Marine biological and water quality surveys for Hanapepe Loop drainage outfall improvements, Maunalua Bay, Honolulu, O‘ahu, Hawai‘i[1]

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Stacey Kilarski
AECOS, Inc.
45-939 Kamehameha Hwy, Suite 104
Kāne‘ohe, Hawai‘i 96744
Phone: (808) 234-7770 Fax: (808) 234-7775 Email: aecos@aecos.com

Introduction

In October 2011, *AECOS,* Inc. biologists conducted water quality and marine surveys to assess the marine resources on the limestone bench and reef flat fronting a drainage outfall at 150 Hanapepe Loop, Portlock, O‘ahu. (Fig. 1). The storm drain line collects street runoff from Hanapepe Loop and the surrounding urbanized area and terminates at the drain outfall into Maunalua Bay. The reconstruction of Hanapepe Loop drainage outfall (the Project) proposed by the County and County of Honolulu includes replacement of the concrete drainage outfall and headwall structures along the shoreline. This involves removal and reconstruction of the existing concrete headwall structure (21 linear ft) with cast-in-place concrete and removal and replacement of a portion (7 linear ft) of the existing drain outlet. All in-water work will be done with hand equipment. A water-inflated dam will be used as a cofferdam to isolate the work area from the marine environment. Any water pumped from the construction site (and water from the dam itself) will be pumped to a Geotube™ mobile dewatering system, located on Hanapepe loop within a 30 cu.yd roll-off container. The purpose of this survey and report is to identify sensitive biological resources that may be impacted by the Project.

[1] Report prepared for Bill’s Engineering for use in project permitting. This document will become part of the public record for the project.

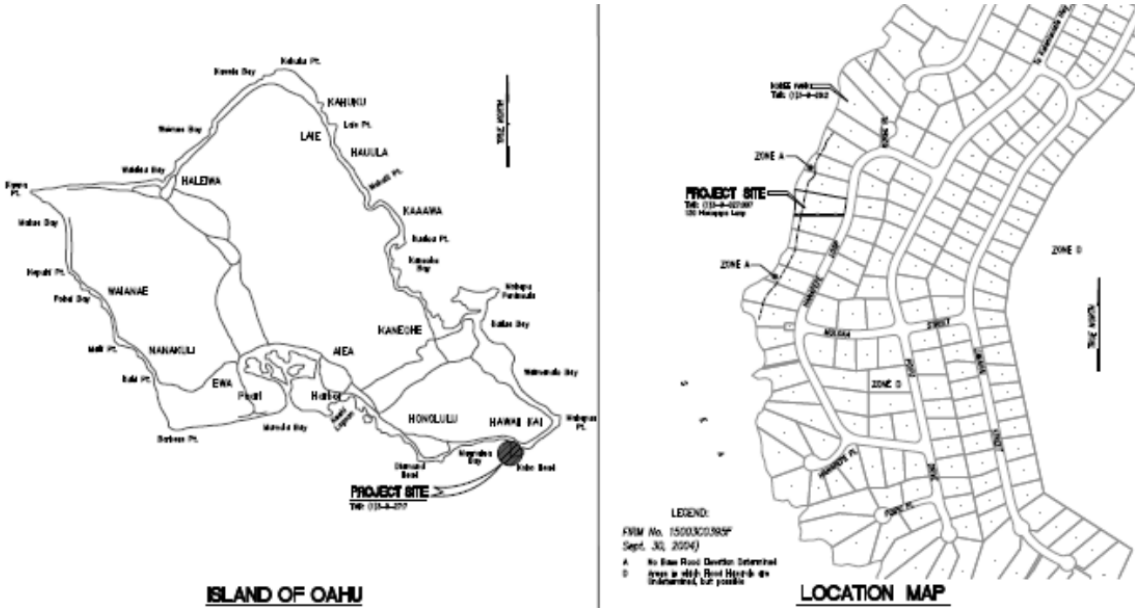

Figure 1. Project location on the Island of O‘ahu.

Site Description

The Project is located along the shoreline adjacent to a residential lot at 150 Hanapepe Loop, in Portlock on the southern shore of O‘ahu. The shoreline in the project vicinity faces nearly due west into Maunalua Bay. To the east is Koko Head, and to the north is Maunalua Bay Launch Ramp facility. A coastal access pathway near Kawaihoa Point provides public access to the western shoreline of Koko Head. People frequent the small beach just north of the project site (Koke`e Beach Park); surf at breaks “Pillars” or “China wall;” spearfish around Portlock Point; and fish from the breakwater, footbridge, and marine bench in Maunalua Bay Launch Ramp facility.

Fronting the drainage outfall is a wide (approximately 40 ft) intertidal limestone bench with depressions that are periodically filled with seawater (tidepools; Fig. 2). Other portions of the limestone bench remain inundated throughout the tidal cycle. A fringing reef extends about 915 m (3,000 ft) offshore and is primarily made up of an ancient limestone platform covered by algae and having very little coral cover, a characteristic typical of shallow reef areas off the south coast of O‘ahu.

