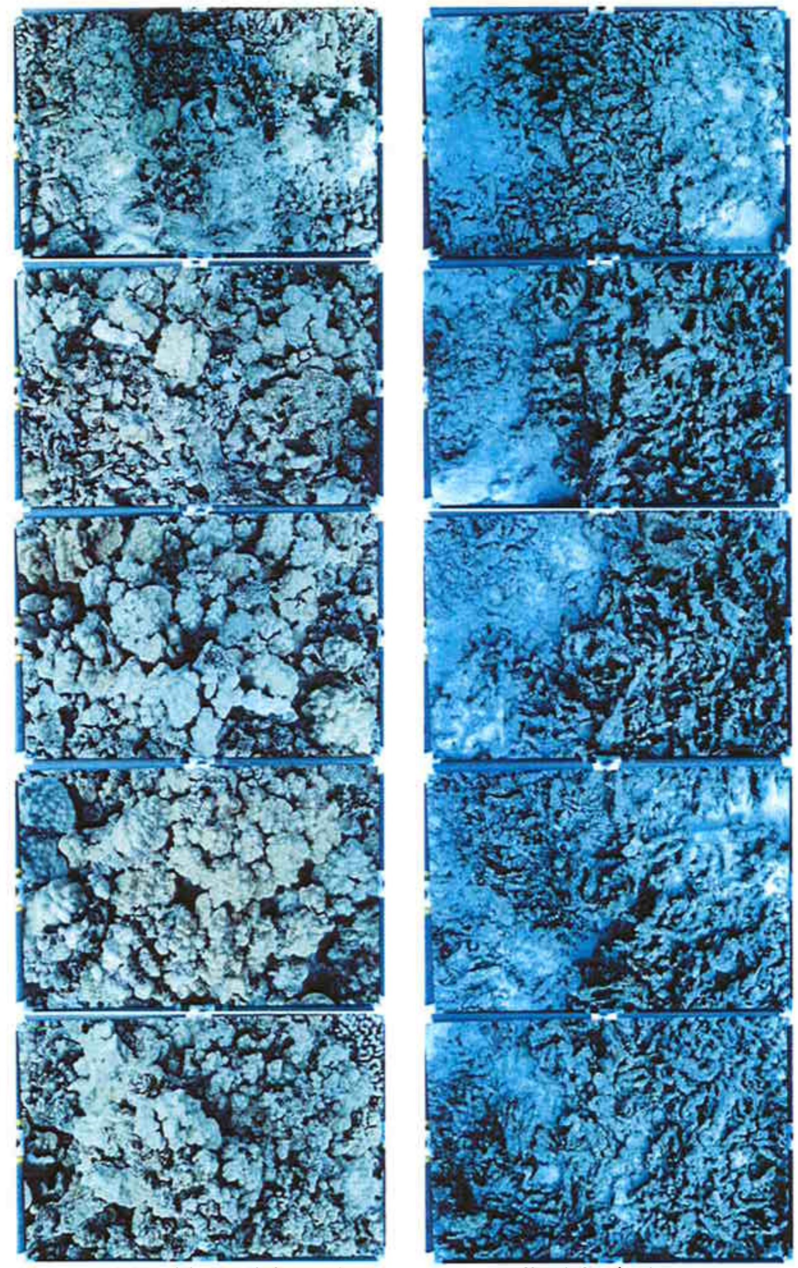
Kaloko-Honokohau Marine Assessment – 2012, Sites 104 and 105



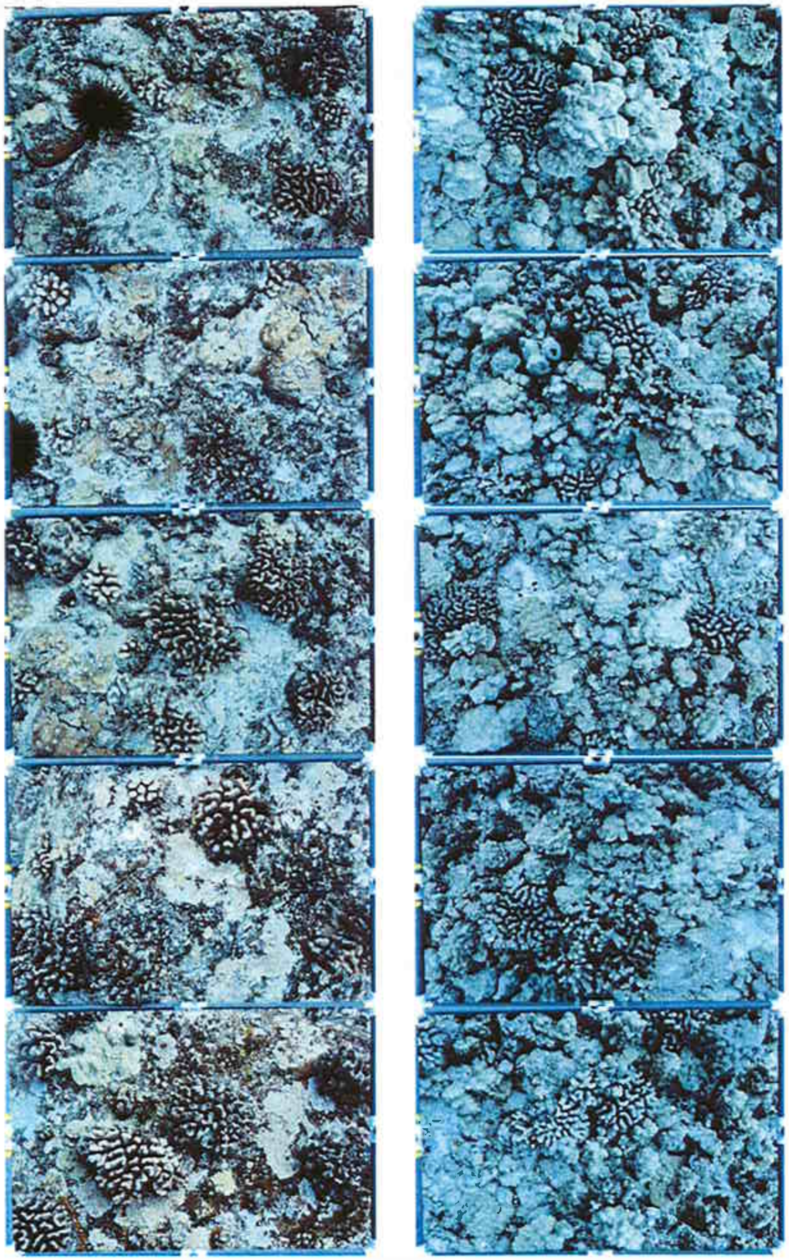
Kaloko-Honokohau Marine Assessment – 2012, Sites 106 and 107



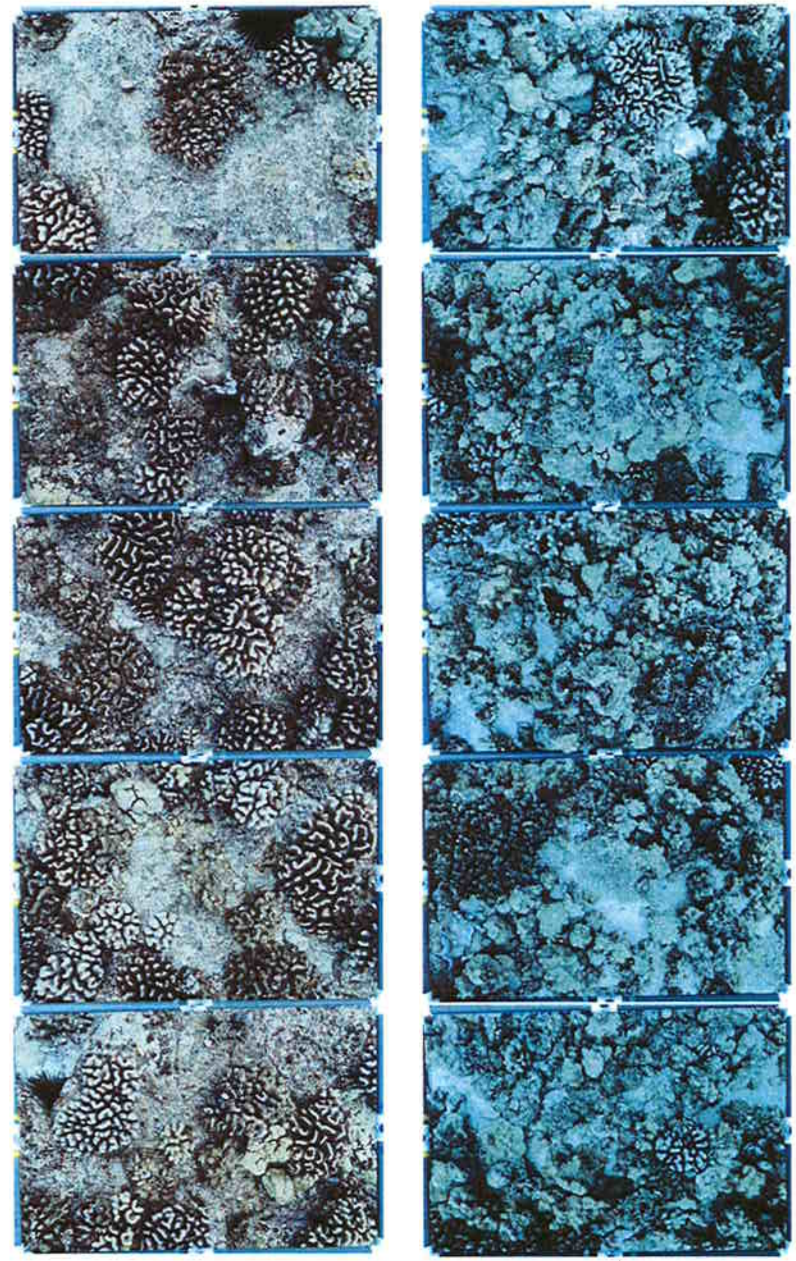
Kaloko-Honokohau Marine Assessment – 2012, Sites 108 and 109



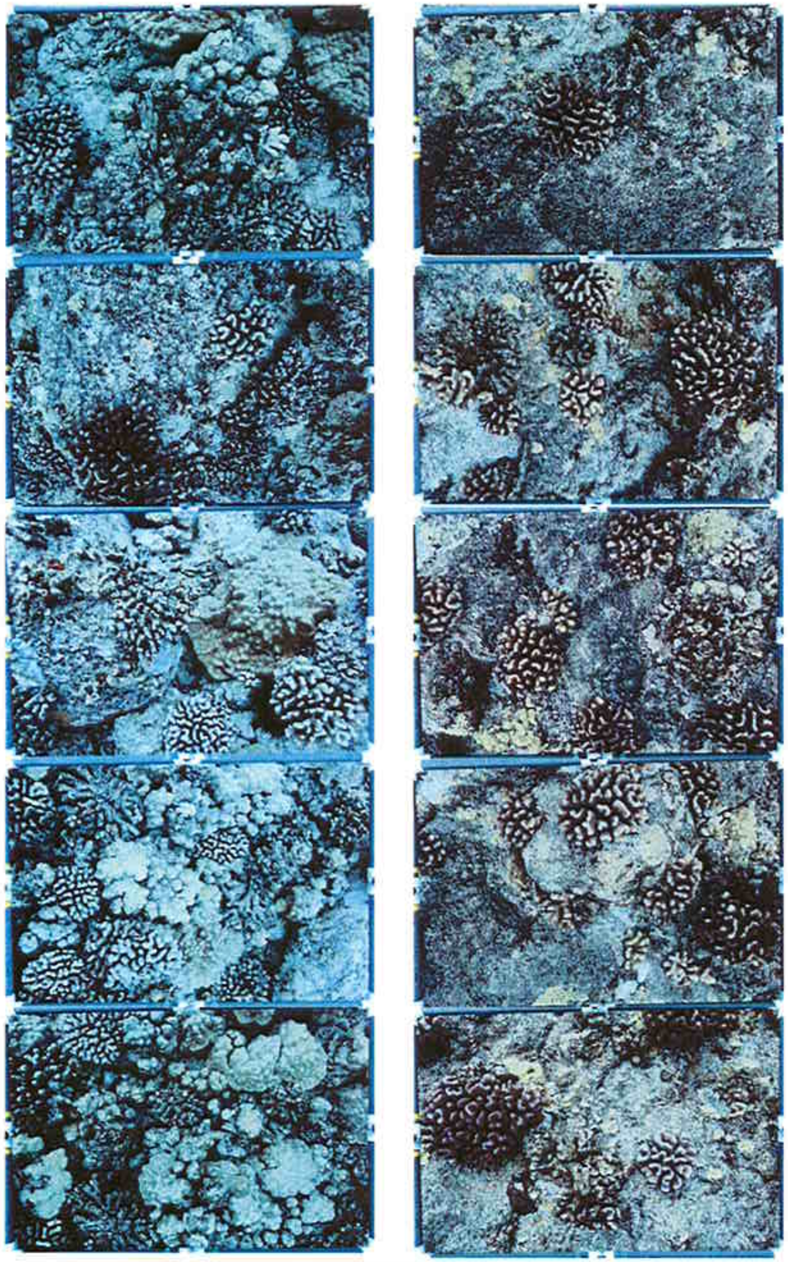
Kaloko-Honokohau Marine Assessment – 2012, Sites 110 and 111