Figure 2. Drainage outfall and headwall fronted by limestone bench and water filled depressions at Project site.

Methods

Marine Biota

On October 11, 2011, *AECOS* biologists conducted a biological reconnaissance survey of marine resources at the Project vicinity. Biologists walked along the intertidal limestone bench during an ebbing tide. The survey began at 9:30 am, 41 minutes before the 0.4-ft low tide (higher low water or HLW). Biologists snorkeled the waters offshore from the Project area, approximately 21 m (70 ft) from the shoreline. Water visibility during the survey was about 2 m (6 ft) on the reef flat. Marine algae, fishes, and macroinvertebrates were identified in the field and verified with various texts (Hoover, 1999; Huisman, et al. 2007). A listing, including relative abundances, of species of macroalgae (*limu*) and marine animals observed in both areas is presented as Appendix A.

Water Quality

To characterize the water quality around the drainage outfall and headwall, and to contribute to establishing baseline water quality conditions for the Project area, three sampling stations were established (Fig. 3). Station "Impact" is located in the water-filled limestone depression in front of the drainage outfall. Sta. "South" is located off the shoreline at the edge of the limestone bench, approximately 15 m (50 ft) south of the drainage outfall. Sta. "North" is located off the shoreline at the edge of the limestone bench, approximately 30 m (90 ft) north of the outfall.

Figure 3. Hanapepe Loop Drainage Outfall Improvement Project water quality sampling stations.

Field measurements for temperature, salinity, pH, and dissolved oxygen (DO) were taken *in situ* at each monitoring station. Water samples were collected from just below the surface at each station in appropriate containers, preserved on ice, and taken to *AECOS* laboratory in Kāneʻohe, Oʻahu. Collected samples were analyzed for turbidity, total suspended solids (TSS), nitrate+nitrite, ammonia, total nitrogen, total phosphorus, and chlorophyll α. Table 1 lists the field instruments and analytical methods used to evaluate these samples.

Table 1. Analytical methods and instruments used for the October 11, 2011 water quality analyses to characterize nearshore waters off Hanapepe Loop drainage outfall, Maunalua Bay, O'ahu.

Analysis	Method	Reference	Instrument
Temperature	EPA 170.1	USEPA (1983)	YSI Model 85 DO meter
Salinity	bench salinometer	Grasshoff et al. (1999)	AGE Model 2100 salinometer
pH	EPA 150.1	USEPA (1983)	Hannah pocket pH meter
Dissolved Oxygen	EPA 360.1	USEPA (1983)	YSI Model 85 DO meter
Turbidity	EPA 180.1, Rev. 2.0	USEPA (1993)	Hach 2100N Turbidimeter
Total Suspended Solids	SM 2540D	SM (1998)	Mettler H31 balance
Nitrate+Nitrite nitrogen	EPA 353.2 Rev. 2.0	USEPA (1993)	Technicon AutoAnalyzer II
Ammonia nitrogen	SM 4500-NH3 B/C	Grasshoff et al. (1999)	Technicon AutoAnalyzer II
Total Nitrogen	persulfate digestion EPA 353.2	Grasshoff et al. (1999)	Technicon AutoAnalyzer II
Total Phosphorus	EPA 365.1 Rev. 2.0	USEPA (1993)	Technicon AutoAnalyzer II
Chlorophyll α	SM 10200 H	SM (1998)	Turner Model 112 fluorometer

Results

Water Quality

Water quality results are summarized in Table 2. Values for temperature, dissolved oxygen (DO), and salinity at Sta. Impact were elevated compared to the stations North and South. The water was supersaturated (saturation greater than 100%) with oxygen at all three stations. Salinity measured at Sta. Impact is indicative of some freshwater input, which is also reflected in the low pH. Chlorophyll α, a direct indicator of phytoplankton biomass, was slightly elevated at all three stations, as were turbidity and total suspended solids (TSS). Ammonia (a dissolved form of inorganic nitrogen) was elevated at Sta. Impact and North, and nitrate-nitrite (another dissolved inorganic nitrogen moiety) was very high at Sta. Impact. Total nitrogen (TN), which includes inorganic, organic, and particulate nitrogen moieties, was high, especially at Sta. South. Total phosphorus (TP) was low at all three stations.

Table 2. Water quality characteristics of nearshore waters off Hanapepe Loop, Maunalua Bay, O'ahu as determined at LHW on October 11, 2011.