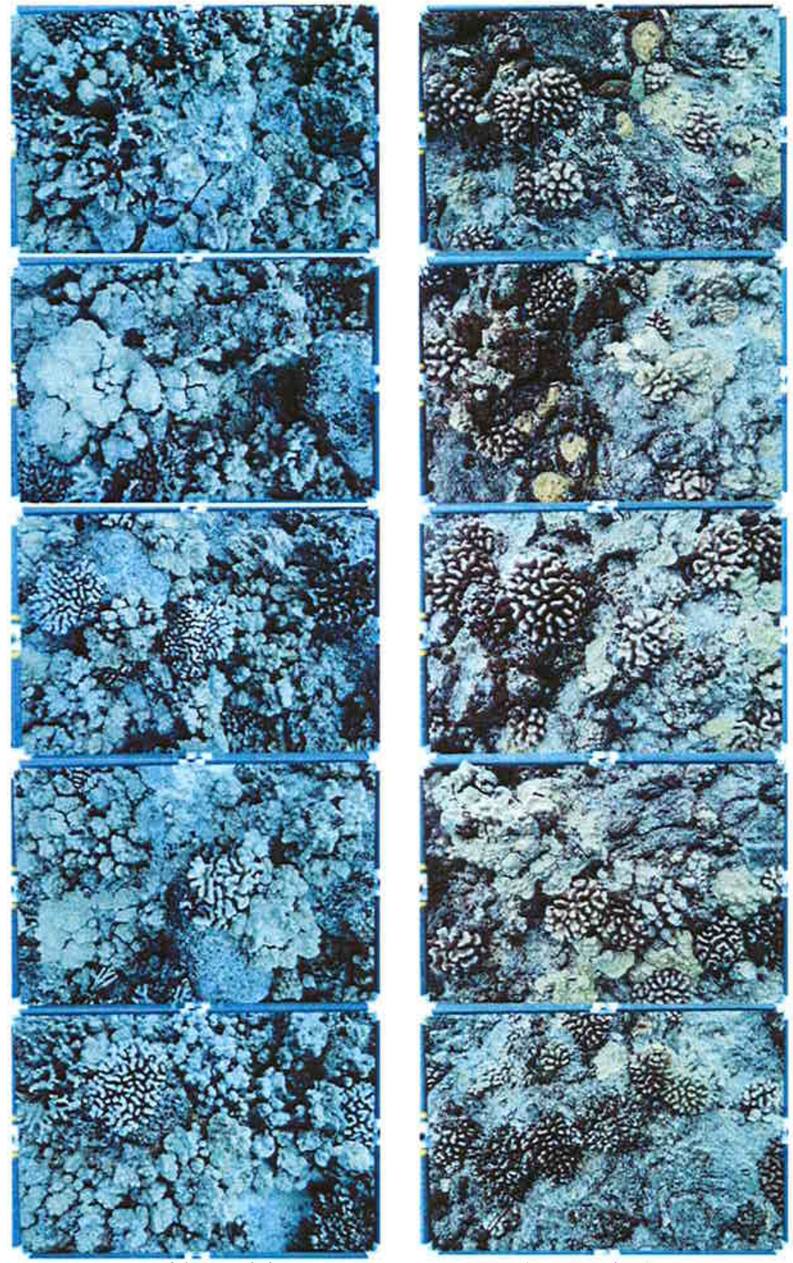
Kaloko-Honokohau Marine Assessment – 2012, Sites 112 and 113



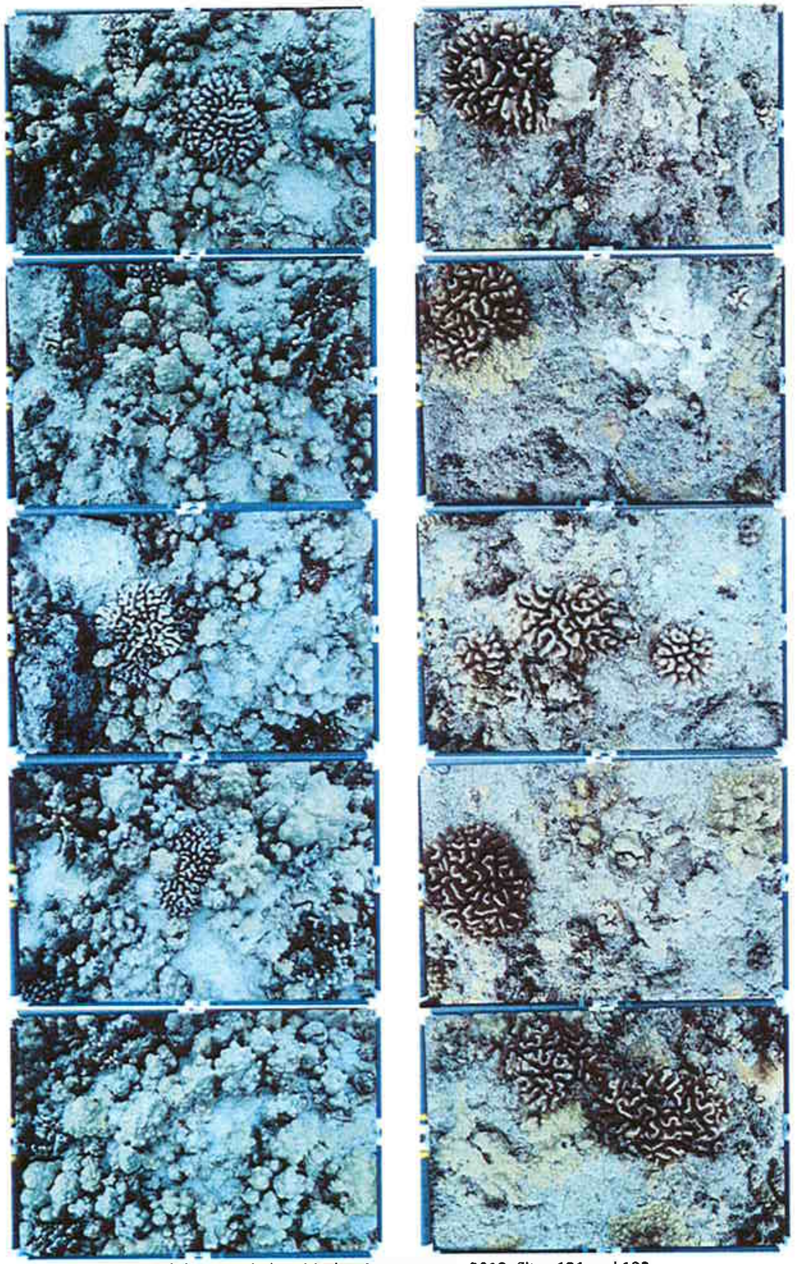
Kaloko-Honokohau Marine Assessment – 2012, Sites 114 and 115