	Time sampled	Temp. (°C)	Salinity (ppt)	DO (mg/l)	DO sat. (%)	pH	
Impact	11:09	27.4	28.9	9.61	143	7.99	
North	11:20	26.4	33.4	7.43	112	8.37	
South	11:15	26.0	33.4	6.93	104	8.30	
	Turbidity (ntu)	TSS (mg/l)	Ammonia (µg N/l)	Nitrate + nitrite (µg N/l)	Total N (µg N/l)	Total P (µg P/l)	Chl α (µg/l)
Impact	0.95	10	34	334	596	16	0.67
North	1.34	13	35	10	228	5	0.54
South	1.12	15	14	14	896	<4	0.67

Marine Biology

Drainage outfall and headwall - The drainage outfall is sparsely covered with small numbers of barnacles (*Chthamalus proteus*). No other life was observed on the drainage outfall structure. The headwall structure was void of any growths. The limestone platform adjacent to the outfall and the water-filled depression directly in front of the outfall and headwall does not host any macroalgae or marine animals (see Fig. 2, above).

Limestone bench - The area of limestone bench closest to the drainage outfall and headwall is submerged only at high tide, and therefore hosts organisms adapted to conditions of the upper interidal. Most notable in this area are false *'opihi* (*Siphonaria normalis* or *'opihi 'awa*) and littoral snails (dotted periwinkle; *Littoraria pintado*). Small numbers of nerite snails (*Nerita picea* and *N. polita*) and *a'ama* crab (*Grapsus tenuicrustatus*) occur in the intertidal zone.

At the mid-littoral zone, depressions in the limestone bench are regularly exposed and submerged by tides. The water-filled depressions host a diverse assemblage of organisms including: goby (*Bathygobius* sp.), marbled blenny (*Entomacrodus marmoratus*), snakehead cowry (*Cypraea caputserpentis*), rock-boring urchin (*Echinometra mathaei* and *E. oblonga*), ashy sea cucumber (*Holothuria cinerascens*), zooanthids (*Zoanthus* sp.), and coralline algae nodules (Fig 4), One small black-lipped pearl oyster (*Pinctada margaritifera*) was

observed. The pearl oyster is protected throughout the State of Hawai'i and it is prohibited to "catch, take, kill, possess, remove, sell or offer for sale" a state protected species (HAR §13-83-1).

Figure 4. The mid intertidal zone of the Project vicinity, with a view of the south extent of limestone bench and water-filled depressions.

A few small (<5 cm diameter) coral heads or fragments (*Porites* spp. and *Pocillopora* spp.) are present in the tide pools; these likely cast up during high sea conditions from parent colonies on the adjacent reef flat. Algae found in the tide pools include: *Caulerpa taxifola*, *Cladophora catenata*, *Halimeda discoidea*, *Microdictyon setchellianum*, *Actinotrichia fragilis*, *Chamipa parvula*, *Galaxaura rugosa, Gelidiella acerosa*, *Laurencia mcdermidiae*, *Peyssonnelia rubra*, *Dictyota sandvicensis*, *Dictyoperis* sp., *Padina sanctae-crucis*, *P. australis*, *Sargassum echinocarpum*, *S. polyphyllum*, *Turbinaria ornata,* and *Lyngba majuscule,* with *Padina* spp. and *Sargassum* spp. being the most abundant. At the edge of the limestone bench, waves crest and with a rising tide, allow seawater to flood the

shoreline. Indicative of the lower littoral zone, algae is abundant, specifically the brown algal species, *Sargassum polyphyllum* and *S. echinocarpum* (Fig 5).

Figure 5. Lower littoral zone of limestone bench, where the brown algae, *Sargassum echinocarpum* and *S. polyphyllum*, are abundant.

Reef Flat - The reef flat offshore of the limestone bench has roughly 1.5 to 2.5 m (5 to 7 ft) of water depth with a slightly undulating limestone bottom and widely scattered coral outcrops (Fig. 6). The limestone bottom is covered with fine sediment, low-growing, turfy algae, and is deeply scoured by boring urchins (*E. mathaei* and *E. oblonga*), which are the most commonly seen macro-invertebrate on the reef flat. Other invertebrates are uncommon and include purse shells (*Isognomon californicum* and *I. perna*) and sea cucumbers (*Actinopyga mauritiana*, *Holothuria atra*, and *H. cinerascens*).

Common algae species observed in the area include *Jania micrarthrodia*. *Lithophyllum kotschayanum, Galaxura rugosa, Padina australis,* and *Halimeda*

discoidea. Other species less commonly seen include *Caulerpa serrulata*, *C. sertularioides*, *Microdictyon setchellianum*, *Coelothrix irregularis, Dichotomeria marginata, Ganonema papenfussil, Peyssonnelia rubra, Portieria hornemannii, Tricleocarpa cylindrica, Padina sanctae-crucis, Dictyota* spp., *Neomeris* sp. and the invasive species, *Acanthophora spicifera*, is rarely seen.