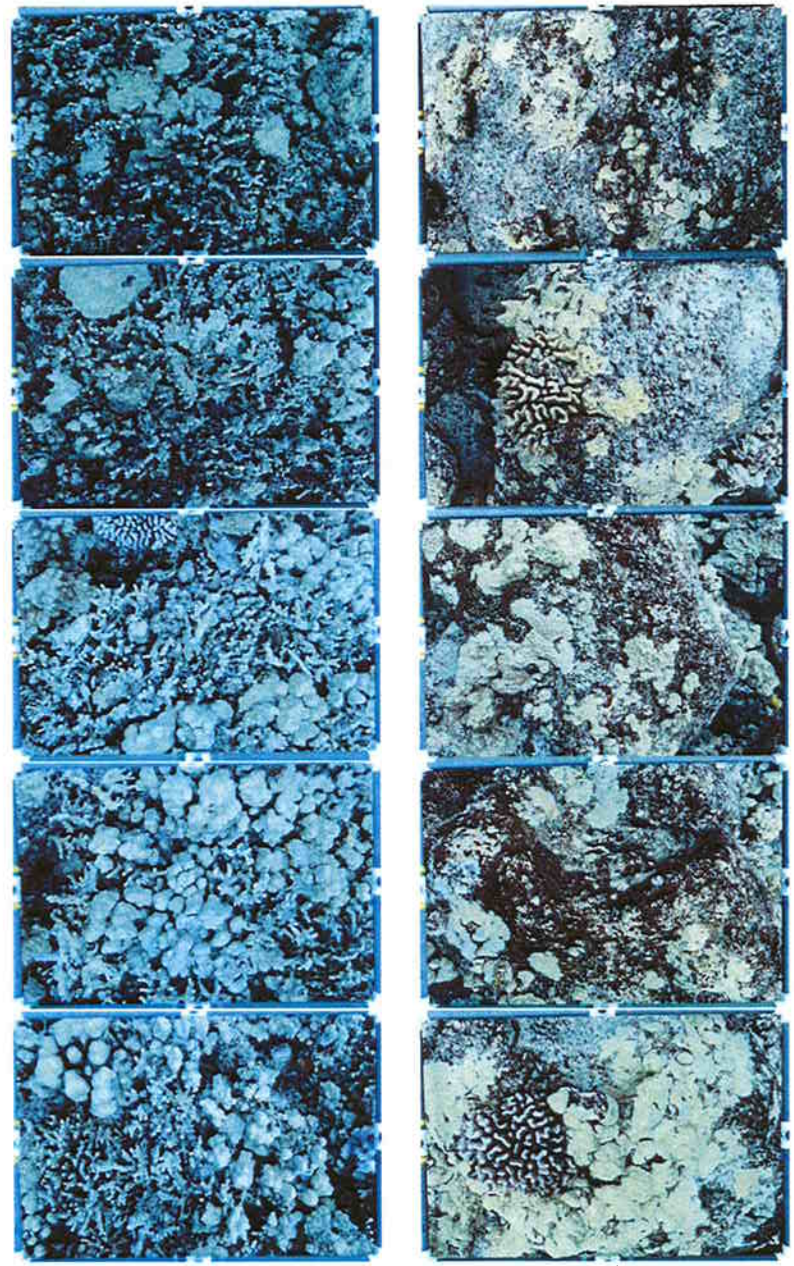
Kaloko-Honokohau Marine Assessment – 2012, Sites 117 and 118



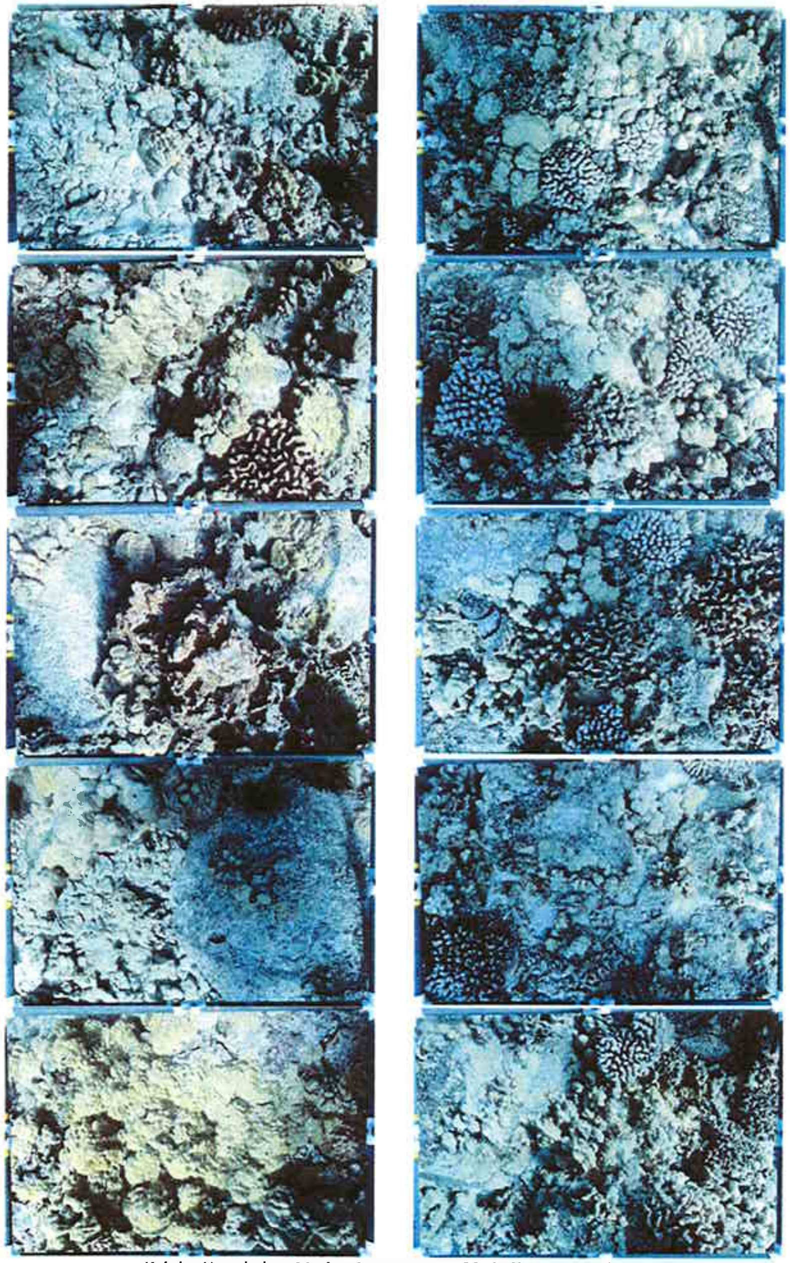
Kaloko-Honokohau Marine Assessment – 2012, Sites 119 and 120