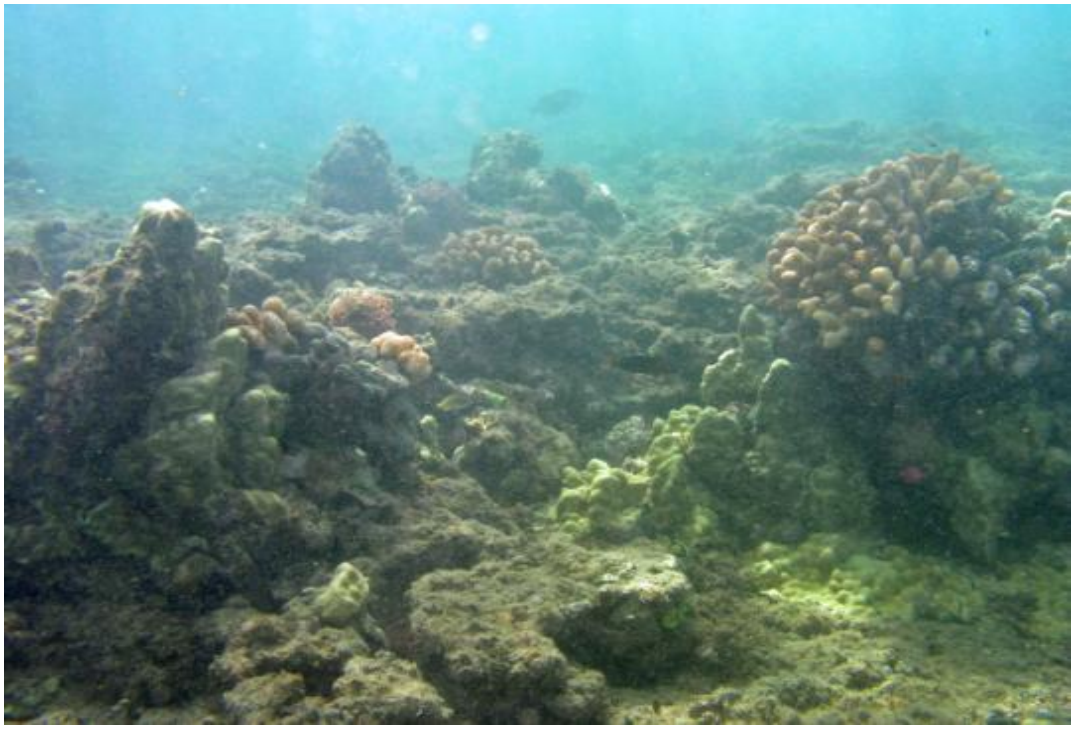

Figure 6. Scattered coral outcrops and scoured limestone of the reef flat area offshore from the Project vicinity.

In the Project vicinity, corals are represented by at least 11 species. The most common coral genus is *Porites* with three species represented: *P. lobata* (lobe coral), *P. lutea* (mound coral), and *P. evermanni* (brown lobe coral). Next most common is *Pocillopora*, with two species: *Poc. ligulata* (thin cauliflower coral) and *Poc. meandrina* (cauliflower coral). Also present are *Montipora capitata* (rice coral), *Montipora patula* (sandpaper rice coral), *Cyphastrea ocellina* (ocellated coral), *Leptastrea purpurea* (crust coral), and *L. bewickensis* (bewick coral) all in low numbers and having low cover.

In the area directly seaward of the shoreline to approximately 12 m (40 ft) offshore, corals are generally small, ranging in size between 5 to 25 cm in

diameter. The diameter of one *L. bewickensis* colony was measured at 40 cm and a few *Pocillopora* colonies of diameter 30 cm were encountered. Remnant coral growth is evident by several large, partially dead, mound-forming *Porites* colonies. In an area approximately 18 m (60 ft) offshore from the front of the bench, several large (>100 cm) *Porites* colonies are present. Most of these colonies appear quite healthy, with minimal mortality or damage.

Figure 7. Common fish species observed on reef flat offshore Project vicinity include convict tang (*A. triostegus*) and saddle wrasse (*T. duperrey*).

Thirty species of fishes were identified in the survey area (see Appendix A) The most common fishes on the reef flat are wrasses (Family Labridae), with numerous juvenile saddle wrasse (*Thalassoma duperrey*) and belted wrasse (*Stethojoulis balteata*) present. Various damselfish, including the brighteye damsel (*Plectroglyphidodon imparipennis*), Hawaiian sergeant (*Abudefduf abdominalis*), and Hawaiian Gregory (*Stegastes marginatus*) are also present. Small schools mullet (*Mugil cephalus*) are seen over the shallow reef flat. Convict tang (*Acanthurus triostegus*) and brown surgeonfish (*A. nigrofuscus*) feed on the sparse algae present (Fig. 7, above). Uncommonly seen species include palenose parrotfish (*Scarus psittacus*), square-spot goatfish

(*Mulloidichthys flavolineatus*), and spotted boxfish (*Ostracion meleagris*). Reef triggerfish (*Rhinecanthus rectangulus*), Hawaiian whitespotted toby (*Canthigaster* jactator), Ambon toby (*Canthigaster amboinensis*), Raccoon butterflyfish (*Chaetodon lunula*), Hawaiian lizardfish (*Synodus ulae*), manybar goatfish (*Parupeneus multifasciatus*), bluespine unicornfish (*Naso unicornis*), ringtail surgeonfish (*A. blochii*), orangeband surgeonfish (*A. olivaceus*), and barred moray (*Echnidna polyzona*) are all rare fishes in the survey area.

Discussion

Water Quality

Water quality samples collected on October 11, 2011 represent low tide conditions on that date and results could vary depending upon tidal stage. Much of the environment immediately seaward of the Project site is intertidal. The upper tidal areas of the limestone bench is dry at low tide and nearly completely inundated at high tide, while the low intertidal area remains flooded throughout the tidal cycle. Waves crest over the limestone bench with the rising tide allowing seawater to flood the area.

The waters of Maunalua Bay between Paikō Peninsula and Koko Head are classified in the Hawai‘i Water Quality Standards (HDOH, 2009) as a Class A “embayment” and as a “Class II nearshore reef flat.” Maunalua Bay is listed on the Hawai‘i Department of Health (HDOH), 2006 list of impaired waters in Hawai‘i, prepared under Clean Water Act §303(d) (HDOH, 2008). This listing is based upon water quality data collected by HDOH in Maunalua Bay (Geocode ID HIW00016) and indicates Maunalua Bay may not meet Hawai‘i water quality standards for total nitrogen (TN), nitrate-nitrite (NO_2+NO_3), ammonia (NH_4), and chlorophyll α in the wet season (presumably meaning not meeting the wet criteria, applicable when freshwater inflow equals or exceeds 1% of the embayment volume per day).

The primary purpose of water quality measurements presented in this report is to characterize the existing aquatic environment, not to set baseline values or determine compliance with Hawaii’s water quality standards. In fact, state criteria for all nutrient measurements, turbidity, and chlorophyll α are based upon having a representative geometric mean value to compare with the standard; a minimum of three separate samples per sampling location would be required to generate this mean. Ideally, multiple samplings would encompass a range of conditions “typical” for this location, including but not limited to such events as rising, versus ebbing tide, wet versus dry weather periods, and even storm events. The criteria presented in Table 3 may be used, together with a

data collected from a series of preconstruction sampling events, to develop decision rules as part of the data quality objectives (DQO) process in an applicable monitoring and assessment program (AMAP) developed in accordance with the required Clean Water Act, Section 401, Water Quality Certification (*AECOS*, 2011).

Table 3. Selected State of Hawai'i water quality criteria for embayments (HAR §11-54-5.2; HDOH, 2009).

Parameter	Geometric mean not to exceed given value	Value not to be exceeded more than 10% of the time	Value not to be exceeded more than 2% of the time
Turbidity (NTU)	1.5*	3.00*	5.00*
	0.40**	1.00**	1.50**
Total Nitrogen (µgN/L)	200.00*	350.00*	500.00*
	150.00**	250.00**	350.00**
Nitrate- Nitrite (µgN/L)	8.00*	20.00*	35.00*
	5.00**	14.00**	25.00**
Ammonia (µgN/L)	6.00*	13.00*	20.00*
	3.50**	8.50**	15.00**
Total Phosphorus (µgP/L)	25.00*	50.00*	75.00*
	20.00**	40.00**	60.00**

* Wet criteria apply when the average fresh water inflow from the land equals or exceeds one percent of the embayment volume per day.

** Dry criteria apply when the average fresh water inflow from the land is less than one percent of the embayment volume per day.

The following non-specific criteria are applicable to both "wet" and "dry" conditions.

- pH shall not deviate more than 0.5 units from 8.1, except at coastal locations where and when freshwater may depress the pH to a minimum of 7.0.
- Dissolved oxygen shall not be less than 75% saturation.
- Temperature shall not vary more than 1 °C from ambient.
- Salinity shall not vary more than 10 percent from natural or seasonal changes.

Water quality at the Project site is influenced by stormwater runoff and freshwater input. Project plans to use a water-inflated dam will isolate the work area which will help to ensure that water quality of the adjacent reef flat is

protected from sedimentation and project-related runoff. Any brief periods of impaired water quality associated with construction should have minimal impacts on the nearby reef flat as daily water exchange is high in this area.

ESA Listed Species

No listed (endangered or threatened; USFWS, 2009) species were encountered in the October 2011 surveys. Sea turtles, spinner dolphins, and humpback whales were not observed during the survey; however, they may occur in the Project vicinity (although well off the shore).

Green Sea Turtle — The most common sea turtle in the Hawaiian Islands is the *honu* or green sea turtle (*Chelonia mydas*), an inhabitant of the shallow waters of Maunalua Bay. In 1978, green sea turtle in Hawaiian waters became listed as threatened under the Endangered Species Act (USFWS, 1978, 2001). The National Marine Fisheries Service and Fish and Wildlife Service (NMFS-FWS, 1998) developed a recovery plan for U.S. Pacific populations of the green sea turtle, a document that aids management decisions to protect the population towards recovery.