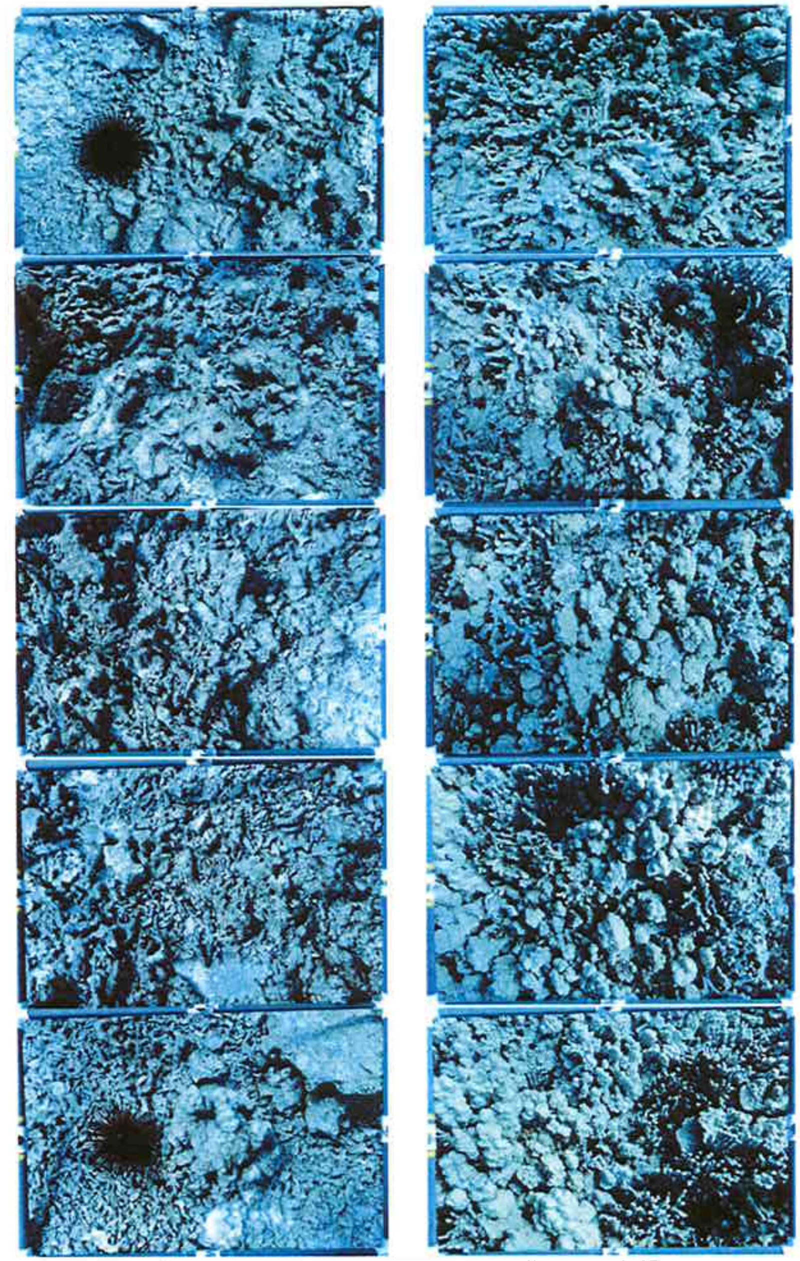
Kaloko-Honokohau Marine Assessment – 2012, Sites 121 and 122



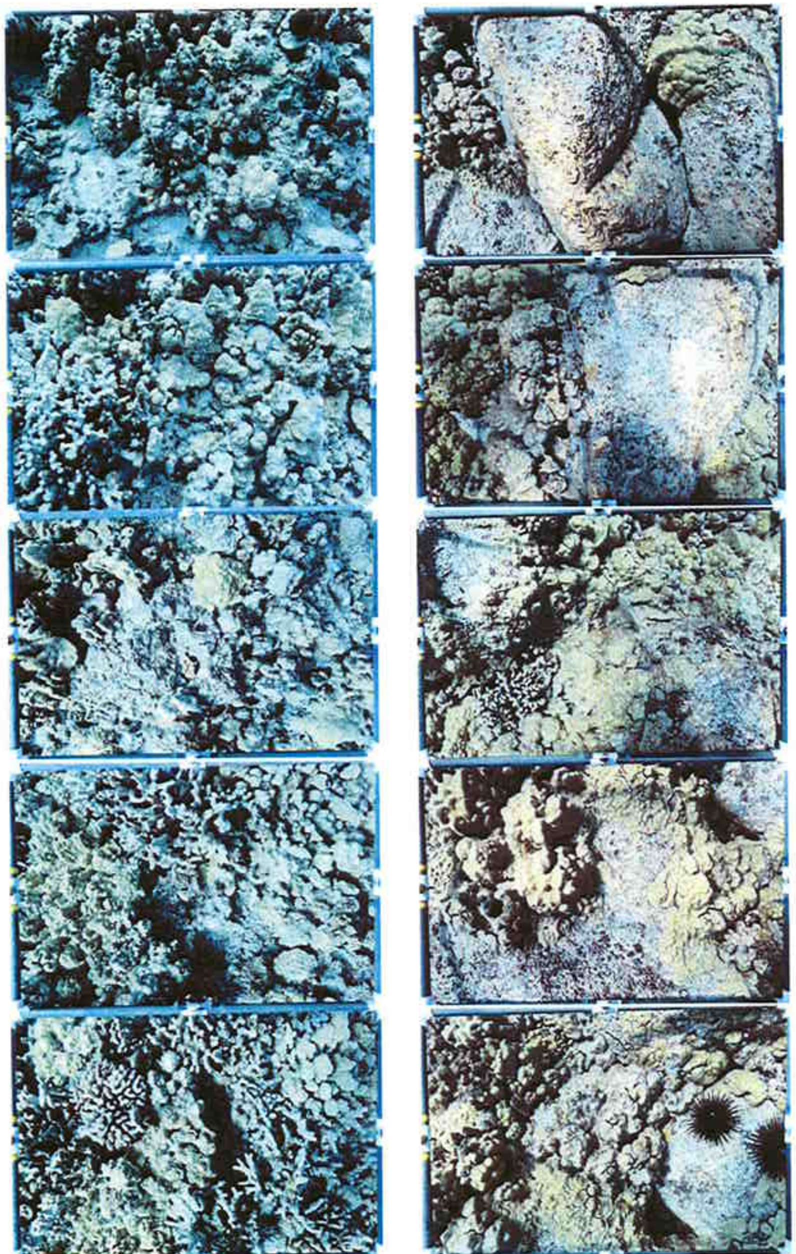
Kaloko-Honokohau Marine Assessment – 2012, Sites 125 and 126