Threats to green sea turtles in Hawai‘i, in order of greatest to least, include: disease and parasites, accidental fishing take, and boat collisions. Lessor threats include: entanglement in marine debris, loss of foraging habitat to development, and ingestion of marine debris (NMFS-USFWS, 1998). Turbidity (murky water) does not appear to deter green sea turtles from foraging and resting areas. Construction projects on the south shore of O‘ahu, at Hawaii Kai and off of Kapolei, have found sea turtles adaptable and tolerant of construction-related disturbances (Brock, 1998a,b).

Traditionally, sea turtles rest in deeper water during the day where they use reef features to shelter themselves (Smith, 1999) and feed over the shallow reef flats at night (Balazs et al., 1987). Before acquiring a status of threatened in Hawaiian waters, green sea turtles would flee upon encountering human swimmers. In recent years, however, green sea turtles here have become exceedingly tolerant of human presence and now regularly come to shallows to feed during the day as well as night (Balazs, 1996).

The green sea turtle diet consists primarily of benthic macroalgae, which the shallow reefs of the main Hawaiian Islands provide in abundance. Red macroalgae make up 78% of the turtle diet and green macroalgae make up 12% (Arthur and Balazs, 2008). The single most consumed algal species is *Acanthophora spicifera*, which is an introduced species first recorded in Hawai‘i in 1950 (Huisman et al., 2007). *A. spicifera* was observed in the Project vicinity,

but in very small amounts and not likely to be of significance for the green sea turtle.

Humpback Whale — The humpback whale or *kohola* (*Megaptera novaeangliae*) was listed as endangered in 1970 under the Endangered Species Act. Prior to protection, the North Pacific humpback whale population was estimated at under 1,000 individuals, compared with an estimated original abundance of at least 15,000 (Rice, 1978; Johnson and Wolman, 1984). In 1993 it was estimated that there were 6,000 whales in the North Pacific Ocean, and that 4,000 of those regularly came to Hawai'i. The population is estimated to be growing at between 4% and 7% per year. Today, as many as 10,000 humpback whales may visit Hawai'i each year (HIHWNMS, 2008).

The waters of Maunalua Bay are within the Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS). Humpback whales normally occur in Hawaiian waters annually from November to May with the peak between January and March (HIHWNMS, 2008). The Project will not directly affect humpback whales, and sounds generated from Project activities are not anticipated to be substantial enough to cause an acoustic disturbance to protected species in nearshore waters. The following in-water acoustic impact thresholds are currently used by NMFS to assess potential impacts to marine mammals (NOAA, 2005; Don Hubner, Pers. Comm., 2011): Onset of Injury (also known as the Permanent Threshold Shift) is 180 dB for cetaceans (whales, porpoises) and 190 dB for pinnipeds (seals). The Onset of Behavioral Disturbance (also known as the Temporary Threshold Shift/Areal Avoidance) is 160 dB when an impulsive sound and 120 dB when a continuous, non-impulsive sound.

Conclusions

Minimal direct impacts from the Project can be anticipated for the intertidal limestone bench. No sensitive biological resources occur in the immediate Project area. Because all Project work will be done with hand equipment transported through the house lot and no heavy equipment will be placed on the intertidal bench, impacts to the few small corals and one pearl oyster present in the tide pools will be avoided. The adjacent reef flat is expected to be only indirectly impacted by the Project.

Potential exists for short term impacts from construction activities on the water quality of the nearshore environment. Possible impacts from construction include introducing sediment into the bay and increasing pH from concrete

pours. Brief periods of impaired water quality associated with construction should have no long term impacts on the intertidal limestone bench and nearby reef flat as daily water exchange is high in these areas. Impacts can be mitigated by employing best management practices (BMPs). A requirement of the Nationwide Permit is to follow the standard BMPs (USACE, 2011)

An Applicable Monitoring and Assessment Program (AMAP) for the Project has been prepared for this Project (*AECOS*, 2011). The AMAP describes the monitoring requirements and the data quality objectives to be met during water quality monitoring efforts for the Clean Water Act, Section 401 Water Quality Certification that must be obtained from the Hawai'i Department of Health for the Project. The intent of the AMAP is to conduct water quality sampling and analysis to monitor potential impacts caused by in-water work. The AMAP includes baseline (preconstruction), during-construction, and postconstruction monitoring. Data collected as part of the AMAP will be used to assess the adequacy of BMPs applied during construction and will facilitate assessing the impacts of the project on Maunalua Bay. If shown to be necessary by the monitoring data, BMPs will be modified during construction to protect water quality.

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Appendix A. Inventory of aquatic biota observed in the Hanapepe Loop Project area, Maunalua Bay, O'ahu, on October 11, 2011.

PHYLUM, CLASS, ORDER, FAMILY *Genus species*	Common name & *Hawaiian name*	Status	Abundance by location: Tidal bench	Abundance by location: Reef flat
	ALGAE			
CHLOROPHYTA	GREEN ALGAE			
Caulerpa serrulata		Ind.		R
Caulerpa sertularioides		Ind.	U	O
Caulerpa taxifolia		Ind.	U	
Cladophora catenata		Ind.	A	
Dictyosphaeria versluysii		Ind.	U	
Halimeda discoidea		Ind.	O	C
Microdictyon setchellianum		Ind.	C	O
Neomeris sp.		Ind.		U
Ulva fasciata	sea lettuce *pālahalaha*	Ind.	U	
RHODOPHYTA	RED ALGAE			
Acanthophora spicifera		Nat.	U	U
Actinotrichia fragilis		Ind.	C	
Amphiroa sp.		Ind.		R
Avrainvillea amadelpha		Nat.		R
Champia parvula		Ind.	U	
Coelothrix irregularis		Ind.		U
Dasya irridescens		Ind.		R
Dichotomeria marginata		Ind.		U
Galaxaura rugosa		Ind.	O	C
Ganonema papenfussil		Ind.	U	U
Gelidiella acerosa		Ind.	C	O
Hydrolithon onkodes		Ind.	U	U
Hydrolithon reinboldii		Ind.	U	U
Jania micrarthrodia		Ind.		C
Laurencia mcdermidiae		Ind.	U	
Liagora sp.		Ind.		U
Lithophyllum kotschayanum		Ind.	U	C
Peyssonnelia rubra		Ind.	C	O
Portieria hornemannii		Ind.		O
Tricleocarpa cylindrica		Ind.		O

PHYLUM, CLASS, ORDER, FAMILY *Genus species*	Common name & *Hawaiian name*	Status	Abundance by location Tidal bench	 Reef flat
OCHROPHYTA	BROWN ALGAE	.		
Colpomenia sinuosa		Ind.	R	R
Dictyota acutiloba	*alani*	Ind.	O	O
Dictyota sandvicensis	*alani*	End.	C	O
Dictyota ceylanica		Ind.		A
Dictyopteris sp.		Ind.	C	R
Hydroclathrus clathratus		Ind.	R	
Padina sanctae-crucis		Ind.	A	O
Padina australis		Ind.	A	C
Ralfsia expansa		Ind.	U	
Sargassum echinocarpum	*kala*	Ind.	A	
Sargassum polyphyllum	*kala*	Ind.	A	
Turbinaria ornata		Ind.	C	U
CYANOBACTERIA				
Lyngbya majuscule			U	
Symploca hydnoides		Ind.		U
CNIDARIA, ANTHOZOA, ZOANTHINARIA				
Palythoa caesia	blue-gray zoanthid	Ind.		O
Zoanthus sp.				O
CNIDARIA, ANTHOZOA, SCELRACTINIA				
POCILLOPORIDAE				
Pocillopora ligulata	thin cauliflower coral	Ind.		U
Pocillopora meandrina	cauliflower coral	Ind.		C
PORITIDAE				
Porites lobata	lobe coral, *pohaku puna*	Ind.		C
Porites lutea	mound coral	Ind.		O
Porites evermanni	brown lobe coral			C
Porites sp.			R	
ACROPORIDAE				
Montipora capitata	rice coral	Ind.		O
Montipora patula	sandpaper rice coral	Ind.		O
FAVIIDAE				
Cyphastrea ocellina	ocellated coral	Ind.		R
Leptastrea purpurea	crust coral	Ind.		R
Leptastrea bewickensis	bewick coral	Ind.		R

PHYLUM, CLASS, ORDER, FAMILY *Genus species*	Common name & *Hawaiian name*	Status	Abundance by location	
			Tidal bench	Reef flat
MOLLUSCA, GASTROPODA PATELLIDAE				
Siphonaria normalis	false ‘opihi *‘opihi-‘awa*	Nat.	O	
NERITIDAE				
Nerita picea	black nerite *pipipi*	Nat.	A	
Nerita polita	polished nerite *kūpe‘e*		C	
CYPRADIDAE				
Cyprae caputserpentis	snake-head cowry *leho kupa*	Ind.	C	U
Cyprea helvola				
THAIDADAE				
Morula uva	grape drupe	Ind.	R	
LITTORINIDAE				
Littoraria pintado	dotted periwinkle *pipipi kolea*	Ind.	A	
MOLLUSCA,BIVALVIA, PTERIIDAE				
Pinctada margaritifera	black-lipped pearl oyster	Ind.	R	
ISOGNOMONIDAE				
Isognomon californicum	black purse shell	Ind.		A
Isognomon perna	brown purse shell *nahawele*	Ind.		U
ARTHROPODA, CIRRIPEDIA, BALANIDAE				
Chthamalus proteus	Proteus’ rock barnacle	Ind.	O†	
ARTHROPODA, MALACOSTRACA, DECAPODA, DIOGENIDAE				
Calcinus laevimanus.	left-handed hermit crab	Ind.		C
GRAPSIDAE				
Grapsus tenuicrustatus	thin shelled rock crab;*‘a‘ama*	Ind.	R	
MAJIDAE				
Schizophroida hilensis	Hilo collector crab *pāpa‘limu*	Ind.		R