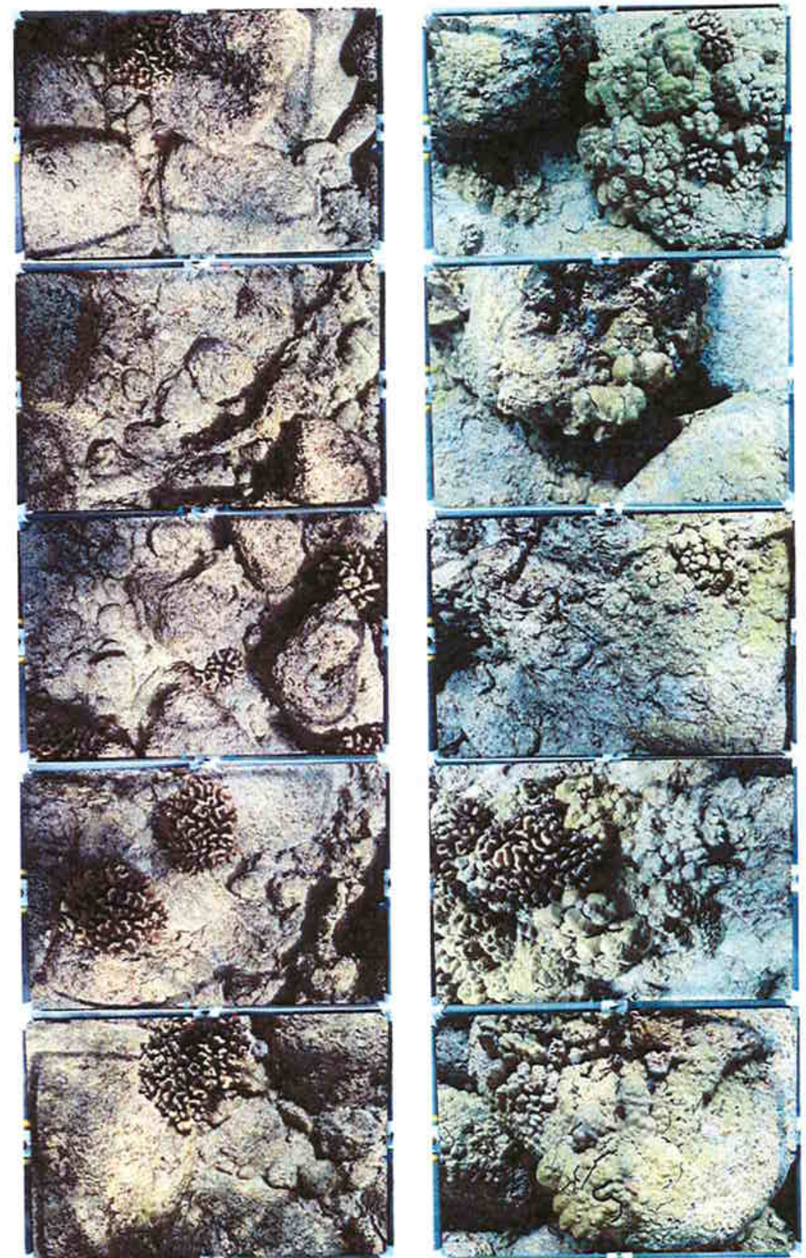
Kaloko-Honokohau Marine Assessment – 2012, Sites 133 and 134



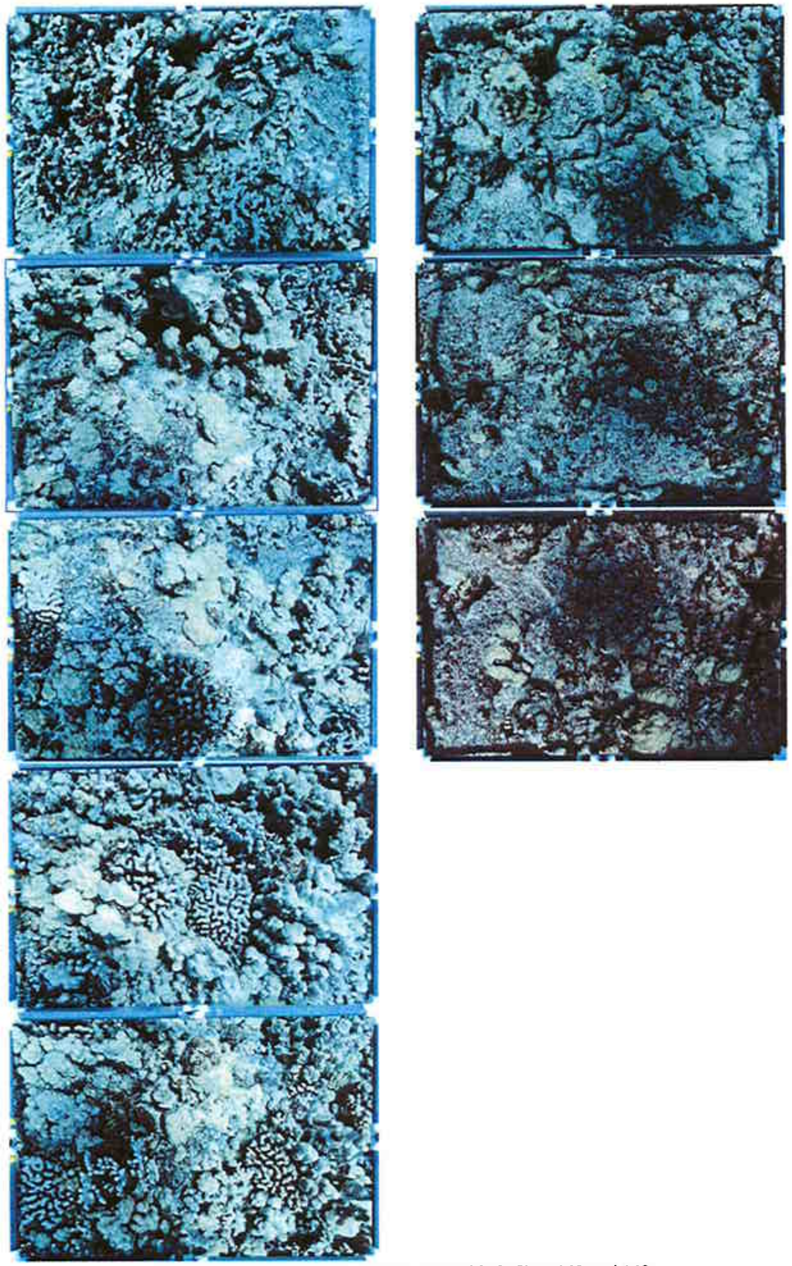
Kaloko-Honokohau Marine Assessment – 2012, Sites 135 and 137