PHYLUM, CLASS, ORDER, FAMILY *Genus species*	Common name & *Hawaiian name*	Status	Abundance by location: Tidal bench	Abundance by location: Reef flat
ECHINODERMATA, ECHNOIDEA, ECHINOMETRIDAE	SEA URCHINS			
Echinometra mathaei	rock boring urchin *ʻina kea*	Ind.	A	A
Echinometra oblonga	oblong boring urchin; *ʻina*	Ind.	C	U
Heterocentrus mammillatus	red pencil urchin *hāʻukeʻukeʻulaʻula*	Ind.	R	
ECHINODERMATA, HOLOTHUROIDEA	SEA CUCUMBERS			
HOLOTHURIDAE		Ind.		
Actinopyga mauritiana	white-spotted sea cucumber *loli*	Ind.		U
Holothuria atra	black sea cucumber *loli okuhi kuhi*	Ind.		U
Holothuria cinerascens	ashy sea cucumber	Ind.	A	C
VERTEGRATA, ACTINOPTERYGII	BONY FISHES			
MURAENIDAE				
Echnidna polyzona	barred moray *puhi leihala*	Ind.		R
BLENNIIDAE				
Blenniella gibbifrons	bullethead blenny *pāoʻo*	Ind.	U	
Istiblennius zebra	Hawaiian zebra blenny	End.	C	
ACANTHURIDAE				
Acanthurus triostegus	convict tang *manini*	Ind.	U	A
Acanthurus nigrofuscus	brown surgeonfish *māʻiʻiʻi*	Ind.		C
Acanthurus blochii	ringtail surgeonfish *pualu*	Ind.		R
Acanthurus olivaceus	orangeband surgeonfish *naʻenaʻe*	Ind.		R
Naso unicornis	bluespine unicornfish *kala*	Ind.		U
MUGILIDAE				
Mugil cephalus	striped mullet *ʻamaʻama*	Ind.	C	C

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MULLIDAE				
Mulloidichthys flavolineatus	square-spot goatfish *weke'ā*	Ind.		U
Parupeneus multifasciatus	manybar goatfish *moano*	Ind.		R
POMACENTRIDAE				
Abudefduf abdominalis	Hawaiian sergeant *mamo*	End.		U
Abudefduf sordidus	black spot sergeant *kūpīpī*	Ind.	C	U
Abudefduf vaigensis	Indo-Pacific sergeant	Ind.		R
Plectroglyphidodon imparipennis	bright-eye damselfish	Ind.		O
LABRIDAE				
Thalassoma duperrey	saddle wrasse *hinalea lauwili*	End.		C
Thalassoma trilobatum	Christmas wrasse *'awela*	Ind.		C
Stethojulius balteata	belted wrasse *'omaka*	End.		C
ZANCLIDAE				
Zanclus cornutus	morrish idol *kihikihi*	Ind.		R
CLUPEIDAE				
Spratelloides delicatulus	delicate roundherring	Ind.		A
SYNODONTIDAE				
Synodus ulae	Hawaiian lizardfish *ulae*	Ind.		R
SCARIDAE				
Calotomus sp	parrotfish	--		O
Scarus psittacus	palenose parrotfish *uhu*	Ind.		U
CHAETODONIDAE				
Chaetodon lunula	raccoon butterflyfish *kikakapu*	Ind.		R
BALISTIDAE				
Rhinecanthus rectangulus	reef triggerfish, *humuhumu nukunuku ahupua'a*	Ind.		R

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KUHLIIDAE				
Kuhlia xenura	Hawaiian flagtail *āholehole*	End.		C
OSTRACIIDAE				
Ostracion meleagris	spotted boxfish: *moa*	End.		U
GOBIIDAE				
Bathygobius sp.	Tide pool goby	Ind.	C	
TETRAODONTIDAE				
Canthigaster jactator	Hawaiian whitespotted toby	End.		R
Canthigaster amboinensis	ambon toby	Ind.		R

KEY TO SYMBOLS USED:

Abundance categories:

R – Rare – only one or two individuals observed.
U – Uncommon – several to a dozen individuals observed.
O – Occasional – seen irregularly in small numbers
C – Common – observed everywhere, although generally not in large numbers.
A – Abundant – observed in large numbers and widely distributed.

Status categories:

End – Endemic – species found only in Hawaii
Ind. – Indigenous – species found in Hawaii and elsewhere
Nat. – Naturalized – species were introduced to Hawaii intentionally, or accidentally.

Other symbol used:

† located on drainage outfall