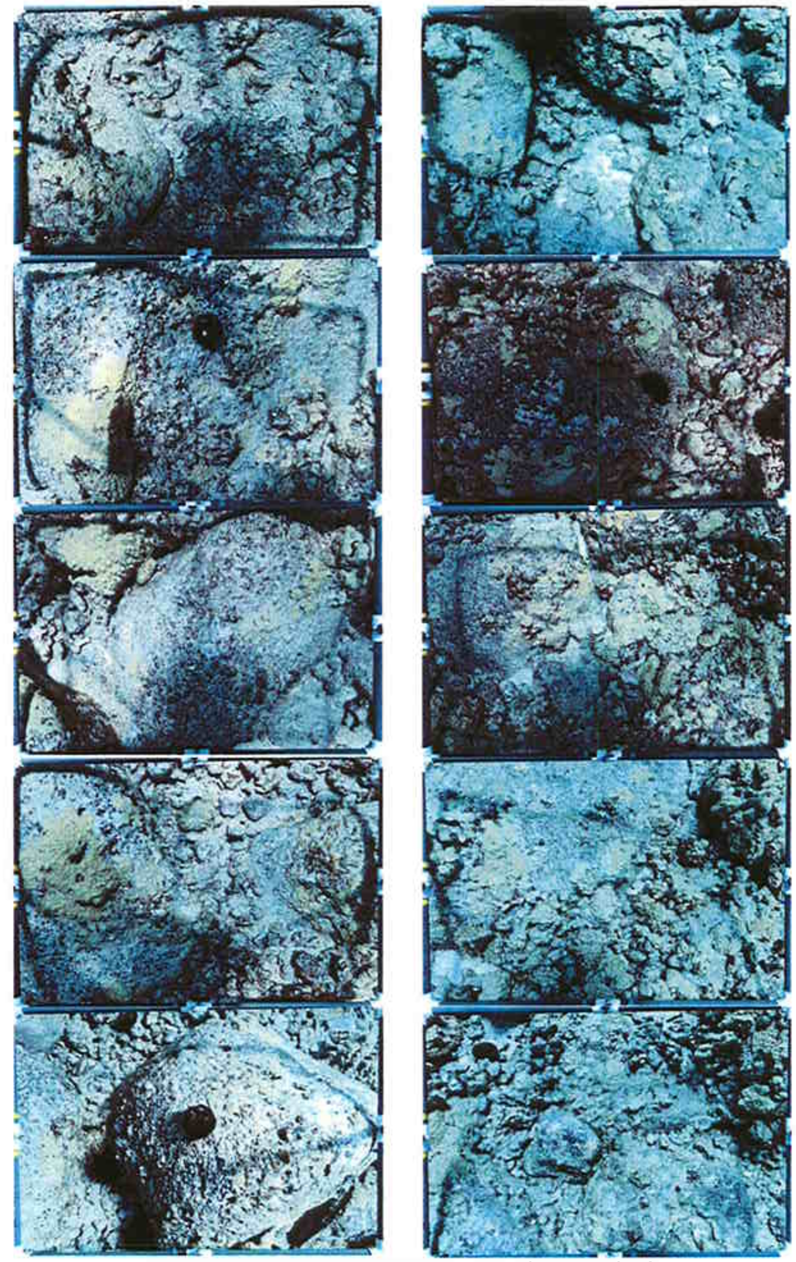
Kaloko-Honokohau Marine Assessment – 2012, Sites 138 and 139



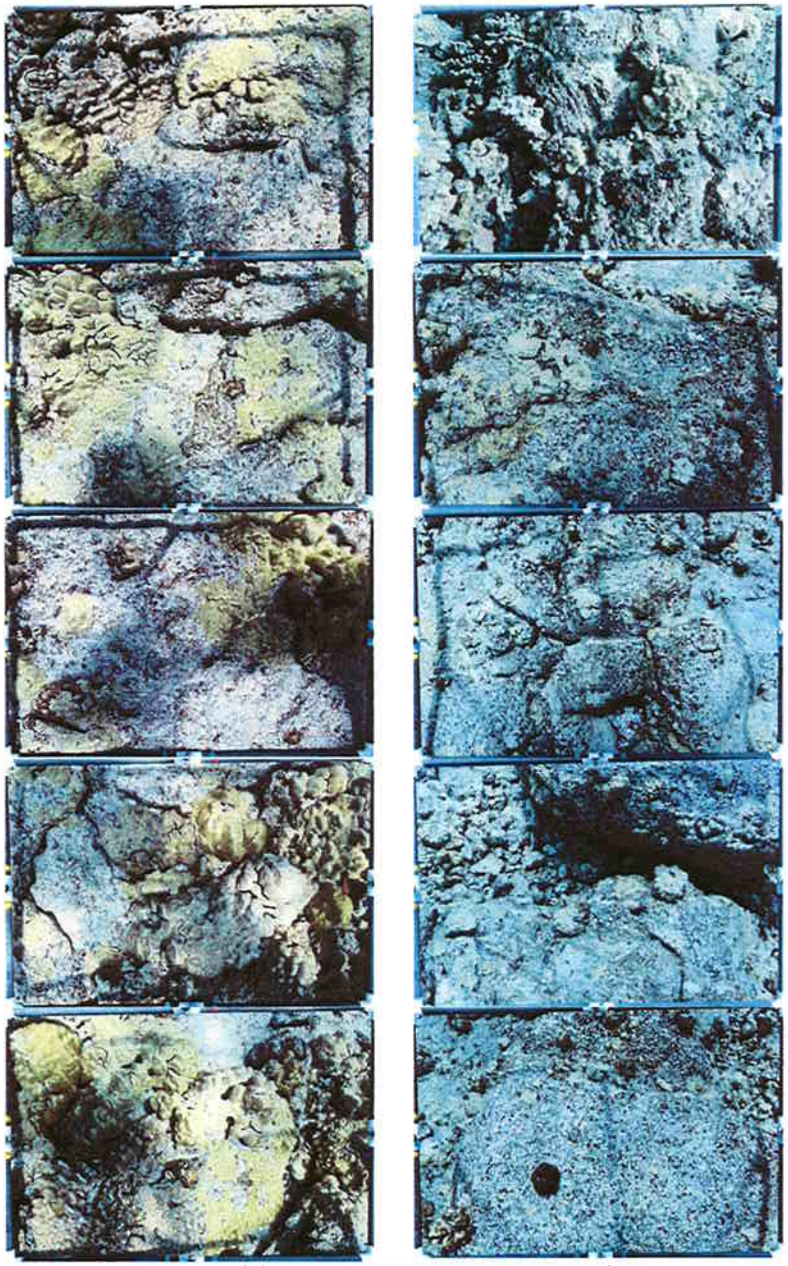
Kaloko-Honokohau Marine Assessment – 2012, Sites 140 and 141



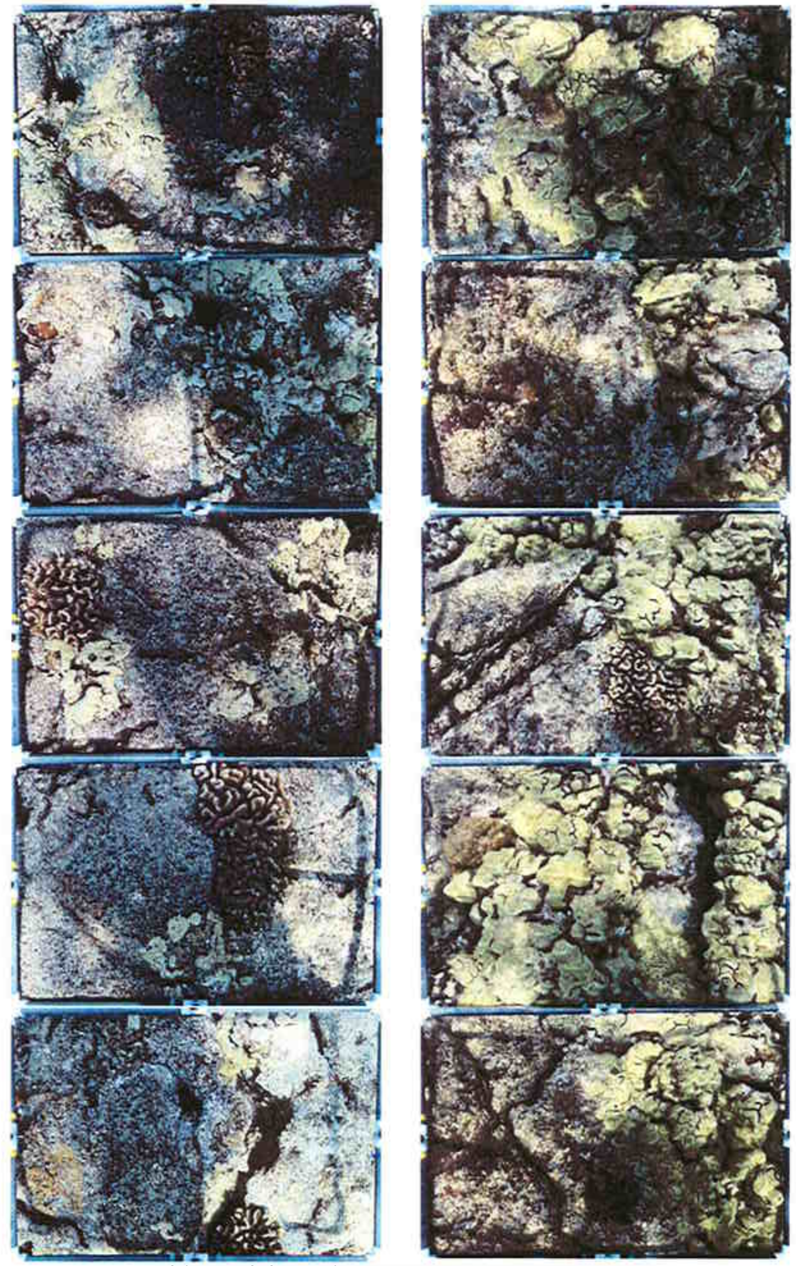
Kaloko-Honokohau Marine Assessment – 2012, Sites 142 and 143



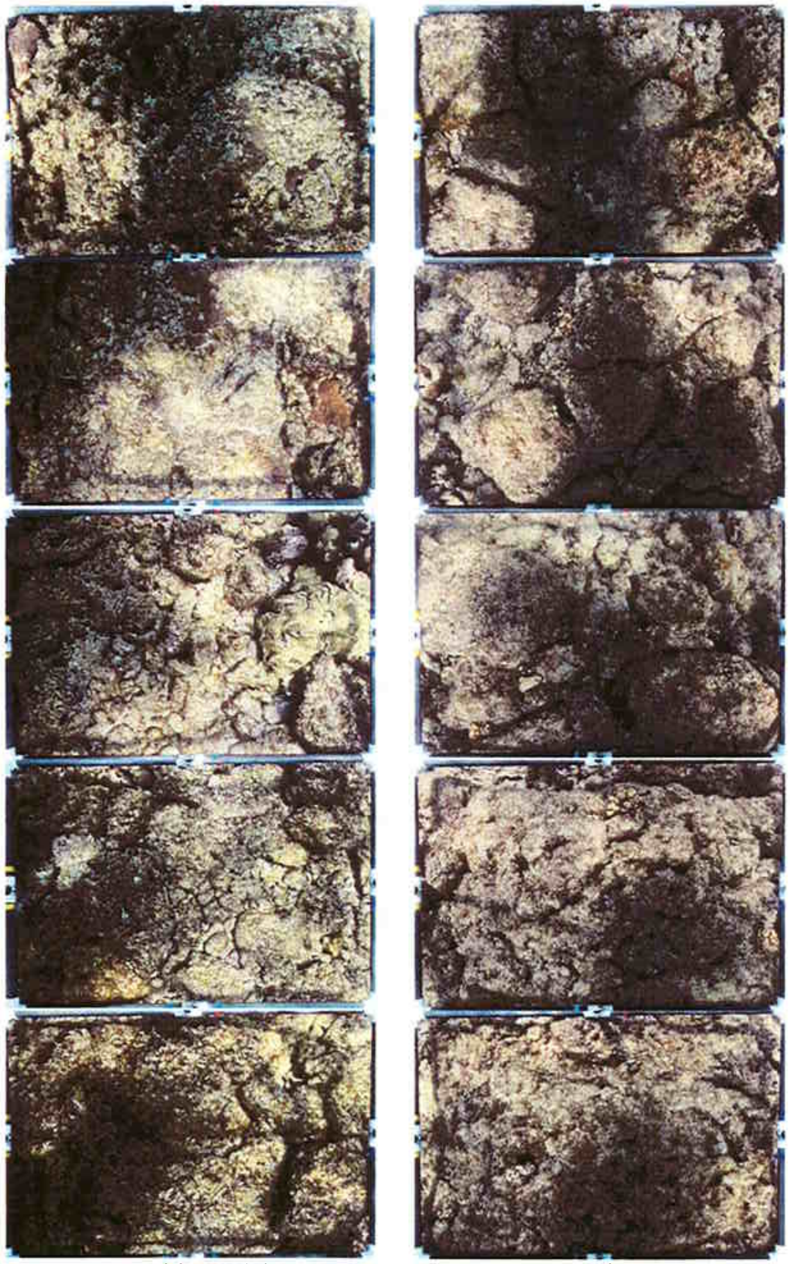
Kaloko-Honokohau Marine Assessment – 2012, Sites 144 and 146



Kaloko-Honokohau Marine Assessment – 2012, Sites 147 and 148



Kaloko-Honokohau Marine Assessment – 2012, Sites 149 and 150



Kaloko-Honokohau Marine Assessment – 2012, Sites 151 and 152

Kaloko-Honokohau Marine Assessment – 2012, Site 154